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**ACADEMIC DEVELOPMENT AND PERFORMANCE
ENHANCEMENT AMONG MINORITY STUDENTS ENROLLED
IN MATHEMATICS AND SCIENCE BASED CURRICULUM
PROGRAMS AT POST-SECONDARY INSTITUTIONS**

presented by

Charles H. Roberts

has been accepted towards fulfillment
of the requirements for

PH.D. degree in Higher Education

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**ACADEMIC DEVELOPMENT AND PERFORMANCE ENHANCEMENT
AMONG MINORITY STUDENTS ENROLLED IN MATHEMATICS AND SCIENCE
BASED CURRICULUM PROGRAMS AT POST-SECONDARY INSTITUTIONS**

By

Charles H. Roberts

A DISSERTATION

**Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of**

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ABSTRACT

ACADEMIC DEVELOPMENT AND PERFORMANCE ENHANCEMENT AMONG MINORITY STUDENTS ENROLLED IN MATHEMATICS AND SCIENCE BASED CURRICULUM PROGRAMS AT POST-SECONDARY INSTITUTIONS

By

Charles H. Roberts

The problem of this study was the continued underrepresentation of minorities in the study of science and mathematics at the post-secondary level, both as successful students in mathematics and science courses generally and as graduates in mathematics and science based curriculum majors. The minority groups of concern to this study are Black American, Hispanic American, and Native American. The continued underrepresentation of minorities in science and mathematics career fields was a secondary concern of this study.

The purpose of the study was to investigate and explore the experiential and motivational correlates of students' behavioral and academic performance for minority students who have participated in a developmental enrichment program in the natural sciences at Michigan State University. This program, the Charles Drew Science Enrichment Laboratory, enrolls students during their first year on campus and provides a comprehensive set of supportive and performance enhancing academic activities for them, including special sections of mathematics courses, a problem-solving seminar, and support measures in other disciplines such as chemistry.

The methods used for this study were; 1) an investigator developed survey questionnaire, 2) structured in-depth interviews with students from the research sample, and, 3) statistical analyses. The sample consisted of a random sample from among students who had been enrolled in the Drew Laboratory at some time during a four-year

period. Participants in the study were asked to complete a 19 item questionnaire and over half of them participated in the interviews. Students' academic records provided additional data which, along with the information from the questionnaire, was used for the statistical analyses. Information from all three sources of information was analyzed and interpreted in order to answer the research questions of the study.

Several conclusions emerged from this study. Among them were: 1) Minority students who intend to study mathematics and science must learn to carefully manage and control the use of their time and develop a sound set of study strategies early in their academic careers, 2) Students' expectations in the environment coupled with cultural differences often served to adversely affect their adaptation to the academic demands of the university, 3) Students' initial encounters, subsequent experiences with university staff personnel, and their initial academic performance were crucial factors in their subsequent success or failure, 4) Many students must experience a dynamic "transformation process" before they are able to perform up to their capabilities, 5) Intervention efforts can be profoundly supportive of students and contribute to substantially improved academic performance if they are designed and implemented according to certain criteria.

Dedicated To:

My Wife,

**Adah. whom I love dearly and who has
struggled with me in this project;**

My Sons,

**Reggie, Chris, and B.J., who have had
to accept my unavailability at times;**

Minority Students Everywhere,

Who continue to struggle against the odds.

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For the support that I've received over the years in my efforts, I would like to send out a note of gratitude to the following individuals: to Charles Thornton and Dr. Judith Krupka, the co-founders of the Drew Laboratory, thanks for your assistance with the development of the questionnaire, for the times that we've had together, and for creating such a wonderful program; to Rodney Barber, who also worked with me for many years, I thank you for being you; to Sharon Griffin, who currently works with, and puts up with, me in the Drew Mathematics Program, you've been great; to Rajesh Lal, who has worked with Sharon and me for the past four and a half years, and who represents the true spirit of

the Drew Laboratory; and, to Dorothy Reed, who is the Coordinator for the Drew Laboratory and whose patience with me has made a big difference.

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CHAPTER I

INTRODUCTION

Context of the Problem

It is clear that certain minority groups have historically not been well represented among students in the life and physical sciences at higher education institutions in this country. As with many other areas of endeavor, society seems to have often accepted this fact as either an unfortunate consequence of the past and present experiences of the minority group members or the result of various forms of "cognitive deficiencies" that members of these groups seem to possess. For whatever the reasons, the fact remains that certain minority groups are grossly underrepresented in the sciences, as well as in most technical areas of study.

During the decades of the 60's and 70's there were significant and often tremendous increases in the numbers and percentages of minority students attending higher education institutions in this country. For example, Astin (1982) found that from 1966 to 1980 the enrollment of first-time, full-time, black freshmen as a percentage of the total enrollment increased from 5.0% to 9.2% and that the enrollment of American Indians increased from 0.6% to 0.9% of the total. The other two minority groups listed, Chicanos and Puerto Ricans, also showed substantial increases (from 1.1% to 1.7% and from 0.2% to 0.9%, respectively) over the 10 year span from 1971-1980. As a matter of fact, some sources have reported figures that are even higher--e.g. The Office of Civil Rights reported black freshmen enrollment to be 12.0% of the total in 1976 and Chicano enrollment to be 3.2% (Astin, 1976).

However, this significant increase in overall enrollment has not resulted in comparable enrollment trends in the sciences and most technical programs of study among

students from these minority groups. By gathering data from several sources, Astin has been able to document both the lower enrollment rates in the major fields of interest here

(in comparison to overall rates) among students from the underrepresented minority groups and the lower retention rates among these students. As can be seen in Table 1, of the five major fields listed, the enrollment rates (as a percentage of the total enrollment) for students from minority groups have been comparably low for all majors, except perhaps Allied Health, and the retention rates (as reflected in the percentages of degree recipients) were even lower--with one notable exception being medicine and dentistry among Chicanos.

Melnick & Hamilton (1981) have presented data which further documents the underrepresentation of black students among graduate and professional students in scientific fields. They summarized some of this data, which was also gathered from several sources, as follows:

...In spite of the significant gains in total black enrollment in higher education in the seventies black students still account for 5.4% of the total first professional degree enrollment and 6.0% of the total graduate enrollment. Graduate enrollment in the life and physical sciences is near 2%, in the health sciences 5%, and 1.4% in engineering. In 1976, black students comprised 6.8% of the total student population in 124 United States medical schools. (p.282)

Thus, the evidence clearly demonstrates that the minority groups included in this study are substantially underrepresented in virtually all science-related fields at both the graduate/professional and undergraduate levels in higher education. The retention rates for these minority groups in particular reflect a need for thorough and comprehensive investigations into the issues and concerns surrounding this situation. This study was designed to contribute to this process by identifying many of the factors which might significantly impact on minority students' academic development and performance enhancement in mathematics, the sciences, and related fields of study in higher education institutions and exploring some of the important issues involved.

Table 1. Distribution of Various Majors by Racial or Ethnic Group

	Entering Freshmen Fall 1971	Baccalaureate Recipients 1975-76	Master's Recipients 1978-79	Doctorate Recipients 1978-79
Allied Health		(N=53,498)	(N=12,022)	(N=496)
Whites	84.5	90.6	89.5	93.8
Blacks	10.8	5.1	5.3	3.1
Chicanos	2.1	1.4	1.4	0.3
Puerto Ricans	0.4	0.3	0.3	--
American Indians	0.2	0.3	0.4	0.3
Physical Sciences and Mathematics		(N=36,407)	(N=7,284)	(N=3,185)
Whites	90.4	92.0	92.3	92.2
Blacks	6.1	4.0	2.2	1.9
Chicanos	0.7	1.2	0.8	0.6
Puerto Ricans	0.2	0.3	0.2	0.6
American Indians	0.1	0.3	0.5	0.3
Biological Sciences		(N=53,797)	(N=6,415)	(N=3,205)
Whites	89.3	90.4	91.4	93.3
Blacks	6.9	4.3	3.4	1.5
Chicanos	0.8	1.7	1.1	0.6
Puerto Ricans	0.7	0.4	0.3	0.2
American Indians	0.3	0.3	0.2	0.2
Engineering		(N=42,688)	(N=11,417)	(N=1,635)
Whites	87.9	91.3	88.3	85.8
Blacks	6.0	3.2	2.2	1.5
Chicanos	2.5	1.7	1.1	0.8
Puerto Ricans	0.7	0.4	0.3	0.2
American Indians	0.4	0.4	0.2	0.1
	Entering Freshmen 1971	Professional Enrollments Fall 1976	Professional Degree Recipients 1975-76	
Medicine, Dentistry, and Veterinary Medicine		(N=83,601)	(N=21,978)	
Whites	88.1	89.2	89.8	
Blacks	6.7	5.3	4.5	
Chicanos	1.0	1.7	1.7	
Puerto Ricans	0.7	0.4	0.4	
American Indians	0.3	0.5	0.3	

Note: From Minorities in American Higher Education (pp. 64-65) by A.W. Astin, 1982, San Francisco: Jossey-Bass.

Statement of the Problem

Experience has shown and data from various sources document the fact that minority students often enter the university with less than desirable academic preparation for the demands that will be placed upon them. The fact that a majority of all entering freshmen are deficient in the necessary academic skills (Blanc, DeBuhr, & Martin, 1983) suggests that this situation is not surprising. The implication for students who enter the university with the intention of pursuing a program of study in the sciences is that unless direct measures are taken to address this concern within the academic structure, the prospects for success for many students will be slim. However, as McDermott, Piternick, & Rosenquist (1980a) have pointed out, usually little or no allowance is made for the kind of academic handicaps (as identified by the authors) possessed by minority (and other) students in the mainstream science courses.

In recent years some institutions have implemented academic support programs which incorporate a concern for the development of the needed academic skills among enrolled students into the structure and processes of the curriculum. At Michigan State University one such program is the Charles Drew Science Enrichment Laboratory. This program integrates special sections of pre-calculus mathematics courses, special sections of Chemistry review sections, a problem solving seminar, advice/counseling, tutorials, independent study projects, career awareness, and other forms of student support services within one unit which is administratively housed in the Office of the Dean of the College of Natural Science.

Since the focus of the program is on the academic development of enrolled students during the early stages of their matriculation, the initial concern of staff members is with the adjustment of these students to the academic demands that will be placed on them at the institution. It has been observed that this adjustment process for students who plan to study mathematics and science at the university is especially difficult due to the nature of these disciplines and the immediate confrontation with the need for well developed academic

skills in their course work. Consequently, while many students have been assisted in making this adjustment, there remains a need to conduct an in-depth investigation into the experiences, behaviors, and perceptions of students to document correlates of achievement and uncover those significant (and often hidden) factors which might impact on students' performance outcomes.

The Status of Minorities in Science and Mathematics

Professional Status

Although it is difficult to obtain very accurate figures on the representation of ethnic minorities among the various scientific and technical professions, several estimates have been made which do document the severe under representation of minorities in these professions. Wilburn (1974) estimated that less than 2% of the scientific and technical personnel in this country was drawn from the overall population of blacks, Chicanos, Native Americans and Puerto Ricans by 1971 even though these groups together reportedly comprised about 16% of the population at the time. He also estimated the total number of black scientists and engineers to be about 12,000, a figure which represented less than 1% of the total workforce in these fields in the U.S. Furthermore, Wilburn stated that these 12,000 black scientists and engineers represented only about 1.6% of the total number of black professional and technical workers. And since 16% of all professional and technical workers were scientists and engineers at the time (according to Wilburn), these figures clearly indicate a traditional preference among aspiring black professionals for professions other than those in science and engineering.

Based on data presented by Astin (1982), the representation of at least two minority groups (blacks and American Indians) among employed scientists and engineers at the doctorate level has improved very little--figures for Chicanos and Puerto Ricans were not reported. Astin estimated the representation of blacks and American Indians among

employed doctorate-level scientists and engineers to be only 1.12% and 0.29% respectively as late as 1979. Melnick and Hamilton (1981) reported that only 1.6% of the 87,000 scientists and engineers in 1974 were black and that less than 0.9% of the doctoral scientists and engineers were black. Among practicing physicians they reported a mere 1.8% black representation, in addition to less than 2% black representation among dentists. Hence, according to these figures, the increase in doctorate-level scientists among blacks was a mere 0.29 percentage points between 1974 and 1979 and the percentage of blacks among the total workforce in these fields continued to remain very low through 1974 as compared to 1971.

Data presented by Mingle (1987) reveals that little real progress was made by underrepresented minorities in the scientific professions during the intervening years between the two surveys. For example, from Table 2 it is evident that, for the most part, the representation of blacks and Hispanics, both in the workplace and as bachelor's degree recipients, was between 2% and 3% for most fields, and that doctorate level professionals among blacks remained extremely low--about 1.5% in the biological sciences and less than 1% in computer science. A further presentation of black and Hispanic representation according to more specific professional categories and among more diverse professions, as given in Table 3, reveals that their proportions among the technical and medical professions listed remain well below their overall representations in the general population.

Educational Status

As was stated earlier, Melnick & Hamilton have documented the under representation of black students among graduate and professional students in scientific fields. Thomas, Mingle, & McPartland (1981) shed further light on the situation by presenting the percentage of degrees received by black students in various fields at the Bachelors, Masters, Doctorate and First Professional levels during academic year 1976-77. By using two tables of percentage distributions that they provide and separating out the

Table 2. Minority Representation in the Scientific Professions: 1985-1987.

1. Biological Sciences

Blacks

- 2.7% to 3% of work force and 1.5% of doctorate level employees

2. Chemistry

Blacks

- About 2.7% of bachelor's degree recipients

3. Mathematics and Computer Science

Blacks

- Less than 5% of Mathematicians at all levels. About 5% of bachelor's degrees in Computer Science and less than 1% of Ph.D.'s

Hispanics

- About 3% of Computer Science bachelor's degrees

4. Physics

Blacks and Hispanics (combined)

- 3% of employed physicists (Asians, 9%)

5. Engineering

Blacks

- 3% annual degrees awarded

Blacks, Hispanics, and American Indians (combined)

- About 5% of bachelor's degrees awarded each year

6. Health/Medical Sciences

Blacks and Hispanics

- 1% of health/medical sciences work force

7. Agricultural Sciences

Black and Hispanics

- 2% of work force

8. Social and Behavior Sciences

Black Economists

- 3% of work force

Hispanic Economists

- 2% of work force

Note: From Focus on Minorities: Trends in Higher Education Participation and Success (p. 29) by J.R. Mingle, 1987, Denver: Education Commission of the States and State Higher Education Executive Officers.

Table 3. Employment in Selected Fields by Race and Occupation in 1985

Field	Black	Hispanic
Accountant	5.9%	4.2%
Computer Programmers	6.4	2.5
Dentists	2.6	2.6
Engineering Technicians	6.4	4.9
Engineers	2.6	2.6
Medicine/Health Managers	8.1	4.6
Physicians	3.7	3.9
Registered Nurses	6.8	2.1

Note: From Focus on Minorities: Trends in Higher Education Participation and Success (p. 28) by J.R. Mingle, 1987, Denver: Education Commission of the States and State Higher Education Executive Officers.

science and technical fields it is possible to clearly document the levels at which black students have received degrees in these fields of study--see Table 4. In addition, Astin (1982) has gathered data from several sources to provide similar data for the various ethnic groups of interest here as presented in Table 5. Furthermore, since his data is longitudinal, the difference between relative enrollments and relative reception of degrees among the population of interest to this study is evident as well. Table 3 also documents the relative popularity of various programs of study among the ethnic groups upon entry into post-secondary institutions.

Astin also presented data on major field preferences and entering test scores of students during their senior year in high school which provide further evidence of the problems of both enrollment and retention of minority students in the sciences--see Tables 6 and 7. The data in Table 6 shows that students from three minority groups (blacks, Chicanos, and American Indians) selected physical sciences/ mathematics and engineering as their major field preference at a rate substantially lower than that of white students, while all four minority groups selected allied health fields at a rate comparable to that of white students. Only black students selected biological sciences at a substantially lower rate than white students while the rates for Chicanos and Puerto Ricans were similar to that of whites and the rate for American Indians was slightly lower.

Table 4. Bachelor's, Master's, Doctorate, and First Professional Degrees Awarded to Black Students by Field and Percent of Total Degrees, 1976-77.

Field	Bachelor's		Master's		Doctorate	
	Total	%	Total	%	Total	%
Agriculture	309	1.4	51	1.4	11	1.2
Architecture	303	3.3	162	5.0	8	11.0
Biological Sciences	2415	4.5	206	2.9	52	1.5
Computer and Information Sciences	361	5.6	67	2.4	1	.5
Engineering	1385	2.8	240	1.5	23	.9
Health Professions	3136	5.4	637	5.0	14	2.6
Mathematics	712	5.0	133	3.6	10	1.2
Physical Science	692	3.1	94	1.8	45	1.3
Totals	9313	4.38	1610	3.68	164	1.87

Field	First Professional Degree	
	Total	%
Dentistry	204	3.9
Medicine	710	5.2
Optometry	15	1.6
Osteopathic Medicine	7	0.8
Pharmacy	10	1.9
Podiatry	11	2.3
Veterinary Medicine	28	1.8
Totals	985	4.68

Field	Bachelor's		Master's		Doctorate	
	Total	%	Total	%	Total	%
Business and Management	10,001	6.5	1,625	3.5	13	1.5

*The figures for Business and Management are presented separately because only a certain proportion of the Bachelor's level degree programs in these fields rely on a broad mathematics and/or science foundation.

Note: From Recent Trends in Racial Enrollment, Segregation, and Degree Attainment in Higher Education (pp. 116-117 and 119-120) by G.E. Thomas, J.R. Mingle, & J.M. McPartland, 1981, In G.E. Thomas (Ed.), Black Students in Higher Education: Conditions and Experiences in the 1970's. Westport: Greenwood Press.

Table 5. Percentage of Each Racial or Ethnic Group Enrolled in Various Majors

Major	Entering Freshmen Fall 1971	Baccalaureate Recipients 1975-76	Master's Recipients 1978-79	Doctorate 1978-79	
<u>Allied Health</u>					
Whites	9.6	6.0	5.4	2.3	
Blacks	11.2	4.6	4.1	1.6	
Chicanos	9.2	4.8	5.2	0.9	
Puerto Ricans	6.2	4.8	5.2	0.9	
American Indians	9.6	4.7	5.9	1.9	
<u>Physical Sciences and Mathematics</u>					
Whites	5.1	4.1	2.7	11.2	
Blacks	3.3	2.4	0.8	4.8	
Chicanos	1.7	2.7	1.6	6.8	
Puerto Ricans	2.0	2.7	1.6	6.8	
American Indians	2.3	3.3	3.7	7.7	
	Entering Freshmen Fall 1971	Baccalaureate Recipients 1975-76	Graduate Enrollments Fall 1976	Master's Recipients 1978-79	Doctorate Recipients 1978-79
<u>Biological Sciences</u>					
Whites	3.5	6.0	4.0	2.4	11.4
Blacks	2.6	3.9	1.7	1.1	3.7
Chicanos	1.3	5.7	2.5	1.8	7.5
Puerto Ricans	4.2	5.7	2.5	1.8	7.5
Amer. Indians	4.5	4.1	3.0	1.6	5.8
<u>Engineering</u>					
Whites	7.1	4.8	4.4	4.0	5.4
Blacks	4.6	2.3	1.3	1.3	2.0
Chicanos	8.0	4.7	3.3	3.3	4.9
Puerto Ricans	8.1	4.7	3.3	3.3	4.9
Amer. Indians	11.0	4.3	2.7	2.4	1.9

Note: From Minorities in American Higher Education (pp. 64-65) by A.W. Astin, 1982, San Francisco: Jossey-Bass.

**Table 6. Major Field Preferences During the Senior Year in High School
by Racial or Ethnic Group for Academic Year 1974-75**

Proposed College Major Field	Rank in Composite SAT Among Whites	Percentage Preferring Field					Overrepresenting (+) or Underrepresentation (-) Relative to Whites				
		Whites	Blacks	Chicanos	Puerto Ricans	American Indians	Blacks	Chicanos	Puerto Ricans	American Indians	
Physical Sciences and Mathematics	1	6.8	3.5	6.0	6.7	5.8	-49-12	- 3	-15		
Engineering	2	11.3	6.9	9.3	13.3	9.5	-39-18	+18	-16		
Biological Sciences	3	11.1	8.6	12.1	12.8	10.9	-24+ 7	+13	- 4		
Social Sciences	4	14.9	19.1	19.7	9.5	12.7	+28	+32	+31	-15	
Allied Health Fields	5	13.7	14.6	13.9	5.3	14.9	+ 7+ 1	+12	+ 9		
Business	6	16.6	19.6	15.6	12.0	18.0	+18	- 6	-28	+ 8	
Arts and Humanities	7	15.0	13.3	11.3	10.6	12.5	-11-25	-29	-17		
Education	8	10.4	14.4	12.0	9.8	15.6	+38	+15	- 6	+50	

Note: From Minorities in American Higher Education (p. 72) by A.W. Astin, 1982, San Francisco: Jossey-Bass.

Table 7. College Admission Test Scores of High School Seniors by Racial or Ethnic Group and Anticipated College Major for Academic Year 1974-75

	Number of Students					Mean Composite SAT (Rank)				
	Whites	Blacks	Chicanos	Puerto Ricans	American Indians	Whites	Blacks	Chicanos	Puerto Ricans	American Indians
Physical Sciences and Mathematics	6,670	365	61	37	22	1,142 (1)	845 (2)	1,016 (2)	915 (2)	979 (1)
Engineering	11,160	706	95	73	36	1,109 (2)	848 (1)	1,018 (1)	918 (1)	969 (2)
Biological Sciences	11,150	888	123	70	41	1,066 (3)	807 (3)	921 (3)	897 (3)	855 (3)
Social Sciences	14,630	1,967	201	107	48	1,029 (4)	735 (4)	866 (4)	796 (7)	839 (5)
Allied Health Fields	13,440	1,499	142	84	56	958 (5)	710 (6)	846 (5)	800 (6)	868 (4)
Business	16,370	2,016	159	66	68	950 (6)	695 (7)	807 (7)	814 (5)	798 (7)
Arts and Humanities	14,770	1,369	115	58	47	930 (7)	732 (5)	845 (6)	831 (4)	808 (6)
Education	10,220	1,488	123	54	59	884 (8)	632 (8)	751 (8)	738 (8)	755 (8)
Total	98,410	10,2948	1,019	549	377					

Note: From Minorities in American Higher Education (P. 70) by A.W. Astin, 1982, San Francisco: Jossey-Bass.

Table 8. Field Selection of Minority Ph.D.'S. 1975 and 1985 by Percent.

	<u>Total U.S.</u>		<u>Asians</u>		<u>Blacks</u>		<u>Hispanics</u>	
	1975	1985	1975	1985	1975	1985	1975	1985
Physical Sciences	13.4	13.0	17.5	19.4	4.1	3.3	8.9	7.5
Engineering	6.3	5.4	21.3	17.5	1.1	2.1	5.0	2.9
Life Sciences	14.6	19.1	18.9	24.9	5.6	7.7	12.9	13.4
Social Sciences	19.0	19.5	12.6	12.0	15.3	19.1	18.5	21.6
Humanities	16.4	12.2	10.5	8.3	8.7	7.3	21.1	17.2
Education	25.4	25.0	13.6	13.4	61.0	52.3	30.4	32.2
Professional Fields	<u>4.9</u>	<u>5.8</u>	<u>5.6</u>	<u>4.5</u>	<u>4.2</u>	<u>8.1</u>	<u>3.3</u>	<u>5.2</u>
Total*	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: From Focus on Minorities: Trends in Higher Education Participation and Success (p. 28) by J.R. Mingle, 1987, Denver: Education Commission of the State and State Higher Education Executive officers.

As shown in Table 8, by 1985 blacks and Hispanics chose the physical sciences at even lower rates at the doctorate level as compared to 1975, and Hispanics chose engineering at a substantially lower rate, while blacks chose it about twice as often as they did in 1975. Among the life sciences both groups chose these fields more often in 1985 but the overall rates of selection remained well below those of the total population as well as those of Asian Americans among all three professional categories.

Data on college admission test scores, as presented in Table 9 provides at least partial evidence of the gap between minority group students and white students with respect to this important entering characteristic, and Table 10 shows differences in performance and tracking. Although there is considerable disagreement over the significance of using standardized test scores as an indication of students' potential for scholastic endeavors, they probably provide some evidence of the degree to which students are oriented to the structure, processes, and general culture of the traditional educational setting in this

Table 9. Average SAT Scores by Racial or Ethnic Groups, 1976-1984

<u>VERBAL</u>	1976	1977	1978	1979	1980	1981	1982	1983	1984
American Indian	388	390	387	386	390	391	388	388	390
Black	332	330	332	330	330	332	341	339	342
Mexican-Amer.	371	370	370	370	372	373	377	375	376
Puerto Rican	364	355	349	345	350	353	360	358	358
White	451	448	446	444	442	442	444	443	445
Other	<u>410</u>	<u>402</u>	<u>399</u>	<u>393</u>	<u>394</u>	<u>388</u>	<u>392</u>	<u>386</u>	<u>388</u>
All	431	429	399	393	394	388	392	386	388
<u>MATHEMATICS</u>									
	1976	1977	1978	1979	1980	1981	1982	1983	1984
American Indian	420	421	419	421	426	425	424	425	427
Black	354	357	354	358	360	362	366	369	373
Mexican-Amer.	410	408	402	410	413	415	416	417	420
Puerto Rican	401	397	388	388	394	3948	403	403	405
White	493	489	485	483	482	483	483	484	487
Other	<u>458</u>	<u>457</u>	<u>450</u>	<u>447</u>	<u>449</u>	<u>447</u>	<u>449</u>	<u>446</u>	<u>450</u>
All	472	470	468	467	466	466	467	468	471

Note: From Focus on Minorities: Trends in Higher Education Participation and Success (p. 6) by J.R. Mingle, 1987, Denver: Education Commission of the State and State Higher Education Executive Officers.

**Table 10. High School Performance and Curriculum Track of
1980 Seniors by Racial or Ethnic Groups**

	Grade- point Average	Educational Track (Percent)		
		Vocational	General	College
Black	2.6	24.5	23.8	51.2
Hispanic	2.6	28.6	34.1	37.3
White, Low SES	2.8	28.6	35.0	36.3
White, High SES	3.2	16.7	17.9	65.4

Note: From Focus on Minorities: Trends in Higher Education Participation and Success (p. 6) by J.R. Mingle, 1987, Denver: Education Commission of the State and State Higher Education Executive Officers.

country. This observation in turn leads to implications for the investigation of adjustment variables, and hence academic development, among students at the post-secondary level.

Contributing Factors

Data from the National Assessment of Educational Progress (NAEP) show that Blacks and Hispanics continued to score lower than the nation as a whole in mathematics through 1978 across all grade and cognitive levels, although there was a small decrease in the difference compared to that found from the 1973 assessment data. According to Anick, Carpenter, & Smith (1981), one of the possible contributing factors is the lower rate of enrollment in mathematics courses among these groups of students. They cite the fact that "Blacks appear to take about one year less of high school mathematics than their peers" . They also state that "This course participation data may help to explain why the difference between the achievement of blacks and the national average increases with age" (p. 564).

Thus these authors have identified one possible cause of the disparity between the performance of blacks and Hispanics and that of the general population. However, the results of their study also indicated that when course background was held constant, the gap in performance remained, though to a somewhat lesser extent. Consequently, it is necessary to probe further in order to determine the precise nature of the problem before

any conclusions can be drawn about its causes. In considering the affective domain, the results from this same assessment indicated that based on student responses, black students; 1) liked mathematics, 2) thought that it was important, 3) wanted to do well in mathematics, 4) were willing to work hard to do well, 5) wanted to take more mathematics, and 6) wanted to enter a career using mathematics (Anick,et.al., 1981). Hence, the initial indication from this assessment suggests that the expressed attitudes of black students toward mathematics is not the prime source of the problem of under achievement among these students.

Minority students' attitude toward science reveals a similar pattern to that found for mathematics, in that students generally were shown to have positive attitudes toward science, science-related fields of study, and scientific research (Kahle, 1982). However, as with mathematics, the achievement levels of minority students in science do not correspond to their (expressed) positive attitudes. Using results from the 1977 NAEP report Kahle was able to summarize minority student attitudes toward science and make some observations about these attitudes in comparison to performance and experiential outcomes. One paragraph of her article on this issue is particularly revealing. According to Kahle:

An examination of some of the attitudinal responses of black students indicates generally positive immediate attitudes, but more nebulous ones about the scope and use of science. For example, more blacks at age 17 found science seldom or never boring (27% of blacks compared with 17% of whites), found it always or often fun (30% of blacks compared with 26% of whites), and always or often liked to go to science classes (48% of blacks compared with 35% of whites). But these same black students had fewer science experiences, found science less useful out of school, and were less aware of scientific methods and of how scientists work. Furthermore, they were less confident in the ability of science to solve current or future problems (NAEP, 1978). Overall, black students appear to like science, but perhaps due to their limited exposure and experience, many do not understand its methodology, technology, or potential. (1982, pp. 541-42)

Thus, in addition to clarifying the nature of minority student attitudes toward science, Kahle has indicated a number of potential factors which might contribute to the lower

achievement of minority students in the sciences.

In his report on the status of blacks in mathematics, Johnson (1984) outlined what he cited as the reasons commonly given to explain black students' failure to take more mathematics than they do. Among them were: absence of role models, lack of significant others who have an interest in mathematical achievement, a failure to receive positive career counseling, a view of mathematics as a subject appropriate for white males, the perceived lack of relevance of mathematics, and lack of success in previous mathematics courses. In making an appeal for more research programs to address these issues, Johnson stated that:

Overall, few definitive reasons can be given for the acute under representation of blacks in advanced mathematics classes. Equally elusive is an explanation for their consistent under-achievement on mathematics tests. (p. 150)

In her review of various studies that focus on the influences on the learning and participation of minorities in mathematics, Matthews (1984) has identified a host of potential factors. With respect to student variables (she discussed parent and school variables as well), her research revealed that minority students more often do not understand how mathematics will be useful in the future or how it is useful in their everyday lives. According to Matthews, minority students "tend to think of mathematics as something done only with pencil and paper in the classroom" (p. 90). And as an indication of the perceived needs of minority students, she found that "Minority students have indicated that they like a teacher who will work with them, give them extra help, explain things carefully, and encourage them in their studies" (p. 90). Matthews concluded her review by calling for more studies in which comparisons are made between successful and unsuccessful students. In a separate article on this issue Matthews (1983) also made a plea for microstudies which would include both quantitative and qualitative analysis. Both of these concerns were addressed in this study.

According to Valverde (1984), although few empirical studies have been conducted

to document the reasons for the under achievement and under representation in mathematics courses among Hispanic students, five likely factors have been consistently identified in the literature as contributing to the problem. They are: 1) language, 2) curricula material, 3) instructional method, 4) teacher quality, and 5) learning style. Because Valverde considers language as a "manifestation of culture", the consideration of culture as a factor is also imbedded in this list. Furthermore, his discussions of the other four factors were largely dominated by culture-related concerns as well. For example, his statement that "The phenomenon of culture connects the language instruction variable with the curriculum variable" (p. 126) is the basis for his argument suggesting that the absence of any real concern for the strong influence of culture in mathematics instruction in this country is a major barrier to the learning of mathematics by Hispanics. In his discussion of cognitive style, Valverde concludes that mathematics instruction has favored field-independent students over field-dependent students to the detriment of Hispanic students who, according to him, tend to possess the later disposition (p. 127).

While discussing issues in Mathematics Education for Native Americans, Bradley (1984) stated that "the mathematics achievement of Indian students is below that of their non-Indian counterparts, and the gap increases as the students progress through elementary and secondary school" (p. 96). In her report she cited a study by Green (1978) in which she found that Indian students gave the following reasons for avoiding the study of mathematics: poor or no counseling; poor, unskilled teachers; negative images of science and scientists; no role models; insufficient money for college; fear of failure; poor preparation in basic skills; low priority given to collegiate education by the community; parental, family, or marital problems; conflicts between cultures; and poor study habits. Among the factors which contributed to this situation, Bradley cited culture, instruction, and the curriculum as being critical. She stated that "Indian students face cultural conflicts imposed by language, communication, and learning style differences between home and school" (p. 104). Cheek (1984), Tsang (1984), and Cuevas (1984) also presented

arguments which point to language and culture as the principle factors which impact on minority students' performance outcomes in the traditional educational setting in this country.

Summary--The Status of Minorities in Science and Mathematics

The data presented here clearly demonstrates that ethnic minorities are severely underrepresented as professionals and students in virtually all areas of scientific endeavor. Although the four ethnic minority groups for whom data is presented comprise 16% to 20% of the population in this country, the reported figures indicate that as late as 1979 they comprised as little as 2% to 3% of the scientific personnel in this country. Figures from blacks and Hispanics from as late as 1987 show little gain. Furthermore, the data on educational attainment in the scientific disciplines by the minority groups suggests that this situation will probably persist for some time. Among students who were enrolled in the various scientific disciplines during the seventies, the four ethnic groups were significantly underrepresented in most disciplines at every educational level, and this underrepresentation tended to increase at each succeeding level.

Several factors have been identified by various researchers and educational professionals which impact on the situation of ethnic minorities relative to the study of science and mathematics. Among them are: lack of role models, limited exposure to science and its processes, negative images of science and scientists, fear of failure, language, inadequate/inappropriate curriculum and instruction, and cultural differences (including learning style differences).

Purpose of the Study and Research Questions

The purpose of this study was to investigate and explore the experiential and motivational correlates of students' behavioral and academic performance outcomes for

minority students who have participated in a developmental enrichment program in the natural sciences at Michigan State University. Correlates of academic achievement were also determined, and special attention was directed at identifying implications of the results of the study for minority students' educational enhancement, post-secondary curriculum and instruction, and student assistance/retention programs. The study was organized around seven research questions:

- 1. What are the critical factors in students' academic backgrounds which affect their ability to adapt to the academic demands of the University, especially for the study of mathematics and science?**
- 2. What do students need to do behaviorally in order to develop the required academic skills for the successful study of mathematics and science at the university?**
- 3. What are the motivational factors which determine (or least have an influence on) whether students do these things or not? That is, why do some students do them and others do not?**
- 4. What are the self-reported reasons why some students eventually do those things which are necessary when they were not originally doing them? Furthermore, what are psycho social dynamics of this transformation process and what are the subsequent effects on students and their academic enhancement?**
- 5. What are some of the adjustment variables and institutional factors which affect students' ability to grow and develop academically and socially, and how do they affect students and their capacity to make sustained progress within the institution?**
- 6. What are some of the significant correlates (both statistically and practically) of student achievement among the members of the research sample?**
- 7. What are the implications of the results of this study for minority students' educational development and enhancement, overall student academic development, and student assistance and retention programs at post-secondary institutions?**

Statements are often made in the literature about possible causes of student under achievement in mathematics and science at the post-secondary level (i.e. poor reasoning

ability, lack of understanding of concepts, etc.) but little useful research focuses on issues related to the development and acquisition of the necessary academic skills within the broader context of the students' experiences. By contrast, this study was designed with the consideration of the "total student" in mind and intended to contribute to the process of establishing a theoretical framework upon which more specific research can be conducted in the continuing effort to answer some of the many questions which arise in relation to the stated problem. Furthermore, since Michigan State is a large land grant university with a broadly diverse student body, the results of this study are probably generalizable to minority students who have matriculated or who might matriculate in a science/technical discipline at any post-secondary institution in the United States.

Participating subjects were administered a twenty-item researcher-developed survey questionnaire which was followed by a twenty to thirty minute structured interview for most participants. The purpose of the questionnaire was to document students' self reported experiences, behavioral outcomes, and perceptions at the university and, to a lesser extent, while in high school. The interview was conducted to clarify and expand on the information obtained from the questionnaire as well as to more thoroughly probe into the nature of the experiences of subjects from the research sample.

Background and performance data from students' records as well as information from selected items from the questionnaire were used to determine correlates of achievement with grades earned in mathematics. Information from the interviews, as well as information from selected questions from the questionnaire, were used to make further comparisons and observations, and to analyze student reported opinions, relationships, perceptions, and longitudinal changes. Recurring themes were also identified in order to "flush out" those subtle and often hidden factors which could contribute to a more complete understanding of the problem.

Definition of Terms

Minority Student--Any student whose background is one of four minority groups (black, Chicano, Puerto Rican, Native American) which are underrepresented in the sciences. Since the overwhelming majority of subjects in the sample population and all of those from the research sample were black, references to minority students for the purposes of this study will, for the most part, mean black students.

Underprepared Student--Students who are not prepared academically for the demands of academic pursuits at a typical four year college or university and for whom success would be unlikely without special assistance and/or special efforts on their part.

Educationally Disadvantaged Students--Students who are at a disadvantage in comparison to the majority of students at a certain educational level relative to factors such as cultural awareness, behavior appropriate actions (for academic progress), awareness of the nuances of the educational/academic processes, cultural /socially based performance deficiencies, or some combination of these and/or other factors.

Academic Development--Refers to the degree to which students acquire/develop both personal and academic skills which are essential for successful academic performance and are able to demonstrate progress as students at the university.

Science Based Programs of Study--Any undergraduate major or curriculum program which could be categorized under one of the following:

Science Program of Study--Any undergraduate major or program usually considered as being within the domain of the natural or physical sciences. The majors that fall into this category are those which are sometimes referred to as the "hard" sciences such as Biology, Physics, Chemistry, and Mathematics, as well as some of their more recent derivatives such as Biochemistry and Microbiology.

Science Oriented Program of Study--Any undergraduate curriculum program which is in part reliant on the natural and/or physical sciences for its academic base. Some of the majors in this category are Nursing, Agriculture, Nutrition/Dietetics, Medical Technology, and Allied Health Programs.

Technical Programs of Study--Any undergraduate major or program of study which has as it's base a firm grounding in mathematics and/or physical sciences. Some of the majors which are in this category are Engineering, Computer Science, and Statistics, as well as certain programs in business and management such as Accounting, Finance, Economics, and Marketing.

Post-Secondary Institution--An educational institution which primarily offers academic curricula designed for students who have completed high school and/or whose formal educational preparation is suitable for academic pursuits beyond the high school level. Trade schools and institutions which primarily offer programs which are nonacademic in nature are not included.

Academic Skills--Those behavioral and cognitive skills which have been determined to be directly related to students' performance outcomes. Included are study skills/habits, reasoning ability, concept recognition, problem solving capabilities, analytical skills, and other more subtle cognitive capabilities.

Student Behavioral Outcomes--Those outcomes in the experiences of students (e.g. amount of study time per week) which are the result of student behaviors rather than being primarily cognitively determined.

Traditional Curriculum Program--Refers to the usual curriculum program at higher education institutions in this country, normally based in a single academic department and consisting of a core of departmental course work, along with a prescribed number of related non-departmental courses. The distinction is between these predominant types of curriculum programs and those which might be considered as innovative or non-traditional in their structure and/or approach.

Traditional Educational Setting--Refers to the typical American elementary or high school setting as opposed to one which might be specifically designed to consider a significant number of the issues and concerns found in this study.

Basic Assumptions

Perhaps the most basic assumption inherent in the conceptualization and design of this study is that students who enter post-secondary institutions deficient in certain needed academic skills can overcome their deficiencies and make reasonable progress toward becoming competitive students within the institution. Of course not all students will make the required adjustments and/or transitions even in the best of circumstances. However, there is sufficient evidence to suggest that given certain kinds of academic support and/or through the use of certain pedagogical strategies and curriculum innovations many of those students who would make the necessary commitments can not only make the adjustments but also become good students in many instances.

A natural correlate to this assumption is that the nature of the experiences of students in the institutional setting will, to a large extent, affect their capacity to make the needed adjustments, especially during students' initial confrontation with the realities of their status within the institution. Consequently, the curriculum structure, the quality of

instruction, the type of initial advice and counseling, opportunity or lack of opportunity for continued academic development and enhancement, peer relationships, and the overall interaction between students and the institutional environment will all have some impact on students' performance outcomes. Furthermore, the initial disposition of students (i.e. study skills/habits, formal reasoning levels, level of persistence, and motivation among others) will significantly factor into this assumption.

Delimitations

This study focuses on the experiences of students during the early stages of their academic matriculation and attempts to relate these experiences to certain behavioral and performance outcomes. However, there was no attempt to do any of the following as a result of this study:

Characterize individual students (or make broad generalizations about individual students) academically, socially, or psychologically.

Compare experiences or performance of students from the research sample with other students outside of the sample population.

Find correlations between the experiences of students from the sample and graduation rates of these students.

Establish the most effective means of assisting students with their academic development in terms of curriculum, pedagogical strategies, program structure, or any other factor which might impact on this development.

Determine the stage(s) of intellectual development for participating subjects.

Develop a method or methods of making predictions about student outcomes or attempt to make any such predictions through the use of the research data from the study.

Determine the manner in which individual institutional factors (e.g. structure of the curriculum, racism/sexism, etc.) might contribute to the problem in isolation from other factors.

Develop any form of retention model for students from the sample population.

Significance of the Study

Perhaps the most significant aspect of this study is that it **probes into the actual experience of students as they attempt to acquire the prerequisite skills for their future study** rather than rely solely on quantifiable data which merely documents performance outcomes. That is, the study views the problem within the broader context of the total situation in which students find themselves and attempts to gain a more in-depth understanding of the problem from the students' vantage point. Furthermore, attention is given to the transformation that must occur among students who are academically deficient while the process of academic development in the sciences is occurring, which leads to important questions and implications for further research in this area of investigation.

Other areas of significance in this study include:

The study included a thorough review of the factors which might contribute to the problems that many minorities have when attempting to study mathematics and science at all levels, some of which are not normally found in mathematics education and/or science education journals. It also included a thorough review of various issues which hold implications for general investigations into the nature of learning mathematics and science at all educational levels.

All participating subjects and all students in the research sample were at one time involved in a special programmatic effort to assist them with their academic development. Hence they all were, for a period of time during their academic matriculation, not only given special guidance about what would be expected of them (behaviorally and cognitively) at the institution but were part of an academic experience in which some of the possible institutional barriers such as indifferent instructors and/or a non-supporting atmosphere were removed as well.

Cultural subordination/oppression in particular was identified and addressed as a critical concern in an attempt to understand the dynamics and complexity of ethnic minority student achievement in mathematics and science.

Although it is a study which was directed at the academic progress of minority students, the results and outcomes contained important implications for mathematics and science education generally, as well as for administrators and staff members of student academic development/enhancement programs, especially at the post-secondary level.

Overview of Succeeding Chapters

Chapter II presents an extensive review and exploration of the issues and concerns related to the problem in an attempt to gain a thorough understanding of it, followed by a survey of previously conducted related research. Chapter III describes the study methodology, including the setting, the research design, the procedures, the data collection methods, and the qualitative and quantitative methods of analysis. In Chapter IV the findings and results of the study are presented and the outcomes from the analyses are given. Chapter V presents the conclusions and implications of the study along with a summary discussion of it and the recommendations which emerged from it.

CHAPTER II

REVIEW OF THE LITERATURE: PHILOSOPHICAL, EXPERIENTIAL, AND EMPIRICAL FOUNDATIONS

Introduction

The first major section of this chapter (Pre-College Experiences of Minority Students) is directed at the dynamics associated with the broader experiences of minority youth in relation to their ability to function successfully in the traditional educational setting in this country. Beginning with early childhood, the life experiences of minority youth, both in and out of school, often differ from those of middle class white youth for whom the schools have generally been designed and around whom the curriculum has been developed. Although these differences are often very subtle and might appear insignificant on the surface, a close investigation of them reveals many plausible factors which tend to inhibit the ability of many minority students to perform satisfactorily in the traditional educational setting in general and in mathematics and science classrooms in particular. This is not to suggest that the identified differences necessarily result in any impaired development or learning deficiency, rather that they might affect students' ability to demonstrate their capacity to perform within the structure, curriculum, and instructional processes of schools where cultural differences are not often taken into consideration. The implication is that by the time ethnic minority students enter post-secondary institutions many of them possess less than adequate preparation for the demands and rigor of science or science based curriculum programs at these institutions. Furthermore, the mainstream curriculum processes of the institutions are generally not designed with a concern for this situation as a significant feature, if at all.

In the second major section of this chapter (The Collegiate Experience and Minority Students), issues which are pertinent to gaining an insight into those aspects of students' experiences which might significantly impact on their academic development and performance, especially in the sciences, are explored. In addition to a review of factors such as institutional environment, the curriculum and its processes, instructional modes and delivery, student anxiety, and academic skills development, this section includes in-depth analyses of certain social/psychological constructs which have traditionally been used to explain behaviors related to students' dispositions toward academic achievement. These constructs are scrutinized in view of several developments in the field of psychology which have enabled theorists to better interpret them within the context of the minority experience. The analyses are therefore used to form a theoretical basis for a broader and more comprehensive understanding of minority student's motivations, perceptions, behaviors, and performance as these students attempt to lay the type of academic foundation needed for the successful study of science and mathematics at the post-secondary level.

The third major section (Post-Secondary Mathematics and Science Achievement) focuses on issues specifically related to the study of mathematics and science at the post-secondary level. Included is an exploration of general student academic development in the study of these disciplines along with contemporary curriculum issues and instructional practices in various institutions of higher education.

In the fourth major section of this chapter (Related Research), a review of reports from past research which have addressed the issues of concern to this study is given. Because the problem of the study is complex, as well as pervasive, and the scope is broad, a wide range of research in type and focus is reviewed. Research on math/science learning, the minority experience in relation to academic achievement, achievement motivation, and student behavioral outcomes at the post-secondary level, among others, are reviewed. Furthermore, research which was conducted at the elementary and high school levels has been included as well.

Pre-College Experiences of Minority Students

Early Childhood Experiences

Perhaps the foremost proponent of a theory on the experiential nature of the learning process has been John Dewey. His treatises which, among other things, explore the necessity of considering the total experiences of the child in making judgements about the quality of his/her educational development have served to form the philosophical basis for an analysis of the situation of minority students by many authors. According to Dewey, ". . . the principle of continuity of experience means that every experience both takes up something from those which have gone before and modifies in some way the quality of those which comes after" (1938, p.35). While this statement is obviously intended to emphasize the importance of the "continuity of experiences" in the educational development of all young people, a closer look at Dewey's position could very well lead one to see it as being even more critical to the situations of minority youth. Their life experiences are often substantially different from, and often in direct contrast to the types of experiences and exposures that educators expect their students to have had. Consequently, minority students will likely face a "discontinuity" of experiences resulting in decreased opportunities to become personally involved with the learning process.

In his article "John Dewey Visits the Ghetto," Phillips (1978) made a direct case for the importance of Dewey's position to the educational development of black youth. In it he stated:

....According to Dewey, education is a continuing process of the re-construction of total experiences, of which only a part takes place in school. If one is a supporter of this philosophy, then it seems reasonable that one would gear one's academic discipline to the experiences of one's students. Therefore, a teacher cannot assume that student experiences are comparable to the teacher's experiences at that time and period in the teacher's life. (p. 11)

Phillips further noted that "....In his book, Experience and Education, which can be considered as an answer to his critics, Dewey clarifies his belief that education should develop natural powers and tendencies of the child as they exist in impulsive form" (p. 12). Hence Phillips sees Dewey's philosophical position as an important reference point from which to investigate minority student educational development.

Several theorists view many non-academic activities as being critical in the educational process of the young. Morris (1966) made a strong case for considering extracurricular activities in his discussion of "The 'Extracurricular' Mode of Discovery." Although they usually take place within the academic environment, the kinds of activities that Morris promoted as being important, such as chess clubs, school newspapers, and interscholastic athletics, are nonetheless usually considered as being outside of the domain of the traditional academic curriculum. According to Morris, these activities "release subjectivity" and frequently allow the student to actually learn and grow more than they would in the "serious" projects of a school's curriculum. Hence, if this is indeed the case, students are likely to grow substantially through activities that take place not only outside of the classroom but outside of the schoolyard itself, provided that the opportunity to engage in appropriate activities does exist. For minority students then, we must question whether or not they have had the opportunity to engage in intellectually stimulating activities of their choice which would induce the personal involvement desired.

Butler (1966) specifically mentioned the importance of "Excursions and projects beyond the walls of the school " in order to supplement book learning by face-to-face relation with real community and social situations" (p. 119). He proposed that decision and selection, questioning and discussion, and observation and experimentation must play a central role in the educational process. However, Norman & Atlas (1978) argued that minority group individuals are often victims of circumstances in which decision making is suppressed. According to them, "Minority-group individuals tend to be victims of controlling circumstances in which decisions are made for them or of situations that prompt

spontaneous, emotional decisions. Minorities are frequently rushed to choose an alternative without having the opportunity to apply rational and reflective processes" (p. 79).

Consequently, the student who is from an environment in which the opportunity for reflective decision-making activity is diminished will likely have less opportunity to develop the kind of decision-making and problem-solving capabilities essential for full intellectual growth. Bayles (1978) has stated that "Reflective thinking is problem-solving; it begins with a problem and culminates in a solution, though many are the occasions wherein the process terminates (sometimes temporarily, sometimes permanently) before a solution is reached" (p. 78). The implication for the student who is to study science or one of the related fields, where problem-solving is so crucial, is that the opportunity to reflect on problems and arrive at personally developed solutions must be made available both in and out of the school environment.

Culture, Problem-Solving, and Social/Cultural Oppression

Cole & Brunner (1971) reviewed the investigations and expositions of several psychologists and anthropologists who concerned themselves with the issue of cultural deficits/differences in relation to the ability of minority group children to perform adequately on intellectual tasks. According to them, the body of data that they reviewed "casts doubt on the conclusion that a deficit exists in minority children, and even raises doubts as to whether any nonsuperficial differences exist among different cultural groups" (p. 868). The central thesis of Cole and Bruner's position relied on the distinction between competence (or capacity) and performance, along with their claim that the manifestation of competence is situationally determined within a cultural context. According to them:

One must inquire, first, whether a competence is expressed in a particular situation and, second, what the significance of that situation is for the person's ability to cope with life in his own milieu. (p. 874)

Furthermore their analysis lead them to the following conclusion which holds definite implications for educational practice:

The problem is to identify the range of capacities readily manifested in different groups and then to inquire whether the range is adequate to the individual's needs in various cultural settings. From this point of view, cultural deprivation represents a special case of cultural difference that arises when an individual is faced with demands to perform in a manner inconsistent with his past (cultural) experience. In the present social context of the United States, the great power of the middle class has rendered differences into deficits because middle-class behavior is the yardstick of success. (p. 874)

One consensus among those who have concerned themselves with the art of problem solving is that good problem-solving ability requires creativity on the part of the individual. Thus any explanation of the essentials of sound problem-solving capabilities among students or others in the general population often revolves around the question of creativity. According to Hayes (1981) creativity is not directly related to IQ. Hence, although IQ is thought to predict how well a student will do in school (at least in the traditional educational setting) it cannot be used as a predictor of innate problem solving ability. In the words of Anderson (1980), "creative thinking, it is widely agreed, is the generation of ideas (a) that are unusual, or original, and (b) that satisfy some standards of value" (p. 123). And Hayes stated that "creative acts depend on a great many of our cognitive processes working together in harmony-processes of representation, search, memory, and decision making" (p. 199). But who has it and why is the important question.

By describing what he has found to be some of the critical attributes of creative people, Anderson provided some possible clues to explain why some people seem to be more creative than others and perhaps provides the basis from which to begin to gain insight into some of the underlying barriers confronting many members of certain ethnic minority groups when attempting formal problem solving activities in the traditional educational setting. Anderson's first attribute, which he labeled "inner strength," was summarized by him as follows:

Creative people seem to take their guidance from within. They have what Carl Rogers calls an "internal locus of evaluation." They are more in touch with their own feelings and thoughts. They seek to shape their

environments, rather than allow themselves to be shaped by it. They form their opinions independently and are not inclined to go along with the judgement of a group or of society. (1980, p. 124)

The other attributes are "openness to experience" (including being comfortable with ambiguity and more accepting of the complex and incomplete) and "high motivation" (including what Anderson described as "a healthy obsession" with their problem, which tends to get them totally involved with it).

In his book Learning and Human Abilities, Klausmeire (1975) included a chapter titled "Problem Solving and Creativity." In it he approached this topic from the point of view that "every human being is capable of learning to solve some problems and to be creative" (p. 300), and treats problem-solving ability and creativity as being interrelated. Furthermore, by citing the results of several studies, Klausmeier not only concluded that intelligence test scores are not highly correlated with creativity but that creativity does not necessarily correlate highly with grades assigned to students either. However, he did explore the nature of creativity and listed some of the personality traits of creative individuals, which was based on the work of Barron (1969). Barron studied living writers, mathematicians, architects, and scientists and Klausmeier's list of traits included the following descriptive statements, among others, which he contended are most common to creative individuals:

Appears to have a high degree of intellectual capacity. Genuinely values intellectual and cognitive matters. Values own independence and autonomy. Is verbally fluent; can express ideas well. Is concerned with philosophical problems; for example, religion, values, the meaning of life, and so forth. Has high aspiration level of self. Thinks and associates to ideas in unusual ways; has unconventional thought processes. (p. 309)

Furthermore, Klausmeier cited a study by Terman (1954), who followed-up a group of gifted children several years later to determine the personality traits of those who were "productive" versus those who were not. According to Klausmeier:

The productive group, far more than the less productive, was superior in these personality characteristics: persistence in the accomplishment of ends, integration towards goals as contrasted with drifting, self-confidence, and freedom from inferiority feelings. (p. 313)

It is evident from Klausmeier's characterization of the attributes of creative people, as well as his presentation from the results of studies by Barron (1969) and Terman (1954), that one key prerequisite for "productive" creativity is that the individual needs to be what might be termed "self-actualized." That is, the individual needs to have come to terms with himself or herself to the point that he or she exerts control from within, without the need for external evaluation before experimenting with new ideas. This in turn implies freedom from the impact of the psychological oppression experienced by many minority group members in society. Therefore, any research on the development of problem-solving abilities (for classroom type problem-solving) among members of certain ethnic minority groups would need to direct attention at the nature of the experience of overcoming the effects of this condition, similar, for example, to the study conducted by Cross (1973). Furthermore, the implication for academic development programs for minorities is that a concern for this issue should be at the forefront of their design.

Sue (1981) pointed out a potential source of the problems confronting minority students who attempt to compete in a highly competitive academic setting in his discussion of the formation of world view as a critical determinant of a person's behavior in the larger society, especially in relation to his/her coping skills within that society. Sue stated that:

....It is reasonable to believe that members of one cultural group tend to adjust themselves to the group possessing the greater prestige and power to avoid inferiority feelings. Yet it is exactly this act that creates ambivalence in the minority individual. (p. 83)

Consequently, members of the subordinate culture could very well find themselves in a state of confusion or conflict as they attempt to cope with the situation. This in turn could prevent them from making the strides toward self-fulfillment and personal achievement that are necessary for higher intellectual pursuits.

According to Freire (1970), at the heart of the problem in education for the oppressed is the "banking concept" of education as generally practiced in the traditional educational setting. Under this concept the student is typically engaged in a process which

relies heavily on mechanical memorization and rote learning. Freire described this process as follows:

The outstanding characteristic of this narrative education, then, is the sonority of words, not their transforming power. "Four times four is sixteen; the capital of Para is Belem." The student records, memorizes, and repeats these phrases without perceiving what four times four really means, or realizing the true significance of "capital" in the affirmation "the capital of Para is Belem," that is, what Belem means for Para and what Para means for Brazil. (pp. 57-8)

Freire contrasted this type of educational process with that which he advocates by stating:

Whereas banking education anesthetizes and inhibits creative power, problem-posing education involves a constant unveiling of reality. The former attempts to maintain the submersion of consciousness; the latter strives for the emergence of consciousness and critical intervention in reality. (p. 68)

One key point by Freire in the first passage quoted here is found in his reference to the lack of "transforming power" in the banking education process. That is, students are not afforded a real opportunity to become personally involved/implicated in the process in a way that allows them to "perceive critically the way they exist in the world with which and in which they find themselves" (p. 71). On the other hand, problem-posing education as advocated by Freire would, according to him, not only accomplish this goal but also assist students "to see the world not as a static reality, but as a reality in process, in transformation" (p. 71).

For minority students in this country this lack of transforming power in the educational process could very well be the critical missing link in their development due to the diversity of ethnic/cultural heritages that exist here and the resultant mixture of "world views" which are likely to differ significantly from that of the majority culture. That is, many of the problems confronting ethnic minority students in traditional educational settings in this country could stem from the fact that their culture or heritage is not at the center of educational practices within the framework of a problem-posing process. Freire maintains that this problem-posing concept in education would, on the other hand,

challenge students to new understandings and bring about a stronger commitment to learning. According to him:

Students, as they are increasingly posed with problems relating to themselves in the world and with the world, will feel increasingly challenged and obliged to respond to that challenge. Because they apprehend the challenge as interrelated to other problems within a total context, not as a theoretical question, the resulting comprehension tends to be increasingly critical and thus constantly less alienated. Their response to the challenge evokes new challenges, followed by new understandings; and gradually the students come to regard themselves as committed. (1970, pp. 68-9)

In the experience of black Americans, several black psychologists have referred to a transformation process as being critical to the ability of blacks to come to terms with their black identity in order to assert their creativity in artistic and intellectual pursuits. Cross (1973) outlined what he labeled the Negro-to-Black conversion experience while presenting his model to explain the various stages through which black Americans pass as they approach psychological liberation within an oppressive society. The five stages of his model are: pre-encounter (pre-discovery); encounter (discovery); immersion-emersion; internalization; and commitment. His description of the disposition of a person who is functioning at the pre-encounter level underscores the nature of the "cruel paradox" of the oppressed black American. Cross stated:

Pre-encounter Negroes are politically naive and are programmed to have faith in the Protestant ethic. There is an extreme dependency on white leadership, and the assimilation-integration paradigm is thought to be the only model for cohesive race relations. Under the dictates of the assimilation-integration paradigm in the development of an "American" identity involves affirmation of "White-Anglo-Saxon-Protestant" characteristics, and negation, dilution, or even denial of non-WASP behavior. As Western standards are inherently anti-Black, the cruel paradox of the assimilated Negro is that, in becoming a good American, he has also become anti-Black and anti-African. (p. 271)

Based on Cross's model, as a black person progresses through the stages of the conversion experience they will confront their blackness in the search for a deeper understanding of themselves and of the situation facing blacks in the larger society--the encounter stage. They then experience "an immersion into Blackness

and a liberation from whiteness" (p. 274)--the immersion-emersion stage. The conversion experiences that Cross described as occurring during this latter stage are especially significant in relation to the transforming process which Freire would probably maintain is necessary if the oppressed are to gain the ability to engage in higher intellectual pursuits. According to Cross:

During the immersion-emersion stage, the person has a creative burst, writing poetry, essays, plays, novels, or confessionals, a segment turns to the plastic arts or painting. People who never before sought or experienced creative activity discover they are able to express themselves in a totally new mode. (p. 274)

Thus, within the cultural experience of black Americans, we find that a certain kind of transformation process might be necessary before many within this group are able to express themselves creatively and make major strides toward reaching their potential in the academic arena. And based on the position taken by Freire regarding the oppressed in general, the same proposition applies to certain other ethnic minorities as well.

Math/Science Education and Culture

As discussed in Chapter I several culturally related factors often hinder the learning of mathematics among ethnic minority students. This concern for culture and its impact on the learning of mathematics surfaces most readily when looking at the situation of Native Americans, as previously reported on by Bradley (1984). Among the specific factors related to language, she noted that the Navajo language "does not have a word for multiply, divide, if, cosine, or sine" (p. 99). She also cited the silence of many Indian students in the classroom (as a result of culture) as often affecting their performance, as well as the tendency of some Indian teenagers to rebel against the strict discipline of federal and parochial schools. Furthermore, according to Bradley, "traditional Indian culture required the development of an excellent memory in order to pass on the culture to the next generation " (p. 100). Thus students who continue to rely on this power of memory in

advanced mathematics courses where reasoning and problem-solving ability are more important will confront difficulties in adjusting to the situation.

The role of language in both the process of learning mathematical concepts and the performance of students on evaluation instruments is well documented and presents definite implications for ethnic minority students. Cuevas (1984), while exploring the problems faced by Hispanic students, refers to mathematical registers, which, he claims, are "the meanings belonging to the natural language used in mathematics" (p. 136). According to him they are "more precise than the natural language itself because the meanings of the terms are much narrower in scope" (p. 136). Furthermore, Cuevas described both the power and subtlety of mathematics registers in the learning of mathematics when he stated:

In addition to vocabulary, a mathematics register also includes styles of meaning and ways of presenting arguments within the context of mathematics. These processes require new structures, which are most often borrowed from specialized forms in the natural language. Examples of expressions adapted from English include: "the area under the given curve" "the sum of the first n terms of the sequence". (p. 136)

Thus, given the power of language and the many different roles that language might play in the learning (and teaching) of mathematics, it is not difficult to imagine the problems faced by ethnic minority students whose cultural development is not firmly grounded in a mastery of standard English and its use.

Among the effects of social/cultural oppression on certain ethnic minority groups, it is likely that the cognitive style dispositions of many from those groups have been shaped, or at least influenced, by the resulting societal experiences. Accordingly, Valverde (1984) was to contrast the dispositions of field-dependent versus field-independent students and highlight the possible implications for classroom instruction. According to him the former "view their environment as unified and having an inherent order" while the latter "view situations in distinct parts and apply structure even when no order is readily apparent" (p. 127). His claim that Hispanics tend to be more field-dependent lead Valverde to

summarize Lovett's (1980) recommendations for the consideration of the disposition of field-dependency in the teaching of mathematics when he stated:

First, field-dependent students may learn mathematics more readily when the teacher provides a high level of guidance, clearly states the outcomes, and structures the lesson. Second, the presentation of material or materials favoring social content seems to be more attractive to field-dependent pupils. And third, working together and minimizing competition is more conducive to learning for field-dependent youngsters. (p. 127)

As with the experiences of Native Americans and Hispanics, the cultural/social experiences of black Americans must be considered in assessing their performance in the traditional educational setting. In addition to language and other cultural factors Young (1981) contended that the broader experiences of blacks in society has a definite impact on the ability of black youth to compete in mathematics and science disciplines in the traditional educational setting. By comparing the affective attributes of scientists, as reported by researchers, to typical black environmental and experiential outcomes, he concluded that "it is no wonder that few blacks become scientists" (p. 263). According to an inventory by Nay & Crocker (1970), as presented by Young (1981), scientists typically have an interest in understanding natural phenomena, are resourceful, understand experimental requirements, have an appreciation for an understanding of the history of science, are curious, and have a high persistence level among others. However, black youth often come from an environment where not only are these virtues not often nurtured, but the situation might demand behavior that is contradictory to developing them as well.

As Young stated:

The Protestant work ethic, one of the basic tenets of the dominant society has had contradictory implications for blacks. Hard work, achievement, and assertion may not bring the same rewards for blacks as for whites. Lives of famous black scientists bear this out. (p. 264)

Within the schools themselves, Young maintained that the science curriculum as usually structured often presents problems for minority youth because of its apparent lack of concern for the personal situation of the students. He made his case as follows:

The current science curriculum and the traditional approach to teaching science compound the social and psychological problems faced by minority students. The scientific curriculum is rigorous, sequential, objective, highly cognitive, and apparently divorced from the affective domain. (p. 264)

Furthermore, according to Young:

The science curriculum requires that one has already worked through personal crisis prior to its undertaking, in as much as the rigor of its content and skills allows no time for pre-occupation with personal problems. (p.265)

Thus, Young made a case that, if taken in conjunction with Sue's (1981) position on the effects of the dominant-subordinate relationship between the majority culture and others, and Freire's (1970) position on the need for a transforming process in the education of the oppressed, illuminates the seriousness of the problems that often confront minority students who attempt to study mathematics and science at any level.

Summary--Pre-College Experiences of Minority Students

In this section factors related to the early childhood experiences of minority youth were explored in conjunction with the social/cultural circumstances of minority populations. From these explorations it is evident that, for certain groups in society, minority status in this country is much more than a superficial condition and that efforts to confront the resulting implications are imperative. It seems clear however, that social/cultural differences need not translate into deficits if the proper measures are taken.

The Collegiate Experience and Minority Students

Due to the tremendous increase in the enrollment of minority students at predominantly white post-secondary institutions during the sixties and into the seventies, the effects of minority students' matriculation at these institutions gained widespread attention among higher education professionals during the decade of the seventies. This attention has led to a myriad of data, statistical analyses, and discussion on this topic. Everything from entering social backgrounds and perceptions to academic achievement and post-baccalaureate experiences has been explored and analyzed regarding the minority experience on the campuses of the various types of post-secondary institutions in this country. Thus by examining the various issues that have emerged as a result of these investigations, it is possible to gain a comprehensive understanding of the nature of the experiences of minority students and construct an additional piece of the theoretical base upon which the present study is designed.

This section begins with a look at the impact of the campus environment of the various institutions from the perspective of the students themselves, with a focus on the implications for their overall development within these institutions. A discussion of the issues specifically related to their general academic development of students follows, highlighted by a delineation of success factors among minority students and an exploration of the cultural dimensions, such as cognitive dispositions which often affect their academic experiences. Relevant concerns about motivation and anxiety are then explored, with special attention given to those subtle aspects of motivation which are critical to gaining a more thorough understanding of the situation of culturally different minorities relative to the motive to achieve. This is followed by a closer look at factors such as study skills/habits, organization of work, learning skills development, and other performance enhancement concerns which have an impact on students' ability to perform up to their potential within the traditional academic structure of post-secondary institutions.

The Institutional Environment

Gibbs (1973) examined the expectations of black students at a western university and found that they were often incompatible with those of the university staff which, in turn, presented many adjustment problems for these students. On the one hand she found that the staff expected that black students would: 1) assimilate into the university community without substantially altering the academic structure or programs; 2) be able to compete academically with white students; 3) blend into the socio-cultural life of the campus; and 4) show gratitude for having been given the opportunity to obtain a quality integrated education. On the other hand black students expected that: 1) the university would be flexible in responding to their needs; 2) college courses would simply be a continuation of high school work; 3) there would exist a greater diversity of activities and life styles at college; 4) they would have more social contact with the surrounding black community; and 5) their presence on campus would lead to their contributing to the university and that the university would provide them with the resources to help tackle the broad social problems of society. According to Gibbs, conflicts which arose as a result of these disparate set of expectations served to exacerbate the problems confronted by black students; problems which were largely a result of their being primarily first-generation college students whose cultural background had not prepared them to negotiate within and through the university structure.

In a later study Stikes (1984) found that a hostile perception of society, a negative self-concept, and a lack of self-disclosure were some of the inhibiting factors for black students. The outcome for these students was summarized by Stikes as follows:

Because of the hostile environment, Black students have assumed many fronts. There are many situational personas that Black students learned to play to exist in the university. Black students had to learn to manage stress and deal effectively with hostile barriers. There were many adjustive styles because of the hostile environment. The students were seldom themselves. They were often angry and anxiety laden. They were removed, hesitant, and mistrustful. Their self-hatred and lack of self-disclosure were other significant considerations for teachers. (p. 194)

Other inhibitors cited by Stikes included problems with language, uneven development, and the use and abuse of time. In a similar investigation, Taylor (1978) listed lack of confidence, a shortage of advocates to aid black students in their negotiation with the system, and denial of opportunity within the institution as major obstacles to black students' academic performance on white college campuses.

In a study conducted by the National Advisory Committee on Black Higher Education and Black Colleges and Universities and reported by Smith (1980), black students at seven predominantly white universities were interviewed in order to document their perception of their experiences at these universities. According to this study:

Statements made during in-depth interviews with Black students revealed that, by and large, they feel depressed, lonely and alienated. They perceive their universities as hostile places in which their relationships with white professors and white students are often demoralizing. (p. 6)

Furthermore, in concurrence with the findings of Gibbs (1973), one of the conclusions of this study was that the divergence of views at one university between black students, who felt that their cultural heritage should have been featured more in the curriculum, and white administrators and faculty, who expressed the opinion that race ought to be down played, created a considerable amount of confusion and tension for black students.

In a study reported on by Jones (1979), black students at nineteen predominantly white colleges in the south were surveyed to determine their attitudes and opinions about their institution. When asked to state the greatest problem that they faced as minority students they listed the following most frequently; subtle discrimination in classes, racial discrimination among the faculty and administrators, as well as among students, white instructors who assume all students have had the experiences that mainly white students have had, the lack of programs directed toward the black students, transformation from a small high school and not enough personal attention from instructors and advisors, teacher's lack of interest, and lack of confidence resulting in mistakes and adjustment problems. And when asked what they would tell prospective black students about the

problems that they would face while attending their institution, the following were among the illustrative responses; the percentage of black faculty and administrators is very low, the social life for blacks is terrible, not enough blackoriented programs and activities, and blacks are left out of a lot of things. In discussing the quality of life for black students at a northern public university, Jackson (1983) also stated that the black students felt alienated by the perceived racial discrimination by faculty and students on campus and a lack of sensitivity to their needs and aspirations. Thus it seems that the perceived problems faced by black students at predominantly white universities are pervasive across regional boundaries.

Following her discussion of the differences in expectations between black students and the university faculty and staff as reported earlier, Gibbs (1973) also discussed the major problem areas for these students, which she determined in her role as counselor to twenty-two black students individually and eighteen in small groups. According to her, six problem areas were mentioned often. They were; establishing a meaningful personal identity, performing successfully in the classroom, confronting social conflicts with blacks as well as whites, gaining autonomy in managing their lives, dealing with sexual and aggressive feelings, and developing long-range career plans. Gibbs further pointed out that most students confronted these problems in multiplicity and hence many were not functioning at optimal levels emotionally, academically, or socially.

Perhaps two quotes excerpted from the summary descriptions of two studies on the issue of the experiences of black students on predominantly white campuses puts the preceding discussions in perspective. In the summary of the report authored by Smith (1980), the following comments were made:

However, at all seven universities, the underlying causes of Black attrition appear to be rooted in the poor quality of Black life on campus. Black students perceive themselves in a hostile environment--a view shared by the vast majority of Black faculty/administrators queried and recognized by almost two-thirds of the white respondents. Black students must attempt to deal with loneliness and alienation as well as hostility from white professors

and students at the same time they are trying to adjust to a largely foreign academic milieu. (p. 19)

And in her statement on the results from various investigations into black student adaptation at predominantly white colleges and universities West (1984) made the following observation:

One consistent finding in all these surveys is the Black students' perception that White faculty are indifferent, ambivalent, or prejudiced toward them. Faculty responses to Black students were characterized as condescending, demeaning, or depersonalizing. Many students felt they were stereotyped by the faculty as poorly prepared, culturally disadvantaged, low achievers who were not worthy of their interest or time. Recent news reports from a number of highly selective colleges, including several prestigious Ivy League schools, indicate that even the most academically capable Black students perceive faculty members as remote, uncaring, and unwilling to treat them as individuals. (p. 42)

As has been made evident so far, among the underlying causes of the problems confronted by black students at predominantly white universities are cultural conflicts which precipitate tension between these students and others within the larger college or university environment. Black and other minority students also experience internal conflicts due to the contradictory nature of the cultural adjustments demanded of them. Foreexample, Smith (1980) noted that universities often send conflicting messages to black students by seeming to view all black students as recipients of special financial aid or academic assistance (i.e. stigmatizing them as one homogeneous group), while at the same time expecting them to "down play their racial identity, frowning on Black societies, Black dormitories, Black dining hall tables, a sense of Black Self" (p. 19). Furthermore, according to Smith:

Black students put pressure on each other in similarly conflicting ways. On the one hand they support university divestiture, Black studies, Black societies, and dating only other Blacks. On the other hand, they want to integrate, to avoid being "stigmatized" as Black, to de-emphasize race, and to interact socially with other races. (p. 19)

Maestras (1977) explored the socio-cultural factors which "impinge on the abilities of young people" (p. 59) in the nation's colleges and universities and observed that cultural minorities often face a critical dilemma when confronting the majority culture. As he put it

The real dilemma for the minority person is that acculturation and the adoption of new values and modes of behavior do not ensure acceptance into the majority's society (p. 62).

Indeed, Gibbs (1974) found that black students at one university, as a result of cultural conflict, exhibited a pattern of adaptation which she described as moving through four stages, or modes, of behavior. They are; Affirmation Mode (movement with the dominant culture, Assimilation Mode (movement toward the dominant culture), Separation Mode (movement against the dominant culture), and Withdrawal Mode (movement away from the dominant culture). Finally, in order to address the problem of cultural conflict and adaptation for black students within the institution's curriculum, Scott (1981) made the following proposal:

A final requirement for the successful survival of first generation college blacks and all black students is the development and/or strengthening of a black perspective useful for appropriate definition of self, and for enhanced learning. ...Where the contributions of black scholars and researchers are omitted, they must be identified; when research findings are distorted by cultural and/or ethnic bias, these distortions must be clarified; where real racial differences are noted between blacks and others, these differences should be clearly interpreted as differences, not as "problems."...Therefore, a comprehensive approach must be employed by faculty to aid black undergraduates in maintaining and further developing a black cultural perspective. The major objective of this approach should be to help students identify and understand biological, psychological, and social differences and similarities between themselves and the dominant culture. (pp. 231-32)

General Academic Development

When minority students enter higher educational institutions they often need extensive development within the academic processes of these institutions before they can be expected to compete successfully with the larger population of students. The fact that the institutions are often not prepared to meet the needs of minority students and under-

prepared students generally (Maxwell, 1979; McDermott et al., 1980; Roueche & Snow, 1979) makes the academic transition for these students even more difficult. According to Maxwell, in order to assist students who are underprepared, instructors need to understand the effect of motivation, learning styles, and stages of normal intellectual development on the students' learning and academic performance. Furthermore, Maxwell claimed that students need to exhibit persistence, flexibility, and a willingness to cooperate with instructors to enhance their opportunity for success. She cited the results of several studies which indicated that underprepared students who are successful

seem to be distinguished by a general adaptive factor that involves goal aspiration, goal orientation, goal involvement, willingness to study hard, ability to solve personal problems, and a feeling of support from significant others, such as parents" (p. 200).

In his delineation of the critical factors for the survival of first generation black college students, Scott (1981) maintained that successful and unsuccessful students among this group do not differ significantly in innate intelligence, motivation, or ability. Rather, according to him, successful students display behaviors which are expected in the college environment. Thus he listed the major differences that separate successful first generation black students from unsuccessful ones as; 1) interpersonal skills appropriate for the academic environment, 2) internalization and translation of educational beliefs and values into appropriate behavioral expressions, 3) participation in and development of functional peer and reference groups that are consistent with future personal, academic, and professional expectations, and 4) possession of a clear understanding of one's self as a responsible person. And while commenting on the communication skills problems of black students, Scott made an observation that contains important implications related to the prospects for minority student educational development generally. He stated that:

Unfortunately, first and second generation black students are often characterized and treated by faculty and college administrators in terms of their past socialization rather than their potential for new learning and resocialization. For example, it is often claimed that black undergraduates

do not have the ability to communicate effectively in terms of reading comprehension, writing and speaking skills. This purported problem is often defined in cognitive terms (i.e. failure to learn). The solutions to the "perceived" problems are traditional remedial approaches that have little or no impact on achieving the desired set of cognitive skills. (p. 228)

Sedlacek & Brooks (1976) have also found that successful minority students exhibit certain distinguishable characteristics. According to them seven key noncognitive variables were useful in predicting minority student success. They were; 1) positive self concept, 2) an understanding of and ability to deal with racism, 3) realistic self-appraisal, 4) preference for long-range goals over short-term or immediate needs, 5) availability of a strong support person, 6) successful leadership experience, and 7) demonstrated community service. Thus it seems that minority students' academic experiences can be enhanced if the proper support is provided, especially with communication skills, and they are induced to exhibit certain behavior patterns which are associated with success in the college environment.

As far as differences in the academic experiences of black students among the various types of institutions are concerned, several sources reported that private universities have been much more favorable for black students than public ones. For example, Boyd II (1981) pointed out that although the experiences of black students in private and public institutions were similar in 1973, the surveys conducted by him and his colleagues indicated that the academic experiences of black students were better at private institutions by 1977. Similar findings were reported by Sedlacek & Webster (1977) and by Smith (1980). Sedlacek & Webster claimed that by 1976 private schools were doing a better job of both enrolling black students (6 or 7% vs. 4 or 5%) and retaining them (6.3% vs. 2.5%). However, according to Smith, black students at prestigious private institutions did often confront problems due to the fierce competitiveness of these institutions which black students were not accustomed to, even if they had attended primarily white or racially mixed high schools.

Boyd II reported some specific findings which highlight academic outcome differences between selective and less selective colleges (whether public or private) among black students at the two types of institutions. He found that by 1977 more black students at selective colleges had a G.P.A. of "B" or better (60% vs. 39%), as well as majored in the biological sciences, engineering, math, and the physical sciences (26% vs. 12%) than did students at less selective institutions, and they more often participated in extracurricular activities. Boyd II also found that twice as many students at highly selective colleges graduated from private high schools compared to students from less selective institutions (18% vs. 9%), which partially explains their higher rate of success. Since black students were previously cited as preferring more personal attention by faculty and staff members, the smaller class sizes and greater opportunity for more interaction between themselves and instructors probably contributed as well.

The quality of the academic development of black and other minority students at public, mostly less selective, institutions appears to depend on the capacity of these institutions to incorporate appropriate measures within the processes of the institution that address the varied adjustment problems that many of these students confront. The National Advisory Committee on Black Higher Education and Black Colleges and Universities summarized the situation with the following statement:

The academic adjustment for Black students at the public universities investigated in the Midwest, East and West, while much slower [than at more elite institutions], is much more difficult. They are not subjected to such rigorous academic requirements but neither are they the academic elite, possessing the superior secondary school training that characterizes the private university students. Most of them do not come from an academic environment where study and scholarship are valued, and there is a carryover effect. As one West Public student described it, "There is some Black-on-Black pressure not to achieve. Many students deliberately give the impression that they're not working very hard." Consequently, the academic socialization of many public university Black students must include such factors as "permissibility to study" (or to achieve academically), "what to study," and "how to study." (Smith, 1980, pp. 9-10)

Hardeman (1983) further clarified the academic adjustment problems of black and other minority students on white campuses by pointing to the interaction of self-concept, mastery of language, and motivation, and the resulting impact on students' ability to function successfully within the academic environments of the institutions. According to her:

Many Blacks tend to enter college with a dynamic sense of their inability to cope with the rigorous demands of higher education or to compete with students who are more advantaged in terms of language sophistication and the repertoire of concepts born of earlier guidance and experience. There is likely to be nothing inherent in their elected curriculum that 'turns them on.' Sensibly, they withdraw from study: the vocabulary of lectures and of textbooks is alien--a foreign language; required reading materials are so complicated that they cannot understand them; trouble with vocabulary and comprehension, therefore, makes their reading rate very slow; and the ideas discussed in lectures and textbooks are so unrelated to their experiences that they cannot become enthusiastically motivated. Consequently, problems with communication skills (i.e., reading, writing, listening and speaking) conspire against the learning process of Blacks and other minority groups. Frustration dampens enthusiasm, motivation dims, and withdrawal behavior becomes evident and defeating. (p. 15)

In order to address the academic development concerns related to minority students, attention must necessarily be directed at the critical elements in the stages of students' intellectual development as well as issues such as motivation, cognitive style, and cultural relevance. Maxwell (1979) cited the work of Perry (1968) as an example of the kind of psychological construct that higher educational professionals can turn to in attempting to gain a better understanding of these elements for underprepared students. As a result of extensive interviews, Perry was able to identify nine stages through which students pass in their personal growth while matriculating in college. At one extreme (position 1) the student feels that there is ultimate truth and right or wrong answers for every question with little room for ambiguity and diversity of opinions. During the middle stages of their development students begin to accept diversity of opinion and begin to see instructors' opinions as existing among those of others rather than as authoritative viewpoints. By the time the student reaches the final stage (position 9) he "experiences the affirmation of

identity among multiple responsibilities and realizes commitment as an ongoing, unfolding activity through which he expresses his life-style" (p. 10). Thus Maxwell holds the view that developmental and remedial education specialists should use Perry's scheme in planning their courses because "developmental skills courses are meant to help students move to a position at which they can accept and learn intellectually demanding course material" (1979, p. 207).

Maxwell also discussed cognitive style (field dependent vs. field independent), locus of control, and self-concept as important psychological constructs which must be considered when planning for the academic development of underprepared students. Her comments on the topic of locus of control in relation to disadvantaged students are particularly revealing. She claimed that:

Disadvantaged students are often said to have a sense of being controlled by external events; they feel powerless over their own lives. Since they feel unable to manage their environment and to obtain rewards by their own behavior, they may attribute their failing grades to teachers' discriminatory attitudes against them rather than to what they did or did not do. A number of programs have reported that counseling helps underprepared students develop a realistic sense of both personal and collective power, which seems to be a necessary prerequisite for succeeding in academic courses (1979, p. 212)

Witkin's (1976) claim that field dependent students show a clear preference for domains that feature interpersonal relations, such as social science and elementary education, whereas field independent students prefer domains in which analytical skills are important, such as the sciences, mathematics, and engineering, highlights the importance of considering issues related to cognitive style when efforts are made to recruit and retain minority students in the sciences. As was discussed in the previous chapter, minority students often exhibit field dependent characteristics due to culturally related factors. Thus, the implication for these students is two-fold: in the recruitment phase of programmatic efforts, attention should be given to encouraging talented students toward the sciences who, due to cognitive style inclinations, might otherwise pass up the opportunity for a rewarding career in the sciences; and in the retention phase there is a need to incorporate a

consideration for cognitive style preferences into the student development processes. As an example of this latter concern, Maxwell (1979) reported on the outcome resulting from one programs' incorporation of the training of women and minority freshmen as tutors in the sciences into its processes. She indicated that "They continued in these majors and stated that the tutoring experience and role gave them status with their friends and an opportunity to help others" (p. 211).

As has been alluded to, one of the major problems associated with the effort to direct attention at and promote the intellectual development of minority students in higher educational institutions is that these students (as a group) often exhibit behaviors and dispositions which suggest to some instructional and academic support staff members that they are inherently deficient in certain cognitive capabilities necessary for advanced intellectual pursuits. However, an exploration of this issue by certain authors in a 1976 volume by Messick & Associates on the implications of cognitive style and creativity for human development lends substantial credence to the position that not only is this not the case but that direct measures can be taken, within the curriculum processes of the institution, to assist students to demonstrate their innate creative and intellectual abilities as well. For example, Cole made the following statement about the need to consider content, structure, and context when judging performance outcomes:

Several lines of evidence, including my own research, have caused me to conclude that people are not content-independent information processors with two levels of abilities. Nor are they consistently good reasoners, or good spatial manipulators, in everything they do. Rather, abilities represent the interaction of content, structure, and context. (1976, pp. 162-3)

In a related discussion of the issue, Gordon (1976) stated that attention should be directed at finding "an appropriate match between differential learner characteristics and differential characteristics of the learning experience" (p. 169) instead of focusing on a "match between the dominant pattern of intellectual characteristics and the outcome, rather than the process, of the learning experience, emphasizing a relationship between preferred

mental modalities and vocational choice" (p. 169). He also claimed that many factors other than mastery of specific cognitive abilities help determine a person's success in a given field of endeavor and that the opportunity for individuals to develop the needed cognitive abilities must be considered as well. On this latter point he stated:

Another consideration: one ought to explore the possibility that the level of ability an individual has attained may be related to the opportunity he has had to develop it. Given Lesser's interpretation [in a previous chapter of Messick's book] that cognitive abilities are probably culturally determined, it seems that the opportunity to function in an area may contribute to the quality of subsequent functioning in that area. Whether one argues as a genetic determinist or as a cultural determinist, it seems clear that the interaction of the individual's basic cognitive pattern with the opportunity to express that pattern may enhance its function. Further, the opportunity to utilize an alternative function may result in the alternative's accelerated development. A prediction made simply from having determined status at a particular point in time may not be adequate. One needs to look at the interaction of the basic pattern with the environmental support for its expression and its possible subsequent level of expression. (P. 171)

Furthermore, Gordon contended that the integration of affective (or noncognitive) and cognitive factors, as well as the compensatory role of motivation must also be considered when investigating the quality of intellectual functioning.

In a much earlier article, Cohen (1969), while addressing the issue of cognitive style and cultural conflict, made certain observations and claims which not only corroborates the positions of Cole and Gordon, but contain additional implications for the clarification of the academic situation of minority students as well. She observed that "the literature indicates that cognitive styles are independent of native ability and that they are definable without reference to specific substantive content" (p. 829). However, according to her, achievement in the traditional school setting depends heavily on an analytic approach to cognitive organization and those who possess a nonanalytic or "relational" style are at a definite disadvantage. She made a distinction between "deprivation," "culture difference," and "culture conflict," and claimed that the first two have to do with the quantitative (deprivation) and qualitative (culture difference) content of information respectively, whereas culture conflict exists when there is an incompatibility between cognitive styles, such as

between analytic and relational styles. But perhaps her most significant findings relative to minority students were that "highly intelligent high-relational pupils were found, in fact, to communicate best with the demands of the school on the concrete level" (p. 840) and that "their ability to reach higher levels of abstraction through relational pathways take them farther away from the higher levels of abstraction reached through analytic pathways" (p. 840). Thus it seems that, unless this situation is addressed in the curriculum and instructional processes of the institution, students who are intellectually capable but "high-relational" in their cognitive orientation could find themselves experiencing increasing difficulties as they attempt to advance through the traditional academic curriculum. Furthermore, this concern is even more crucial in the sciences where analytical reasoning is so essential and the material content becomes progressively more abstract as students advance.

Scott (1981) addressed some of the concerns expressed by Cole, Gordon, and Cohen when he proposed some possible solutions to the communication and socialization (into the academic system) problems of first and second generation black students. In order to assist students to communicate more effectively Scott called for faculty members to: 1) recognize and conceptualize the cognitive and affective factors which account for the existing kinds and levels of communication among students; and 2) implement corrective action to help students develop (or improve) their interpersonal skills. On the issue of socialization, Scott proposed that faculty members should "resocialize" black students so that they exhibit the desired behavior. Two examples given by Scott are contained in the following statements:

For example, it ought to be quite evident that if first generation blacks are socialized to attend college for purposes of getting a "good job" after four years of college, it will require considerable resocialization to motivate and prepare these students for graduate and professional study. If black college students are socialized to achieve short-term success in their homes, and local communities, it should be obvious that these students will need to learn how their previously successful behavior is capable of being modified for continued success on college campuses. (p. 229)

In the volume by Messick & Associates (1976), Pelz addressed the concern for environmental support for the expression of the "basic patterns" of cognitive functioning by exploring what he promoted as the essential ingredients for colleges and universities to nurture the creative problem solving capacities of their students and staff. They deal with competence, curiosity, self-confidence, and involvement among students and staff alike, and, according to Pelz, these qualities reinforce each other in the creative problem-solving process. Thus Pelz insisted that institutional processes should promote learning as "a process of active seeking rather than passive absorbing" (p. 235) to build competence; instructional activities which stimulate curiosity, such as self discovery and group projects; the building of self-confidence or "intellectual independence" through shared decision making; and the development of a strong commitment to creative problem solving and research activity through involving members of the academic community in the various processes of the institution. As a final comment, it is quite apparent that, in light of all that has been stated about the status of minority students in higher education, the ingredients suggested by Pelz are not simply important but critical to the intellectual development of these students. Equally critical is their implementation within a culturally relevant and performance enhancing context.

Motivation and Anxiety

A concern for the motivation of students is one which runs throughout all levels of education. However, when discussing motivational issues, American educators often treat motivation somewhat superficially in that discussions often center around the concern for appropriate methods or classroom strategies to get students "motivated" or excited about the material that teachers want to present to them. This approach leaves a lot to be desired if one is concerned about the deeper and more subtle aspects of students' motives to perform as teachers would have them perform and achieve academically over the course of their progression through the educational system at each level. Therefore, there is a need to

focus attention on those more subtle and often hidden factors that affect students' motives to achieve (or not to achieve), especially if any meaningful interpretations of the motives of minority students are to be uncovered and explained. The complexity involved when considering motivation was implied by Hardeman (1983) when she stated that:

There are both biochemical and psychological dynamics operative in motivation. One's perceptions of self and of society produce the energy and the direction of behavior toward a goal. Energy and direction are the essentials of motivation. Clearly formulated goals generate enthusiasm. And enthusiasm triggers the necessary endocrine secretions (e.g., adrenalin, blood sugar, etc.). (p. 15)

And comments by Scott (1981) on the issue of the motivation of black students in higher education illustrate the need for a careful analysis of what is involved and an awareness of the circumstances when judgements are made about students' motivation in the academic setting. Scott made the following observation:

Many faculty frequently bemoan a perceived lack of ambition and motivation by black undergraduate students. They insist that black undergraduate students currently have more and greater "opportunities" than ever before to enter college, study and perform well, and continue graduate education, with more than adequate supports along the way. I find this assessment of the "opportunities" available to black students essentially incorrect and misleading. An "opportunity" is not a singular, unrelated event; it is a combination of favorable circumstances--almost always with an element of chance. To state that black students do not take advantage of their opportunities may be saying little more than black students do not engage in sufficient risk taking; or that some black students view their "opportunities" as extremely limited. (p. 229)

There are many theoretical constructs which have been developed to explain why some people in society have a high level of motivation to achieve and others do not. Exploration and research into achievement motivation has been quite prevalent since the early 1950's. Chapman & Hill (1971) surveyed the literature on achievement motivation and provided several definitions and descriptions of it from many sources. The following samples from their survey afford some insight into the nature and role of achievement motivation as a factor in human behavior:

The achievement motive is an underlying personality characteristic which involves a learned predisposition to attain success in competition with an internalized standard of excellence (p. 1.1).

Achievement motivation is defined as the striving to increase or keep as high as possible one's capability in all activities in which a standard of excellence applies, and where the execution of such activities can, therefore, either succeed or fail (p. 1.1).

Motivation is not to be understood as a final causal element as it may be in common-sense psychology; rather the term refers to the interaction dynamics of many factors in a given person-environment relationship involving goal-directed experience and behavior. Potential and actual motivation should be differentiated (p. 1.2).

Motivation theory is not synonymous with behavior theory. The motivations are only one class of determinants of behavior. While behavior is almost always motivated, it is also almost always biologically, culturally, and situationally determined as well (p. 1.2).

Motivation is the result of interaction between characteristics of personality and immediate environmental influences (p. 1.2).

Within the context of the present study the concern is for the nature of achievement motivation in consideration of both the entering personal characteristics of students from the sample population and their subsequent experiences on campus. A central thesis contained in a discussion of achievement motivation by de Charms (1982) raised interesting questions about the impact of the minority experience in society on the motive to achieve. According to de Charms:

An adequate understanding of human motivation demands a conception of human beings that can encompass the everyday feelings of volition, of deliberate, intentional action--the experience of personal causation. Underlying this thesis is the proposition that human action is free, in the sense that a person can, by choice, influence the future. Action is therefore not determined by physical events. Human action is not just human behavior, because behavior is determined by and reducible to physical or biological events. (p. 42)

Thus if, as de Charms suggested, basic to an adequate understanding of human motivation is the proposition that human action is free in the sense that one can influence the future, then it appears that attention should be directed at the potential implications of

this proposition for students whose backgrounds are from segments of society where the level of ability of people to influence the future is at least debatable.

In an article which explored some psychological concomitants of the black personality, Azibo (1983) reported on his investigation of "the psychological functioning of the black personality." The study was conceptually grounded in what Azibo referred to as "the psychological Blackness of Black people" and the subjects of his study (students enrolled in an introductory psychology class at a community college in St. Louis) were administered Williams' Black Personality Questionnaire (Wright & Isenstein, 1978). Measures of personal causation (according to de Charms, 1968, 1976), were then obtained through the analysis of fantasy stories. Azibo summarized his findings as follows:

In sum, personal causation was shown to be a major motivational concomitant of the Black personality. This means that as one experiences overt and covert behavior(s) induced by becoming Black and resultant of being Black [psychologically speaking], he or she experiences feelings that reinforce and energize the new personality. (p. 61)

Further, Azibo's discussion of the possible implications for interpreting and enhancing the intrinsic motivation of black people is especially important. He contended that:

The positive correlations between the Black personality and personal causation and the logic of that research ...suggests that enhancing Blackness concomitantly results in enhanced personal causation. Thus, by enhancing Blackness the primary impediment to improvement in a motivation depleted client is ameliorated: the lack of intrinsic motivational energy. That is, the degree of concomitance between personal causation and the Black personality represents the amount of intrinsic motivation available to the Black client via achieving Blackness. (p. 63)

Hence Azibo's conclusions from his study concur with the views of Cross (1973) and Stikes (1978) among others who's positions seem to suggest that an immersion into blackness (that is, the black sociocultural viewpoint) should be at the base of the psychological and educational development of black people.

It is often noted that one of the more self-defeating elements in the behavior patterns of underprepared students is the tendency to give up when confronting a challenging

situation or to refuse to experiment with ideas in order to find possible approaches to solving problems. One of the psychological constructs which helps explain this behavior is a phenomenon referred to as learned helplessness. Mark (1983) suggested that learned helplessness is "an adaptive response to situational demands" and, in part, is an outcome of attributing failure to lack of ability (regardless of effort). It is postulated as being the result of a conditioned response to a lowered expectation of success by teachers and others in society. One important implication is that those students who possess the learned helplessness disposition will not persist at school related tasks in the face of negative feedback as well as those students who have learned to press on in spite of lack of encouragement and/or occasional failures in the past.

Although most often discussed as a contributing factor in the lower achievement of girls in areas such as mathematics, engineering, and science, this phenomenon certainly seems to apply to certain minorities as well. Thus Mark's statements about the implications of the learned helplessness phenomenon for females in mathematical development might serve equally as well in partially explaining the lowered persistence level and motivation to succeed, especially in mathematics and science, often found among minorities. She stated that:

Unlike verbal skills, math skills involve new units of information and of conceptualization in order to progress into more specific and differentiated areas such as calculus or trigonometry. At each new level, a tremendous degree of persistence is necessary to master the material, persistence that is far more likely to be expended by males than by females, given the kind of socialization and expectations that each sex in our culture is exposed to. Boys have been encouraged and expected to be proficient at math, while girls have not. (p. 3)

A central thrust of this study in relation to achievement motivation is the exploration of those psychological concomitants that affect the capacity of students to do those things that are necessary for academic development to occur over a (sometimes extended) period of time. The fear of success, science anxiety, math anxiety, test anxiety, and time management anxiety, among others have been postulated to have an impact on student

development in general and on the progress of students enrolled in science-based programs of study in particular. The fear of success was first formulated as a construct to explain the motive to avoid success as a result of Horner's (1968) "attempt to explain and understand the conflicting sex-related findings of research on achievement motivation" (p. 124).

Postulated to arise as a result of the fear of losing one's "sense of femininity and self-esteem... and/or social rejection because of success," (pp. 16-17) the potential impact on students from the sample and research populations of this study is quite conceivable, especially since the majority of them are female. Zuckerman, Lanance, Porac, & Blanck (1980) conducted a study which "examined the extent to which fear of success moderates affects of choice and task outcomes on intrinsic motivation, causal attribution, and subsequent choice behavior" (p. 503). As a result of this study the authors concluded that a person with a high level of fear of success is likely to exhibit self-defeating behavior. According to them, "Such a person is less likely to strive for success (as indicated by the choice behavior of our subjects) and less likely to benefit from the achievement of success (as indicated by the attributions and intrinsic motivation of the same subjects)" (p. 511).

Canavan-Gumpert, Garner, & Gumpert (1978) described success-fearing persons as possessing a trio of achievement-related motives. According to them:

We see the behavior of success-fearing persons in achievement situations, then, as guided by three principle motivational tendencies. First, they have a strong motivation to achieve success that energizes and directs them to strive for achievement. They also possess, however, a primarily unconscious motivation to retreat from or avoid success. This motivation is likely to be aroused when they are close to achieving success and helps them to ward off or cope with the anxiety that imminent success engenders in them. Finally, these persons live with a strong motive to avoid failure that leads them to ensure that they remain as far from failure as their abilities allow. (p. 23)

The linking of an understanding of the nature of this construct to the cultural context in which it is found by these authors is especially significant to the minority experience. They stated that "the existence of a constellation of motives... becomes more understandable in light of the cultural context within which it is initiated and maintained" (p. 27). They also

contended that "the understanding of a culture and its consensually shared beliefs and values is vital to a full understanding of any common neurosis" (p. 26). Indeed, Hawkins & Pingree (1978) claimed that the findings of their study on this issue "suggest that the fear of success phenomenon can be usefully interpreted as a result of cultural expectations" (p. 545).

Fleming (1978) examined fear of success and achievement-related motives in black college women. Among her findings the following are pertinent to this study:

Among middle-class women, the hypothesis that Fear of Success would not inhibit performance on experimental behaviors was confirmed. (p. 710)

nAch [need for achievement] tended to be negatively related to the Math SAT score and to arithmetic performance in competition with males. (p. 710)

For the women of working class origin, none of the hypotheses were supported. The need for achievement was only weakly (and nonsignificantly) aroused in competition both before and after performance feedback, while Fear of Success was the strongest negative predictor of performance after feedback. (p. 711)

Success avoidant motivation,...was related to more approach avoidance conflict with respect to math and science.... (p. 712)

Thus, Fear of Success in this group exhibited a strong negative impact on a number of achievement-related activities that fall within a general class of nontraditionally feminine behaviors. (p. 712)

Science and math anxiety have also been identified as contributing to students' inability to make the kind of strides necessary to grow and develop within a science based/oriented curriculum program. Though a certain amount of anxiety is generally acknowledged as being beneficial in the learning process, an excessive amount of it can become debilitating. Mallow & Greenburg (1982) pointed to the seriousness of this situation when they contended that:

Science anxiety is a phenomenon of national scope that is well known but little understood and rarely dealt with. Like its relative, math anxiety, it paralyzes students (especially women and disadvantaged minorities) who, by any measure of intelligence and industriousness, should do well. It acts

as a career filter, preventing students from entering many fields because they fear enrolling in the science courses that are the prerequisites. (p. 356)

In another article on science anxiety by these two authors they elaborated on the impact of science anxiety on women and minorities specifically, when they claimed that:

Women and disadvantaged minorities are particularly hampered by science anxiety. Lacking many role models and facing covert (and overt) messages about their abilities to grasp science, they shy from anything technical in numbers far greater than their proportion in the population. (Greenberg & Mallow, 1982, p. 48)

Thus, given the seriousness of the situation for women and minorities in general, one possible implication is that, even among those students from these groups who arrive at the post-secondary level with aspirations of studying science and have academic profiles which suggest that they should succeed at it, subtle messages which raise doubts about their ability to succeed in science could impact negatively on their performance and persistence levels. As a matter of fact, Greenberg & Mallow claimed that science anxiety is pervasive among science majors generally and listed some of the outcomes resulting from it when they observed that:

Even among science majors, fear and avoidance of science are widespread. Many students, for example, major in biology in the expectation of going to medical school. These students are often not enamored of science and are under a good deal of pressure to get good grades. They opt for the easiest science courses they can find. They are as fearful as their friends in the humanities, but they have less opportunity to avoid science courses. Their anxiety comes out in other ways: "clutching" on exams, inability to concentrate on the material of science courses, and even physical illness. (p. 41)

Referring to the myths about science that contribute to anxiety, these authors stated that students often believe that; science is an uncreative process, science is a list of formulas, the scientific mind and the artistic mind are mutually exclusive, or science is "rigid" while art is "free."

Frankenstein (1984) listed several misconceptions about learning among students who are math anxious and presented suggestions on how to assist students to overcome them by learning how to learn mathematics. Her list included the following:

I'm the only one who didn't learn elementary school math when I should have ...I'll never be able to learn math. (p. 169)

Smart people do math fast, in their heads, and in one sitting. (p. 172)

I'm stupid if I make a mistake or ask questions in class. (p. 173)

There's only one correct answer and one correct way of solving each math problem... and only the teacher knows them. (p. 175)

Armed with these and other misconceptions about the study of mathematics and their ability to learn it successfully, math anxious students necessarily need a great deal of development in order to overcome the inherent obstacles. That this condition is pervasive, as has been found by Sachs (1982), implies that attention to it necessarily needs to be broad based. Sachs investigated the relationships among entering math skills levels, test anxiety, and examination performance for students in introductory mathematics courses at a large urban community college. The results of his study indicated that "indeed, regardless of incoming skills level, examination performance suffers in the context of related anxiety" (p. 22). As a result of an extensive review of the literature he also found that math anxiety (and test anxiety in general) is quite pervasive among students across different types of institutions (selective vs nonselective).

The personal management of time is one of the demands placed on students which has also been found to impact negatively on many. As described by Strang (1981), time management anxiety results from society's expectation about the use of time and is pervasive among the population. As he put it:

On the cognitive level, our culture instructs us that this precious asset, time, is to be managed in the most efficient manner possible. But, because this message is so strong and because its application is so pervasive in our lives, the importance of time management takes on affective overtones; we come

to fear that we will allow time to "get out of hand." We display the core attitude, time management anxiety. (p. 365)

Strang conducted a study on time management anxiety among undergraduate students at a large university and found that students sampled "commonly associated their management of personal time with feelings of anxiety: feelings manifested, for example, by embarrassment, worry, being uncomfortable, and being disturbed" (p. 367). Female students, according to Strang, consistently demonstrated more anxiety than did male students. However he did not include being minority as a unit of analysis in his study.

Performance Enhancement Factors

Neame & Powis (1981) drew an important link between motivational concerns and learning skills development in their discussion of the nature of learning how to learn. They contended that the motivation for learning is linked to the reward (either external or internal) which the learner gains through his/her time invested in studying and concluded that students must come to recognize and respond to both external and internal motivation. The nature of the link between motivation and learning was characterized by the authors as follows:

The stimuli which might trigger learning in a particular direction are many and varied, and they regularly occur in all our daily lives. The fact that many of these triggers fail to initiate learning may be that the underlying motivation in that dimension is absent, or that the trigger is either not recognized or deliberately ignored. (p. 887)

Their discussion on the personal dispositions needed to recognize triggers for effective learning is particularly crucial to the experience of minorities in light of the culturally related inhibitors (e.g. lack of self disclosure) that have been explored in this chapter. They stated that:

The important feature is to develop the ability to recognize the triggers when confronted by them and to have sufficient basic motivation, knowledge and understanding to respond appropriately and initiate learning. The response

to the trigger will also depend in part on the character of the student. He must have sufficient insight and humility to recognize that his skills in the particular area are not what they might be: that is, he must have the ability to be realistically self-critical. (p. 887)

In a study reported on by Hart & Keller (1980) students attending a large midwestern university who had performed poorly during their initial semester of study were asked to indicate the factors that could have adversely affected their scholastic achievement. The results of this study, while not surprising, documents many of the reported reasons for poor performance among students. According to the authors:

The freshmen in this study placed the greatest responsibility for their low grades on their own lack of motivation, improper study habits, and inattention to school work. A majority indicated that their failure to schedule time wisely, to develop adequate study habits, to keep up with course work, and to learn how to study well were major or moderate reasons for their lack of academic accomplishment. More than 40% reported that their inability to concentrate, lack of personal discipline, emphasis on extracurricular activities, and unrealistic idea of the amount of study required was of similar importance in explaining their poor scholastic performance. (p. 530)

The evidence from Hart & Keller's study suggests that the predominant performance impact variables for entering college students are motivation and study habits. Armbruster & Anderson (1981) were able to characterize the nature of the act of studying as a result of their survey of the literature on this issue. According to them:

The act of studying involves a complex interaction of four major variables: (1) the nature of the criterion task or goal for which the student is preparing; (2) the nature of the material the student is studying; (3) the cognitive and affective characteristics of the student, and (4) the strategies the student uses to learn the material. (p. 154)

Furthermore these authors were able to draw several conclusions from the reported research that they surveyed. Among the more significant ones were: (1) Any technique can help if it helps the student process information correctly, whereas blindly applying a particular technique is not necessarily helpful; (2) Students often need special training

before certain techniques can become effective; and (3) Students need training in self-questioning techniques.

McDermott, et al. (1980a) have documented some of the problems faced by minority students who attempt to study science at the post-secondary level. Among other factors, they pointed to the fact that many students with whom they had worked "have not developed the reasoning skills that are necessary for acquiring scientific concepts, for organizing them into a conceptual framework, and for applying them in appropriate situations" (p. 136). Blanc et.al.(1983) made a distinction between those students whose reasoning skills are at the formal (abstract) operational level and those whose skills are at the preformal level as described by Piaget and Inhelder. According to them, the evidence suggests that as much as 50 percent of entering college freshmen has not attained the formal level of reasoning, which roughly corresponds to the results reported on by Maxwell (1979) as noted earlier. This situation is especially critical in the sciences since a high level of abstraction and concept identification is important, even for many, if not most, introductory courses. And if, as these authors state, those students who operate at the formal level are able to "perceive a series of concepts as an integrated system," while others "may see only a series of facts to be memorized under an arbitrary heading," (p. 82), then the prospects for students in the latter group who attempt to pursue a program of study in the sciences will be very slim until the necessary cognitive skills are mastered.

Armbruster & Anderson (1981) contended that "expert" students follow a definite sequence of strategies in gaining comprehension of course material. According to them:

Expert students engage in study strategies that draw on their cognitive and metacognitive abilities. These strategies include (1) focusing attention, (2) encoding (getting the information from the page into the head), (3) monitoring comprehension, and (4) taking corrective action when comprehension fails. (p. 154)

Neame & Powis (1981) also addressed this issue by outlining six basic steps in the learning process. They were given as; (1) recognizing areas of deficiency, (2) perceiving and recognizing appropriate triggers or cues which initiate and orientate study, (3) defining the scope of the material being studied, (4) seeking and gathering relevant data and information, (5) critically evaluating the data for validity and relevance, and (6) integrating the newly derived information with existing knowledge.

The behavior patterns exhibited by students while participating in the curriculum process of their particular programs of study have also been found to be significant. A small scale study with this type of focus was conducted at a prestigious eastern institution and was reported on by Lin (1982). Lin investigated the behavior of students enrolled in a Physics course in an attempt to gain some insight into why the quality of performance often seemed immune to efforts by instructors to improve the presentation, delivery, format, and content of their courses. He relied primarily on interviews with enrolled students to gather information, although a questionnaire was administered to inquire about problem-solving styles and study habits. The kind of insight that Lin was able to gain about student behavior in relation to that expected of students was quite revealing, especially since this particular institution is highly regarded and one would expect that students' behavior would more closely resemble that of the "ideal" student. For example, in discussing the students' response to his inquiry about how they studied their textbook Lin made the following observation:

Despite the fact that my question made no reference to assigned problems, an overwhelming majority of students reported that these problems significantly influenced what they studied in their textbooks. They attempt to minimize "unnecessary" (i.e. not problem-set related) reading. Their primary focus (almost their only focus) is on getting the problem set done. Further discussion revealed that only a few did the example problems with the book closed; the rest just said they followed them in the book. (p. 153)

As far as the students' approach to getting the problem sets done is concerned, Lin found that students tend to try to get them done in as short a period of time as possible with little

priority given to mastery of the content. These and other examples illustrate the kinds of behavior exhibited by students whom Lin characterized as "grade motivated" students. His description of many of the performance behaviors of these students typifies much of what has been witnessed and reported on about disadvantaged and underprepared students.

According to Lin:

The prototypical grade-motivated physics student takes the course because it is required. His problem sets and exams are often incoherent and illegible; they contain an occasional picture, equation after equation without words of explanation, undefined symbols, and many numbers. In class, he often asks "What will the exam cover?" and "Are we responsible for that?" At home, he works only when assignments are due or tests are pending.
(p. 152)

Summary -- The Collegiate Experience and Minority Students

In this section a broad range of issues and concerns germane to a thorough understanding of the problem of this study were identified and explored. From the kind of institutional environment in which minority students often find themselves, to the circumstances of their academic development, their motivation to achieve, and their ability to enhance their performance, a host of factors, both documented and postulated, which help explain the context and nature of the problem were examined. Consequently a comprehensive framework from which to synthesize the many facets of this investigation was established.

Post-Secondary Mathematics and Science Achievement

As students proceed in the study of science and mathematics at the college level, the degree of their success or failure at each stage will depend on a combination of their prior preparation, the extent to which they exert the effort needed, and the extent to which institutional resources are directed at meeting the academic development needs of these students. This section explores crucial issues related to all three concerns. Issues related to

students' general academic development in mathematics and science are investigated. Discussions of issues more specific to minority students are integrated into the general presentation.

Academic Development in Mathematics

Other than proposals such as those to individualize instruction, operate mathematics learning centers, promote mastery learning, conduct small group sessions, and other classroom based forms of addressing the problems of students who are deficient in the skills needed for the successful study of mathematics at the post-secondary level, there exists only a relatively small number of references in the literature which address the general concern for student development in the learning of mathematics. That is, little attention seems to be directed at comprehensively and programmatically meeting the many needs of students who possess a wide variety of deficiencies by considering the host of academic development factors that have been explored in this chapter. However, the pervasiveness and seriousness of the situation was documented by Maxwell (1979) when she noted that researchers have determined that "over half the college freshmen in this country have not reached the level of formal operations, which is necessary to understand the abstract concepts required for modern college preparatory and college mathematics" (p. 335). Other barriers to the learning of mathematics by underprepared students, as cited by Maxwell, include; difficulty with the language and symbols used to communicate mathematical ideas, poor instruction, inadequate curriculum construction, virtually unreadable textbooks, poor problem solving and reasoning skills, and math anxiety. For minority students, the problems resulting from cultural differences, as have been explored in this chapter, would apparently serve to exacerbate this situation.

Among those who have explored general academic development issues relative to the study of mathematics at the post-secondary level, Page (1984) made a broad appeal to mathematics educators to develop new initiatives in meeting the needs of "widely differing

populations" by revolutionizing their intellectual, philosophical, and social perspectives. He claimed that instructors need to attend to what they convey to students about mathematics and its value, and how the communication takes place. He elaborated on this concern by stating that:

Implicit in each of these factors is the realization that effective learning is rarely possible if teachers of mathematics cannot introduce and develop concepts in a manner commensurate with their students' information - processing abilities and levels of understanding. This realization subsumes an awareness of the fact that a large constellation of behavioral patterns may be at work in predisposing students to success or failure in their mathematics courses, particularly so at the basic skills level. Thus, teachers of mathematics must appreciate individual differences and understand how psychophysio-social factors impact on styles of learning. (pp. 6-7)

Page also stressed the need for instructors to become aware of their own cognitive preferences when he noted that:

The nature of interaction conducive to learning will vary according to the student's background and psychological profile. Since setting, ambience, and interaction are interrelated, it is not immediately clear if students' classroom inactivity result from culturally-related reasons, because they are consciously (or unconsciously) separating and disinvesting themselves from classroom instruction, or because they feel anxious and uncomfortable in the educational environment. (pp. 7-8)

Thus Page recognized the need to consider cultural, as well as psychological, differences in the mathematics classroom at the post-secondary level and urged instructors to become alert to the nuances involved in order to plan strategies that better meet the needs of diverse student populations. Other general principles which Page considers crucial in the mathematical development of college students were stressed through his suggestions to instructors, which were accompanied with examples to illustrate his points. He strongly urged instructors to; assist students to gain a thorough understanding of concepts through "multimodal" representations of them and providing opportunities for experimentation, present key notions and important principles in a way that illustrates their utility for solving various classes of problems, help students improve their ability to reformulate and

restructure problem representations, anticipate and preempt students' misinterpretations, assist students with information management (through the way exams are constructed, how homework assignments are structured and questions are phrased, interactive discussions, term papers and projects, and serving as role models in solving problems), stress the importance of verification and analysis, and encourage students to become partners in "an interactive collaborative learning environment."

Covington & Tiballi (1982) recommended applying Bloom's Taxonomy of Educational Objectives (which are based on separating out precise levels of learning from knowledge to evaluation) in developmental mathematics courses. They made their case by stating that:

In effect, Bloom's Taxonomy not only offers clarity in communicating objectives but also precision in lesson planning and intellectual development--especially appropriate in the remedial/developmental math classroom. For if any group of students needs a carefully designed structure of progressively difficult learning activities, the developmental students need it. Usually such students have an intense fear of math based on feelings of incompetence in basic computation, understanding math word problems, or in general, anything having to do with mathematics. (pp. 4-5)

According to the authors, through the use of Bloom's taxonomy, instructors could assist students in gaining confidence and reducing their feelings of anxiety, as well as move more students from the basic levels of learning (knowledge) to more complex levels (analysis, synthesis, and evaluation) through precise formulation of behavioral objectives. They also provided several examples to demonstrate the activities and classroom practices that could be used to bring about the desired student development that they advocated--see Table 6 for one example.

Another example of a strategy to bring about increased student development in the mathematics classroom was reported on by Keith & Keith (1985) who proposed that mathematics instructors should use writing activities to complement other teaching techniques and improve students' learning of mathematics. They used writing assignments in freshman-level pre-calculus courses and stated that their aims were:

- 1) To facilitate their [students'] learning and retention of basic concepts;
- 2) To give students some experience in various types of writing relative to mathematics; namely, on the spot and overnight summaries, reaction journals, expressive writing relative to their feelings toward math and their problems in learning mathematics, problem-definition and description, and demonstrations of comprehension in tests, etc.;
- 3) To provide the instructor with feedback concerning students' grasp of and facility with those concepts in a way that would facilitate our interaction as teacher and student. (p. 2)

According to the authors, students need assistance in learning precision with the language of mathematics in order to gain an accurate understanding of concepts and they suggested that student-teacher interaction through the use of writing assignments facilitates this process. They concluded that the use of writing assignments will; 1) improve class participation, 2) challenge even the better students, hence broaden opportunities for conceptual growth, 3) stimulate discussions and demystify the language of mathematics, 4) help students appreciate the need for explicitness in communication, 5) force math educators to consider curriculum implications, particularly at the college level where "departmental controls and tight schedules provide little room for the kind of discursive trial-and-error approach to learning that writing assignments can make available in the mathematics class" (p. 9).

Page's (1979) discussion of a small group strategy for enhancing the learning experience of students in mathematics courses illustrates one of several ways of organizing mathematics instruction at the college level. Page had four major objectives in mind when he developed his strategy; 1) To maximize student learning by encouraging students to ask questions, 2) To ensure the active participation of all students by motivating the weaker students to work beyond their normal level and encouraging better students to serve as tutors as peer guides -- thus encouraging all students to probe further into their understanding of the topics, 3) To assist students in discovering why certain procedures work, thereby giving them insight into how they can learn and teach themselves properly

posed questions, and 4) To demonstrate that mathematics is a lively, creative, and meaningful means of communication through the positive learning process gained from student interaction and feelings of academic fellowship. With these lofty objectives in mind Page explained that this strategy involves dividing the class into groups of equal or almost equal size with roughly the same proportion of stronger, weaker, and average students. Four or five problems are then selected and assigned to each group and a fixed time is given during which the groups should work on the problems. The groups are then ranked according to the number of worked out problems (meaning all members understand and are able to explain them) at the end of the fixed time interval. Groups compete according to a set of rules governing presentation of problems and challenges from other groups, etc. and members of winning groups are rewarded according to a previously agreed upon plan (e.g. each member receives additional points towards the final grade). Page suggested that group compositions be changed for each session to encourage work with others in the class and he concluded that after a few sessions "this strategy will loosen up the class, increase its familiarity with the procedures, and ensure that all the objectives (1) - (4) are realized" (1979, p. 858). However, he did not present any evidence or data to substantiate his claims, nor did he mention any plans to conduct a study to investigate the effectiveness of his strategy.

One example of a programmatic effort to meet the general academic development needs of students in mathematics was reported on by Maxwell (1979). This program consisted of a comprehensive learning system for underprepared engineering freshmen which coordinated counseling and class lectures with tutoring, workshop sessions, and help sessions. Called the "quasi-modular approach," it offered the following features: 1) two specially designed developmental math courses were integrated into the regular curriculum; 2) specially prepared, challenging modules, which used project-type problems, were used to assist students who had deficiencies in arithmetic or algebra; 3) classroom methods which consisted of lecture, followed by work sessions, followed by individual

consultations; 4) a time frame to complete the courses which was flexible and tailored to meet individual needs, with the objective of preparing students for calculus; 5) remediation in English which was included as a concomitant, but independent, part of the program; 6) a science-engineering club to provide students with an awareness of career opportunities and a social environment. According to Maxwell, the fact that this approach included lectures as a central feature was critical because students were able to become accustomed to this standard form of presentation from the beginning rather than having to confront the additional burden of adjusting to it later.

Another example of a program to assist academically deficient minority students was reported on by Treisman (1983). This program, called the Mathematics Workshop, was conducted at a prestigious western university and had five functions: (1) To build a community of minority freshmen who were academically oriented and a source of peer support; (2) To provide minority students with extensive orientation and ongoing academic advising; (3) To monitor students' academic progress and adjustment to the University environment, and advocate their collective and individual interests; (4) To provide students with ongoing supplementary instruction in reading and writing the technical language of mathematics, and assess their understanding of mathematical concepts and problems; and (5) To link high school-level and undergraduate-level affirmative action efforts. According to Treisman "The ultimate aim [of the program] is to develop independent learners who can function effectively beyond their sophomore year" (p.4). Some of the distinguishing features of this program included; structured study groups which were formed before classes started, in-depth interviews and screening tests which were conducted during the students' first week on campus, personally designed academic plans for each student with monitoring performed by a sophomore student who also served as a buddy, a non-remedial emphasis in the operation of the program, and provisions made to have program students serve as informal tutors and advisors for area high school students. As evidence of the success of this program, Treisman cited the following facts; that the average grade of the

first-term workshop students was B- whereas the average grade of their non-workshop counterparts was D-, that none of the workshop students failed to complete his/her mathematics class even though almost half of the non-workshop minority students failed to do so, that none of the sixty workshop students had left the university by the end of the academic year despite the fact that thirty percent of the overall minority population drop out, and the fact that all but five of the workshop students completed their second year at the university whereas over fifty percent of all black students from the same entering class had dropped out. However, Treisman did not include any data on the levels of mathematics courses to which workshop students had progressed.

Academic Development In Science

Underprepared students who intend to study science and technical fields of study at the post-secondary level confront a host of academic adjustment problems, especially with respect to the expectations of instructors and staff members of most institutions. Maxwell (1979) has identified several problems confronted by students who study science generally, and she indicated that students might experience trouble with a combination of them. They are: the information explosion, mastering terminology, visualization skills, reading skills, problem solving, and method of instruction. She cited chemistry as the most difficult course that large numbers of students must take. McBay (1978) listed some of the barriers to the successful study of science that confront black students upon entering college, including the following: lack of experience in the analysis and interpretation of data and in the experimental method of inquiry; inadequate problem-solving skills, study habits, and standardized test performance; trouble with scientific or mathematical language; lack of a firm commitment to science; absence of role models; lack of financial resources which forces students to work excessively; uncertainty about long term rewards; and uncertainty about job availability. She also claimed that the scientific disciplines themselves contain

certain barriers, among them being; a mastery of basic and advanced mathematics, long laboratory hours, numerous required courses, and little obvious financial or other reward.

As a result of their investigations into the major problems confronting minority students in the sciences, McDermott et al. (1980a) were able to identify certain limitations that, according to them, minority and other academically disadvantaged students bring with them to the study of science. They are; lack of experience on which to build the abstractions of science, weakness in mathematical and verbal skills, lack of confidence in their ability to solve problems through their own reasoning, and low personal standards for academic achievement. As was mentioned in Chapter I, they stressed the fact that no allowance for these limitations is usually made in mainstream science courses, and they concluded that most of the difficulties experienced by these students cannot be remedied in the traditional science lecture courses. Furthermore, according to them:

The fact that many of these same problems also exist among second and third year students indicates that time and the university environment alone cannot be relied upon to solve them. What is needed is instruction in which concrete experience and individual attention foster the development of intellectual skills, study habits, and self-confidence along with subject matter understanding. Several scientific disciplines can serve this purpose. (p. 135)

Among the specific difficulties that impede student progress in science courses, McDermott, et al. listed, confusion of two concepts that apply to the same situation, lack of connection between reality and representation, problems with scientific reasoning, and inability to reason by analogy and to transfer to a new context.

As it is with minority students' academic development generally, the implementation of processes to enhance their development in the sciences must necessarily include a consideration for the many cultural factors which impact on their ability to function successfully within the traditional academic structure of higher education institutions. Watson (1977) made the following observation about this concern:

Because scientific studies are more rigorous, and since science is seen to be more distant from our daily lives and cultural experiences than the humanities and the social sciences, a student, to be successful as a science major, must become acculturated in a "distinctive" subculture - a subculture that is rigidly based on logical and quantitative analysis, the precise use of language and terms, and long, tedious hours of problem sets and laboratory work. (pp. 98-9)

Young (1981) and Maestras (1977) concurred with the views of Watson and both of them pointed to the cultural conflicts that can arise when minority students study science.

Referring to the black experience Young stated:

The absence of positive affect in science teaching deters blacks from science (and probably many other students). Although generalizations have many exceptions, research has verified what most blacks already know and believe about distinct differences in priorities, perceptual frameworks, and communication styles between the black and dominant cultures. Black culture generally places stronger emphasis on the affective domain. There is a sense of pride in the black community in being people-oriented and sensitive to feelings. Blacks often evaluate the affect of a situation before making a decision on the cognitive content. (p. 264)

And Maestas described a particular kind of conflict often confronted by Mexican-Americans and American Indians when he maintained that:

In that subset of society occupied by scientists, however, a few matters tend to aggravate the rejection that is felt by the minority person. A part of this rejection has to do with the way that terms are defined. For instance, thinking and discourse in science are "rigorous." The opposite of that, as the minority student perceives the definition, is the method by which members of his or her culture have gained knowledge and passed it down from generation to generation. The result is that even the method of his or her own reasoning is placed in doubt. (p. 62)

In order to meet the needs of underprepared students, Roueche & Snow (1979) claimed that developmental education efforts and programs should contain the following elements: well-defined and operationalized philosophies and rationals; well-developed plans for the identification and placement of students; integrated programs within a division or department of developmental studies; well trained counselors and learning skills specialists; a staff which is self-selected and specially trained, especially in counseling; and

developmental courses that last a year or more and which include; 1) a total learning system, 2) multiple entry levels into carefully ordered course sequences, 3) personal and professional involvement of all staff, and 4) a willingness to deal with student problems on generalized fundamental levels. Maxwell (1979) reviewed the reports on several efforts to improve science skills among students and found that many programs, particularly at large universities have come to rely on science specialists or graduate students to provide supplemental assistance to students within the traditional structure. In some instances learning centers have emerged which include assistance with basic science courses and preparation for admission examinations for professional schools. In other instances skills specialists or regular faculty offer tutoring and skills training through an academic department.

Kolz & Snyder (1982) and Brouwer (1984) have proposed representative methods of assisting students with their development of problem solving skills in chemistry and physics respectively. Kolze and Snyder actually were concerned about boredom among students enrolled in a large lecture section of a chemistry course and the subsequent inattention to instructors' efforts to explain important concepts and problem solving techniques to them. Therefore, in order to encourage students to actively think about the course material and participate in class, they decided to develop lecture handouts which contained problems that students were required to solve at some point during the lecture. The authors noted that, although the use of this method reduces the amount of "talking time" available during lectures, the payoff is that once students become accustomed to having to do something during lectures they become much more involved and more likely to try to clear up misconceptions that they might have or find errors that they might have made. Thus they claimed that students will become engaged in the kind of information processing needed for "real learning."

Brouwer's proposed problem posing model of instruction in physics was based on an analogy with Freire (1970). He was concerned about the use of the banking concept of

teaching (as discussed in Chapter II) that pervades in science instruction, a concept which treats students as objects in the learning process. In the problem posing model, however, students are active partners in the adventure of learning. On this facet of the model

Brouwer stated that:

A fundamental element of this method is dialogue or interaction. The teacher does not bring people the message, but through dialogue, he makes them aware of their situation. The teacher regards the people he encounters as co-investigators; the teacher must have a profound respect for the people with whom he interacts, a faith in their own ability to analyze, to develop, or recreate their conceptions or reality to become more fully active as human beings. (1984, p. 604)

Furthermore, according to Brouwer, a main assumption inherent in this method is that students learn best and more quickly those things that have become important in their lives--an especially critical concern especially for minority students. This factor was a central element in Brouwer's statement which, in essence, defines problem-posing education as developed by Freire, and also contains important implications for minorities, in light of their experiences in society. According to Brouwer:

This method of education then begins with people (students) in the situation in which they exist, creates in them, through dialogue, an awareness of that situation and its limitations, presents them with alternative possibilities or modes of existence, and then guides people in applying their new insights to the world in which they exist. (p. 604)

In presenting his model, Brouwer listed four rules of instruction which he hoped would also provide a way of designing workshops on science teaching for university lecturers: 1) Allow students, in a problem situation, to make explicit their own preconceptions or hypotheses concerning the problem posed, -- the setting up of "cognitive dissonance" creates a "need-to-know" in students and helps make the problem their own; 2) Present the current conceptual explanation of the problem raised as a more sophisticated model of the topic studied--thus leave the possibility that better models will be developed later so that students will not view science as being static; 3) Apply the new explanatory models in familiar and new situations--students need to have their intuitive

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understanding developed at each level for effective future learning; 4) Test scientific understanding both conceptually and quantitatively -- students decide what's important based on tests and assignment. As a final observation, Brouwer noted that one outcome of the problem-posing model is that students often will not initially appreciate this approach and will even resist it because "there is a certain feeling of intellectual security associated with having a fairly consistent and secure conception of reality. People do not really want to be thrown into the freedom of questioning their own conception of reality in order to develop, by hard work, a new conception" (p. 604). Thus it seems that anyone wishing to put this model into practice would necessarily need to prepare for the resulting challenges associated with this phenomenon, otherwise the entire purpose might be defeated.

McBay (1978) outlined some of the strategies for removing the barriers (which she listed) to the successful study of science by black students that have been employed at several predominantly black institutions over the past several years. She grouped them as student oriented, faculty oriented, and program or facility oriented. Student oriented strategies include; summer programs, study skills/learning resources centers, tutorials, seminars and newsletters, smaller classes, innovative instructional strategies, and programs for student research and independent study. Faculty oriented strategies include study leaves, workshops and seminars, special conferences, and research opportunities and facilities. Program strategies include; equipment and facilities modernization, curriculum revisions, long-range planning, management and evaluation, use of computers in science and math courses, and adding faculty persons who possess needed expertise. She also reported on the success of one college which initiated a comprehensive effort to increase its enrollment and retention of science majors and noted that the primary factor in gaining more than twice as many science majors at this college was the summer program. She concluded her discussion by calling for more long-range institutional plans, cooperation among institutions (especially between major universities and minority

institutions, faculty training conferences, establishment of a national data bank and more aid programs for students in order to increase black representation in the sciences.

McDermott et al. have developed and operationalized an integrated program in the sciences for minority students at a large western university which contains many of the elements suggested by Rouche and Snow, as well as strategies outlined by McBay, and follows a basic approach reported on by Maxwell. Initiated in an attempt to address the problems of small numbers of minority students who were succeeding in the sciences, the program includes a three-quarter (or term) interdisciplinary course (to which recruitment and advising were coupled), a biology course, and a three-quarter physics sequence. The interdisciplinary course includes skills development efforts (such as note taking), reading in science, using the library, writing papers and reports, and health professions career information. The curriculum for the biology and physics courses were "designed to develop scientific reasoning within the context of subject matter that will be useful in subsequent science courses" (1980c, p. 262). Emphasis is placed on the interpretation, rather than memorization, of facts. In addition to curriculum and instructional innovations, the authors listed the following factors as having an impact on the success of their program: large staff to student ratio, specialized training of staff members, a good tutoring program (including a close working relationship among tutors and instructors), required attendance and homework, sound selection and placement of students, motivational strategies, and strong institutional support.

Based on her review of a study by the Retention Task Force of the National Research Council Committee on Minorities in Engineering, on the retention of minority students in engineering, Maxwell (1979) outlined what she found to be the characteristics of successful programmatic efforts at reducing attrition rates. They include; well-integrated and coordinated components with a variety of services, constant and steady evolution over several years, administratively housed in the college (or other unit) of engineering rather than being university based, effective counseling, tutoring by minority upperclassmen, and

personal interactions between students and staff members. She indicated that the task force cited admissions criteria and the quality of support services as the two most important variables under the control of the institution. Other important findings of the task force were that the faculty needs to be flexible with course scheduling and placement for freshmen students, that instructors should guard against the overemphasis on theoretical concepts, and that a part-time job might adversely affect students' performance.

Bromery (1981) provided an overview of a minority retention program in engineering at a large eastern university which had three major components; "a well engineered tutorial program, a broad based social counseling program, and a carefully designed remedial program" (p. 255). An interesting feature of the tutoring program was the maintenance of a fairly complete file on those professors from whom former students of the program took courses, including their examinations and expectations of students. Program students were tutored accordingly and tutors even attended some of the professors' lectures in order to be able to help students learn how to manage their notes and lecture materials. The counseling program included social and financial counseling, with much of it done in the dormitories. Their remedial program was designed to assist students after they recognized their own problems and requested assistance. Finally, Bromery pointed out that staff members also developed many auxiliary problems to teach students study habits and the proper use of the library.

As evidence of the success of their program, Bromery cited the 65% graduation rate of their students compared to the much lower rate prior to the implementation of their program as well as the fact that over half the students with GPA's greater than 2.5. He also mentioned career counseling to high school students (many of whom had not considered a career in science) as an important activity of their program and pointed to the initial method of funding the program (directly from private foundations to the black faculty organization), and the fact that staff members tried to make sure that students did not feel like they were part of an experiment, as factors in the programs' success. An observation

by Bromery from the results obtained from data collected on students suggests definite implications for those involved with minority student academic assistance programs in the sciences. He stated that:

Our experience with the program suggest that in general SAT scores are meaningful at the low and high ends. In the middle range, we found that there was little correlation between the college level academic achievement or grade point average and the SAT scores. (p. 258)

Among the other programs reported on in Thomas (1981), the source in which Bromery's report was found, were the Minority Introduction to Engineering Summer Program and a summer enrichment program for minority/disadvantaged undergraduates at a large midwestern university. The former program is a comprehensive effort sponsored by the Engineers Council for Professional Development. As reported on by Richards, Williams, & Holland (1981), it was operational in thirty institutions across the country and high school students were brought to the campuses during the summer between their junior and senior years in order to familiarize them with engineering and college life. The latter program, as reported on by Carey, Singh, & Pillinger, was "basically designed to sharpen the academic skills of the disadvantaged/minority students and to familiarize them with the subculture, norms, and expectations of the university environment" (p. 295). Courses taught were Math, English, and Personal Orientation (how to study and succeed in college), and the program included continuous counseling, individual tutoring, and close monitoring of students by faculty and staff members. Among the keys to success, the authors pointed to a "holistic" approach, competent and sensitive program sponsors and administrators, and pre-exposing students to the norms and subcultural expectations operating in most large, complex colleges.

Among programs reported on in Melnick & Hamilton (1977), were three health careers summer programs and an undergraduate research training program. One of the health careers programs, as reported on by McGinnis and designed for entering freshmen at a small historically black college, was quite extensive in that it not only offered courses

in the sciences, an English course, and a problem solving course, but it also "provides the students an orientation to health (meetings with health professionals and curriculum planning) and an introduction to the social aspects of health policy" (p. 212), and included a preceptorship program with local physicians, hospitals, and medical schools, in which the health-care delivery problem in Mississippi was emphasized. Students also worked for eight to ten weeks at hospitals, medical schools, comprehensive-health centers, and private clinics. As evidence of the success of the program, McGinnis indicated that enrollment in science curricula at the college more than doubled in three years and over half of that fall's entering freshman class planned to enter a health career, compared to 10% a few years earlier. Two achievement related indicators were the fact that grades of students who had participated in the program were about 0.5 grade points higher than those of other science students and the fact that scores on standardized examinations had risen from a mean of 12th percentile to 28th percentile.

The undergraduate research training program, as reported on by Hamilton, was established at a graduate school of biomedical sciences at a large university in the south, and was aimed at increasing the number of minority graduate students in the biomedical sciences. Undergraduate students and faculty members from predominantly black colleges were recruited for research training at the Oak Ridge National Laboratory as well as in the school's graduate training program. Students worked 30 to 40 hours per week in the research laboratory and spent 5 to 10 hours a week in biomedical sciences courses and seminars. As evidence of the success of the program, Hamilton cited the fact that 60 of 67 participants graduated, 23 went on to medical or dental school and 18 went on to graduate programs. Finally, Hamilton offered some recommendations as a result of his experiences with the program which should be of interest to anyone involved with science education or health careers education. He concluded that the biology curriculum should include courses in cell and molecular biology and biochemistry, and biology majors should take mathematics through calculus, as well as a course in physical chemistry. Furthermore, he

found that minority students were weak in quantitative skills and thus should be given plenty of opportunities to practice and exercise these skills.

Summary--Post-Secondary Mathematics and Science Achievement

It is evident from the explorations of this section that, while students' previous preparation is crucial to their prospects for success in mathematics and science, there exists a variety of ways to assist them with their academic development and performance at the college level. As was made clear in the previous section, there is also a strong need for a thorough understanding of students and their dispositions if measures directed at elevating their performance levels are to be successful.

Related Research and Previous Studies

Pre-College Math and Science Achievement

Studies which focus on the early experiences of minority/disadvantaged students such as those by Kornbluth & Sabban (1982) and Marrett (1982), highlight the importance of considering many culturally impacted experiences and dispositions of these students when searching for predictors of their subsequent academic performance in mathematics and science. By conducting a study with eighty-four fifth graders enrolled in a Title I math program for underachieving disadvantaged students and determining their cognitive style preferences (field-dependent vs. field independent), Kornbluth and Sabban were able to investigate "the interaction between cognitive style and study method on the mathematical achievement of disadvantaged students" (p. 135). In addition to the expected result (based

on the results of previous studies) that field-independent disadvantaged students performed better than field-dependent disadvantaged students, which "may result from the preference of field-independent students for analyzing and imposing organization on poorly organized stimuli, and their ability to ignore distracting cues" (p. 138), the authors also found no difference between the two groups in their performance in the individual (vs. group) study method. They stated that their study "indicated that for disadvantaged students at a lower level of mathematics achievement the individualized study method has its advantages: field-dependent students were able to overcome their difficulties and achieved as well as field-independent students" (p. 139), and they attributed this finding to the students' need to work at their own pace while receiving individual guidance and immediate reinforcement. Thus one implication of the findings of this and other similar studies is that the method of organizing instruction in mathematics and science and the type of support provided can impact on the academic achievement of disadvantaged grade school students. As a matter of fact Marrett (1982) found that the organizational pattern of the school itself (e.g. teacher involvement in decision-making) could affect the enrollment tendencies of minority males and females in high school mathematics and science courses.

Results from studies by Gerace & Mastre (1982) and Moore (1982) on the learning of mathematics by Hispanic and American Indian students respectively not only further documented the need to consider cultural influences when planning for instruction in mathematics and science for minority students, but revealed ideas for further specific areas of research and suggested ways in which educators can enhance the learning experience for these students as well. Gerace and Mastre's study, which made use of clinical interviews, was focused on the cognitive development of Hispanic adolescents while learning algebra. According to them:

It was found that students preferred not to use algebraic techniques in solving problems, were poor at verbalizing definitions and procedures and at translating problem statements into equations, did not use their textbooks very much except as a place to find assigned problems, and treated algebra as a rule-based discipline, not as a concept-based one. (p. 1)

After an extensive exploration of the cultural issues that might influence the dispositions of minority students in the learning process (e.g. cognitive styles and others which were explored earlier in this chapter), they suggested that further research be conducted with questions such as "Why are students inclined not to read their mathematics textbooks?" (p. 97) and "How do programs that combine career counseling and role models affect the attitude and motivation of minority students to pursue mathematics?" (p. 98). Their recommendations stressed, among others; the need for students to participate in the learning process, the desirability of attaining harmony between the pedagogic style of the teacher and the textbook, the need to hold students responsible for reading the textbook, the placing of emphasis on precision and consistency, the feasibility of using microcomputers, and the need to demand that students verbalize the rules, strategies, definitions, and procedures that they employ in solving problems.

Moore's study investigated "those elements of the Navajo culture that potentially impact either positively or negatively upon a Navajo student's attainment of mathematical concepts" (1982, p. 3). The specific areas of his investigation included language differences and patterns, the role of folklore among American Indian cultures and its significance for mathematics learning, the use of memory in mathematics learning, imaging in problem solving, conservation of concepts such as weight, shape and area, and the impact of cultural traditions such as the importance of clans in Navajo culture. Among the observations made by Moore, based on the results of his investigation, the following are noteworthy: 1) There are no words in the Navajo language for certain English words, such as if, multiply, and divide, which are important in learning mathematics; 2) The quest for unity, harmony, order and beauty in the Navajo culture is consistent with "those views of the greatest contributors to the development of mathematics"; 3) The evidence suggest that some Native American students do not readily accept hypothetical thinking, thus possibly affecting their problem solving capacities; 4) The importance of memory in American

Indian cultures can be used to the advantage of Indian students if carefully considered in the instructional process; 5) There is a need to further investigate "the degree to which conflict between a first language and a second language in which a problem is phrased affects the process of solving problems" (p. 18); and 6) When certain cultural traits, such as the apparent characteristic trait of "slowness" among a certain Navajo clan are perceived as negative traits in the classroom, students from that cultural background can be adversely affected. Perhaps the major implication from these and other observations by Moore is that mathematics educators need to become thoroughly aware of cultural factors that might impact classroom learning by students in order to better plan for the appropriate responses to them in the instructional process. As was repeatedly intimated by Moore in his discussions, a major restructuring of the curriculum and approaches to teaching are not necessarily needed to accommodate this consideration, but educators will be in a much better position to enhance the learning experiences of all of their students if they more thoroughly understand the possible consequences of the many subtle factors uncovered in his investigation.

Tina Jacobowitz (1983) conducted an investigation into the factors which affected the science career preferences of black eighth grade students. She found that, although males, and females had similar mathematics achievement scores, sex was the strongest predictor of science career preferences (thus indicating strong sex-role considerations), and that "results of the data analysis indicate that science self-concept accounted for a significant proportion of the criterion variance" (p. 526). Indeed, the fact that females in general continued to exhibit math/science performance inhibitions because of sex-role patterns of behavior into the decade of the 80's has been documented by, among others, Wolleat, Pedro, Becker, & Fennema (1980) as a result of their investigation into the causes to which high school students attributed their performance. The subjects for their study were male and female students from ten midwestern high schools who were enrolled in college

preparatory algebra and geometry classes. In discussing their results the authors stated that:

Females, when compared to males, exhibited more of the learned helplessness pattern in their attribution of success and failure in mathematics. They more strongly than males use effort (unstable) to explain their success and less strongly than males point to ability (stable) to explain their success. When explaining math failure, females invoke more strongly than do males the attributions of ability and task difficulty (both stable). (p. 363)

Furthermore, they found that males and females reported different strengths of the causes of their performance even when evidencing similar performance on mathematics achievement tests. And they asserted that the results of the study suggested that "females' lower confidence in their ability to learn mathematics and their lower persistence in mathematics study may indeed be affected by the attributional patterns they learn to use" (p. 365). Thus, as demonstrated by the results of these two studies, performance inhibitors related to sex could tremendously impact on female enrollment and persistence in science and mathematics at both the pre-college and college levels, and hence needs to be addressed.

Another sex related performance inhibitor was investigated by Leder (1982) and the results revealed some of the complexities involved when searching for reasons why females do not persist in studying more intense levels of mathematics (and hence more advanced levels of the sciences) as well as males. Leder investigated the relationship between the fear of success (FS) construct and the mathematical achievement of seventh, tenth, and eleventh grade boys and girls in eleven randomly selected coeducational schools from a metropolitan area in Australia. She wanted to "delineate and describe sex differences in mathematics achievement and participation (if any) among the sample studied and to investigate the usefulness of the FS construct in explaining such differences" (p. 126). The instruments used in the research were a mathematics performance measure, an FS measure, and an information questionnaire which questioned students' intentions regarding further education and future mathematics courses.

Based on the data collected, Leder found that at grades seven and ten boys performed significantly better than girls despite no differences in the number or type of previous mathematics courses; that sex difference in intentions to take further mathematics courses were found only when the intensity of mathematics courses taken were considered; that the relation between FS and grade level seems to be more complex for boys than for girls; and that high FS was generally associated with higher performance in mathematics. She further observed that:

From the findings obtained it appears that girls who perform well in mathematics are more likely to be high in FS and yet that, for some, high FS tends to be incompatible with continued high performance in mathematics. Possibly some of the girls high in FS resolve their conflict situation by either opting out of intensive mathematics studies or by lowering their performance and thus no longer continuing to be conspicuously successful.... It seems likely that different girls may be affected by the FS type of conflict at different stages of their education and that resolving such conflict may be a continuing process taken by different girls at different times. (p. 133)

Leder also noted that the findings of Wolleat et. al., "that girls more strongly than boys attribute success in mathematics to unstable factors but failure to stable factors" (p. 133), were relevant to the results of her study in that this attributional pattern was inconsistent with a willingness to persist in the intensive study of mathematics.

The Campus Experiences of Minority Students

Several studies which dealt with the campus experiences of minority students were cited in the section titled The Institutional Environment. Many of the studies explored in this section are similar in scope and focus to some of those studies. However, the aim in this section was to present a comprehensive summary of the findings from among a representative sample of studies from which conclusions were drawn and observations were made about the nature of the collegiate experiences of minority students in this country. One intended outcome was to arrive at a holistic picture of the many interrelated issues and concerns which have been documented as demanding attention if one is to gain

an adequate understanding of the context of the problem of the present study and investigate it knowledgeably.

The results of a study by Koplik & DeVito (1986), which compared the personal problems reported by freshmen from the class of 1976 to those reported by freshmen from the class of 1986 at a medium-sized metropolitan university, documented the changing state and pervasiveness of students' needs and problems and suggested that students should be surveyed regularly if adequate support services are to be provided. The survey, which was conducted by the counseling center of the university, made use of four different test inventories which questioned students about their interests, study habits, attitudes, test anxiety levels, and general personal problems. Problem areas were grouped into ten categories from areas such as health and physical development to finances and employment (including adjustment to work while in college as well as prospects for a future vocation), to social-psychological and personal-psychological relations, to family, moral, and religious concerns.

An interesting outcome from the results of this study was the fact that in virtually every one of the ten categories students from the class of 1986 reported significantly more problems or concerns than students from the class of 1976, suggesting that perhaps students of 1986 found it generally more difficult to cope in a college environment than did students from a decade earlier. The authors summarized the basic conclusions of their study by stating that:

College students seem to be more trouble today than they were 10 years ago. There seems to be an increase in reported distress by college students in every aspect of their lives. In addition, there are six differences between the two classes on reported problems, differences that may reflect changes in society and the new challenges for today's students. (1986, p. 126)

About students' concerns about the future, the authors observed that:

Students in C '86 were found to worry more over future success in life than those in C '76; in fact, the most prevalent student problem was wondering if I'll be successful in life" (Future: Vocational and Educational (FVE), the

final problem area). Students feared unemployment after graduation and were concerned about choosing courses to prepare them for employment. (p. 129)

One possible implication of this seemingly dominant concern about the future is that students will not be likely to exhibit the kind of patience needed to develop adequate coping mechanisms as they would in the absence of such concern. Thus the other reported problems might become further exacerbated.

Two studies, which were conducted four years apart, compared the problems and concerns of black and other minority students to those of white students at two different large, state supported universities, one located in the east and the other located in the midwest. For the first study, which was conducted and reported on by Webster, Sedlacek, & Miyares (1979), a stratified random sample (by class and ethnicity) of junior and senior students was surveyed using a 51-item problem checklist which covered six areas of concern. The second study, by Baum & Lamb (1983) relied on information gathered from among all white and black students who sought assistance from the counseling center of the university over a two-year period of time. In addition to an 18 item checklist of personal, social, and academic concerns, the researchers used assessments of counselors to determine the frequency and nature of the problems and concerns of students from the two research groups.

Webster et al. reported that the results of their analysis revealed that only four items discriminated among the four ethnic groups, which included black Americans, white Americans, Hispanic Americans, and Asian Americans. Native American was dropped as a unit of analysis due to sampling problems. Hispanics experienced problems with "finding scholarships and other financial aid"; whites expressed more "problems of sexual adjustment" than blacks; and blacks expressed more problems in "feeling you are a victim of racism" and "experienced discrimination because of your race" than the other three groups. Furthermore, the results indicated that six factors; alienation, financial aid, study skills, residence related problems, negotiating the university system, and discrimination,

"were able to account for 86 percent of the common variance in responses from all students, regardless of racial/cultural group" (p. 167) and that "all students regarded academic - vocational issues and working their way through the university system as their biggest problems" (p. 169).

The results reported by Baum and Lamb indicated "that the most frequently presented concerns at this university counseling center were the same for both black and white students" (1983, p. 129) and "that where differences did emerge in presenting concerns, these differences seemed to be in the academic domain" (p. 129). The greater variability in reported problems by white and black students when these problems were assessed by counselors was also noted by the authors. As a result of their findings they pointed to the need for counselors not to have initial biases regarding the concerns of black students and observed that "perhaps the initial focus of counseling with many black students seeking the help of a university counseling center might be on the identification and resolution of academic problems" (p. 130).

Two studies, by Jackson (1978) and Gibson (1983), investigated the adaptive behavior of black students at large predominantly white universities, one located in the midwest and the other located in the southeast. Jackson's study examined the favorable and unfavorable adaptive behaviors of minority high risk students (mostly black) according to what he described as "six critical adaptive behaviors." According to him, his results indicated that there were five major findings of his study: that students were able to re-align expectations when they were not overwhelmed by dissonance, whereas a clustering of unfulfilled expectations caused problems; the feelings of being forced into an environment exacerbates the situation; gregarious personalities seemed to have an advantage over introverts in building relationships; students' "identification" with needed resources determined the strength of their linkage to them; and the establishment of compatibility appeared to be related to a sense of community, making a contribution, and essentially being involved in the environment.

Unlike Jackson's study, Gibson's exploratory effort attempted to document students' perceptions and perspectives about their academic and social adjustment to the university without focusing on any pre-determined adaptive behaviors. Through the use of open-ended interviews, questionnaires, participant observation, and examination of official documents, Gibson was able to identify four significant adjustment variables; family support, the initial university reception, peer relationships, and individual characteristics, with peer relations being the most influential of the four. She also found that the need to succeed by making good grades without assistance and the need to be accepted, especially by white peers, were significant concerns of the students investigated. Furthermore, Gibson discovered that freshmen who adjusted well could be characterized by at least two of the following: 1) prior friendships with black students at the university, 2) high school friendships or experiences with white peers, 3) strong self-images, and 4) positive attitudes about the university. Thus in both adaptive studies the findings suggested that the adjustment of black freshmen at predominantly white universities depended on a combination of campus, personal, and community/environmental factors, a fact which deserves attention by those who intend to investigate minority students' adaptation on college campuses.

Suen (1983) investigated the relationship between alienation and attrition among black and white students at a four year public university in the rural midwest and found that black students scored higher than white students along all dimensions of alienation and that the correlations between alienation and attrition were higher among black students. Suen concluded that "Black students felt more alienated within a predominantly White campus than did their White counterparts. The most important contributor to total score difference [on the alienation scale used] was [black students'] significantly higher level of social estrangement" (p. 120). It is likely that the level of students' self-esteem, particularly regarding racial identity for black students and certain other minority students, is a significant factor affecting the degree of alienation experienced by them. In order to

determine the relationship between the level of racial identity and self-esteem among black students, Parham & Helms (1985) used the model presented by Cross (1971) as a theoretical base and two inventory scales as instruments. These scales were used to gather data from students at four predominantly white universities, one in the south, one in the midwest and two on the west coast. The possible implications from the results of the study were partially summarized with the following statements:

The findings suggest that Black students who devalue themselves because they are Black may have low self-esteem. Deciding, however, to confront these negative feelings in the encounter stage may be indicative of an emerging, positive racial self-concept. Surprisingly, the data suggests that once a student enters the immersion stage, his or her level of self-esteem seems to decrease. Perhaps the sudden discovery of oneself as a Black person, fueled by feelings of anger and hostility toward Whites, reintensifies feelings of guilt, insecurity, and shame associated with the student's previous denial of his or her Black identity. . . . Once students come to terms with their identity and internalize positive feelings about being Black, the level of self-esteem may begin to increase. (Parham and Helms, 1985, pp. 145-146)

Because of the potential strength of relationship between self-esteem and racial identity, the authors concluded that "knowledge about attitudes of racial identity is valuable for anyone who wishes to understand Black people, particularly Black students (p. 146)."

One of the most comprehensive studies of black students' development at the post-secondary level was conducted by Stikes (1984). After reviewing pertinent related literature on black students and analyzing it to determine a theoretical base for the design of a model of black student development, Stikes interviewed several black students from two large predominantly white midwestern universities. He published the results from case analyses of sixteen subjects, ten from among students who were categorized as disadvantaged and six from among the general population of black students. The five research questions for the study focused on the following: academic performance and personal behavior changes among students, with attention to the factors which influenced these changes; coping strategies and problem-solving processes; how problems manifested themselves; the effects of admissions and financial aid problems; and how students

developed and changed over the span of their college years. Stikes' conclusions about the general development of black students suggest important and even critical implications for those involved with black student assistance problems and/or those who would research this topic. Stikes stated that:

Disadvantaged students seemed to take at least two years for their potential to unfold, and for many regularly admitted students it took at least one year. It took time for them to rid themselves of the cultural shock, to get acclimated to the environment, to learn coping strategies, and to succeed academically and socially. (p. 51)

The problems confronted by black students, as identified by Stikes, were widely varied in type and complexity. Stikes found that black students distorted the common American concept of time and seemed to function in an informal time system which often caused them to be late for appointments and classes. The second identified problem was characterized by Stikes as "inappropriate socioacademic attitudes, behaviors, and perspectives." About this problem he noted that students "used those old skills that they had learned in their communities to succeed; unfortunately, these skills often conflicted with those necessary for achievement in the college environment" (p. 52). Furthermore, Stikes observed that no "self-reinforcing system" existed to assist students in sustaining academic achievement and that "the students' problem did not seem to be an incapacity to achieve; rather, the problem seemed to be how to manifest and sustain achievement. They did not know how to reward themselves" (p. 52).

Motivation, language, and what Stikes termed an "inappropriate perspective on education" were three additional interrelated problems identified by Stikes. About motivation he noted that students "wanted concrete, observable rewards to sustain themselves" (p. 52) and that they found it difficult to achieve in classes which seemed irrelevant or which had instructors and/or course material that they did not like. Stikes' attention to the language problem was directed at students' different language patterns coupled with their reluctance to adapt to the accepted norms of academia, which often

resulted in retarded academic growth. Regarding students' perspectives on education, Stikes observed that many students would avoid authority figures who could have potentially provided needed assistance until after they were confronted with a crisis situation, and that they did not appear to value "learning for its own sake or the process of learning how to learn."

Stikes discussed several personal-social problems similar to those explored by Taylor (1978), Gibbs (1973), and Jones (1979). According to him, personal-social stress was a major impediment to their academic achievement and he stated that "sources of distress for students included over involvement in activities, lack of confidence, conflict with their families over whether or not they should attend college, and immaturity or dependency" (p. 54). Racial identity problems, which were compounded by a nonsupportive environment, financial problems, the inability to disclose their problems, and a predisposition to accept failure were also identified as contributing to black students' inadequate and often uneven development on predominantly white campuses. One paragraph of Stikes' report provides an especially revealing composite picture of the situation confronting many black students, and perhaps many students among other minority groups on predominantly white campuses in this country. He concluded that:

Black students, and particularly disadvantaged black students, manifested typical problems of underachievers. They tended to be overly optimistic about their success and to gloss over failures and shortcomings. Often they rationalized their poor records of achievement by blaming teachers or making other excuses. They also exhibited strong tendencies to delay activities until the last minute and did not have a regular routine in which to accomplish their tasks. Furthermore, disadvantaged students may have been underachievers if they had ability, because their negative interests and attitudes blocked achievement. That is, a black student may have had the ability to achieve, but it may not have been reflected in his or her academic performance because of conflicting cultural variables, class perspectives on education, skill deficiencies, and inappropriate attitudes. (p. 53)

Stikes identified several developmental changes in his report which were outcomes of the various coping strategies employed by black students on predominantly white campuses. About these changes he noted that "most students seemed to manifest the

potential for growth, and those who grew significantly improved their academic achievement. They increased their self-confidence and self-esteem, became more independent, and developed their personalities, though to a lesser degree" (p. 58). He further observed that development in one area enhanced development in other areas but he could not always identify the sources of change for students. Perhaps surprisingly, Stikes concluded that, generally, positive changes in the academic skills and performance areas occurred ahead of positive personality changes.

About the developmental needs of students, Stikes stated that "it seems apparent that black students need to continue to grow in personal security and self-directed behavior" (p. 66). While discussing specific developmental needs of black students he noted that they could benefit from; an accelerated development of a "facilitative identity", more emotional development and exploration, greater freedom to explore relationships with others without regard for race or color, at least for some students, more black cultural events, the inclusion of the black experience in the curriculum, and having the educational process address itself to the needs of black people. Stikes further concluded that general courses should relate more to the lives of students so that they will not feel the need to retreat to all-black associations for positive self-fulfillment and that faculty members need to project an image of functioning as "helpful agents" to students. Finally, Stikes mentioned that black students' development often lags behind that of white students initially but their achievement often exceeds that of white students during the latter stages of the college years. Thus, of particular relevance to this study, he concluded that "the factors affecting the initial lag [in achievement] and the subsequent increase in achievement need to be delineated so that impetus can be given to factors to improve the overall development of black students" (p. 69).

Fleming (1984) conducted a large scale study which was "constructed as a cross-sectional study that compares freshmen and seniors in fifteen institutions in order to obtain data that will support reasonable inference as to the progress that black students make in

black and white colleges" (p. xi). Fleming contended that the results of her study "confirms the already widely acknowledged premise that positive interpersonal supports constitute a precondition for cognitive growth" (p. xi). The data for her study was collected in many forms; through intensive testing for cognitive growth, from the completion of questionnaires by students, from observations of students who worked competitively under controlled experimental conditions, through in-depth personal interviews, and from the examination of official transcripts. According to Fleming, on the basis of her findings, black students generally received "better intellectual and psychosocial development" in predominantly black institutions. Among black students at predominantly white institutions, she found general feelings of dissatisfaction, which students often attributed to "a lack of institutional support, negative interactions with instructors, and feelings of abandonment (p. 167)." Black male students were found to "undergo excessively frustrating experiences that thwart virtually every evidence of academic drive (p. 168)," which often resulted in tension releasing (but probably academically non-enhancing) behavior such as overindulgence in extracurricular activities. Black women, on the other hand, were found to develop a "facility for surviving," often at the expense of their psychological well being. And, perhaps ironically, Fleming noted that the relatively male-free environment in which many black women functioned often contributed to opportunities for enhanced career development.

Post-Secondary Academic Development Among Minority Students

Several studies have attempted to determine correlates of academic achievement among college students and many of them have either been targeted specifically at minority students or have included race or ethnicity as an independent variable. Further, many recent studies have investigated minority students' academic development and achievement within the context of special programs which were designed to raise the levels of achievement and performance of participating students. The first of the two sections which

follow begins with a brief examination of two studies which were directed at uncovering significant correlates of academic achievement among the general population of college students, then explores the results from studies which were focused specifically on minority students. The second section examines the effects of special programs for minority students as reported in the literature.

General Academic Achievement

Griffore & Griffore (1982) trichotomized the GPA's of 304 first term freshmen at a large midwestern university into high, middle and low categories in order to obtain correlates of first term achievement among these students. The high and low groups were used for analysis and the independent variables were Academic Self-Concept (ASC), Debilitating Test Anxiety (DTA), Facilitating Test Anxiety (FTA), and Sense of Academic Futility (SAF). They were measured through the use of questionnaires both prior to the students' first term and at the conclusion of it. Among the findings, the authors reported that; the high achieving group had a higher initial ASC than the low achieving group and the difference increased over the first term, there were no initial differences between the two groups on SAF and FTA but on the post-test the upper group scored more favorably on both, and there was no difference between the two groups on DTA either on the pre-test or the post-test. From their results the authors concluded that:

If there are general observations which can be made from these data, one such observation may be that relatively low initial college achievement may exact a heavy toll on students' academic self-concept and on the belief that they personally control their academic success. At the same time, relatively high achievement appears to have a relatively slight impact. (p. 252)

Thus this conclusion from the study would appear to contain significant implications for higher education personnel who are involved with efforts to assist students with their adjustment to college level academic work.

Mathison (1984) surveyed over sixty studies which investigated predictors of college academic achievement. Based on his examination of the results of these studies he was able to characterize successful students when he stated that "in general successful college students excelled in high school, obtained high scores on college entrance examinations, possess good study habits, and appear to be more introverted, more responsible, more academically motivated, and more achievement oriented than most college students" (p. 384). Indeed, Perry's (1981) investigation to identify factors which affect academic performance and persistence among Mexican American, black, and Anglo students at a large university in the southwest lead him to conclude that high school grades and SAT scores correlated positively with college grades. However, he also found that the high school attributes consisting of GPA, SAT scores, and size of high school did not correlate with persistence, perhaps indicating that the parameters affecting this variable are more complex. Braddock II & Dawkins (1981) found that among black students who attended traditionally white four-year institutions, high school GPA's and study habits were good predictors of college grades but that aptitude test scores were not good predictors. Furthermore, as a result of their analyses of the data from their study, they made the following claim:

Our findings in general, suggest that: (1) both intellectual [or conventional] and nonintellectual [or nonconventional] factors may influence academic success in college; (2) the relative importance of specific predictors (intellectual or nonintellectual) varies across type of college setting; and (3) predicting black academic achievement is more problematic in traditionally white than traditionally black colleges and universities. (pp. 325-26)

The last finding above that predicting black academic achievement is more problematic in traditionally white institutions corresponds to the findings of Stikes (1984) and Fleming (1984) that black student development at predominantly white institutions is uneven at best, suggesting that the process of effectively delimiting parameters for sound useful research about this problem can prove difficult. Chase & Johnson (1984) used nontraditional data to uncover discriminating factors for successful vs unsuccessful

specially admitted inner-city students at a large midwestern university while Tracey & Sedlacek (1985) investigated the relationship between several noncognitive variables to academic success for black and white university students at a large eastern state university. Chase & Johnson's study investigated the relationship between success in the first year of college and eight items from admissions applications for 250 students. According to them, only two items--number of courses in high school English (with a grade of C or better) and rank in high school class--discriminated between successful and unsuccessful students. The items for which no relationship to success was found were number of courses in mathematics with a grade of C or better, the size of the high school class, student's birth order, father's education, mother's education, and marital status of the parents. Further, neither traditional variable (SAT-verbal score or SAT-math score) was found to be a reliable predictor. Thus, among the academic variables, only two were predictors of success, while none of the nonacademic variables were found to be reliable predictors, as was the case with the two traditional academic variables.

Tracey & Sedlacek used their Noncognitive Questionnaire (NCQ) to assess eight noncognitive dimensions for a sample of white and black students at a large, eastern state university: 1) positive self-concept, 2) realistic self-appraised, 3) understanding of and an ability to deal with racism, 4) preference for long-term goals over more immediate short term needs, 5) availability of a strong support person, 6) successful leadership experience, 7) demonstrated community service, and 8) academic familiarity. They contended that the NCQ was at least as accurate as or better than SAT scores alone in predicting grades of both black and white students. They found that the items of the questionnaire which reflected positive self-concept and realistic self-appraisal were predictive of grades throughout students' academic careers whereas items related to the preference for long term goals were predictive for first and third semester grades. Prior community service experience and an understanding of racism were significantly related to persistence among black students. Several other findings were reported by the authors but one conclusion by

them in particular might have been most significant. They contended that "the results of the study indicate that a different process is involved in academic achievement for Black and White students. Many variables are related to the success of minority students that are different from those for White students" (1985, p. 409).

In a similar study, Castillo (1983) found that the factors which were related to academic success for minority students were different from those for majority students and that minority students scored higher on measures assessing the affective domain while majority students were higher on measures assessing the cognitive domain. However, Smith (1983) investigated the relationship between self-concept and academic achievement for disadvantaged minority EOP students and found no correlation between the two, at least for the measures of achievement (GPA's and achievement test scores in English, math and reading) used. On the other hand Smith did find that there was some evidence that counseling does have a positive impact on student achievement for the sample population of the study.

Dawkins & Dawkins (1980) investigated the relationships between black students' perceptions and experiences and academic performance at a large state supported eastern university by surveying students enrolled in a heavily populated Afro-American studies course to obtain information about four categories of items; 1) racial perceptions and experiences, 2) reasons for attending college, 3) advisement and social participation, and 4) social background and high school performance. They then measured the strength of relationships between each of these variables and students' current grade point average. The following were among the findings of the investigators: Students who did not perceive prejudice among professors and those who had more contact with whites were more likely to have higher GPA's; Students who indicated that the improvement of intellectual capabilities and development of academic skills were primary goals for attending college were more likely to have high GPA's, whereas students whose primary objective was to get a good paying job were less likely to be among the high achieving group; Frequency of

contact with advisors was not related to academic performance; Involvement in or the intention to become involved in black organization was not strongly related to academic performance but a larger proportion of students who were active in other campus organizations were among the high achieving group than those student who were inactive; Students from rural or predominantly white communities were more often represented among the higher achieving students than those from predominantly black backgrounds; and High school grades were positively related to academic performance.

Haynes (1978) conducted a study which examined the impact of the expectations of university faculty on the self-concept and achievement of black marginal students at a predominantly black urban university. He concluded that teachers' expectations of marginal students do influence their achievement and self-concept but that self-expectations had a stronger influence than the teachers', and that achievement and self-concept were often significantly related, depending on the measures used. Another study which considered faculty members' attitude and/or behavior toward minority students was conducted by Trujillo (1984), who investigated instructor-student interactions in order to determine whether these interactions were different depending on the minority/non-minority status of students. Instructors' academic expectations of minority students were also investigated.

According to Trujillo the results of his study indicated that instructors took a greater amount of time to respond to questions from non-minority students, asked more complex questions of them, and pressed them more often to clarify their responses to instructors' questions. However, no significant differences were found in the actual number of responses or the number of non-complex questions asked of students. Regarding expectations, Trujillo concluded that instructors expected as much of minority graduate students as they did of non-minority students but that they had significantly lower expectations of minority undergraduate students as compared to non-minority undergraduate students. Thus when the results of Trujillo's study are considered in light

of the reported findings of Haynes, the possible implications for the quality of the academic development of marginal minority students becomes apparent.

The impact of academic advising has also been investigated as a primary factor in the academic experience of minority students. Burrell & Trombley (1983) surveyed minority students from five predominantly white institutions of varying size, type, and minority enrollment (2% to 10%) to assess their perceptions of student support services on their respective campuses. They were asked to rate each of seven support services according to its importance to them and identify individuals to whom they would turn for help with academic, personal, or financial problems. Academic advising was found to be the most important support service to these students and they indicated a preference for seeking advice on academic matters from minority advisors (as compared to minority students, professors, or administrators, or whites in general), and turning to family members regarding personal or financial problems.

In order to enhance the effectiveness of academic advising for minority students Glennen, Baxley, & Farren (1985) recommended an intrusive advising system which "takes an aggressive approach in requiring students to come in for advising at frequent intervals" (p. 336). It also provided academic support services where needed and promoted cultural awareness among students. As a result of the implementation of such a system at a public university in the southwest with a large minority enrollment, the following results were reportedly achieved after three years of operation; a 25% reduction in minority attrition, a 6% increase in the number of graduates, an 8% increase in the number of students on the Dean's List, and a 3% increase in minority employment after graduation.

Finally, an example of a study which examined the relationship between locus of control and academic achievement was reported on by Hudesman, Avramides, Loveday, & Wendell (1985). Their study was designed to determine whether internally oriented students and students who applied early to an urban college would be more likely to have

higher GPA's and persist more often over three semesters than externally oriented students or those who registered later during the application process. All subjects for this study were incoming freshmen in a special assistance program which had a 90% minority enrollment and they were administered a locus of control inventory during the first two weeks of the fall semester. According to the authors their results "indicate that locus of control and allocation phase [time of application] are related to a variety of academic success measures, including GPA, satisfactory academic performance, and re-registration at the college after one year" (p. 24). Thus Hudesman, et al. suggested that intervention strategies for students should include steps to change their orientation toward internal control and assist students with the development of improved management skills. Gonzales (1984) reported similar results for specially admitted Hispanic students at a large western university. Further, he found a moderate to strong relationship between study habits, attitudes, and academic achievement.

The Effects of Special Programs

Several studies have been published which investigated the impact of programs to assist disadvantaged and/or minority students at predominantly white institutions. The reports on the results of these studies have often documented many of the factors associated with success in assisting participating students with their academic transitions, as well as identified many of the academic and non-academic indicators of success and nonsuccess for these students. Regarding a program's impact, Mingo (1984) conducted a longitudinal study at a large southeastern university on the impact of a special services program on participating students and found that the retention rate of black freshmen in the program was only slightly lower than that of all freshmen at the university--an impressive outcome considering the usual characteristics of special program students. On the other hand, Mingo found that the graduation rate of program students was not as high as that of the total student body, perhaps indicating that although the program was helpful in assisting

students with their initial adjustments to the university, the effects of the many factors which impact negatively on their ability to sustain continued academic growth served to lower the graduation rates of program students.

Johnson (1984) wanted to identify predictors of persistence for students who used the services of an educational services center at a private midwestern urban university and she reported both expected and unexpected results. According to her, the "predictable" findings were that white underprepared students persisted at a higher rate than underprepared black students, that most persisters were enrolled in Arts and Sciences, and that persisters had higher GPA's. Among the "not so predictable" findings, Johnson reported that non-persisters were more likely than persisters to have parents who had attended college, that the reading test scores of persisters and non-persisters were not significantly different, and that almost half (46.2%) of the persisters were from the lowest SAT and ACT groups. Thus this last set of findings suggests that identifying factors associated with success as indicated by persistence among students who use special educational services, or who are enrolled in special programs, might be a complex process, a conclusion often expressed in the literature.

Kulik, Kulik, & Shwalb (1983) performed a meta analysis on findings from 60 evaluation studies of special programs. These studies had been selected, based on predetermined criteria, from among over 500 studies initially considered and reviewed. They contained findings regarding both achievement and persistence among enrolled students. After performing various analyses on the reported data, Kulik, et al. concluded the following:

Special programs devised for high-risk college students have had basically positive effects on these students. This generalization holds true when the effects of these programs are measured by changes in GPA and when effects are measured by changes in persistence in college. The generalization also holds true for different types of programs for high-risk college students: reading and study skills courses, guidance sessions, and comprehensive support services. These programs raised student GPA's by .25 to .4 standard deviations. The special programs also raised persistence rates from 52 to 60 percent remaining in college. (pp. 408-409)

Among the potentially disappointing findings of this investigation was the fact that new programs were found to have a stronger positive impact on student performance than existing ones. According to Kulik, et al. a possible implication of this finding is that the energy, enthusiasm, and maybe even funding required to maintain the effects of special programs are difficult to sustain. They concluded the presentation of their findings by calling for more careful monitoring of individual programs and quantitative controlled evaluations of them to detect the subtle factors which might contribute to program success.

Keimig (1983) surveyed the literature to determine the characteristics of successful learning improvement programs for underprepared post-secondary students. She concluded that "successful programs were found to have two broad characteristics in common: comprehensiveness in their support services, and institutionalization into the academic mainstream" (p. 2). Among her specific findings, Keimig concluded that successful programs were flexible as well as broad ranged in providing support services; contain curricula which are adjusted as courses, tutorial services, remediation, and social and psychological support are planned; have the perception of the developmental concept as an institutional mission; and have integrated their learning services into the academic mainstream. In addition, Keimig found that successful programs have departmental or divisional status within their institutions and maintain close working relationships with academic units. Less successful programs, on the other hand, were found to emphasize remedial courses and precollege efforts, to provide no academic support in their courses, and operate outside the academic mainstream, prompting Keimig to conclude that they fail "to effect the long-term changes in the institution's and student's behavior through which lasting gains in GPA and persistence are made" (p. 14).

Post-Secondary Mathematics and Science Achievement

General Studies on Mathematics and Science Teaching and Learning

Several studies have investigated various factors related to the study of mathematics at the post-secondary level. Christianson (1983) investigated the relationship between Piagetian cognitive developmental stage and cognitive skill levels by using placement test results for students enrolled in self-paced remedial/developmental mathematics courses and regular statistics and elementary functions courses, as well as two tests to determine cognitive stages of students. The cognitive stage tests were re-administered to students who were given special problem solving instruction to determine gains in cognitive levels. Among the findings from this study, Christianson reported that a significant positive correlation was found between mathematics placement level and Piagetian stage, that a relationship existed between gains in mathematical skills and cognitive stages for the remedial/developmental courses, that no gender differences were found in measures of cognitive stage, that males had taken more prior mathematics courses than females, and that the experimental problem-solving instruction helped to improve the skills related to the mathematics placement test scores but not the scores of the test which measured cognitive stage. Based on the results of his study Christianson recommended diversifying instruction for courses at the lower level to include activities which encourage the development of formal thought and the conduct of more research on group assessment instruments which classify students according to cognitive stage.

In order to investigate sex-differences in mathematical achievement among pre-calculus mathematics students, Stones, Beckmann, & Stephens (1982) administered The Beckman-Beal Mathematical Competence Test for Enlightened Citizens to 1046 students at four state colleges and six community colleges who were enrolled in courses which the authors categorized as College Algebra, Mathematics for Elementary Teachers, and Applied Mathematics. Based on their analyses of the response data these investigators found that

over the total sum of all subcategories of the test there was no significant difference in performance between males and females. However they did find some differences in the way in which males and females performed, as they observed that "the subcategories in which males excelled were subcategories in which knowledge of specific course content was important. The subcategories in which females excelled were subcategories in which the ability to reason mathematically was important..." (p. 297).

An example of an attempt to identify classroom practices which might impact students' academic development in mathematics is MacDonald's (1984) investigation of the method of utilizing homework in a mathematics precalculus College Algebra course. He compared three methods; one in which homework was collected, graded, recorded, and returned in the next class session (MG), one in which a quiz was given at the beginning of class with problems similar to the current homework exercises (QC), and a third method which was similar to the second one except that one review question was included (QR). MacDonald reported that there was a significant difference in achievement on exams two and three (performance on the first exam was used as a covariate in the analysis) favoring the QR treatment in both cases. However there was no significant difference in achievement on the final exam, nor was there any significant difference in course grade, although the group which was administered the QR treatment performed slightly better. In all cases the mean of the group receiving the HG treatment was lowest. Finally, the finding that when ability level was considered in the analysis, only among the high ability group was there any significant difference in achievement, again favoring the QR treatment, seems to suggest that for the low and middle groups the identification of successful methods of enhancing their academic development in mathematics is more complex than it is for the high group.

In order to determine factors associated with achievement in the first course in calculus Edge & Friedberg (1984) conducted a study in which data on first semester calculus students at a large midwestern university was used to determine which variable

from among a set of both academic and nonacademic ones would best predict achievement. According to the authors, availability of information was somewhat influential in selecting variables. The dependent variable was performance in the calculus course as measured by the course grade, and although several course sections and students from different semesters were subjects for this study (for replication purposes), the fact that there was a uniform final exam in the course helped to decrease the variance in the criteria for determining grades and the level of proficiency expected in the course to earn specific grades. Edge and Friedberg concluded that the best predictors of success for all three groups of students were the algebra pretest and high school rank. According to them, this confirmed their hypothesis that students' abilities in the manipulation skills of algebra play a significant role in their success with calculus. And their comments about the possible implications of the "unexpected" finding that high school rank was the second most accurate predictor of success contains implications which are particularly important to investigations into the calculus achievement (as well as achievement on other mathematics and/or science courses) of females, minorities, and underprepared students. They stated that:

As suggested in other research, the reason for this [finding] may include psychological factors in addition to academic ones. It may in fact be the case that rank in class represents a measure of competitiveness as well as a characteristic of long-term emotional adjustment as mentioned earlier (in their discussion). (p. 140)

On the issue of math anxiety, Calvert (1981) conducted a study at a small midwestern college to determine the relationship between the level of students' mathematics anxiety and sex, age, mathematical background and last grade received in a mathematics course. According to him the results revealed that females had a slightly higher levels of math anxiety than males, students who had only taken general mathematics in high school possessed higher levels of math anxiety than those who took more difficult courses, and that students who had received a "C" in their previous mathematics course were found to have higher levels of math anxiety than those who had earned higher grades. Age was not

a determining factor for math anxiety. Frye (1983) investigated the effect of students' prior knowledge of their mathematics skills on math anxiety among freshman students at a medium sized state college in a mideastern state. After administering the Mathematics Anxiety Rating Scale (MARS) she administered two diagnostic tests of basic skills in arithmetic and elementary algebra, prepared by the College Entrance Examination Board, to two groups. Frye provided the results of the diagnostic tests along with prescriptions for remediation to the experimental group. From her analysis of the data she concluded that lowered math anxiety (as measured by MARS) can be achieved through the diagnosis of basic skills and appropriate prescriptions for remediation.

Among those studies which explored general factors related to college students' study of science courses, two studies by G. E. DeBoer documented some of the factors related to both students' enrollment and their success in these courses. His first study was intended to determine factors which affected students' decisions about whether or not they should continue taking science courses beyond their initial experience with them. DeBoer surveyed freshmen at a small liberal arts college in the northeast regarding their perceptions about their performance in their initial courses and whether they planned to continue taking science courses. He summarized the results of this study by stating that:

...the intention of successful students to continue in science was directly related to their attribution to ability..., and inversely related to task ease.... Gender, mathematical aptitude, and performance in the initial science course were not related to students' plan to continue in science.

For students who experienced subjective failure, only attribution to task difficulty, a stable factor which would discourage continued participation, approached statistical significance.... Gender, mathematical aptitude, and performance in the initial course, as well as attribution to luck, ability, and effort, were unrelated to the students' plans to continue in science. (1984, pp. 327-328)

DeBoer's second study was directed at determining both cognitive and noncognitive correlates of success for students in their first college science course. He was particularly interested in the general issue of the continued underrepresentation of women in science

and the identification of specific factors which might contribute to this situation. Thus DeBoer's study included cognitive factors such as attribution for success or failure at achievement tasks (as described by the learned helplessness phenomenon), and personality variables, such as diligence at academic tasks, degree of self-control, and interest in problem solving and reflective thinking. These variables were postulated as potentially affecting students' performance in their first science course and hence possibly impacting students' decisions about their future participation in science. Data for the study was gathered from the results of inventories given to freshmen students during the orientation period at a small liberal arts college in the northeast as well as from a survey questionnaire which asked students to rate factors which might explain their academic performance at the conclusion of the first semester. From the data collected DeBoer concluded that "the women who took science in their first semester in college were quite similar to men except that they were less oriented toward the activities that scientists engage in, such as problem solving, analysis, and conducting original research" (1985, pp. 157-158). Further, persistence, rashness, and future orientation were found to be strongly related to the science performance of women but not to men. Thus while women and men in this study were very similar in most respects they were unlike in certain personality characteristics which could affect their decisions about their choices regarding the direction of their academic careers and hence their future professional aspirations.

Wollman & Lawrenz (1984) conducted a study "to see whether dropouts and other students who have difficulty with physics ('high-risk' students) can be identified; (a) by including mathematics reasoning items along with mathematics skill items on a mathematics pretest, and (b) by using records of past performance in conjunction with the mathematics pretest" (p. 386). Four hundred eighty-three students enrolled in an introductory, noncalculus preprofessional physics course at a large southwestern university were administered a 13-item mathematics pretest, which included both skill items and reasoning items, during the second week of the semester. From their analyses of the data, the

investigators found that they could distinguish between students who performed well and those who experienced some degree of difficulty but the specific distinguishing characteristics were not identified with the measures used in the study. They also found that for students who completed the course, mathematics ability was a good predictor of achievement. For future investigations into this question Wollman and Lawrenz suggested the use of interviews (rather than group tests) to uncover those hidden "non-mathematical" abilities which might affect achievement and hence the drop-out rate among physics students.

Among other studies which attempted to identify significant factors in the academic development of science students, those by Johnson (1981) and Yeany & Miller (1983) yielded results which demonstrate that identifiable factors exist which could significantly affect students' capability to achieve. Johnson found that students' actual engaged time (as observed) and their perceptions about their amount of engaged time in the science classroom were positively correlated with achievement, despite the fact that a negative relationship was found between observed engaged time and reasoning ability. Thus, since achievement scores were also positively related to academic aptitude and reasoning ability (as measured by standardized tests), this finding suggests that students whose pre-course characteristics might not predict success can improve their chances of performing well through their willingness or ability to become actively involved in the instructional processes of the course. And while attempting to determine the effects of diagnostic/remedial instruction on science learning, Yeany and Miller found that diagnostic feedback can significantly enhance students' performance when they stated that "the surprising result in this study is the source of the impact [on achievement]: It does not appear to be the remediation but rather the diagnostic feedback" (pp. 24-25).

Minority Students' Math/Science Academic Development and Achievement

As a result of a study by Treisman (1985), which documented the mathematical performance of black students who participated in the mathematics Workshop, as was reported on in the previous major section of this chapter (and which was conducted at a prestigious western university), many of the critical behavioral factors associated with academic success and failure among black students in mathematics were delineated. A portion of Treisman's efforts were directed at identifying common characteristics of black students which might help explain their dismal performance (prior to the establishment of the workshop) when compared to Asian and majority students. He conducted in-depth interviews with 20 black and 20 Chinese students and the results from these interviews lead to the following conclusions:

Regardless of class or educational background most black students maintained a sharp separation between their school lives and their social lives.

Unlike Chinese students, black students rarely studied with classmates.

Black students devoted about eight hours per week to homework whereas Chinese students devoted roughly 14 hours per week to it.

The collaboration of Chinese students enabled them to "check out" their understanding of what was expected of them and "provided them with valuable information that guided their day-to-day study" (p. 14).

Black students did not make use of free tutoring available through "minority support" programs, and when they did seek out help it was usually too late to make a difference.

Black students failed to make effective use of campus advisors and counselors.

One particular observation by Treisman illustrates the compounding effects of the problems often confronted by black and other minority students in the academic areas. According to him:

...black students rarely sought help from teaching assistants. But even when they did, their inability to define their needs clearly coupled with the low expectations that many TA's held for the academic achievement of black students usually precluded a fruitful exchange. (p. 19)

The quantitative analyses of this study uncovered results which not only documented the effectiveness of this particular programmatic effort but provided further evidence of the kinds of performance outcomes which can be realized when a strong commitment is made to promoting the academic development of students regardless of their previous backgrounds and certain forms of corrective action are taken. According to Treisman, the following were among the findings from the data analyses of his study:

Grades earned in the beginning calculus course (the initial mathematics courses offered through the Workshop) by Workshop participants were, on average, one full grade higher than those of non-Workshop minority students.

Workshop participants continued to outperform their non-workshop counterparts in subsequent mathematics courses -- with Workshop students performing at about the level of the overall population.

Workshop students persisted at a similar rate as all freshmen, and this was true of "Special Action" and "EOP" students as well as of "Regular Admit" students. Furthermore, Workshop students persisted to graduation at about the same rate as all students.

For the two entering classes for which data was available 44% of black Workshop students graduated in a "mathematics-based" major compared to 10% of black non-Workshop students and 11% for black students who entered the university during the pre-Workshop years. The grades of Workshop students were about three-quarters of a grade higher than non-Workshop students in each of three MSAT score triads, and the average grade of Workshop students in the lowest triad was higher than that of non-Workshop students in the highest triad. The average grades received by Workshop students were higher than those received by comparison groups (based on MSAT scores) of white and Asian students.

Among the earlier studies which investigated minority students' achievement and development in the science, Malcolm, Hall, & Brown (1976) were able to identify many potential critical factors as a result of their survey of participants at a conference on the status of minority women in the sciences sponsored by the American Association for the

Advancement of Science. While many issues were explored at this conference, such as the professional experiences of minority women in the sciences, one paragraph in the report of this conference was especially enlightening regarding the perceptions of the participants about their collegiate experiences. Malcolm, et al. summarized their findings as follows:

It was frequently reported that course work at the undergraduate level had been somewhat difficult, not because of intellectual inadequacies, but rather due to a combination of factors. For most of the conferees, secondary school course work had been easy. At the undergraduate level, the problem was often that the necessary preparatory courses had not been offered at the secondary schools they had attended. In many instances precollegiate academic preparation was of a lower standard than that expected by the college. Typically, secondary school had not been sufficiently demanding for them to have developed strict self-discipline and study habits. Where rigorous laboratory science had not been available prior to college, orientation to lab work was an additional hurdle. Most of the conferees felt, as do most scientists, that undergraduate exposure to research would have been beneficial. Most found college work considerably more challenging than secondary schools, but well within the range of their abilities. Exclusion from informal study groups, usually all male and/or majority made their pursuit of academic excellence difficult. Access by minority women students to fraternity test files, for example, was virtually unheard of. (p. 15)

McNamara & Scherrei (1982) also presented findings regarding minority women in the sciences when they reported on the results of their investigation into the status of college women who were pursuing careers in science, mathematics, and engineering. One of the aims of the study was to identify those personal characteristics and precollegiate experiences which contributed to college women's successful completion of undergraduate majors in these three areas of study. A national survey was used in which data from various sources were gathered, then follow-up surveys and interviews with several of the sample subjects were conducted to complete the data gathering process. Among the significant findings, which were arrived at through a trend analysis, a longitudinal analysis, and an analysis of the interview data, the following were particularly relevant to the problem and issues investigated in this current study:

Minority women are not only underrepresented among college freshmen planning to pursue degrees and careers in science and engineering, minority

students who do indicate an interest in these fields enter college with poorer academic preparation than their white peers.

By the end of the decade of the 70's, the goals and aspirations of science oriented minority women were as high and, in some cases, higher than those of science-oriented white women despite their generally poorer academic backgrounds.

High school mathematics preparation is critical to successful completion of an undergraduate degree in the sciences, mathematics, and engineering. Variables reflecting the strength of precollegiate mathematics training accounted for more variance between students who achieved this outcome measure and their peers who majored in nonscience fields than any other variables in the study.

Parental education, occupation, and other measures of students' socioeconomic background are not highly significant predictors of successful completion of an undergraduate degree in scientific and technical fields when college graduates are studied.

When the science persistence rates of white, black, and Hispanic women are compared with those of white men, we find that women, especially minority women, who enter college planning to major in the sciences or math are less likely than white men to graduate with a degree in these fields or in any science-related field. Interest in science and math develops early and is reinforced by academic success in these subjects and by teachers who are remembered as outstanding members of their profession.

Almost half of the minority women who attended high school in the states reported that counselors had discouraged their educational and career aspirations, the usual explanation given being that the counselor perceived their aspirations as unrealistically high.

The individuals most frequently cited as role models were teachers, college instructors, and older students--usually women.

Hands on research experience is critical to the development of scientific interests, of skills that are essential to success, and of self-confidence in one's abilities. Since such experience also tends to confirm or disconfirm one's interest in a research career, the earlier students become involved in research the better. (pp. 7-9)

Atwater & Simpson (1984) conducted research to determine cognitive and affective variables which might affect black freshmen in science and engineering at a large predominantly white university in the southeast. They used a survey questionnaire and university records as sources of data to gather the necessary information on 184 students from engineering, agriculture, life sciences, physical sciences, and mathematical sciences who had participated in an earlier study and who volunteered to participate in this one. The

results reported were for the 70 freshmen among this group. The findings of this study indicate that there was a mixed bag of relationships uncovered. For example, among the pre-enrollment variables SAT-M was a significant predictor of achievement for successful students but the university predicted GPA was not significantly related to achievement for nonsuccessful students, prompting the investigators to observe that mathematics is probably a significant factor in the achievement of black freshman students. None of the noncognitive background variables such as exposure to black role models (black school personnel), size of high school graduation class, and proportion of black students in the school were found to be significantly related to achievement, which, according to Atwater and Simpson, could have been due to the lack of variation in these variables among the population sample.

Among the affective variables, locus of control was not found to be significantly related to achievement but significant relationships were found between achievement motivation, academic self-concept, and achievement for successful students whereas the same was not true for nonsuccessful students in this study. Regarding Students' attitudes; perceived science professor's attitude toward students, attitude toward the university and the whiteness of the university, and attitudes toward science professors were found to be significantly related to achievement. A significant correlation was also found between perceived success and actual achievement of black freshmen. Thus, based on their findings, Atwater and Simpson concluded that "results from this study support the hypothesis that black freshmen in science and engineering who come with a strong mathematics background will be successful. Also, selected attitudes toward and perceptions of the university may influence their achievement...." (pp. 109-110).

Minority students' academic development and achievement in engineering has received considerably more attention in the literature than has their development and achievement in the sciences. This is probably partially due to the fact that there has been more organized national, regional, and local efforts to attract minority students into

engineering. These efforts have often included substantial funding from industry and other sources, thus prompting more of a demand to evaluate their effectiveness and document successful intervention practices. Landis (1985) and Gordon (1986) have reported on general surveys regarding these nationwide efforts in order to disseminate information on significant overall developments and factors related to student achievement. Landis developed a handbook on retention efforts in engineering which included 16 chapters by various authors on issues such as admissions, summer programs, monitoring student progress and academic advising. According to him, findings in the literature indicate that seven features of Minority Engineering Programs (MEPs) were related to success: 1) the use of a comprehensive approach; 2) being based in an academic unit; 3) a professional orientation of directors (rather than a purely academic one or a cooperate or government orientation); 4) a practical problem-solving approach to student retention; 5) the use of results-oriented measures in the operation of programs; 6) the use of professionals and volunteers from outside organizations; and 7) the quality of the professional staffs of this programs.

Gordon's descriptive analysis of programs and trends in engineering education for minority students contained a discourse on what he and his colleagues (who assisted in preparing his report) found to be the "more salient" conclusions in the literature on the facilitation of student academic development for the successful study of the technical sciences. His list consisted of the following:

- a. Exposure early in the life of the child (ages 5 or 6 to 12 years) to rewarding hands-on experiences in mathematics, science and technology with ample opportunities to exploring, discovering, and questioning relationships between concepts and materials.
- b. Early and continually mediated learning experiences in which learners are guided in their identification of salient and distinguishing features, lawful relationships, taxonomic indicators, and other aids to information processing, which also serve to maintain a balance between challenge and frustration in learning.
- c. As obvious as it may sound, exposure to relevant experiential and theoretical course work is increasingly recognized as an essential factor in

this facilitation of student academic development. Such exposure is certainly not a sufficient condition, but we now recognize that it is an essential condition which is not experienced by large numbers of minority students. We are also increasingly aware of how difficult it is to assume that schools are able to provide the course work in an appropriate way to minority students.

d. Incidental or directed learning experiences designed to enhance cognitive competence, such as problem solving, critical thinking, meta-cognition, knowledge acquisition strategies, and the executive management of mental processes.

e. Targeted instruction and remediation where teaching and tutoring are informed by psychoeducational assessment data which enable the customization of learning experiences to meet the specific as well as generic needs of learners.

f. Socialization to the demands and rewards of academic and professional life appears to be essential to the development of students whose natural environments have not provided much socialization experiences. Young people who are the first generation of their family to seriously pursue academic work and higher education have had fewer opportunities to learn the demands and routines of rigorous academic work. (1986, pp. 8-9)

Among the investigations of individual student development programs in engineering, studies by Williams (1981) and Coles (1983) attempted to identify significant predictors of success and characterized the nature of success for student participants in the respective programs. Williams' study was conducted at a large southwestern university and his findings served to support the conclusions of those who have found that certain non-intellective variables such as sex were of no value in predicting success of students whereas Students' active involvement in the processes of the academic system is positively associated with success. SAT scores were found to be only a marginal predictor of success and program participants were found to be significantly more successful than non-participants. Coles evaluated the effect of several selected variables on the academic persistence of 407 first year engineering students with marginal academic characteristics at a large southeastern university. Among his findings was the fact that the most powerful predictor of persistence among these students was first year grades, which once again points to the importance of positive initial experiences of students. He also found that the persistence of tutored students was comparable to that of non-tutored students who had

better academic profiles upon entry to the university, thus indicating the utility of this often used support service. Non-intellective variables such as race, motivation, and hours of work were not predictive of persistence among the students in the study.

Finally, in order to determine whether professional minority enrichment programs really work, Wine & Cooper (1985) conducted a controlled study to "provide an empirical evaluation of an enrichment program for minority engineering students" (p. 366) at a medium sized midwestern university which emphasized science and engineering curricula. They matched the 17 minority students in the program with 17 nonminority students on the basis of verbal ability and another 17 nonminority students by mathematics ability. The enrichment program included a comprehensive 7-week summer component, and the students were provided with certain forms of support throughout the school year although there was no indication that any kind of special classes were made available to them. The dependent variable for this study was first year GPA and all of the subjects for this study completed their first year. Wine and Cooper found that the GPA for the minority students was slightly higher than that of either of the matched groups, prompting them to conclude that the program was successful in reaching its goal. They also suggested that further studies which compared the performance of minority students who participated in such programs with that of matched groups of minority students who did not participate in such programs could also prove valuable in yielding important information.

Summary--Related Research and Previous Studies

Based on the research results explored in the fourth and final section of this chapter, students' pathways through the education pipeline in mathematics and science can often be filled with many real barriers. Beginning at an early age, students' cultural situations and the extent to which these are considered in the educational processes of the respective institutions can be crucial to the prospects for real progress in the study of these disciplines. At the college level, initial adjustments can become paramount to successful development. Among minority students, experiencing enhanced academic development at majority

institutions appears to be particularly problematic. However, several studies point to the fact that special programs and other intervention efforts can be particularly helpful to students if they are instituted in certain ways.

Chapter Summary

The quality of students early childhood education was found to depend on a host of in-school and out-of-school experiential factors. For minority students, the extent to which cultural connections are made between their out-of-school experiences and in-school activities seem paramount. More specifically, it seems that the likely presence of the effects of social/cultural oppression must be recognized and possible cultural concomitants, such as a field-dependent disposition, would need to be addressed in order to avoid having cultural differences become deficits. In mathematics and science education the role of language in learning should be closely examined as well.

Explorations of students' collegiate experiences, and especially those of minority students, revealed that there are a host of factors which likely affect the quality of students' experiences generally and minority students' in particular. The adaptations and development of minority students at majority institutions were found to be especially precarious, apparently primarily due to the difference in expectations between minority students and institutional staff, negative perceptions of students about the environment inadequate academic preparations of these students, and the failure of institutions to consider and respond to the many culturally related factors that are crucial to minority students' development and growth in the environment.

As with minority students' overall development, their academic adjustments and progress in the academic system of majority institutions were found to often be problematic as well. Several sources were found to document the fact that certain behaviors and dispositions were characteristic of successful students on campus. However other sources

pointed to the need to consider students' cognitive style preferences and the cultural dimensions of their dispositions, especially in relation to their motive to achieve, if progress is to be made in meeting their needs. Furthermore, math/science anxiety and time management anxiety among students were also identified as requiring close attention . Specific performing enhancing measures and skills of successful students, such as their approach to studying/learning, their level of abstract reasoning, and their ability to conceptually organize course content.

A few proposals were found, such as group work and use of writing assignments, for the enhancement of instruction in mathematics. However, it seems that little attention has been paid to comprehensively addressing students' overall academic needs through mathematics instruction. In the sciences, several ideas were advanced to consider cultural relevance and students' development of the requisite cognitive skills in the instructional process. Programs in mathematics, science, and engineering, which claim success in advancing the participation and of minority students in these areas, were reviewed in this section.

Research and previous studies related to the issues and concern of this study were found to document factors associated with the quality of students' experiences of students at all levels. At the pre-college level, studies on students school experiences, cultural dispositions, and gender revealed significant factors in the study of mathematics and science among minority students. For example Korbluth & Sabban (1982) investigated the interaction effects of cognitive style and study method among underachieving disadvantaged fifth grade students and, among other results, they found that the individualized study method could assist those students who were field-dependent to improve their performance. Marret (1982) found that the organizational pattern of the school itself could affect the enrollment tendencies in mathematics of minority students. Regarding the problems facing Hispanics, Gerace and Mestrel (1992) found that problems with language and the tendency not to read the textbook were primary problems, and they

advocated harmony between the pedagogic style of the teacher and the textbook, among others. Moore (1982) found that the Navajo culture does not readily accept hypothetical thinking, which, along with the importance of memory in the culture, could adversely affect students' problem-solving abilities. When the effects due to gender were investigated, Jacobowitz (1983) found that sex was the strongest predictor of science career preference, Wolleat, et al. (1980) concluded that the learned helplessness phenomenon affected females more than males, and Leder (1982) found that girls who were high in fear of success tended to have higher achievement in mathematics, but lowered persistence towards the study of more advanced courses.

That students generally experience a host of problems was well documented by the studies reviewed and the differences between those problems reported by minority students were not always substantially different from those reported by majority students (Webster, et al. 1986; Baum & Lamb, 1983). However, there were more problems reported by students in 1986 than there were in 1976 (Koplik & Divito, 1986). Among black students Jackson (1978) and Gibson (1983) were able to identify adaptive factors, with Jackson finding that the clustering of unfulfilled expectations caused problems for students, and Gibson concluding that it is possible to characterize students who adjusted well. Suen (1983) documented the level of alienation among many black students and Parham & Helms (1985) advocated a knowledge about the attitudes of racial identity of black students if institutional staff members are to understand these students. Among the many findings of Stikes (1984) were the following; that disadvantaged black students appear to need at least two years of development on campus for their potential to unfold (with many regularly admitted students often needing at least one year), that black students were plagued by an inadequate or inappropriate view of education, and that students' overall growth in the environment tended to result in improved academic performance. He recommended the inclusion of the black experience in the curriculum of the institution. Fleming (1984) found that there is a need for positive interpersonal supports for black students, and that the

experiences for black students at majority institutions were not as rewarding or growth-producing for black students as they were at historically black institutions.

Regarding students' academic development and achievement, it was found that; initial low performance of students can become costly to them (Giffore & Giffore, 1982), aptitude test scores were not good predictors of the performance of black students but high school GPA's and study habits were (Braddock II & Dawkins, 1981), prior community service experiences were significantly related to persistence among black students and many of the variables related to the academic success of black students were different from those for white students (Tracey & Sedlacek, 1985), and not perceiving prejudice and having more contact with whites was an indicator of a higher GPA for black students (Dawkins and Dawkins, 1980). Haynes (1978) maintained that teacher's expectations of marginal students influenced their achievement but he also found that self-expectations had an even stronger influence, and Trujillo (1984) found that instructors sometimes related differently to the questions of minority students than they did for non-minority students, thus possibly negatively impacting their academic development.

As was mentioned earlier in this chapter, academic advising is a crucial factor in students' prospects for success, and documenting this observation was the finding by Burrell & Trombley (1983) that it was the most important support service listed on a survey of minority students from five predominately white institutions of varying size. Glennen, et al. (1985) recommended an intrusive advising system which required students to come in for advice on a regular basis, whereas Hudesman, et al. (1985) concluded that steps should be taken to change students' orientation toward internal locus of control and the development of improved management skills.

The effects of special programs for minority and/or disadvantaged students have also been studied. In his study, Johnson (1984) revealed the surprise findings that, for students who used the services of an educational center, non-persisters were more likely than persisters to have parents who had attended college, and that almost half (42.2%) of

the persisters were from the lowest SAT/ACT groups. Mingo (1984) found mixed results for black students who participated in one special program in that, on the one hand, the retention rate for freshman students was only slightly lower than that of all freshmen, but that, on the other, the graduation rates of program students was not as high as that of the total student body, indicating that mediating factors possibly came into play later on. Kulik, et al. (1983) concluded that special programs were generally helpful to students but that newer ones were better, possibly indicating that efforts of this type are difficult to sustain. Kermig (1983) was actually able to characterize successful programs as; comprehensive, institutionalized, having a perception of a developmental concept, and having their learning services integrated into the academic mainstream.

Regarding mathematics instruction, Christianson (1983) recommended diversifying instruction for courses at the lower level to include activities which encourage the development of formal thought, and Edge and Friedberg (1984) found that the best predictors for success in calculus were the algebra pretest score and high school rank, thus indicating that students' diligences in doing well in school might be more important than factors such as standardized test scores, at least within the context of this study. Calvert (1980) found that females had slightly higher levels of math anxiety than males, but Frye (1983) also found that by diagnosing students' basic skill levels and prescribing measures for remediation, math anxiety can be reduced.

As far as the sciences are concerned, DeBoer (1984) found that attribution to ability was positively correlated with intention to continue in the sciences but that mathematics aptitude and performance in the initial science course were not. This finding coupled with Johnson's (1984) finding that students' engaged time with the course material was positively correlated with achievement in science though not with reasoning ability, seems to suggest that students were pre-course characteristics might not predict success could possibly improve their chances of performing well through their behavioral efforts. Furthermore, Yeancy and Miller (1985) found that diagnostic feedback can significantly

enhance students' performance, and, illustrating the importance of doing well in mathematics, Wollman & Lawrenz (1984) concluded that mathematics ability was a good predictor of achievement in Physics.

Malcolm, et al. (1976) surveyed minority women and found that they reported that poor pre-college academic preparation, lack of exposure to research early on, and being excluded from study groups were among the factors that contributed to their problems in studying science at the college level. Likewise McNamara & Sherrei (1982) surveyed minority women and, in addition to poor academic preparation among them, found the following; that mathematics preparation was critical to their success in the sciences, that interest in science and mathematics was often reinforced by teachers who are remembered as outstanding members of their profession, that counselors had discouraged many minority women, and that hands on research experience was important. Treisman (1985) found that black students maintained a sharp separation between their school lives and their social lives, that they rarely studied together (for math courses), that they studied less frequently than expected and that they did not seek assistance as much as they should have. However, the importance of performance in mathematics among minority students was highlighted by Atwater & Simpson (1984) who found that the SAT-M score was a good predictor of performance among students in science and engineering.

Regarding the effects of special programs in science and engineering for minority students, Landis (1985) concluded that they should; be comprehensive, be housed in an academic unit, and have a practical problem-solving approach. Coles (1983) found that the most powerful predictor of persistence for students in a special program were first year grades, and Wine & Cooper (1985) concluded that an enrichment program for minority engineering students was generally successful in reaching its goal. The last two investigators also suggested that further studies, which compared the performance of minority students who had participated in such programs with that of matched groups of students who had not, could prove valuable in providing useful important information.

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

Introduction

As was stated in Chapter I, the purpose of this study was to investigate experiential and motivational correlates of behavioral and achievement outcomes for minority students who have participated in a special assistance and enrichment program in the College of Natural Science at Michigan State University. More specifically the intent was to;

1) explore the many and varied issues which are germane to a thorough understanding of the host of factors that could impact on students' academic development, particularly in mathematics and the science based disciplines, 2) document the collegiate (and to a lesser extent the pre-collegiate) experiences and perceptions of students from the research sample, 3) ascertain correlates of students' behavioral outcomes in relation to the identified related issues and documented experiences and perceptions, 4) determine correlates of academic achievement according to students' performances prior to, during, and after participation in the special program, and 5) identify implications for similar student assistance programs at American post-secondary institutions.

Because of the desire to obtain information from students which demanded in-depth explorations as well as responses which were more direct and immediate, structured interviews followed the use of an investigator developed questionnaire to document students' experiences, observations, perceptions, and performances both past and present. Most of the subjects for the study were either matriculants in or had planned to become matriculants in programs of study which demanded that they complete a core of courses in mathematics along with prescribed courses in science, engineering, computer science, or business during the initial stages of their study at the university. The questionnaire

(Appendix A) contained 19 items which required students to respond to both open-ended and structured-response questions. The intent in the construction of the questions was to elicit responses from students which, when summarized for each student, would provide a comprehensive picture of the behavioral (and to a lesser extent, perceptual) outcomes which were directly related to their academic development prior to and during their enrollment at the university. The interviews, which were structured according to standard procedures but formatted to allow students freedom of expression, were designed as a means of expanding on the information from the questionnaire as well as to probe more thoroughly into the experiences of students in order to gain further insights into their observations, opinions, and perceptions about these experiences. The central aim was to; 1) determine those factors which were likely to have an impact on students' capability to come to grips with their situation in the academic environment, use the resources made available to them (whether through the special assistance program or outside of it) to plan a course of action to promote their academic development, then act on their plan in a way that would result in sustained academic progress, 2) explore the nature of these factors as impactors on students' behavior while attempting to uncover possible clues to explaining how these factors might interact with each other and with other phenomenon in the environment to affect behavior, 3) identify crucial elements in the behavior of students which were likely to affect their academic performance either positively or negatively, and 4) analyze this information in conjunction with that from the questionnaire and students' records in order to answer the research questions of this study.

The Population and Sample

The target population for this study was the set of all minority students in this country who have entered a predominantly white post-secondary institution with the

intention of, or eventually became desirous of, pursuing a major in one of the curriculum programs of interest to this study. The decision was made early in the development of the design of this study to draw a sample from among students who had participated in the Charles Drew Science Enrichment Laboratory--a special assistance and academic enhancement program for minority students which is operated through the university's College of Natural Science, but which, during the time period when most of the subjects for this study participated, enrolled students who intended to pursue a wide variety of majors at the university. Thus the research population became the total of all students who had been enrolled in the Drew Laboratory (to be referenced as the Drew Program) for at least one term. The final sample consisted of eighty (80) students randomly selected from among the pool of all students who had been enrolled in at least one Drew Program Mathematics course between and including fall term 1980 and spring term 1984.

Other than the fairly obvious reason of accessibility, the decision to define this particular research population and select a sample from it was based on the opinion that the diversity of participating students was such that this population would fairly well represent the larger on-campus population of minority students from the curriculum programs of interest, as well as the target population. Furthermore, the in-depth nature of the study demanded that the sample was drawn from among students who were most likely to be willing and able to provide the kind of information desired. The sample was selected from among those who had been enrolled in a mathematics section of the Drew Program because the mathematics courses formed the central instructional core around which the program's various academic development and support components were designed and structured. Included in both the research population and sample were students ranging in classification from freshman to senior, though the majority were freshmen during the time of their participation in the program. Also included were a few students who had entered the university prior to fall term 1980.

Because the concern of the study was with the determination of correlates of behavior and achievement in the absence of any experimental design or sample subgroupings, a simple random selection from the entire population was drawn. This method of selection helped control the variance and eliminate some of the bias in the data (Wiersma, 1985), as well as insured a greater degree of generalizability of results (Cates, 1985). According to Cates, "Random sampling methods are preferable, since they enable the researcher to choose a sample which should resemble the defined population closely. Random selection generally breaks up patterns which might exist in other selection processes and increases your confidence that your sample is typical of the defined population (p. 56)." The selection of a relatively large sample, in addition to also favorably impacting the generalizability of the results of the study, provided greater latitude in performing the statistical analyses involved.

Students' Academic Environment

General University Environment

Michigan State University is a large midwestern land-grant university which attracts students and faculty/staff members from across the country and from around the world. It is organized around fourteen colleges/schools, of which the student population range from a high of over 7500 students (College of Business) to a low of around 450 students (School of Nursing). During the time of the matriculation of most of the sample population, the enrollment in the College of Natural Science was in the 4000 to 4600 range, and the academic programs varied from those in the biological sciences to those in the physical sciences, mathematics, and statistics. The university combines a wealth of research activity in fields of study from the social sciences to agriculture, with a mix of instructional, academic, and non-academic enhancement programs and efforts.

Freshmen are admitted by the university's admissions office. Some students will be selected to participate in certain academic programs such as in Honors College, and other students will select other programs, such as James Madison College or the Lyman Briggs Program in the College of Natural Science. Depending on students' intended major and/or course of study, they can immediately begin receiving academic advice through the various colleges/schools which will usually have a designated office for this purpose. However, routine matters such as advice about general university requirements or the process for dropping or adding courses are often handled through residence halls satellite units of the Undergraduate University Division. Once students have fulfilled the prerequisite requirements for their chosen majors, they are assigned a faculty advisor in that college/school. Some colleges/schools, notably Business and Engineering, have specific GPA requirements for a set of core courses, depending on students' majors, while others only require a minimum standard, such as a 2.0 overall GPA and in the major requirements.

During the decade of the eighties, the undergraduate population of about to students included an enrollment of about 8 % to 11 % minority students and a black student enrollment which ranged from 6 % to 6.5 %. The social atmosphere for minority students at Michigan State University seems to present a mixed picture. On the one hand, minority students have formed and/or have engaged in a variety of organizations, programs, and activities over the years which were (or are) aimed at their concerns and interests. On the other hand, they often complain about feeling culturally isolated in such a large institution and that institutional racism often serves to make their experiences less pleasant. The perception of elitism and/or racism among faculty and staff members of the institution by a number of minority students has also apparently affected their view of the quality of their academic experiences as well. The views of students from the research sample about both the social and academic atmosphere at the university are documented in the next chapter.

Among the university-wide special programs for minority and/or disadvantaged students at the university are the programs that are housed in the Office of Supportive Services (OSS). The largest of these programs is the College Admissions Achievement Program (CAAP), which enrolls students who often do not meet all of the university's admission requirements and/or who meet certain criteria, such as being a first generation economically disadvantaged student. Through this program students are provided with a host of services, such as tutoring, counseling, workshops, and seminars designed to foster their development in the system. Although there is a summer component for new enrollees, only a certain portion of new CAAP students will participate in them in any given year. The OSS unit also administers programs, such as the Summer Research Opportunity Program (SROP), which are aimed at providing students with a variety of experiences that encourage their continued growth as students toward further pursuits.

Other support efforts for minority students at the university include; the Minority Aide Program, which provides minority student counselors throughout the residence halls system to assist minority students with their varied needs and concerns, the Engineering Equal Opportunity Program, which has historically conducted special sections of mathematics courses at the pre-calculus and introductory calculus levels for minority Engineering majors, along with tutoring and other forms of personal and academic support, and the Minority Business Program, which has traditionally offered special sections of the basic accounting courses required of all Business majors, along with tutoring and other forms of academic support.

The College of Natural Science at Michigan State University enrolls students who pursue curriculum majors in one of the several academic departments or through an interdisciplinary program. The academic departments offer the traditional curriculum programs in the biological and physical sciences which are designed to prepare students for careers in research, teaching, or the professions. Pre-professional advisors provide guidance and assistance for students who plan to pursue program of study leading to

matriculation at a post-graduate health professions institution until those students choose a specific major. Once students decide on a major, faculty members in the respective departments advise them.

The Drew Laboratory

The Charles Drew Science Enrichment Laboratory emerged as a student assistance and academic development program out of an effort to develop an educational process through which a larger proportion of minority students might perform successfully in science based programs of study and gain the academic foundation needed for future professional careers in the natural sciences, as well as in the medical, dental, and related professions. This effort began during the 1976-77 academic year as part of the affirmative action process in the university's college of Natural Science. At the outset, this effort was structured around a sequence of pre-calculus mathematics courses and students were recruited from among all minority students at the university who intended to pursue a major which had as part of its core requirements the successful completion of a set of mathematics courses up to a certain level. The level of mathematics required depended on the college in which the major was found and the requirements of the particular department through which the major was offered. Consequently, students who participated in the program over the first several years intended to pursue the study of a wide variety of majors commonly found in the following colleges; Natural Science, Engineering (which offered the Computer Science Major), Nursing, and Business. A smaller proportion of students were planning a major in colleges such as Agriculture and Natural Resources and Human Ecology, as well as in the various social science disciplines such as Psychology and Criminal Justice. The level of mathematics required for these majors varied from Math 108 (College Algebra) to one or more calculus courses to higher level mathematics courses. Most of the majors in the College of Natural Science required at least two terms of calculus, while most of the majors in the College of Business required Math 108 along

with Math 109 (College Trigonometry) or Math 110 (Finite Mathematics), and the majority of majors in the College of Engineering required the completion of the entire calculus sequence (four courses), as well as at least two to four courses beyond that level, usually to include Differential Equations and Matrix Theory. The College (now School) of Nursing required the completion of Math 108 only.

The original effort from which the current Drew Program emerged included a full complement of student development and support activities including pre-enrollment orientation, advice and counseling, tutoring, study sessions and review sessions, and career awareness. Various ad-hoc activities were also included in order to assist enrolled students with their adjustment to and preparation for the demands of the academic processes of the university and their development of the skills and cognitive abilities needed for success in their chosen curriculum programs. After the formal approval of the culminating structure of program during the 1982-83 academic year - a structure which had essentially existed since the 1979-80 academic year - a problem solving seminar sequence was added to the curriculum as a way of supplementing the mathematics instruction, which by this time had come to include a pre-calculus seminar as well as an occasional offering of beginning calculus. Through this course students were also assisted with their development of many of the skills needed to confront the wide range of problem solving situations which they would eventually confront in the campus environment, thus promoting their overall growth as students. Actually an earlier version of this sequence had been offered for two years prior to its formal inclusion in the program but with different course numbers.

Although potential students were identified and contacted prior to their arrival on campus, beginning with the fall 1979 incoming class, as late as spring term 1983 students could enter the program at any time during the academic year. Those who were accepted were placed in the appropriate mathematics course (Math 082 - Intermediate Algebra, Math 108, or Math 109) based on their score on the Mathematics Department's placement exam

or having earned a grade of 2.0 (C) or better in the prerequisite mathematics course. As a result of this initial policy of allowing students to begin their participation in the program at any time during the year the program began attracting large numbers of students during winter and spring terms who, in many instances, had performed poorly in the department's regular course sections. However, beginning with academic year 1983-84 a policy was instituted which required all students who intended to participate in the program, whether invited or self-selected, to begin during fall term of their freshman year. It was instituted for two basic reasons; the experiences of the two previous years had demonstrated the futility of trying to successfully run a comprehensive academic enhancement program while allowing students to "drop in" at any time during the year, and it was clear to the staff members of the program that students needed to proceed through an intensive process which began at the beginning of their academic experience at the university, if not prior to it, if they were to achieve in rigorous academic curriculums at the levels required for future academic and professional success. In an effort to address this second concern, the staff made, and continues to make, every effort to meet with all prospective students at least once during the summer preceding their enrollment at the university and again immediately prior to the fall term of their enrollment to conduct orientation sessions and get them scheduled properly for their classes. As a matter of fact, pre-enrollment workshops were conducted in Detroit--the area from which the majority of participating students come - during the summers of 1982 and 1983. They involved weekly meetings at which staff members attempted to facilitate a more thorough orientation process and begin some academic skills development and awareness activities.

The decision to structure the Drew Program around a sequence of mathematics courses was based on the conclusion that the best way to assist students and promote the kind of academic development that they would need for the successful study of the sciences and technical disciplines was to build an academic development and enhancement system around a well conceived sequence of instruction and academic support in mathematics. The

system was designed to consider students' backgrounds and experiences while developing the proper mechanisms through which to reach the established goals and objectives of the program. Among other things, this meant that during the early stages of the development of the program every effort was made to, in essence, "learn from the students" in order to refine the various processes of the system as its development progressed. Fortunately the staff members--which at the time consisted of two co-directors, who functioned in many capacities, two mathematics instructors, a counselor/administrative assistant, and several student assistants and tutors--collectively possessed several years of experience working with minority and/or disadvantaged students in various educational capacities.

Consequently there existed a strong philosophical and experiential foundation from which to build a sound system which would foster continued academic progress among students.

In the interest of promoting the development of sound learning skills, which depends on good study strategies, sound problem solving and reasoning abilities, and many other cognitive skills, the instruction in mathematics was designed to consider a host of academic skills factors such as precision in language interpretation and use, analysis of informational data, mathematical and scientific problem solving, written and verbal explanation of solutions, concept recognition, the use of analogies, and many others. The approaches to developing these skills among students were integrated into the instructional processes of the mathematics courses and support components, such as study/review sessions and tutorials, rather than considering them as separate activities. Therefore, unlike the traditional instruction in mathematics, the development of the targeted skills and abilities among students became more important than the topical content of the Courses themselves.

Another feature of the mathematics instructional process (which became known as the mathematics Learning System--Appendix B) which differed from the traditional processes, was that it was directly coordinated with the processes of the other components of the Drew Program's academic development system. In essence all staff members worked together to meet the needs of enrolled students in consideration of their total

situations. This included the usual concerns associated with the advice/counseling process as well as getting involved to confront any unusual circumstances which might have arisen. Students were required to follow certain behavioral guidelines in an established path toward academic progress beginning with their placement in the appropriate course (usually Math 082 or Math 108) and including the scheduling of prescribed counseling sessions, study sessions, problem solving sessions, review sessions, and any other set of activities deemed appropriate to sustaining and promoting their progress (see Appendix C for examples of student guides). Thus the intent was to push all participants to higher levels of performance and achievement regardless of their initial status as students.

The broad objectives inherent in the processes of the learning development system were to prepare students for the successful study of science related disciplines in general and for success at the level of calculus in mathematics. Therefore the staff expected that once students completed the mathematics courses, through the program's pre-calculus seminar (see Appendix D for a description), they would have mastered most of the basic skills needed as a foundation for continued development. However, considering that most students need continued assistance with sustaining their academic development and the fact that in a large research oriented university one cannot assume that students will receive the kind of attention which would naturally promote this development in their regular university courses, students are allowed and encouraged to continue to use the resources of the Drew Program virtually for as long as they wish. The services which were/are made available include assistance with scheduling courses to suit their circumstances, counseling, calculus study sessions, tutoring in Physics and Chemistry, and various other forms of academic assistance as requested by students, such as assistance with organizing material for better performance in their courses and help with developing strategies to gain acceptance to professional or graduate school. Many students maintain contact with the program throughout their undergraduate academic careers at the university while some use

its services occasionally and others terminate their contact after completing Drew Program course sections.

Table 11 compares the final exam scores of Drew mathematics course sections with those of the regular university sections between and including winter term 1980 and spring term 1983. The final exam scores for the regular sections were voluntarily reported by graduate TA's who taught the respective sections, thus not all sections were included. However, in most cases the number of sections included was well over half of all sections of a particular course. The table shows that from the beginning, Drew sections tended to rank in or near the top half of all sections, and that, by winter term 1982, Drew students began to often score higher than average on final exams, in some instances (e.g. fall 1982 for Math 109) much higher. Although no data on final exams is available for comparison purposes beyond spring term 1983, Drew sections continued to average well above the cut-off score for a 2.0 grade, and during at least one term the Drew average (165) was in the 4.0 range on the exam grading scale which was used that term.

Table 12 compares the mathematics GPA's in courses taught in the Drew Program for three groups of students who entered the university during the 1982-83 school year. The three groups consisted of the following: students who were invited to participate in the Drew Program and who did participate, students who were not invited but who chose to participate, and students who were invited to participate but who did not. For Math 082, Math 108, and Math 109, invited participants had the highest GPA's by far, followed by volunteer participants, then invited non-participants. Thus, the evidence suggests that there are advantages to participation in the program, especially among students who begin at the lowest levels of mathematics courses. Furthermore, since the grade difference between invited participants and invited non-participants in Math 108 is two-thirds of a grade point, the implication could be far reaching and especially critical for students who plan majors in science and/or technical areas because of the importance of this course to those majors.

**Table 11. Comparison of Final Exam Scores
(Drew Sections vs. Non Drew Sections)**

<u>Term</u>	<u>Year</u>	<u>MTH Class</u>	<u>n</u>	<u>x</u>	<u>Range of Means</u>	<u>Drew Rank</u>
WTR	1980	Drew 108	61	108.67		
		All 108	1237	116.99	134-92	23 of 45 sections
SPG	1980	Drew 109	33	105		
		All 109	579	111	132-90	9 of 26 sections
FALL	1980	Drew 108	28	118.07		
		All 108	1641	126.27	156-89	39 of 6 sections
WTR	1982	Drew 108	25	108.8		
		All 108	1089	111.7	129-80	21 of 41 sections
		Drew 109	19	122.58		
		All 109	543	118.01	147-77	10 of 25 sections
SPG	1982	Drew 108	28	115.78		
		All 108	469	104.75	121-90	5 of 18 sections
		Drew 109	14	92.2		
		All 109	454	96.57	117-65	14 of 22 sections
FALL	1982	Drew 108	22	104.05		
		All 108	555	99.18	114-89	7 of 20 sections
		Drew 109	19	131.10		
		All 109	132	120.82	135-112	2 of 8 sections
WTR	1983	Drew 108	29	111.82*		
		Drew 109	14	139.86**		
SPR	1983	Drew 108	13	110.77		
		Drew 109	24	104.52***		

* No data on non Drew sections was collected for winter and spring terms of 1983.

** The cut-off score for a 2.0 grade on the final exam for Math 109 winter term was 120 points, and the mean for the Drew section was in the 2.5 range.

*** The cut-off score for a 2.0 grade on the final exam for Math 109 spring term was 106 points.

Table 12. Comparison of Mathematics GPA's
(Entering Class of 1982)

Course	Invited Participants		Volunteer Participants		Invited Non-Participants	
	N	Mean	N	Mean	N	Mean
Math 082	17	2.21	23	1.83	45	1.60
Math 108	22	2.59	28	2.02	59	1.92
Math 109	14	2.21	19	2.11	39	2.06
Math 290	7	2.71	6	2.83		

Further evidence of the benefits of participating in the Drew Program is contained in a report to the Dean of the College of Natural Science from the program Co-Directors' office. It provided results for the incoming class of 1980 and the incoming class of 1983. When the outcomes for Drew students were compared to those for students who were invited to participate but declined, the following were found:

- 1) 75% of original Drew students had graduated or were enrolled in good standing at the university compared to only 44% of the non-participating students;
- 2) Non-participating students were twice as likely to have dropped out of school;
- 3) Non-participating students were four times more likely to have been dismissed from school;
- 4) 69% of Drew students were still enrolled in the College of Natural Science vs less than 10% of the non-participants;
- 5) 48% of Drew students had completed the second term of calculus vs 25% of the non-participants;
- 6) The average grade for Drew students in first term calculus was 2.13 whereas it was 1.56 for non-participants.

The Design of the Study

Rationale

As stated in the introduction to this chapter, this study was designed with an intended use of a mix of qualitative and quantitative research methods. Among the reasons for this decision were the following: 1) This was an exploratory study which attempted to uncover a host of subtle factors which might have some significant relation to a complex problem; 2) Effectively addressing the research questions which emerged during the course of the development of the research problem demanded a more thorough investigation than would have been possible with the use of only one mode of research; 3) The broad theoretical base for the investigations in this study was such that the mixed mode approach was apparently most appropriate to an adequate exploration of the relevance of the many implications to the resulting concerns of this study.

According to Cohen & Manion (1985) there are several instances where the multiple-method approach (triangulation) in educational research is especially appropriate. The following statements by them are especially relevant to this study:

1. Triangular techniques are suitable when a more holistic view of educational outcomes is sought.
2. Triangulation has special relevance where a complex phenomenon requires elucidation.
3. Multiple methods are suitable where a controversial aspect of education needs to be evaluated more fully.
4. Triangulation is useful when an established approach yields a limited and frequently distorted picture. (pp. 260-262)

Indeed this last concern was an especially influential one as the research problem and feasible ways of investigating it were being considered. It became apparent that much of what was being reported on the problem in the literature not only failed to address it sufficiently (i.e. comprehensively enough for a thorough understanding of it) but

contributed to further misunderstandings as well. To assist in countering this situation Cohen & Manion suggested that triangulation might be preferable because of its possible enhancement of the research process itself when they stated that, "exclusive reliance on one method [of research], therefore, may bias or distort the researcher's picture of the particular slice of reality he is investigating" (p. 254). And while addressing the question of how to combine methods, the authors concluded that:

No simple directive can be given for the question, how are the methods to be combined, for the answer will depend to a great extent on the objectives of the study, the particular situation, and the relative weighting which the researcher considers desirable to assign to the methods providing him with data. (1985, p. 265)

An article by Jick (1979) further illuminated the advantage of triangulation as it had developed in social science research and contained some critical elements affecting the decisions regarding this study. In particular Jick stated that:

...That is, beyond the analysis of overlapping variance, the use of multiple measures may also uncover some unique variance which otherwise may have been neglected by single methods. It is here that qualitative methods, in particular, can play an especially prominent role by eliciting data and suggesting conclusions to which other methods would be blind. Elements of the context are illuminated. In this sense, triangulation may be used not only to examine the same phenomenon from multiple perspectives but also to enrich our understanding by allowing for new or deeper dimensions to emerge. (pp. 603-604)

Among the advantages of triangulation which are particularly relevant to this study, Jick noted that it increases the researcher's confidence in his/her results, and "may help to uncover the deviant or off-quadrant dimensions of a phenomenon" (p. 609), "can lead to an enriched explanation of the research problem" (p. 609), and allows for a synthesis or integration of theories. Among the disadvantages of triangulation, Jick listed the difficulty with attempts at replication and the problems which can arrive if it is used for the wrong reasons, such as to compensate for an unclear theoretical or conceptual focus or the

tendency to use one method as "mere window dressing" for the other without explicit justifications for the use of each.

Qualitative Methods

Since survey questionnaires and personal interviews are common methods of investigation in conducting educational and social science research, opinions abound regarding the theoretical grounding and basic tenants for their consideration as well as the proper procedures and/or guidelines for their use. According to Cates (1985), "the major advantage of using the questionnaire is that, if properly prepared, it can offer a reliably consistent presentation of items" (p. 97). However, Borg & Gall (1979) contended that if the survey questionnaire is to be used then the investigator should "be able to state specifically and in detail what information you [the investigator] need, what you will do with this information after you get it, and how each item on the questionnaire contributes to meeting your specific objectives" (p. 292). Gordon (1980) concluded that the primary advantages of the questionnaire are its economy and the ability to provide anonymity.

Because many of the references in the literature on the use of interviews have discussed them as extensions of the use of survey questions, many comments about interviews apply to the use of questionnaires as well. On using the interview in the research situation, Cates stated that "the major advantage of the individual interview is that the interviewer can tailor it to the person being interviewed and can utilize both verbal and nonverbal cues in determining the responses." (p. 97) Borg & Gall further elaborated on this point by stating that "perhaps the interview's principal advantage is its adaptability. The well-trained interviewer can make full use of the responses of the subject to alter the interviewer situation." (p. 310) And they pointed out one of its more specific favorable features when they observed that "the interview is likely to yield more complete information than other methods when open-ended questions pertaining to negative aspects of the self need to be asked." (p. 311) Gordon (1980) listed the improved ability to get respondents

to supply "accurate and complete information immediately;" the opportunity to be certain that respondents correctly interpret questions, especially when the research emphasis is on discovery rather than measurement; the greater control over the situation possessed by the investigator; and the ability to evaluate the validity of information as advantages of the interview.

Borg & Gall noted that although adaptability is an advantage provided by using the interview it is also the source of one of its principle disadvantages; subjectivity and the possible bias which might result from it. They claimed that many factors, which they referred to as "response effects" might contribute to biasing data, including eagerness of the respondent to please the interviewer, the possibility of a "vague antagonism" between the two, and the interviewer's tendency to allow preconceived notions to affect the accuracy of the information received. Cohen & Manion also cited bias as a major problem with interviews and pointed out that this bias might be more the source of invalidity than the commonly inferred "face invalidity," which refers to questions appearing not to measure what they claim to measure. They cited the work of Cicourel (1964) as the basis from which to list five unavoidable features of the interview situation that need to be considered in planning for the interview situation: 1) factors that inevitably differ from one interview to another, 2) the respondent might feel uneasy, 3) both interviewer and respondent tend to hold back, 4) lack of clarity of meaning, and 5) the impossibility of having every aspect of the encounter within rational control.

Regarding the problems inherent in constructing a questionnaire Wiersma (1985) recommended care and thoroughness in the development of items that deal with a meaningful research problem, clearly defining the data, and the construction of items after the research problem has been properly identified. Cohen & Manion (1985) provided a list of the types of questions which should be avoided when constructing a question; leading questions, highbrow questions, complex questions, irritating questions, questions which use negatives, and open-ended questions on self-completion questionnaires unless it is

used in an interview situation. And Borg & Gall (1979) suggested that the researcher should be able to explain why a certain question is being asked and how the responses will be analyzed.

Regarding the conduct of the interview, Wiersma (1985) contended that a good rapport between the interviewer and the interviewee is essential for accurate and truthful responses. He observed that "the interview should be structured to obtain the necessary information efficiently in a friendly but businesslike atmosphere. If possible, there should be some accuracy checks on the responses" (p. 145). Wiersma also suggested that care is taken with data-recording procedures to guard against interfering with the interview process itself. In order to structure the interview situation, Gordon (1980) described strategies to introduce the interview, explain the purpose of the interview, explain to the respondent the method of selection, provide anonymity, record the interview, and plan for the opening question. He also suggested that the interviewer attempt to recognize and plan for the effects of potential inhibitors of good communication during the interview and make an effort to include facilitators of communication. His list of inhibitors of communication were discussed under the following categories; competing demands for time, ego threat, etiquette, trauma, forgetting, chronological confusion, inferential confusion and unconscious behavior. The categories of facilitators of communication included; fulfilling expectations, recognition, altruistic appeals, sympathetic understanding, new experience, catharsis, the need for meaning, and extrinsic rewards.

Borg & Gall (1979) explored several methods of effective communication, including initially engaging the respondent in a few minutes of small talk, phrasing questions in common language, pausing between questions, and guarding against asking too many successive closed-form questions or using leading questions. As a way of continuously evaluating the interview as it proceeds, Cohen & Manion (1985) suggested minimizing interview guidance, making provisions for the full expression of the respondents' definitions of the situation bringing to bear a broader range of stimuli and

responses, and the eliciting or responses of an in-depth nature and within a personal context. On this last suggestion they stated that "the interview should bring out the effective and value-laden implications of the subjects' responses to determine whether the experience had central or peripheral significance. It should elicit the relevant personal context, the idiosyncratic associations, beliefs, and ideas" (p. 311).

Quantitative Methods

The emphasis in this exploratory study was on exploring experiences, observations, and perceptions of students in order to uncover significant factors and relationships which might have impacted their behavioral patterns and in turn might have affected their academic performance and achievement. In an effort to gain a more thorough understanding of any relationships which might surface through the qualitative methods and determine specific correlates of academic achievement among the research sample, quantitative methods were employed. Data from students' records and from the questionnaire were assembled and analyzed. Borg & Gall (1979) made the following timely comments about relationship studies:

Relationship studies are concerned primarily with gaining a better understanding of complex behavior patterns (e.g., school achievement) by studying the relationships between these patterns and variables to which they are hypothesized to be causally related (e.g. intelligence). This research design is especially useful for exploratory studies in areas where little or no previous research has been done. (pp. 478-479)

Regarding the correlational method specifically, Borg & Gall suggested that its primary advantage is that it allows the measurement of a large number of variables and their interrelationships, as well as the degree of relationship, simultaneously. Cohen & Manion (1985) maintained that correlational studies are appropriate when the research is attempting to discover or clarify relationships, and when variables are complex, thus not amenable to experimentation and control. They also pointed out that, although less rigorous than the

experimental method, the correlational techniques "allow for the study of behavior in more realistic settings" (p. 160). According to them its limitations include; the fact that it does not establish causes for behavior, the potential for identifying "spurious" patterns of behavior, its inherent "atomistic" approach, and the relative impreciseness of the correlation index due to the unreliability of variable measurements. Of course many of these concerns are addressed in this study through the complementary effects of mixing methods.

While referring to the identification of research variables, Cates (1985) stated that "the three sources most useful in identifying these variables are the review of the literature, personal experiences, and thoughtful reflection. Whenever possible, [the researcher] should attempt to bring all three sources to bear on a problem" (p. 87). The design of this study employed an extensive use of all three sources. First, the expansive review of the literature presented in Chapter II not only laid the foundation for a comprehensive understanding of the research problem but provided a rich source for the identification of significant variables as well. Second, the investigator possessed a wealth of experience in working with minority and disadvantaged students in a variety of capacities, including counseling, tutoring, advising, instruction in mathematics, the design and coordination of curricula and programs, and instructional and program evaluation. Thirdly, the length of time (several years) devoted to delineating the scope and focus of the research problem and feasible methods of investigating it provided the opportunity for a great deal of "thoughtful reflection" about the many issues and concerns related to the problem and the ways in which they might be analyzed and synthesized to produce meaningful results.

Reliability and Validity

According to Cates (1985), "reliability refers to the consistency with which an instrument produces equivalent scores. Such equivalence is determined in relation to repeated administrations as well as administrations to a variety of subjects" (p. 124). Since the only paper and pencil instrument used in this study was an investigator developed

survey questionnaire, which was varied in format, there was no basis for calculating any of the reliability coefficients which are commonly determined when standardized instruments are used. Thus the concern for reliability during the pilot testing of the questionnaire, as well as during the initial interviews, was directed at developing processes and procedures which would include as much consistency as was feasible. This included steps to standardize the schedule format and to check students' responses for conformity to the intended format and content of the questionnaire items.

Cates defined validity as "the measurement or representation of what something claims to measure or represent" (p. 131). Accordingly, both internal and external validity need consideration. For non-experimental studies, internal validity is not as clearly defined as it is for experimental studies, but Wiersma's statement that "internal validity deals with being able to understand the data and draw conclusions from them" (1985, p. 98) is appropriate for either type of study. Cates maintained that the researcher should concern himself or herself with the appropriateness of the sample and sampling technique, the response or participation rate and pattern of participation of the research sample, and the reliability and validity of the instruments used in order to address the concern for internal validity.

Cates defined external validity by stating that it "is determined by the extent to which the researcher can state that [the study's] findings are applicable to samples and populations other than the sample used in the study" (p. 135). This type of validity is often referred to as generalizability, and, based on the discussions of it by Cates and others, the primary concern in a nondifference, non-experimental study should be over whether the sample population is similar to the target population and whether research sample reflects the research population. These concerns were addressed earlier in this chapter.

Implementation of the Study

Selection of the Sample

All of the class lists for the Drew Program's mathematics courses beginning with those for fall term 1980 and continuing through spring term 1984 were used to develop a list of all students who had been enrolled during this period of time. The names of all students from this list were ordered and a table of random numbers was used to select a random sample of 85 students (26.2 % of the total). Thus every student who had been enrolled in at least one Drew Program mathematics course had the same chance of being selected regardless of the length of participation in the program, mathematics course at entry to the program, class standing, or any other criterion. Eventually the final research sample consisted of 80 students (24.6 % of the total) because five students whose names originally appeared on the list either were enrolled at the university for only one term or left the university before the completion of their first year of study.

Development and Administration of the Questionnaire

The purpose of the questionnaire was to document students' behaviors, experiences, performances, and opinions about them at the university and, to a lesser extent, during their high school years (Appendix A). The objectives which guided the development of the questionnaire were: 1) To determine Students' study patterns for mathematics and science while in high school; 2) To document students' high school performance in mathematics and science; 3) To elicit students' opinions regarding their confidence in their academic ability in mathematics and science, 4) To determine the problems experienced by students which might have affected their academic performance at the university; 5) To determine the study strategies and sources of assistance used by students for their study of mathematics; 6) To document students' behavior patterns and changes in their behavior patterns relative to the study of mathematics and science at the

university; and 7) To elicit students' opinions about their overall experiences, especially those related to the study of mathematics and science at the university.

The initial phase in the preparation of the questionnaire began with the development of several questions directed at obtaining responses from students about a broad range of activities and concerns, many of which were non-academic but which were included due to the issues which surfaced while reviewing the literature. During this phase of the development of the questionnaire, the specific focus of the research problem had not been narrowed to its final point. Hence the initial questionnaire was much broader in scope than the final product would become and many questions were eventually eliminated altogether, while others were revised to fit the desired focus and format.

The early versions of the questionnaire were administered to several sections of the Drew Program's courses during academic years 1982-83 and 1983-84 for the purpose of gauging students' responses and conducting early pilot testing (Borg & Gall, 1979, Wiersma, 1985), as well as to collect information which was useful in the on-going development process of the program. In the meantime the process of narrowing the focus of the study continued, along with the elimination, addition, and/or revision of certain questions. For example, the format of the question regarding the number of hours of study per week for students' high school mathematics class had to be re-formatted to include smaller intervals of time due to the clustering of responses given by students. Several students were also interviewed at some point in time after they completed the questionnaire in order to pretest the proposed interview process.

After the development of the final form of the questionnaire was completed students from the research sample were contacted to solicit their participation in the study. Beginning in spring term 1985 some students were contacted by phone and others were sent a letter of transmittal (Appendix E) to request their cooperation by either coming to the investigator's office (or to some other designated location) to complete the questionnaire and be interviewed or completing the questionnaire and returning it by mail. Due to the

time constraints some students completed the questionnaire at one session and were interviewed during a separate session at some later point in time.

This process continued throughout the spring and summer terms of 1985 and into academic year 1985-86. A few questionnaires were completed and still fewer interviews were conducted into academic year 1986-87. Many of the students who participated in the study during the latter stages of the process were responding to follow-up efforts, which included a follow-up letter (Appendix F) which explained why it was important that they respond to the request for their participation and requested their cooperation by responding. Other students had missed previous appointments and were responding to a request for them to honor new ones.

At one time that students came in for their appointment they were greeted and engaged in a few minutes of small talk. Because most of the students were known by the investigator as former students and/or Drew Program participants, there existed a basis from which to begin a cordial conversation and establish a good rapport. After the small talk students were given more detailed instructions regarding the completion of the questionnaire and the follow-up interview. They were then escorted to a room where they could be alone to complete the items on the questionnaire and they were told that if they had any questions they could return for assistance or they could wait until after completing those portions for which they had no questions. The time needed to complete the questionnaire was 20 to 30 minutes.

Once students completed the questionnaire they were engaged in a short conversation regarding their responses as the responses were being checked for accuracy and conformity to the intended format of the questions and to see if they reflected the intentions of the student. This conversation included comments on students' responses to forced-response items as well as open-ended items and notes were made on any comment which might have added something significant (relative to the purposes of the study) to

their response and/or made it more complete. The conversation also served as a bridge to lead into the interview phase of the sessions.

Format and Conduct of Interviews

As was stated earlier in this chapter, interviews were conducted to expand on the information from the questionnaire and to probe more thoroughly into the experiences of students in order to gain further insights into their observations, opinions, and perceptions about these experiences. Included in this process was an attempt to allow students freedom of expression while guiding them through a predetermined path in order to gather the desired information. To facilitate this process an interview protocol (Appendix G) was developed which contained the major questions for which responses were desired and which further delineated the focus of the study. However, there was no rigid adherence to the interview guide as the interview proceeded, as every effort was made to allow students to freely express themselves and share their opinions and perceptions.

At the outset of the interview process, students were asked if they would mind the use of a recording device during the interview. All but one student agreed to having the recorder, a small battery operated model, in operation as the interview was in process and most of them seemed to react as if there was no need to question them about their approval in the first place--an apparent indication of a certain amount of trust on their part. As the interview proceeded every effort was made to remain cognizant of potential inhibitors of communication (Gordon, 1980) and to control them as much as possible. Within the context of this study the likely inhibitors were competition for students' time, forgetting, and inferential confusion.

In order to get students to be as complete and thorough in their responses as possible, attention was given to the facilitators of communication as discussed by Gordon (1980). The altruistic appeal was perhaps the principle means through which students were encouraged to put forth a strong effort to be as accurate and complete as possible on the

questionnaire as well as during the interview. That is, since all of the students who consented to participate in this study were, at one time, participants in the Drew Program (some for several terms) they were made aware of their possible contribution to it through the use of the information that they were willing to share for the benefit of other students in the future. As a matter of fact, several of the students appeared to have been pleased to know that their opinions were of value to someone in a position of authority and were thus quite willing to cooperate in any way that they could, indicating their appreciation for being recognized in this way.

Other Research Data

Most of the students' background data, including information from their high schools (GPA), standardized test scores (ACT and/or SAT), and MSU Placement Test scores were obtained from the Office of Admissions. Students' transcripts, from which their grades were obtained and GPA's were calculated, were received from the Office of the Registrar. Approval from the Human Subjects Review Committee was obtained to gain access to students' records after a review process by this committee had been conducted.

Hypotheses and Statistical Analyses

The statistical methods found to be most suitable in analyzing the quantitative data of this study were the t-test for independent samples and the correlation method. The research questions of the study that lend themselves to quantitative analysis and the relevant research hypotheses are stated below, along with the specific statistical methods used to perform the analyses. Thus, the Pearson Product Moment Correlation Coefficient will be computed and used to test all hypotheses dealing with correlation. The t-test for independent samples will be used for testing differences in means.

Question 1: What are the critical factors in students' academic backgrounds which affect their ability to adapt to the academic demands of the university, especially for the study of mathematics and science?

Hypotheses 1-45

H₀: There will be no significant correlation between each of the 9 pre-enrollment variables and each of the 5 initial performance variables listed below:

Pre-Enrollment Variables

- a. High School GPA
- b. ACT English Score
- c. ACT Math Score
- d. ACT Social Science Score
- e. ACT Natural Science Score
- f. ACT Comprehensive Score
- g. MSU Arithmetic Placement Score
- h. MSU Math Placement Score
- i. MSU Chemistry Placement Score

Performance Variables

- a. First Math Grade
- b. First Chemistry Grade
- c. First Term GPA
- d. Second Term GPA
- e. First Year GPA

H₁: There will be a significant correlation between each of the 9 pre-enrollment variables and each of the 5 initial performance variables listed above.

Question 2: What do students need to do behaviorally in order to develop the required academic skills for the successful study of mathematics and science at the university?

Hypothesis 46

H₀: There will be no significant correlation between Math GPA and each of the Last Math Strategy variables given in question 14 of the questionnaire, and listed below.

Items for Question 14:

- a. Outline the assigned material content.
- b. Do assignments everyday and try to keep up with the class.
- c. Review the previous assignments before doing new ones.
- d. Keep an organized notebook or loose leaf binder.
- e. Work on Problem Sets early and often.
- f. Take notes in class and study from them.
- g. Read the textbook and study examples.
- h. Review the course material over the weekend.
- i. Do extra work (such as even numbered exercises)
- j. Read each section before it is discussed in class.
- k. Skim over sections to be covered later.

H₁: There will be a significant correlation between Math GPA and each of the Last Math Strategy variables given in question 14 of the questionnaire.

Hypothesis 47

H₀: There will be no significant correlation between Math GPA and each of the Last Math Source of Assistance variables given in question 15 of the questionnaire, and listed below.

Items for Questionnaire # 15

- a. Tutoring
- b. Study Sessions
- c. Problem Solving Sessions
- d. Instructor's Office Hours
- e. Review Sessions
- f. Assistance from roommate or friend
- g. Group Sessions with other students

H₁: There will be a significant correlation between Math GPA and each of the Last Math Source of Assistance variables given in question 15 of the questionnaire.

Hypothesis 48

H₀: There will be no significant correlation between Math GPA and Last Math Strategy Effort combined score.

H₁: There will be a significant correlation between Math GPA and Last Math Strategy Effort combined score.

Hypothesis 49

H₀: There will be no significant correlation between Math GPA and Last Math Source of Assistance Importance combined score.

H₁: There will be significant correlation between Math GPA and Last Math Source of Assistance Importance combined score.

Hypothesis 50

H₀: There will be no significant correlation between Math GPA and Amount of Study Time for all classes at the time of completion of the questionnaire.

H₁: There will be a significant correlation between Math GPA and Amount of Study Time for all classes at the time of completion of the questionnaire.

Hypothesis 51

H₀: There will be no significant correlation between Science GPA and Amount of Study Time for all classes at the time of completion of the questionnaire.

H₁: There will be a significant correlation between Science GPA and Amount of Study Time for all classes at the time of completion of the questionnaire.

Question 4: What are the self-reported reasons why some students eventually do those things which are necessary when they were not originally doing them? Furthermore, what are the psycho social dynamics of this transformation process and what are the subsequent effects on students and their academic enhancements?

In order to document changes in behavior among the students in the research sample, t-tests for independent samples were used to determine whether or not there were significant differences among the responses given for the items in questions 14 (about effort exerted on various study strategies) and 15 (about the importance of various sources of assistance) between those given for the first mathematics course and those given for their last mathematics course.

Hypotheses 52-62

H₀: There will be no significant difference between students' First Math responses to the 11 items in question 14 and their Last Math responses.

H₁: There will be a significant difference between students' First Math responses to the 11 items in question 14 and their Last Math responses.

Hypotheses 63-69

H₀: There will be no significant difference between students' First Math responses to 7 of the items in question 15 and their Last Math responses.

H₁: There will be a significant difference between students' First Math responses to 7 of the items in question 15 and their Last Math responses.

Question 6: What are some of the significant correlates (both statistically and practically) of student achievement among members of the research sample?

Hypothesis 70

H₀: There will be no significant correlation between students' prior confidence in their ability to do well in mathematics and any of the performance variables listed below.

- a. First Math Grade (FMG)
- b. Math 081/082 Grade
- c. First Math 108 Grade
- d. First Chemistry Grade (FCG)
- e. First Term GPA (FT GPA)

H₁: There will be a significant correlation between students' prior confidence in their ability to do well in mathematics and any of the above performance variables.

Hypothesis 71

H₀: There will be no significant correlation between students' prior confidence in their Math 108 Grade and any of the performance variables listed below.

- a. First Math Grade
- b. Math 081/082 Grade
- c. First Math 108 Grade
- d. First Chemistry Grade
- e. First Term GPA

H₁: There will be a significant correlation between students prior confidence in their Math 108 Grade and any of the above performance variables.

Hypotheses 72 - 95

H₀: There will be no significant correlations between each of the 6 background variables and each of the 4 performance variables listed below.

Background Variables

- a. High School GPA (HS GPA)
- b. ACT Math Score (ACT M)
- c. ACT Comprehensive Score (ACT C)
- d. MSU Math Placement Test (MSU M)
- e. MSU Chemistry Placement Test (MSU C)
- f. First Term GPA (FT GPA)

Performance Variables

- a. Math 290 GPA
- b. Math GPA
- c. Science GPA (SCI GPA)
- d. Tech GPA (TECH GPA)

H₁: There will be significant correlations between each of the 6 background variables and each of the 4 performance variables listed above.

Advantages and Limitations

The fact that the investigator, who had taught or had been in contact with most of the students in the research sample of the study as the Mathematics Coordinator of the Drew Program, was so close to the situation of these students resulted in both advantages and limitations. On the one hand, this closeness provided keen insight into students' backgrounds, dispositions, attitudes, perceptions, etc. Thus this closeness and its resulting knowledge were quite helpful as students were being approached about participating in the study and as students were prodded into in-depth explorations of their experiences and perceptions during interviews. Knowledge about students also assisted the process of confirming the accuracy of students' responses, as well as promoting thoroughness in data/information collection.

On the other hand, the investigator's closeness and knowledge of students introduced the likelihood of increased interviewer bias during interviews, as well as possibly increasing the potential for bias in the analysis of the results. Furthermore, students' might tend to give answers that they think are expected or acceptable in their view, or perhaps become reluctant to give certain responses due to concern about the potential reactions of program staff members or other consequences. All of these concerns were considered during the conduct of the study.

Other advantages and limitations of the design and conduct of the study are listed below.

Advantages

The triangulation method allowed for a more thorough investigation of the research problem. The exploratory nature of the study was crucial to this concern as well.

The sample was fairly accessible to the investigator, thus this contributed to a high participation rate.

The fact that all of the students were interviewed by one interviewer likely contributed to increased reliability of students' responses during interviews.

The fact that attempts were made to probe in-depth into students' views and experiences contributed to a more thorough understanding of the problem than would have been gained otherwise.

Limitations

The reliance on retrospective self-reported responses of students about their previous experiences created the potential for inaccurate results.

The fact that there was no match-paired group of students to serve as a control group in the design of the study resulted in the lack of opportunity to extend the analysis to broader comparative methods.

Although MSU enrolls a very diverse student population, the fact that none of the students were non-participants in the Drew Program decreased the opportunity to take advantage of this fact. For example, all of the randomly selected students in the sample happened to have been black, thus the other minority groups were not included.

The lack of control for variance limited the interpretation of the statistical results, and/or prevented further statistical analysis in some instances.



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CHAPTER IV

PRESENTATION OF FINDINGS AND ANALYSIS OF RESULTS

Introduction

In this chapter, information and quantitative data from the interviews and questionnaires, as well as other research data, are presented and results from both qualitative and quantitative analyses are illustrated and summarized. The chapter begins with a discussion about how the enormous amount of respondent information and research data were managed. Afterwards a profile of the research sample, including some comparative analyses, is given. After a statement of the research questions and brief comments about them, the presentation of the results found in the eleven thematic categories which emerged is given, including quantitative analyses of related data and summary remarks for each category. Following a summary of the research findings--based on a synthesis of qualitative and quantitative results from all eleven categories--analysis of the relevance of the collective results and findings to the theoretical foundations, philosophical positions, and empirical evidence presented in chapters two and three of the thesis is given.

Maintenance, Preparation, and Organization of the Data

The interviews were transcribed onto loose-leaf paper and the transcripts were kept in a large loose-leaf binder. They were then reviewed to determine broad thematic categories, such as "Experiences in High School", and the categorized results were arranged in separate sections of the binder. Qualitative information from the questionnaires was similarly reviewed and categorized. The quantitative data was recorded on data coding

sheets and programmed onto a floppy disc for analysis on an IBM compatible personal computer which had the SPSS-PC software program installed in it. Some statistical analyses were also performed on the university's mainframe computer.

After all of the interviews were completed and all questionnaires collected, the information from them was further reviewed to reduce the large number of categories (21) which still existed and to get a more complete view of the descriptions presented by students. The resulting categories were further scrutinized and sub-categorized in order to "flush out" the major themes under which a clear picture of the experiences of students could emerge while providing a foundation for identifying critical factors associated with their successes and failures during various stages of their development. A concern for thoroughly identifying and analyzing the impact of these factors on the quality of students' experiences also guided this process.

The end result of the continued refinement of the information and data was a set of 11 thematic categories. Each category was then reviewed further to identify sub-themes and make further observations. This was done by taking key statements on each topic by each student who commented on that topic and examining them to determine the resultant themes and observations which emerged. Statements by students were also screened for accuracy and meaning at this stage of data preparation and organization.

Profile of Research Sample

Tables 13 and 14 present comparisons of the pre-matricular data among students from the research sample, the overall campus population, and all black students at the university. Table 15 shows the entry majors among students from the research sample only. Table 16 indicates the levels at which students in the research sample ended their study of mathematics, while Table 17 reveals their final majors. All data for the tables was taken from students' transcripts as of Winter Term 1987, or from other university records. The majority of students included in the research sample had either graduated or left the

**Table 13. Comparison of High School GPA and ACT Scores Among the Research Sample,
All University Students, and All Black Students +**

Variable	Research Sample			All University #			All Black #		Sample vs. Univ t =	Sample vs. Black t =	Univ. vs. Black t =	
	N	Mean	SD	N	Mean	SD	N	Mean				SD
HS GPA	75	3.00	0.42	5730	3.22	0.43	455	2.96	0.41	4.40*	0.76	12.67*
ACT ENG	75	15.79	4.47	5162	20.64	4.18	379	15.85	4.95	10.50*	1.15	18.38*
ACT MTH	75	15.04	5.93	5162	22.69	6.02	379	14.67	6.59	11.08*	1.14	22.98*
ACT SOC	61	14.43	6.23	5162	21.50	6.02	379	14.54	7.03	8.82*	0.13	18.29*
ACT NAT	61	17.38	4.91	5162	24.58	4.86	379	17.68	5.12	11.39*	0.45	25.38*
ACT COM	75	15.65	4.30	5163	22.48	4.18	379	15.80	4.89	13.65*	0.26	25.97

+ Data for the research sample included all available data for all of the students in the sample. All University students excludes Black Students. All Black Students excludes Students from the research sample.

The sample for All University students and for All Black students included only students who entered the University Fall Term, 1982, as new students.

* Significant for $p \leq .01$

Note: HS GPA = High School Grade Point Average; ACT ENG = ACT English Score; ACT MTH = ACT Mathematics Score; ACT SOC = ACT Social Science Score; ACT NAT = ACT Natural Science Score; ACT COM = ACT Comprehensive Score.

Table 14. Comparison of MSU Placement Test Scores and selected GPA's among the research sample, All University Students, and All Black Students. +

Variable	Research Sample			All University #			All Black #		Sample vs. Univ t =	Sample vs. Black t =	Univ. vs Black t =
	N	Mean	SD	N	Mean	SD	N	Mean			
MSU RD/CM	76	16.78	4.71	5578	21.95	5.50	455	17.26	9.49*	0.59	19.01*
MSU ARITH	43	25.05	4.61	663	26.61	4.88	226	22.81	2.21*	2.86*	10.03*
MSU CHEM	58	5.28	1.80	2513	7.36	2.97	164	5.03	5.66*	0.84	12.85*
MSU MTH	76	11.92	5.11	5580	16.49	6.00	455	11.41	7.43*	0.80	19.38*
1st Tr GPA	80	2.29	0.78	5463	2.67	0.65			4.34*		
1st Yr GPA	80	2.37	0.59	5336	2.68	0.60	461	2.20	4.52*	2.35*	16.28*
2nd Yr GPA	76	2.34	0.50	4583	2.76	0.51	321	2.34	7.27*	0.05	16.36*

+ Data for the research sample included all available data for all of the students in the sample. All University students excludes Black Students. All Black Students excludes Students from the research sample.

The sample for All University students and for All Black students included only students who entered the University Fall Term, 1982, as new students.

* Significant for $p \leq .01$

Note: MSU RD/CM = MSU Reading Comprehension Test Score; ARITH = Arithmetic Test Score; CHEM = Chemistry Test Score; MTH = Mathematics Test Score; 1st Tr GPA = First Term GPA; 1st Yr GPA = First Year GPA; 2nd Yr GPA = Second Year GPA.

Table 15. Students' Entry Major

<u>Major</u>	<u># Students</u>	<u>Percent</u>	<u>Cumulative Percent</u>
Pre-Professional ⁺	32	40.0	40.0
Natural/Physical Science	13	16.3	56.3
Business	12	15.0	71.3
Engineering	8	10.0	81.3
Nursing	4	5.0	86.3
Social Science	2	2.5	88.8
Other	2	2.5	91.3
No Preference	<u>7</u>	<u>8.8</u>	<u>100.1</u>
Totals	80	100.1	100.1

⁺Pre-Professional students were mostly pre-medical or pre-dental students. There is no actual pre-professional major at M.S.U. During the time of this study, students who were listed as pre-professional were advised through the Pre-Professional Advising Center of the College of Natural Science, but they had to eventually choose a specific major in the college or transfer to a program or major in a different college. Until that time they could be referred to or seek advice from faculty/staff of the respective program or major.

Table 16. Students' Last Mathematics Course

<u>Courses</u>	<u># Students</u>	<u>Percent</u>	<u>Cumulative Percent</u>
Higher Than Calculus II	10	12.5	12.5
Calculus II	14	17.5	30.0
Calculus I	12	15.0	45.0
Drew Prog. Pre-Calc. ⁺	7	8.8	53.8
Finite Math [*]	6	7.5	61.3
College Trigonometry ^{&}	20	25.0	86.3
College Algebra [%]	<u>11</u>	<u>13.8</u>	<u>100.1</u>
Totals	80	100.1	100.1

⁺This course was described in Chapter IV in the section on the Drew Laboratory.

^{*}This course is used primarily as a terminal prerequisite for majors in the College of Business.

[&]During the time of matriculation of students from the research sample there were a few majors in the College of Natural Science, such as Medical Technology, for which this course was the terminal prerequisite. Most of the others required at least one or two terms of Calculus.

[%]During the time period of this study majors in nursing and agriculture were among those which required this course as a terminal prerequisite.

university by that time. All of the remaining students had reached at least their fourth year of study.

Tables 13 and 14 reveal the expected results when comparing pre-matricular achievement and aptitude variables among students from the three groups considered. That is, upon entry it was expected that students from both the research sample and all black populations would present GPA and test score profiles which were statistically different from those of the overall population of students. This held true without exception as indicated in the first and third columns of t-values of each table. That the research sample did not differ significantly from the larger population of black students at the university upon entry is confirmed by the second column of t-values in each table in that, other than two exceptions (MSU Arithmetic Score and 1st year GPA), the t-values found did not reveal statistical significance. The difference in the Arithmetic placement test score is probably attributable to the fact that the research sample is composed largely of students who intended to pursue majors which required a certain foundation in mathematics, while the difference in first year GPA could be partially attributable to the amount of direct academic support and assistance provided to members of the research sample through the Drew Program during their first year in most cases. In any event the important consideration here is that since the two populations present essentially the same academic profile, the basis for establishing generalizability of results to the larger target population of affected minority groups is strengthened. Furthermore, the extent of profile differences between the two minority samples and the overall population of students, which for most variables was virtually a full standard deviation or more, documents both the need for extensive intervention efforts on behalf of the target groups and empirical investigations into the nature and processes of their academic development.

Table 15 presents the entry majors of students from the research sample in order of preference. As can be gleaned from these results, majors in the sciences (including Nursing), engineering, and business account for 86.3% of the intended majors of this

Table 17. Students' Final Majors[±]

Major	# Students	Percent	Cumulative Percent
Natural/Physical Science	22	27.5	27.5
Agriculture and Natural Resources	12	15.0	42.5
Human Ecology	12	8.8	51.3
Business	5	6.3	57.6
Nursing	1	1.3	58.9
Social Sciences	18	22.5	81.4
Comm. Arts and Sciences	5	6.3	87.7
Undergraduate Univ. Division*	7	8.8	96.5
Other ^{&}	<u>3</u>	<u>3.8</u>	<u>100.3</u>
Totals	80	100.3	100.3

[±]The last major listed on students' transcripts from winter term 1987.

*This was listed as the major for some students among those who had not graduated. In most cases this probably meant that they had not chosen a definite major at the time of release of transcripts or their records had recently been transferred and the listing had not been posted on their transcript.

[&]There were perhaps three or four Engineering majors from among research population but none were members of sample.

group. On the other hand, Table 17 presents the majors which were listed for students at the time of acquisition of their transcripts, which, for the students who had graduated at the time (the majority), was the major in which they received a degree. It should be noted that the majors in the College of Human Ecology were majors such as Human Nutrition or Dietetics which required a certain number of science and mathematics courses for their completion. Thus if these majors are considered along with those in the Natural/Physical Sciences, Agriculture and Natural Resources, Business, and Nursing, then almost 60% of all students had a final major which either had a Natural Science foundation or was in one of the areas of Business. Table 16 reveals that 30% of students from the research sample finished at least two terms of Calculus, 45% finished at least one term of Calculus and that

almost 79% had completed mathematics through College Trigonometry. The 79% excludes the 7.5% who took Finite Math.

Other data from students' records and students' responses from the questionnaires revealed the following additional information about the students in the research sample:

--Students reported that they averaged four to five hours per week of study for their mathematics class in high school and seven to nine hours per week for all their classes.

--Students generally thought that their high school preparation in both mathematics and science was good (in a range of poor to excellent).

--The expected amount of study required at the college level, as reported by students, averaged about 12 hours per week for all classes and the actual reported study time during the first term also averaged 12 hours per week. The reported amount of studying for all classes at the time that students completed the questionnaire averaged about 16 hours per week, or about one third more than the first term.

--Fifteen (18.8%) of the students in the research sample began their study of mathematics with Beginning Algebra (Math 081), 35 (43.8%) began with Intermediate Algebra (Math 082), and 28 (35%) began with College Algebra (Math 108). Thus not only did they begin at the pre-Calculus level but the majority (over 60%) began their study of mathematics at a level which is generally considered remedial or developmental (Math 081 or 082).

--Students reported that they studied about eight hours per week for their first mathematics course and between 11 and 12 hours per week for their last mathematics course (at the time of completing the questionnaire). They also reported few missed classes (between one and three) in either their first or last mathematics course.

Research Questions

In order to investigate the problem of this study, students' reported behaviors (and opinions about them) and a variety of performance and achievement indicators were explored. The results were analyzed to determine critical factors, related outcomes, and significant correlates. As was stated in Chapter I, the study was organized around seven central questions:

1. What are the critical factors in students' academic backgrounds which affect their ability to adapt to the academic demands of the university, especially for the study of mathematics and science?

2. What do students need to do behaviorally in order to develop the required academic skills for the successful study of mathematics and science at the university?

3. What are the motivational factors which determine (or at least have an influence on) whether students do these things or not? That is, why do some students do them and others do not?

4. What are the self-reported reasons why some students eventually do those things which are necessary when they were not originally doing them? Furthermore, what are the psychosocial dynamics of this transformation process and what are the subsequent effects on students and their academic achievement?

5. What are some of the adjustment variables and institutional factors which affect students' ability to grow and develop academically and socially, and how do they affect students and their capacity to make sustained progress within the institution?

6. What are some of the significant correlates (both statistically and practically) of student achievement among the members of the research sample?

7. What are the implications of the results of this study for minority students' educational development and enhancement; overall student academic development; and student assistance, and retention programs at post-secondary institutions?

Since the findings of this study are presented within the context of the eleven thematic categories, the results which were gained from exploring the various categories are given during the presentation of the findings for each. Thus those results which pertain to a respective research question will likely be found in the presentation of more than one category. However, a summary of the results, arranged according to the research questions, will be given at the end of the chapter.

Question 1 obviously lends itself to a variety of statistical analyses. It will also be addressed through qualitative analysis. Questions 2 and 3 will be addressed primarily through qualitative analysis but question 2 is addressed partially with the assistance of

quantitative analysis as well. Question 4 and 5 are addressed through the use of qualitative information. Question 6 is addressed primarily by statistical analyses, and all of the results obtained were considered in addressing question 7.

The statistical analyses used in obtaining results for this study rely heavily on mathematics achievement (grades and grade averages) and development (progress in course work). As was brought out earlier, although the study is directed at student development in the sciences and science related disciplines, as well as mathematics, the reliance on achievement in mathematics as a critical variable in statistical analyses, rather than in some other discipline(s), was an intentional element in the design of the study. Not only was (and is) the Drew Program centered around a mathematics learning system with its full complement of support components, but the rationale for this focus (the need for students to succeed in prerequisite mathematics before they can even consider a program of study in the disciplines of concern) also suggests that any study of this type should have mathematics achievement and development as fundamental performance measures. Furthermore, the academic skills and cognitive abilities needed for success in mathematics include a great many, if not the great majority, of those skills and abilities needed for the successful study of the sciences and the more technically oriented disciplines. Finally, the disparity in course work among the research sample of this study precluded a heavy reliance on performance in science and technical courses in the analysis of the data.

Presentation of Thematic Categories

The results found in the exploration of the eleven thematic categories which emerged are presented in this section. They are presented in the form of Principal Observations, discussions of the Principal Observations, data/information displays, and presentations of outcomes from statistical analyses. After a brief introduction and/or some preliminary comments, statements of Principal Observations, which were arrived at after

reviewing and analyzing the interviews and information from the questionnaires, are given. Supporting evidence is then presented in the form of characterizations of students' statements of opinions, perceptions, and retrospective observations, as well as in the form of actual quotes by students. Students were given fictitious names for this purpose. During the presentation of the supporting evidence for each Principal Observation, further observations are given and comments are made regarding students' responses to amplify and/or clarify certain subtle points which could lead to a more in-depth understanding of the presentation. This will be followed by the display and discussions of quantitative data and other information from the questionnaire, and statistical analyses appropriate to the respective thematic categories. The presentation of each major category will conclude with some concluding remarks (Summations) to further amplify and expand on those points which were deemed germane to a more thorough understanding of the research problem and its related issues. Principal Observations, free standing quotes, and concluding remarks are preceded by brief (usually two word) descriptors.

1. High School Experience

Although not all of the students interviewed discussed their experiences while in high school and the questionnaire did not contain any open-ended questions about them, several interviewees were questioned about their pre-college academic experiences and/or they explored certain aspects of these experiences during the course of the interview. After a review of these discussions, two major themes emerged which characterized the conversations of most students; the lack of expectation by teachers that students would study a minimum amount at home for their various courses, and a lack of real challenge and/or enrichment in the academic experiences of their high school. Two other observations resulted from reviews of information from the questionnaire and analyses of data from students' records.

Principal Observation 1A--Inadequate Preparation

Students consistently reported that they were not required to [or there was little demand on them to] study very much at home, or necessarily engage themselves in learning strategies such as taking notes or outlining their work as conditions for receiving good grades in high school. Consequently they were likely to find that they (in their opinions) did not develop the habits and strategies needed for the successful study of entry level college courses. Furthermore, from discussions of their experiences in adjusting to the academic demands at college, it was evident that not having experienced a level of intensity in academic preparation which could adequately serve as a foundation for college level work hampered students' prospects for a less stressful academic adjustment process.

To illustrate both the situation as found in this observation and its' link to students' collegiate experiences, a brief quote by Sauncha makes a direct point. While discussing her adjustment to the academic demands of college she made the following comments:

Learning to Study

Well I knew it was going to be a lot more work than I was used to [in high school]. It was hard for me to get used to taking notes because I never had to take notes in high school. Since I never had to take notes I never studied. So I had to learn how to do all of that.

When Sauncha said that she never studied in high school she apparently meant that she did little work outside of class which was not directly related to getting homework assignments done. That is, she probably did not use notes, textbooks, workbooks or other course materials to sort out information in order to "learn" the subject matter for her courses. Thus, in her opinion, she had to find out how to do that once she arrived in college. Sabrina also seemed to be suggesting that she seldom studied at home when she stated that **"in high school you can just study your stuff in school and you'll be done,"** and Evan intimated a similar sentiment when he mentioned that he would **"come home put his books down"** after school. Walter concluded that he did not have study habits in high school and that he should have studied more than he did. Kyra also mentioned that she did not study for her mathematics course(s) much while in high school because, according to her, math was easy for her. Marie also mentioned that she

did not need to study much in high school and Terri claimed that she studied only on the nights before exams.

The revelations of Linda point to the pervasiveness of the problem of students entering the university without the proper habits and skills. She attended a private high school which was noted for its academic reputation, yet she found that, like other students, she had to learn a great deal about managing herself in the academic environment of the university. In her words:

Low Expectations

I had no study practices. Who studied [in high school]? That was really something I think I had to learn to do. There are three. . .there are two other girls here with me now; we started elementary school together and now we're in college. We went all the way through high school, everything together and we sit around and talk about this a lot. I can't really say that my high school, as private and parochial as it was, really prepared me for studying. Because it was such a small school and such a closed school it was almost like you passed on the fact the [your teachers] knew [your] parents, or the teachers knew your whole family, your brothers and sisters. Not, per se; they made you do some work, you know, but it wasn't really what I needed to get up here and do really well. I didn't learn that until after maybe even my third term here. I'm not sure.

The response of Sherri to my observation regarding the fact that she had indicated that she did not like science in high school illustrates a lack of discipline and demand on students, as well as an apparent lack of enrichment -- a topic which is explored in the next section. The following was Sherri's observation about her attitude toward her science course:

Teacher Inadequacies

I think that a lot of it had to do with the teachers. One teacher I had for chemistry was so boring and people did what they wanted [to do]. I was into sports also, so it was a class I really blew off. I didn't like it at all. Once I got to physics my teacher was a bit stricter but once I reached that level I had already lost my feelings for science. I liked physics a bit more. I thought it was cute.

About her experiences in math, Sherri's remarks suggested that, although her efforts had been less than desirable, her grades had not reflected that fact. She concluded that:

Limited Motivation

Precalculus [in high school] was everything or a lot of what was in 108 and I sat back and lights came on. I wish now, looking back, I had applied myself more because [Math] 108 and 109 could have been a breeze. In high school I only studied enough to get by and I still got good grades. When I got into [a special section of math for engineering majors] I did really well in [Math] 109.

There were a few exceptions to this general pattern of little effort for rewarding grades. For example, Latisha mentioned that her parents demanded that she do at least a prescribed amount of home work at home and that she, consequently, averaged about eight hours of study per week for her mathematics courses. Deena indicated that the fact that she was the only black student in her high school made her feel pressured to perform well and thus work hard. She also stated that she studied seven to eight hours per week for her mathematics courses. Shirley described a self-induced pattern of late hours and intense studying which was motivated by a strong desire to get her school work done, even to such an extent that her mother would often force her to go to bed.

Principal Observation 1B--Insufficient Challenge

With few exceptions students reported that they were not challenged academically or intellectually during their high school years and there was no evidence from their comments that they were engaged in any "enriching" academic activities or experiences either. The pattern seemed to hold true regardless of the type of school (private/parochial, or public/inner city, or suburban). As far as their experience in science classes in particular, there was virtually no comments which might have suggested that any students perceived them as stimulating, rewarding, interesting, or otherwise challenging, and/or enriching. Those who did comment on these classes tended to emphasize their non motivating and non rewarding characteristics.

Among the comments noted as part of the discussion of Principal Observation A, Sherri claimed that she was neither challenged nor inspired in her Chemistry class and the remarks of Linda included a reference to the lack of a strong push to work hard from her teachers. In a similar vein, Enis noted that in his opinion his problems in adjusting to the academic demands of college life could be partially traced back to not having been challenged or exposed to enough creativity in the curriculum during high school. While

describing her adjustment to studying mathematics, Karla alluded to not having been pushed to strive beyond a certain level as having had a negative affect on her ability to adjust. This observation was also made by Linda when she described the academic environment at her small high school. Lisa indicated that even though the rapport with the teachers was good there was little incentive for students to reach for lofty academic goals. She concluded that **"Even though they encouraged us to do well - How can I put it? - they never pushed us; they never really tried to make us work hard for what we could do."**

Indeed certain elements in the previous academic experiences of students can often have profound impact on the quality of their subsequent academic experiences. This is a claim which is embedded in the next Principal Observation.

Principal Observation 1C--Critical Events

As students moved along in their high school matriculation they often found that key events, circumstances, attitudes, and features of their experiences stood out as substantially affecting the quality of their overall experiences both during the remainder of their time in high school and during their adjustment to college life.

As an example, Melvin described his experience of having been reluctant to continue with the study of mathematics in high school because his friends were beginning to "drop out of mathematics" as he reached the higher grade levels. Thus he concluded that his academic development in mathematics had been hindered as a result and that this contributed to the adjustment problems in mathematics (he had to repeat Intermediate Algebra) which he experienced at the university. Melvin also reported that he had a fear of doing story problems (which according to him, was partially ameliorated by the experience of doing Problem Sets for Drew Program mathematics classes) because of an "attitude" which he developed while in high school. Makeda on the other hand, stated that mathematics was her favorite subject in high school and that she did not hesitate in taking as much as she could. However, during her senior year she took a course called

"Computer Mathematics," in which the emphasis was on using the computer to do mathematics rather than on development and growth in mathematical abilities. Thus she concluded that she did not experience any further mathematical development beyond her junior year, despite having taken an additional course. This fact, in turn, could have contributed to her testing into a remedial course (Math 082) rather than into a higher level course as she had expected.

Annette reported that her unawareness of the importance of mathematics in the academic arena contributed to her not having taken as much math as she feels she should have taken. As she put it:

Mathematical Hesitancy

...I really didn't know the importance of it [mathematics], how important it was to learn math. I didn't really want to... I wanted to but then again I didn't want to take a lot of math, because it was something you had to put a lot of time into and I was into a lot of extra-curricular activities. Therefore, I didn't get as much math as I should have. I found that out when I got here (to the university).

Fortunately her self-confidence and inner desire to do well, along with her apparent eagerness to learn math and science, propelled Annette to a level of academic success which resulted in her gaining admission to medical school. However, several other students also expressed regrets about not having taken as much mathematics in high school as they later concluded that they should have taken, and some of them seemed to react as if the negative consequences were more lasting. Finally, one student mentioned an interesting experience during her high school years which left a lasting positive impression on her. According to Margaret she tutored several students while in high school because she **"was the only one who liked math"** and she thought that this experience had helped her retain mathematical concepts and thus adjust more smoothly to her mathematics course at the college level.

Questionnaire Results and Discussion

As was previously reported, students reported that they averaged four to five hours per week of study for their mathematics class while in high school and seven to nine hours per week for all of their classes. The accuracy of these figures is highly questionable, especially considering the fact that if the higher number were taken for mathematics study time and the lower number were taken for "all" study time, the difference is only two hours per week. However, the important consideration here is that the amount of time devoted to their studies, by their own account, is consistent with students reports of little study time in high school compared to that expected at the college level. The average rating of students' opinions of their prior preparation in mathematics and science (good in a range of poor to excellent) is also consistent with their views, which was highly variable. The average reported high school grade for all students was a solid B for both mathematics and science, which is also consistent with their views about their prior preparation.

Summations - High School Experience

1a. Other Directedness Some students seemed to be "pleading innocence" by stating that they didn't work hard because they weren't required to or by making comments such as "I didn't do well (or didn't like a certain class) because the class was boring!" There seemed to exist an attitude which directed all or most responsibility for their actions (or non actions) to others. It is certainly reasonable to expect that when this attitude is carried into the college environment the results can become devastating. In addition, the literature oppression. . .

1b. Academic Naiveté The remarks from students about their high school experiences seemed to suggest that many of them were aware of not having received (nor earned) what they would need for their future educational development. However, for the most part, students did not seem to feel that any particular group or groups in society should have been responsible for this situation existing. Furthermore their experiences apparently promoted a fairly narrow view of what the essence of the educational experience is about--an observation which is supported in the presentation of the next thematic category (Adjustment to College).

1c. Disconnected Content Another observation which emerged during the course of interviewing students and which was partially substantiated in the next presentation is that the schooling which these students received was, for the most part, heavily grounded in rote learning and rule based activities

which were disconnected from students' own cultural experiences. Thus Freire's (1970) "banking concept" of education is very much in evidence.

1d. Performance Inhibition The fact that some students commented (without being prompted) that they didn't know why they didn't do certain things suggests that some had indeed pondered this question, yet had not answered it. Thus the apparent complexity of their motives to perform begins to emerge.

1e. Cumulative Impact The lasting affects of certain events, episodes, and circumstances in students' previous experiences, as reported here, suggests that the journey through the educational pipeline is a precarious one which is susceptible to many forces and influences. A positive concomitant of this observation is that certain teachers, other educational staff members, or even community members can substantially enhance the quality of the experiences of students. A further implication is that once students enter the college or university those with whom they have initial contacts can play a significant role in determining the prospects for students' adjustment and growth.

2. Adjustment to College

Students' experiences in attempting to adjust to the demands of college life generally and the study of mathematics and science in particular was of primary interest to this study. Consequently, virtually every student who was interviewed and/or completed a questionnaire was asked to comment on some aspect or aspects of their adjustment experiences. As reported in the literature, the expectations of students often differ from those of the personnel of the institution (e.g. Gibbs, 1973), and students are often unaware of many of the fundamental ground rules of college matriculation which are often taken for granted as being apparent by faculty and staff members with whom students have contact. Students' attitudes and behavioral dispositions, the campus environment, and the quality of initial contacts further combine to affect the prospects for students' adjustment to the university and to the demands on them to develop and maintain sound academic learning skills.

Principal Observations 2A--Expectancy Misconceptions

Perhaps the most pervasive factor which affected the ability of students to confront the realities of the campus environment and its

demands, both personal and academic, was the misconception of entering students about what would be expected of them once they began their matriculation at the university. Students consistently reported that their perceptions of reality regarding the demands on their time and the need to control its use, as well as the level at which they would be expected to learn course material from the outset, were unrealistically low and that they were often unaware of their ignorance (or at least its seriousness) until they were well along in their academic careers. Furthermore, they were found to be woefully unaware of many of the most basic processes and behavioral expectations (both written and unwritten) governing standards of conduct and self regulation. Comments from students suggested that they often assumed that the collegiate experience would essentially involve a continuation of the kinds of experiences to which they had become accustomed in high school. Consequently many seemed to have envisioned an environment in which one or more of the following would be true:

i. Demand Assumption Relatively little, or only a small increase in, effort would be demanded of them to gain the rewards of academia (e.g. professional careers, financial benefits or post-graduate studies) which they had anticipated.

ii. Independency Assumption University academic staff and support personnel would function to look after their every need and concern and things would simply "work themselves out" with little direct relationship to the amount of effort on their part to "take care of themselves."

iii. Piecemeal Learning The "educational" experience would essentially involve the memorization of facts or bits of knowledge, and that as students the important concern was how to get the best grades possible through the use of the best available "tricks of the trade" without regard for academic development.

To illustrate the disparity between students' expectations and reality, the comments of Makeda get right to the point. She stated that:

Uninformed Expectation

I knew it would be more studying than it was in the high school years. But I don't think I expected staying up like past eleven to study, nothing like that. I expected, oh like I can study a couple hours after dinner and I'm fine. ...I really hadn't expected late hours.

Candice echoed these remarks and pointed to the difficulty of overcoming this initial adjustment problem when she observed that:

More Studying

Compared to high school I had to study more, I knew that, but I didn't study that much more. That was my downfall during my first term. That's

about the only thing that I remember that concerned me - was getting into the flow of how to study because I never did study for high school.

Tiesha's statements on this issue highlight some of the specific behavioral outcomes and academic consequences of the lowered expectations and misconceptions of students.

According to her:

Superficial Effort

When I first came here I didn't know how to study because I didn't know anything about college anyway. So I thought that academics would be the same as high school. You study for about two or three hours and you four point (make an A in) everything. So I really didn't study. And when I did study I'd start at 9:00 p.m. During the day I'd just do whatever I wanted. Usually I'd start late and I wouldn't do all of the problems anyway. I didn't feel like being bothered. Whenever I had to go over my assignment I would just glance over it, I wouldn't pick the details out. I overlooked a lot of things so it showed on my test. I knew the concepts but I really didn't know the details so it would all catch up with me.

Karla revealed that she did not know why but she was initially determined not to grow as a student and refused to increase her efforts beyond what she had originally intended. As she put it:

Restrained Effort

In high school I did well in math, although I didn't study a lot. Up here in [Math] 082 it was like you had to study, and in-depth, whereas I just wanted to stay at the minimum instead of going beyond what the teacher was saying. I felt I should be able to get it at this level. I shouldn't have to go up another step. I refused to put forth more effort to get it. I don't know why. I think I came here with the wrong philosophy. I felt MSU would be similar to (her high school) and if I did what I did in high school I'd be alright. But it's very different.

Karla went on to point out that she had not done very well in that particular class and the shock of that experience prompted her to work harder the next term.

Among the small number of students whose expectations were in line with those of university personnel, Sean mentioned that he was confident about his exceptionally strong academic foundation and that he considered the first few courses at the university to be essentially a review for him. Regina commented that people kept saying that college was

hard so she expected to work hard after she entered the university. As a matter of fact, according to her, she had to ease up some from her initial behaviors because she found herself staying up until the late hours of the night too often to complete all assignments. Patrice stated that she expected to and was willing to study hard but she simply found it difficult to get very much out of the time which she was devoting to studying during the first two years or so. And Annette observed that although there was a lot of peer pressure to neglect her studies during the initial stages of her college career, she expected that the demands on her time would be stringent and she was strong willed enough to do what she had to do despite the distractions.

Regarding students' unawareness of the basics of functioning in the collegiate environment, the experiences of two students illustrate the kinds of decision making situations which can confront students early in their careers and potentially affect (often seriously) their prospects for adjustment. Sherri's problems began before her first term even began -- during the summer orientation process. Like virtually all students, she took the arithmetic and mathematics placement exams during the first day of orientation. Students received their scores on the second day of orientation and when Sherri received her's (she tested into Arithmetic) she was upset, yet she did not take the situation seriously. Consequently she did not bother to find out that she could have taken a retest to test out of the course, and when she enrolled in it in the fall she did not study for it and developed a negative attitude about mathematics at the university. This in turn affected her performance (at least initially) in her next mathematics class. Fortunately she was able to overcome the negative effects of these initial experiences but the fact that she was enrolled in the Drew Program for her third, and most critical, course to that point (Math 108) must be considered; especially in light of the documented effects of minority students' participation in special programs at majority institutions.

Andrew cited an example in his experiences which was much more common among the interviewees and has been observed quite often by the investigator. He was given a

schedule during his first term which was not only demanding but included a course (in accounting) in which he probably should not have been enrolled. Because of his lack of awareness of his situation he tried to adjust to the situation by increasing his efforts and managing his time better in an attempt to perform adequately. However, he found that he made little progress in this direction but, unlike many other students, he made the correct decision to drop the class before it became a part of his permanent records, that is by midterm. Thus he apparently became aware of his options and was able to avoid the potentially negative consequences of his initial ignorance.

While discussing her inadequate study patterns, Tiesha explained her apparently uninformed views about the demands of college work, which she concluded had contributed to her mediocre academic performance during her first year, and she also revealed some of the factors in her background which she believed had lead to her state of being uninformed. An interesting aspect of her situation at the time of the interview (at the end of her second year) was the fact that she had sat in on some of the classes in which she had previously performed at a mediocre level--this at the urging of a Drew Program staff member who was concerned about her academic foundation. Thus Tiesha's comments were probably buffeted by a certain amount of previous reflection on her part about her status as a student. She gave the following account of her experiences and opinions about them:

Gross Underestimation

Usually when I had to do something that was due on Monday I'd usually do it Sunday night. Having three classes, to tell you the truth, I thought "well three classes - I'll only meet three days a week - how hard can it be in college." That's what I thought. I thought this is going to be easy. You know, you get out in four years, it has to be easier than high school. Nobody taught me any different. Both of my parents didn't finish high school so I didn't know anything about it. In school they didn't reinforce it, they didn't give any background saying what college is all about. So I basically didn't study. I didn't know how and because of that I felt that I was incapable of doing [well]. So my taking the classes over I had to prove to myself that I could do it, it was a matter of applying myself and see that you have to tackle things.

During the course of conducting the interviews, students who had participated in one of the pre-enrollment summer orientation workshops sponsored by the Drew Program were asked about their opinion of the workshop's effectiveness in promoting awareness of what to expect in the fall. All of them agreed that they were helpful and the comments of Evelyn were especially enlightening. She observed that:

Adjustment Facilitator

It (the workshop) had a lot of impact on my adjustment to the university. I became very aware that this would be a totally new experience for me and it would be something different and I would definitely have to work hard to succeed at the university. I really think it was a positive experience because after I met people up here and I told them about experiences, ...a lot of things I could just handle better. A lot of academic things, preparatory things I could do to get adjusted (as suggested by program staff members).

However, comments by Evelyn later in the interview point to the complexity of the problem of getting minority and/or disadvantaged students fully acclimated to the educational process. Despite the fact that she was apparently a serious student who had concluded that she was well aware of her situation (and who, in the opinion of the investigator, had become a well adjusted student at the time of the interview), Evelyn revealed that it took her a year and a half to fully recognize the level at which she would need to function. She stated that **"Winter term of my sophomore year, that's when I started realizing that it takes a lot more than what you're doing to accomplish the goals you've set for yourself."**

Among the consequences of students' unawareness of the importance of certain behaviors and/or erroneous assessments of themselves, perhaps the most devastating is the unfavorable impact on their potential to develop appropriate study patterns and learning strategies. For example, Rachael mentioned that initially she was "just coming home and doing a few problems" instead of trying to learn the material. Levon stated that he **"was not really studying to master the material,"** while Cora cited her tendency in her first mathematics class to simply observe the material and conclude that she knew it from high school without checking to find out if she did, as one of her problems. Sabrina

commented on her lack of preparation for the level of intensity needed to approach studying in college as a major obstacle for her and Andrew revealed that he wished that he had taken advantage of the tutorial study rooms which were available to him when he was enrolled in the Drew Program's mathematics courses. Interestingly, he also revealed that although the importance of attending study sessions had been stressed by program staff members, he was not convinced that he had to be as consistent in attending as he had been told. Thus his ignorance was compounded by stubbornness -- a critical problem among a seemingly large proportion of students from the research population.

Even among students who apparently had attempted to "behave appropriately" and had worked hard towards their academic advancement, the confrontation with the reality of their lack of preparation for the level of learning mastery needed at the college level could become distressing. For example, Shirley made the following comments in response to being asked to describe what it was like when she first realized that, despite the enormous amount of time which she reportedly had devoted to studying in high school, as a learner she was functioning well below the level needed in college:

Demand Realization

Well it was a thing, first I was kind of analyzing myself because I talked to different people. I thought it was a mental block as far as [my] holding myself back. I came to this college with a big ego thinking I'm going to turn this college upside down, because I did it in high school. I had always done it in high school, elementary, junior high - I always did really well. As far as taking classes over, I had never taken classes over before. I never got D's before - maybe twice in high school, but I always came out shining. I never did outright flunk. When I came here it was a different story. Like I said, I used to always put in the time when I was in high school, but when I came here I had to put in extra, twice that or three times the time I used to put in, and that's a lot more.

Shirley further revealed that even though she was putting in a great deal of time with her studies initially, she probably was not as systematic and organized as she should have been and that, like Andrew, she "blew off" many of the suggestions from staff members about the use of her time.

Due to her apparent in-depth reflection on student development issues Tiesha once again was able to provide some revealing detail about both the mistakes that students often make in approaching their studies and what it takes to confront the problem. According to her:

Consistent Effort

Basically I didn't have a study pattern, I just didn't study at all. And if I did study, I'd study at the last minute. I usually studied the day before the test. Whereas with math you have to study. You have to constantly keep up with it. You don't necessarily have to do all the problems, the most important thing is knowing how to apply the principles. If you can apply the principles you can come back to a problem and say this is how I do an algebra problem or a quadratic problem. But if you're doing a problem just to get it done you're really not doing anything, you're just writing it on paper - a waste of time and of your knowledge in the first place. For my study habits I've learned that I have to constantly keep up with it, especially me because I'm not a person that catches on really fast. It doesn't stick in there. I have to keep reinforcing it basically.

As a final example of how students' unawareness of their academic status affects their initial ability to develop and grow academically, one episode in the experience of Evelyn demonstrates the importance of having the appropriate academic services available to students at critical junctures in their experiences. While discussing her adjustment to the university, Evelyn made the following comments about her experiences in a writing course:

Course Adjustment

ATL (American Thought and Language) was quite different from any other writing experience I ever had. When I was in high school I thought I was a very good writer because I'd done very well on my papers in my grammar courses and everything. But when I got up here it seemed as though I was behind to some extent. I wasn't on the college level I guess you could say. But since I'd gotten acquainted with the people in the Drew Program, [a program co-director] helped me a lot with my papers and so that was a hard adjustment, because I had to adjust mentally to say "well, ahhh, I'm not a good writer after all." Then too it took a lot of my time. It took me longer to write a paper than I think I was supposed to take. But now, since I got that help from [the two co-directors] and I worked more on all aspects of my paper, right now I can write a paper in two days. (At this point there was an expression of pride by her.)

Karla related similar feelings and experiences and her comments about them are presented in the next thematic category as a conclusion to the discussion of students' adjustment problems.

Principal Observation 2B--Managing Independence

Based on their reports, many students apparently found that realizing the positive benefits from their new independence on the college campus did not happen without a concentrated effort on their part, or, in some cases, without some painful confrontations with the realities of their situations. Furthermore, they often found that their ability to handle the kinds of responsibility which they were forced to accept would not simply evolve over time. As a matter of fact, many students seemed to have found that the need to handle the responsibility which came along with their new freedom initially presented a problem rather than an opportunity to express themselves in ways which would enhance their growth and development towards becoming better students and more mature persons.

As she discussed her experiences in adjusting to college life, Berniece made some comments which brought to light what it was like to suddenly have, as most students do, a multiple set of concerns which they would necessarily need to confront, as well as the problems inherent in facing the reality of having to manage the use of her time for the first time, while functioning in an impersonal campus environment. In responding to the question of her adjustment to university life, Berniece made the following observations after having mentioned coming from a predominantly, black background as a concern:

Accepting Responsibility

That (suddenly becoming a minority) and not having anyone to wake you up or tell you to go to class or having a parent to say its your responsibility to do what you have to do, and budgeting money and my finances and all of this. ...I was still a minor. That made things difficult. I couldn't get certain forms taken care of and everything. Even though I was being given this responsibility they would still say you're not mature enough. And I was given two standards - you can't sign this but I'm actually doing this. I was only 17 and it was too much at that one time, as far as looking at your major and what you had to do or what you should be or place you in. The fact that I was just a number, they were not concerned about what you do or what you enjoy. Well if you want to be in this major this is what you do, this is how you do it. No [consideration] for the type of person you were. You were just placed in a block and you fit the role. And I didn't particularly like the system. I was rebellious in the sense that I'm not just anybody. You know, what about what I like doing? ...And just the

impersonal nature of it all. First no friends up here, and no family and being used to having your family and friends around and you've been just placed in a campus and that's it.

About her misuse of time Berniece had this to say:

Time Mismanagement

I think I had too much time. I had always been use to going to classes in high school, from classes I did volunteer work. And so I always had just a limited amount of time to do things so I did it. When I came up here I went to class at 9:00 and I was finished at 12:00. And basically I had nothing left to do until 9:00 the next morning. I always said I don't have to study now I can study later. I had so much time on my hands that studying was the last thing I wanted to do. So more than likely I would be studying at 11:00 o'clock at night, when I could actually have studied at 1:00 or 2:00 o'clock [in the afternoon] and get it over with. I'd leave it for the last minute. If I had a job where I went to work, came home, ate dinner, you know I only had this much time to study, I would do it (study) because I had no other time to do it. But when given all this time and freedom and a different place you tend to go off to learn about the place and studying tends to be the last thing you want to do, even though that's what you actually come to do.

By winter term Berniece had a job and she credited her decrease in "wasting time" to that fact.

Several students echoed Berniece's sentiments regarding the problems created by the sudden absence of constant adult guidance and direction once they arrived on campus. For example, Sylvia mentioned that her having been accustomed to personal attention as a factor in her adjustment whereas Lora cited not having homework collected as well as her own penchant for procrastinating as crucial adjustment factors. Deena also cited homework as a factor by observing that while she was in high school she was used to having her parents ask "Did you do your homework?" That served to keep her in check and the absence of this kind of prodding at the university was cited by Deena as being significant. Kreisha mentioned that she was often late for her first math class because it was across campus from her form and she didn't have a bus pass. And Melvin, when asked what he would suggest to new students, made comments which apparently reflected his observation that students often don't accept responsibility for themselves as they should. He responded

by commenting that **"They should probably get into a habit of doing their homework without having the teacher have to check it every day,"** and he went on to say that new students should **"never let your friends talk you into taking too much of your time out as far as going out to a party or something."**

The conversations with two students included discussions which contained statements which not only summarize the situations of many students, but represent problems found on different ends of the adjustment continuum as well. One student's discussion of his transition from high school to college illustrates the negative academic effects of lack of discipline and the comments of the other about her tendency to overcommit herself, despite her apparent maturity, demonstrates the need to exercise careful control of the use of one's time, initially. Larry seemed to suggest, as did several other students, that he needed step by step guidance about how to approach a managed study pattern when he stated:

Self-Discipline Experience

As far as the transition [from high school to college] was concerned, in high school they watched us more, and you had to study. You should study for one hour, two hours, whatever, and they would watch us a bit more. But here, just the excitement of being here in college and you finally have the chance to do better and all this. But I wasn't disciplined. I think the main problem when I first started was discipline. I didn't know how to discipline myself. I had no one to tell me how to really study for a course. A course like [Math] 082, as simple as that course is you still have to maintain a good study program, a study management program. You have to pace yourself. You have to study everyday. With mathematics, I didn't realize at the time, I would wait to the last minute. I would let it all pile up. I would do homework all at one time, thinking I was going to pull off some magical trick. ...As time went on I realized that you can't do that, you have to pace yourself to absorb the material.

Lolita, on the other hand, indicated during her interview that, despite the fact that she considered herself to be a well adjusted person both personally and academically, she found herself misusing her time, thus jeopardizing her academic progress. While discussing her major adjustment concerns she made the following comments:

Non-Academic Commitments

I think that the problem that has plagued me throughout my college career has been the fact that I'm over committed. I love to be involved. However, I think that you have to put limitations on yourself and it's taken me a long time to realize that I'm not superwoman. I had to go through a lot of changes that first term, really the first two years. And that's still a problem because there's so many things that I want to do, and I have many interests. A lot of times I think that people are more educating than textbooks. So I find myself a lot of times [engaged in] in-depth conversations with people as it gets later and later and it's like "ok I'm too sleepy to do any homework." So I'll have to get up that morning to do the homework that I should have done that night before and it puts you at a disadvantage.

Although Lolita observed that this activity was preventing her from doing her homework properly it is noteworthy to point out that it was not "frivolous activity." Furthermore her maturity was evidenced by the fact that she developed a time management plan and attended workshops at the Learning Resources Center in order to gain better control of her time and improve her study and learning skills.

Minority students have consistently been found to complain about the campus environment of predominantly white colleges and universities since they began arriving on these campuses in increasing numbers during the 1960's. As evidenced by the responses given during the interviews for this study, minority students of the 1980's not only shared this concern, but the fact that many of the perceived problems had not been resolved seemed to confuse and/or frustrate many of them.

Principal Observation 2C--Minority Burden

The environment of the college campus seemed to adversely affect many students. Many of the problems confronted by some students were common among the overall population of students (as explored in the literature), but these problems were often compounded by students' minority status.

Minority status as used in this observation refers to cultural and ethnic differences rather than race and/or gender as such. These will be explored under a subsequent

category. Within the context of this observation, students' perceptions about themselves in the larger campus environment is the primary concern. For example several students mentioned that the size and impersonal atmosphere on campus presented problems. Having large classes and/or taking courses which were taught with the use of television videotape or audiotape were often cited as specific examples of institutional factors which were perceived as adversely impacting on students' ability to adapt to the academic milieu of the campus. Another form of academic problem resulted from what might be referred to as "the sociology of the classroom environment." Perhaps due to cultural reasons, minority students often seem to dislike certain aspects of the classroom atmosphere and its proceedings. For example, Anthony complained of being made to "feel dumb" because of the reactions from other students to his questions. Other students cited the dispositions of professors, such as seeming to become annoyed at their questions or reacting in a condescending way to their request for attention or assistance. Still others cited problems with registration, scheduling, and other types of procedural problems. Representative of the feelings of many students were the sentiments of Lolita (who was previously cited as well adjusted) as she reacted to the impersonal nature of courses:

Stereotypic Expectations

That's one major thing I don't like about State either. I think in a lot of classes you kind of feel like a statistic. Because people say this is a weeder course and if you happen to fall into the category of getting a D or F then you feel like you're a failure. And I don't think any university should make you feel that way, especially if you tried your best.

That students' complaints could stem more from considerations other than cultural or ethnic ones might certainly have been the case for some; e.g. Sauncha mentioned that her coming from a very small high school was the root of her problems. However most students seemed to think that the cultural dimension was more prominent. The comments of Berniece were representative of those of many students, especially those from majority black inner cities. Berniece stated that:

Minority-Status Adjustment

Coming from a predominantly black [environment], a black high school; being placed in a situation where I was now a minority was hard to deal with. Adjusting to classes where you are the only minority and the looks students give to you. I never felt inferior to anyone but I realized what it meant being a minority.

Lolita, on the other hand, maintained that the cultural aspect was never a problem for her. However, her comments about it revealed that the concern over cultural differences was evident among black students generally. In response to being asked about her adjustment to the university (without any mention of culture), Lolita made the following observations:

Cultural Adjustment

Culturally I didn't have any problem adjusting. I came from a white background in that I attended parochial and private schools all my life. And I lived in an integrated neighborhood. So that wasn't a problem for me, although I have some friends and I've talked to people, and that's been a serious concern of theirs. It's like "I've never been around all these white people or I've never been around all these black people." And that in itself has caused them some problems.

Because of minority students' perceptions that cultural and ethnic differences do play a major roll in their adjustment experiences it would appear that students' initial contacts with significant others at the university could become important to their adjustment patterns. The examples of Evelyn and Karla who were able to get successful intervention assistance at critical points in their early experiences illustrate the importance of this consideration. However, more often than not, students pointed to experiences which they perceived as negatively impacting on them as examples of what they recall their initial contacts to be like.

Principal Observation 2D--Staff Encounters

The responsiveness of academic and non-academic personnel of the university during students' initial encounters with them and the perceived receptiveness of academic planners (whether orientation personnel, advisors, or others) significantly affected students' opinions about the quality of their adjustment experiences at the university. Furthermore, negative outcomes, in some cases, were such that they seriously adversely

affected students' academic progress and/or future career choices. Positive outcomes, on the other hand, tended to at least encourage students in their efforts.

The example of Andrew (who experienced scheduling problems), which was given earlier, was indicative of the kind of negative encounter with the realities of university life which can occur very early in students' academic careers. An example of a student whose negative encounter occurred even earlier was that of Kyra. Like Andrew's example her's was more of an encounter with the system than it was with any particular individual. Kyra went through late orientation, which is held immediately prior to the start of fall term classes, and she felt rushed to get through the process despite having to wait in long lines (in one case for up to five hours). To make matters worse, she had to take placement exams during this time and she believed that this fact contributed to her testing into Math 081 (Beginning Algebra), which is the lowest level mathematics course offered in the Department of Mathematics. Consequently, she reported being very discouraged about her situation.

Because all of the students who participated in this study were at one time enrolled in the Drew Program, virtually every one interviewed made a comment at some point during the interview about how their enrollment in the program was important to their development in one way or another. Some mentioned its importance in terms of providing a real opportunity to grow and learn while others mentioned it in terms of it acting as an advocate to the large university on their behalf. The importance of both roles was clearly illustrated in the examples of Joyce and Roselyn. Joyce related both positive and negative experiences in her encounters with university personnel. On the one hand she reported that her German instructor was "a very encouraging type of person" who was understanding and made students feel at ease with him. Thus Joyce thought that having this class early in her academic career was of benefit to her adjustment process. However she also reported that her college advisor overloaded her with classes and refused to allow her to have any say in developing her schedule. What upset her most was that he insisted on enrolling her

in the self-paced chemistry course over her objections. The result was that she flunked it, despite doing very well in mathematics courses which were at a much higher academic level.

The disclosures of Roselyn, which were also about a negative experience with an advisor, resulted from her providing some background to what her overall experiences were like prior to enrolling in the Drew Program. She gave the following account:

Misguided Advice

What happened was I was a freshman in [a science major]; there was a lot of stuff that I didn't know and for some reason the advisors told me that it was necessary for me to take these certain courses. So I was taking these Natural Sciences courses - (which are general education courses for non-science majors) - and I found out that I didn't have to take them because I was a science major. And that kind of threw off my first year.

She related the fact that she actually took two terms of the three term sequence before she realized what had happened. The discussion then turned to speculation over whether or not racism (in the form of lowered expectations of certain minorities) might have been a factor in this situation -- a topic which will be explored under a subsequent thematic category.

The last example is that of Lora, who cited an experience with a pre-professional counselor which she perceived to be clearly racist. Of importance here is the fact that this occurrence was during her freshman year and it conceivably could have profoundly affected her future career choice. In response to being asked if she had experienced discrimination due to her female and/or minority status, Lora related the following:

Stereotypic Reception

Being female, no! I did run into some problems.... I was in [a pre-professional program] for a while and I found them (the staff of the professional program in which she was interested) to be very prejudiced. I heard all these rumors but I didn't know it would start right in [the counselor's] office. When I went to see her she talked to me like, when I told her.... I came right in and she looked at my folder and she saw [Math] 108. She was like "You didn't repeat it? You took it fall term and you didn't repeat it?" Like it was impossible for a black person to come in and not fail 108. She was saying all of these little things. She said something about three point (3.0) or whatever for the "regular" people but for you only two point (2.0), like I was abnormal. I was like, "For the regular people?"

According to Lora this episode turned her off from that particular profession and she eventually went into a different major. Thus her perception of racism, whether intended or not, had a profound impact on her at the time. However, she did go on to perform quite well as a student, as evidenced by the fact that she eventually attended graduate school.

In a fitting close to the exploration of this category, the following summary, which was given by Karla, is presented because it ties students' academic background experiences to their adjustment problems as well as provides specific detail about the kind of experience shared by many students as they attempt to adjust, academically to the demands of college level work. In response to being asked to comment on what she thought was significant about her high school experiences, Karla made the following comments:

Transitional Experiences

In high school I did well in most classes. I was an A/B student from ninth to twelfth grade. Honors, basically, in high school. I never really had to study and if I did study it wasn't in-depth, just the minimum. And the same for writing papers. And I could get away with it. When I got to MSU it was like the minimum wouldn't do. It was like, "alright we want the maximum, or as close as possible." It was hard to adjust to it. Like in ATL when I turned in my first paper and my teacher just tore the paper up and I could not see what was wrong with the paper. As time progressed on and she let me read four point (4.0) and three point (3.0) papers. I could actually see how their papers differed from mine, how they flowed. By my second term ATL [course] I realized something wasn't right. In high school all A/B's and now... . She referred me to the Learning Resources Center and said talk to an advisor over there. I talked to [the director] and explained my problem. She told me to re-write the paper before I turned it in to my teacher, keeping in mind how the other papers were written. So when I turned it in to my teacher I ended up getting a three point (3.0). So that made me happy. I ended with a two point five (2.5) in the course. I knew the topics covered; topic sentence, thesis statement. But I don't think I understood them until I came here. In high school I wrote maybe one research paper, so the things I learned up here I learned on my own.

Thus Karla was able to determine, relatively early on in her academic career, that it was up to her to do something about her lack of preparation from high school. That she had given considerable thought to this situation is evidenced by the fact that she was not

directly asked to discuss the above experiences. Rather, she immediately thought about them when her high school experiences were mentioned.

Questionnaire Results and Discussion

Table 18 gives the results from question 6 on the questionnaire which requested students to list the major adjustment problems which they encountered at the university. The three highest ranked problem areas, for which the sum total of the number of

Table 18. Major Adjustment Problems

<u>Problem</u>	<u>Responses</u>
Amount of Studying Needed, Developing Study Skills	29
Disciplines, Handling Independence	15
Managing Time	12
Impersonal Environment, Course Structure	12
Large Campus, Getting Around	10
Minority Status, Racism	08
Personal Problems, Roommate Problems	06
Fast Pace of Courses	05
Learning Chemistry by Tapes	04
Weather, Food	04
Financial Aid, Money Management	02
Total	107

responses represented the majority of all responses, were either academic initiative or self-disclosure type of responses. Thus, for the most part, students seemed to place the responsibility for their adjustment on themselves (or more specifically on their unawareness and/or underpreparedness) rather than on the structure of the institution. Among the other responses were the following; not being a social butterfly, research papers, grading on a curve, cultural differences, midterms and finals, feeling dumb, and motivating myself. Among other results from the questionnaire, less than one third (20 of 62) of the sample who completed the questionnaire (and one half of those who responded to the question

about using a time management plan) indicated that they had developed a time management plan during their first term, and only one fourth of those (5 of 20) indicated that they followed it during the term. However, almost 70% (34 of 49) of those responding indicated that they had used a time management plan subsequent to their first term, which suggests that a large proportion of students eventually decided that the management and organization of their time was important to their academic progress.

It is interesting to note that the reported average actual study time of students during their first term (about 12 hours per week) for all classes was about the same as the amount of time that they had expected to study. Furthermore, the reported actual time was less than one half the amount normally expected by conventional standards, which stipulates at least two hours of study outside of class for each hour in class plus extra time for exam preparation, etc.--or an amount which is greater than 24 hours per week for a twelve credit hour course load (the minimum for full time status for undergraduate students at the university). At the time of their completion of the questionnaire, students reported studying about 21 or 22 hours per week, still lower their conventional standards. The average number of hours per week which they reported studying for their first mathematics course during their first term (about eight), though not a great deal lower than the minimum expected according to the above standards (which would be at least 10 hours per week for the five credit mathematics courses), was substantially lower than has been recommended in the literature (e.g. Treisman (1985), recommended about 14 hours weekly) as well as that recommended by the Drew Program staff (about 15 hours per week -- See Appendix C). The reason for the "extra" time for mathematics is that it is generally acknowledged that in order for students to master mathematical topics and concepts at the level needed for success on exams, they must engage in extensive practice of homework exercises and other assignments as well as repeated review of the course content. The amount of time that students reported studying for their mathematics course at

the time of the completion of the questionnaire (about 12 or 13 hours per week) was more in line with the above recommendations.

Summations - Adjustment to College

2a. Expectational Impact It is interesting to note that the four students who commented that they had high expectations of the demands of college level work, were among the most successful to have participated in the Drew Program over the years. As of the time that the results of this study were being reported, two of them were in medical school, one had a good position with state government, and the other was with a major corporation.

2b. College Naiveté It is notable that students' lack of awareness of what to expect on the college campus could have been as severe and pervasive as reported. Yet students' responses were not only consistent on this matter but there was little evidence that they felt that any of the "significant others" in their past had been negligent or had "let them down." It was as if students were suggesting that "that's the way it is" or "that's too bad" and therefore their unawareness should be taken into consideration once they begin their studies at the university.

2c. Transitional Complexities A concern related to the above one was addressed in Chapter III under the section on the Drew Laboratory. It was noted that staff members had observed that students often find it very difficult to include certain adaptive behaviors and study habits (e.g. attending study sessions consistently and practicing their homework extensively) into their regular routines despite repeated attempts by staff members to have them do so. In fact many seem to actively reject the idea of the "real learning experience" and/or resist or neglect those behaviors appropriate to "learning to learn." Students have even, on occasion, been found to use certain "gaming strategies" (such as delaying tactics) which they apparently believed had proven successful in the past. It seems, or it might be postulated, that the interaction-effects of cultural oppression and an inadequate educational preparation (which itself might be postulated as partially resulting from the fact that cultural oppression had not been considered in the educational process) have served to make the resistance to performance enhancing strategies a most critical problem among certain cultural and/or ethnic groups.'

2d. Dependency Assumption Students seemed to exhibit little awareness of the need for continuous vigilance about things which affect them or a recognition of the necessity for them to "take care of themselves" in the environment, or to "protect themselves." This, in turn, could partially explain the lack of effort on their part to consistently do those things which would seem "behavior appropriate" to academic development. Furthermore, time alone (at least during the first year or two) does not seem to adequately "cure" the problem -- an important consideration for student development and assistance programs.

2e. System Inadequacies. In consideration of the above remarks, the existence or lack of existence of a comprehensive academic development system which effectively addresses the inherent concerns would be a crucial factor when viewing the prospects for minority students' academic adjustment and progress. It would appear that students would need to be "induced to" or "required to" perform (behaviorally) in certain ways initially; while their need to experience real personal growth and develop sound learning skills (study habits/strategies, reasoning and problem solving abilities, etc.) is being considered. However, to "force" students to perform in certain ways on the one hand while attempting to promote skills which demand creativity and self-regulation would appear to be inherently contradictory and difficult to accomplish. But upon further consideration of the fact that many students noted the benefits gained from participation in the summer workshop (as described in Chapter IV), as well as the fact that students could vividly recall and validate the importance of positive encounters with university personnel, the potential for real impact through intervention efforts appears likely. The pervasiveness of the effect on the entire target population would seem to be the primary concern.

2f. Institutional Concerns That several forms of institutional barriers to students' academic development exist is evidenced under another thematic category. With regard to students' initial adjustment, there appears to be two primary concerns, both of which seem to be culturally based; the apparent importance (based on their comments) of minority students experiencing positive initial encounters with university personnel, and the perception among many students that the campus environment is not only impersonal, but the "system" is intentionally designed to exclude (or "weed them out"), rather than include, them as well.

2g. Racism Perceptions That students do perceive various forms of subtle and not so subtle racism, whether real or not, is also documented under another category. The experiences of Lora and Roselyn are examples which illustrate the seriousness and precariousness of the situation in that, due to these encounters occurring early in their academic careers, their very futures could have been altered. In the example of Lora, the fact that the course in question (Math 108) has a reputation for high failure rates--a fact which has even prompted student demonstrations in the past--leaves open the possibility that the staff person was actually attempting to compliment Lora. However, due to her perceptions at the time, the effect would apparently be the same (i.e. negative) whether this was the case or not.

2h. Blame Complexities That students placed the major share of the responsibility for their adjustment on themselves rather than on the university seems to suggest that by the time they completed the questionnaire they had, for the most part, begun to look within themselves for answers to their problems. However, their interview discussions indicated that they were well aware of the many institutional factors which could affect their academic and personal development capabilities as well -- as is documented in other thematic categories in this chapter.

2i. Preparation Consideration The fact that all of the students from the sample (and the overwhelming majority of minority students generally) tested below the level of calculus on their mathematics placement exam and a large portion of them begin below College Algebra (Math 108) leads to

serious implications for their academic development in mathematics and science (relative to the institution's curriculum/instructive arrangements). This issue is addressed in the category on students' adjustment to the study of mathematics.

3. Confidence, Motivation, and Encouragement

It has been well established that affective concerns such as self-esteem, confidence, and motivation play key roles in the intellectual functioning of human beings. These factors have been postulated as often being especially critical to the academic development and subsequent success of minority and/or disadvantaged students (Scott, 1971; Hardeman, 1983; Perham & Helms, 1985). From the interview results of this study it is evident that minority students themselves generally attach a great deal of significance to these factors in their experiences and students' responses often contained elements which strongly suggest a desire on their part to have their concerns considered within the academic and developmental support processes of the institution.

Principal Observation 3A--Limited Self-Confidence

The majority of interviewees seemed to have a relatively low level of confidence in their ability to achieve at a high level at the university, despite the fact that many had done well in high school, and some had achieved at a high level during the initial stages of their academic work at the university. From their comments it appeared that they had often accepted some of the myths associated with minority and/or social background status with regard to the prospects for achievement within the academic setting. Thus, in some cases, students' motivation was low due to their perceived chances for success rather than because of some actual event or series of events.

To illustrate the pervasiveness of the problem of lack of confidence, one student who was not initially confident in her ability due to having been told that she would not be able to continue her academic success from high school, eventually graduated from the university with honors. Another student stated that she was made to feel that the high school from which she graduated was not very good and that, consequently, she would

find academic success difficult to achieve. A third student mentioned that her confidence was affected by the things she had heard from students from her high school who had attended Michigan State University ahead of her. She believed that some were good mathematics students and therefore was surprised to hear that they were experiencing difficulty. Correspondingly, another student's confidence in her academic abilities was negatively impacted during her junior year in high school due to a series of events which occurred during that period. She further revealed that well into her matriculation at the university she had not regained it.

Whereas some students begin with doubts about their abilities others begin to doubt themselves after experiencing academic difficulties. For example, Lolita related her reaction to receiving her first D in a course (Math 108) throughout her years of schooling. She stated that the experience "put a damper on things" and resulted in feelings of inferiority on her part and the reaction of "I'm stupid, I flunked." However, after talking to several other students who assured her that it was common to experience trouble with the course she felt much better. Nevertheless, she revealed that, at the time of the interview, she still did not appreciate being made to "feel like a statistic" in a "weeder course" such as Math 108 when she had seriously tried to do well. Several students expressed a similar sentiment. Some other students indicated that their confidence was affected due to becoming intimidated in some of their courses by the behaviors and perceived attitudes of their fellow classmates. Still other students mentioned that their confidence was lessened by testing into Beginning Algebra or Intermediate Algebra on the mathematics placement exam; a situation which is looked at in the thematic category on adjustment to mathematics.

The comments of Tiesha on this issue seems to summarize the sentiments of many students as well as highlight the problems many of them have in putting their educational development in proper perspective. As Tiesha described her own frustrations over not having been properly prepared for the demands of college level academic work she concluded by expounding on what she believed, in retrospect, to be the crux of the problem

for students. In doing so she established one important link between self-esteem and the ability to progress academically when she stated the following:

Self Appraisal

When I got up here it was a blow to my mind. You know, I'm like, "What's wrong with me, why can't I do it?" I think a lot of students feel incapable and their self-esteem sort of goes down because they feel like, you know, "Why can't I do this, why am I getting two points (2.0 grades)?" But you can't look at that, you have to look at [the fact that] this is a college and they're teaching you the principles because if you're going to get a degree you have to be able to teach that to someone else. That's one concept where I just came to realize and take it one step at a time instead of just looking at it and trying, as you were saying, to keep up with my peers. That's something I had to struggle with.

Tiesha went on to describe what she later concluded was a mistake in judgment when she decided to take regular university mathematics course after having made a 1.5 (D+) in the Drew section. At the time she thought that it might be easier and took this course of action rather than examine herself to find out how she could have improved on her work regardless of course section.

Principal Observation 3B--Positive Reinforcement

Encouragement, especially from faculty/staff members and others who were viewed as authority figures and/or whom students respected, was a key factor in initially enhancing students' confidence and motivation. Furthermore, as students began to perform better academically and earn better grades their confidence in themselves and their abilities seemed to be more pronounced.

The comments of Kreisha about her lack of confidence in her abilities in the study of science and mathematics illustrate both the dynamics involved (at least in this example) when students lose or fail to develop confidence in themselves and the kind of experience which might help them gain or regain it. In response to being questioned about her experience in eventually coming to actually like studying mathematics at the university after initially being somewhat reserved about it, Kreisha made the following comments:

Dispositional Transition

Yes, I started to like [mathematics]. I come from (an urban public high school which was purportedly designed for better students) and it was known for having smart kids, [and] they mainly catered to kids who already knew [the academic material]. I never was able to catch on to science related things very fast, so when I got into the Drew Program [the instructors] took more time explaining the problems and [they] didn't mind people raising their hands [to ask] questions or [they'd] stay extra time after class. That made me kind of put my wall down, open up and say okay I'll try it. Then I found out that I did like [mathematics]. I was just so scared to try it - people would think I was stupid just by [my] saying anything about it. Then I noticed that other people were asking the same kind of questions I was asking.

Rachael mentioned that friends and tutors in the Drew Program helped her with her confidence by sharing their experiences with students, while Lolita related that fact that her ATL instructor encouraged her and motivated her to do well. This sentiment regarding an instructor was also expressed by Joyce who provided some revealing details about how one person in a position of authority in the campus environment made a real difference to a student who was attempting to adapt to it. After Joyce was questioned about the people, events, or experiences which she thought had been beneficial to her adjustment to the campus environment the following conversation ensued:

Understanding Prof.

- | | |
|--------------|--|
| Joyce: | Yes, I met my German teacher. I really think he helped me out. He's a very encouraging type of person. |
| Interviewer: | I see. |
| Joyce: | Like if you messed up on a test he was understanding. It wasn't...he understood - anybody can mess up on a test. |
| Interviewer: | That's interesting. |
| Joyce: | So one test didn't make that much of a difference. |
| Interviewer: | So he made you feel, I guess, at ease with him for one and... |
| Joyce: | He seemed more human. You know what I mean? |

Interviewer: Yes I see. So he was immediately [identified by you as] one of the people or events that really helped you make an adjustment to the university.

Joyce: Yes.

Interviewer: Could you give any other ways in which knowing him helped you?

Joyce: How he kind of helped me?

Interviewer: Yes, other than the fact that he was encouraging.

Joyce: Well my impression of professors before was they were the type of people you don't talk to them, or anything. They stand up there and lecture and walk out of class, right. And he changed my impression. I think that really helped in that...I think if [he] hadn't been the person who was teaching German I probably would have quit studying German after the first term.

Just as faculty members and other university personnel can encourage students in their academic pursuits they can just as easily have the opposite effect if they are perceived as discouraging to students. For example Regina revealed her perception that the faculty in the department of her major at the time were not supportive. As evidence she described an incident in which she had a death in her family and although she had done 5 1/2 out of 6 computer programs, the professor would not accept her excuse for not having done the other 1/2 program. According to her, he even commented that **"I don't even know for sure if anyone died."** Her conclusion was that **"None of the professors in the [department of her major] were encouraging me to try, they were all encouraging me to leave."**

Several students mentioned that once they found that they could perform at a certain level and/or became more comfortable with their approach to their studies they gained confidence, realized increased motivation, or both. For example, Kreisha mentioned that even though her **"Motivation [had been] low due to a lack of confidence"** both her confidence and motivation increased after she performed well. Nyla stated that she gained confidence after earning a 3.5 grade in a mathematics course despite the fact that she

had previously experienced a severe case of mathematics anxiety. And Larry and Marie related the fact that their changes in the use of time and study skills, respectively, which resulted in improved performance, had increased their confidence and motivation.

Although students might have their confidence and/or motivation elevated through encouragement or improved performance, the comments of Latisha illustrate the volatility of this situation in that a turn of events can bring about a reverse disposition. According to Latisha, although her grades in mathematics during her freshman year (all 4.0's) had given her a lot of confidence, her "ego was deflated" after she earned a 2.5 grade in her first calculus course. Thus her confidence was shaken despite the fact that a grade of 2.5 in Calculus is not a very bad grade, especially considering the nationwide concern over students' performance in Calculus (Steen, 1984), and the problems apparently associated with students adequately preparing to study it through enrollment in the typical pre-calculus courses.

An exception to the general pattern found among students regarding the dynamics of the interaction effects of confidence, motivation, and encouragement was found in the person of Candice. Throughout the interview she was steadfast about her strong sense of her confidence in her ability to handle the academic demands of the university whatever they might be. One sequence of events in particular illustrated this point. After failing to make the minimum grade (2.0) in Math 108 considered acceptable for continuing into Math 109 she decided to enroll in Math 109 during the following term anyway, then she repeated Math 108. Upon being questioned about his decision she stated that she never doubted her ability to do well in Math 108 in the first place and that she knew that not only could she have done well had she "applied herself" but she was extremely confident that she would do well in Math 109 as well, as opposed to simply hoping that things would work out satisfactorily as so often has been observed to be the case for students in similar situations. As things turned out she performed very well in both courses.

Principal Observation 3C--Reward Expectation

The initial motivation for students was often due to the novelty of the campus environment and the excitement generated by the anticipation of the rewards to be derived from the college experience. However, the anticipated rewards often revolved around social events and students often did not seem to realistically appraise their academic situations. Thus the initial excitement did not necessarily result in the development of a plan or set of strategies aimed at successfully adapting to the academic environment.

That the novelty of the situation generated excitement and anticipation was, not surprisingly, expressed by several students. Speaking for herself, Roselyn stated that **"When I first came [here] I was pretty excited about college and studying,"** and Lolita related her belief that this sentiment was widespread when she commented that students generally are "all hyped up" about college initially. Marie expressed her recollection of the link between her initial motivation and the novelty of the environment when she observed that **"I felt like my motivation was high (during her first term). You know, coming up here and everything. I was all 'geeked' about the atmosphere and everything. I had high motivation."** And Sabrina provided a fitting summary of what appears to be the initial disposition of many students with the following comments:

Social Expectations

I think your attitude when you're a freshman, when you first come in, is totally different [than it is afterwards] as far as motivation towards school anyway. I think there's more motivation about being at a college and being away from home - "Let me see what I can do, and party, etc." - is more or less your motivation. You know, grades [or academics] are there because of your parents.

That the over reliance on the novelty of the situation as a motivation in conjunction with the failure to recognize the seriousness of the academic situation can hinder student's academic development or even lead to grave consequences can be gleaned from the comments of Larry as he described his own attitude and disposition about the college experience. He began a discussion of his initial lack of discipline and foresight about the realities of academic life at the university by stating that:

Procrastination Disposition

When I first came here I was thinking about "Well I'm glad I'm here in college and well I'll just have a good time and we'll relax and I won't pressure myself too much. I know I'm going to do well eventually." What I kept doing was procrastinating, putting [studying] off to the last minute. I couldn't divide my time, study time and my activity time playing basketball or sports or whatever. It all goes back to discipline.

Principal Observation 3D--Grade-Motivated Behavior

The biggest single motivating factor in swaying students toward a more "behavior appropriate" approach to academic matters was grades. This concern was usually expressed as a desire to avoid poor grades or to make better grades (or bring up the GPA) rather than as a desire to excel academically.

The experience of Deena illustrates one scenario in which students might come to the point of deciding to face the reality of their situations and "buckle down." Deena made a 1.0 (D) in Math 082, as is often the case, she decided to continue on with Math 108 instead of repeating Math 082. After failing Math 108 she realized that she had made a mistake (by not working hard in Math 108 as well as not repeating Math 082) and that she would have to work hard while repeating the course. Thus she reported that it took two terms of bad grades to motivate her to "do right." Candice, as discussed in the previous section, also reported that she was similarly motivated after making a 1.0 in Math 108. Kyra, on the other hand, commented that her fear of doing poorly in Math 081 during her first try at it prompted her to work so hard that she not only did well but she was able to complete Math 082 during the same term, as provided for by policy of the department.

Evan and Kreisha both expressed their desire to perform better in terms of bringing up their GPA's. As Evan put it, **"When I got my first report card and saw a 1.97 [GPA], I said I had to do something about that. Being pre-med, that was not good."** Rachael expressed her motivation as a desire to get better grades generally while Margaret and Sherri expressed desires to alter their courses as students. As Margaret

put it "I couldn't just stay like that forever," and Sherri concluded that she was "messed up" and needed to "get on the good foot."

Principal Observation 3E--Motivation Fluctuation

There were consistent reports of motivation decreasing or vacillating over time during students' first year. Spring term was especially difficult. However, students had trouble determining specific reasons for this phenomenon. It appeared that students sometimes "burned out" due to the pressure to sustain the demanding rigid regimen needed for academic success. Some students mentioned the weather, either cold during winters (cabin fever) or sunshine during spring (spring fever) as possible contributing factors. Encouragement from significant others in students' lives was mentioned by some as helping them through the "tough times."

Roselyn mentioned the traditional factor of homesickness as affecting her motivation but she also said that the pressure from working and studying so much without breaks had seriously affected her ability to perform. Evelyn and Lolita both mentioned the weather as possible contributing factors toward their decrease in motivation and they both mentioned that external support from family and friends was crucial to their ability to persist through those periods when they were not "into it." At least one student, Marie, observed that because her study skills had improved extensively, when she came to periods of decreased motivation she was not as negatively impacted as she otherwise would have been.

The description of Karla regarding her bout with "spring fever" not only provides some specifics about what it is like but illustrates both the feelings of exasperation over not understanding why it is happening and the negative consequences which can follow. She described her experience as follows:

Missing Effort

By Spring term, I don't know what happened, but I regressed. By this time I had [Math] 109. I went to class everyday, took notes and came home and put the book on the desk, and wouldn't pick it up until the next day. I did the homework some but it took until the sixth or seventh week of class and I realized "I am failing this class." Fine time to realize it. I don't know why, whether it was the weather and I wanted to spend more time outside or what.

Finally, the comments of Latisha about her vacillating motivation and a summer job experience which profoundly affected her perspective on the meaning or importance of a college education, not only demonstrate the volatility of students' motivation status but point to the kinds of non-academic concerns which affect students as well. In response to being questioned about any changes in her motivation over time Latisha commented that:

External Influence

It's kind of like in peaks, I would say. When I came [here] in the fall I was really really motivated. By spring term I was motivated but I wasn't as motivated. ...But then over the summer I become motivated because I was going to work everyday and I would rather [have] gone to school; go study. And I guess I saw the importance of the college experience as far as it's better than going out to work everyday. So when I came back fall term I was motivated.

Upon being questioned about what specifically had contributed to this feeling she related that:

Reality Confrontation

The area I was working in (warehousing and distribution); I didn't like the people and just thinking about having to do that everyday, forever, it was just depressing really. People are cold.

Students' responses on the questionnaire indicated that upon entering the university they perceived their preparation for the study of college level mathematics to be good, or precisely midway between poor and excellent. Their responses also indicated that, prior to their first mathematics course, their opinion of their chances for doing well were slightly less than good but better than fair (with very good being the best rating). On average, prior to taking Math 108, students thought that they would earn a grade which would have been midway between 2.5 (C+) and 3.0(B). Thus students' responses suggest that they were certainly not over confident of their prior preparation or in their opinions about the kinds of performances that they would initially realize at the university.

There was no significant correlation ($p \leq .01$) between students' reported prior confidence in their ability to do well in mathematics and any of the following performance

variables; First Math Grade, First Math 108 Grade, First Term GPA, or First Chemistry Grade. However, there was a slight correlation ($p = .014$) between initial confidence and the Math 081/082 Grade.

There was no significant correlation ($p \leq .01$) between students' prior confidence in their Math 108 Grade confidence and their First Term GPA or First Chemistry Grade.

There was a significant correlation ($p \leq .01$) between their Math 108 Grade Confidence and the actual grade in Math 108, as well as the First Math Grade, and a slight correlation ($p = .018$) between Math 108 Grade Confidence and grade in Math 081/082.

Summations - Confidence, Motivation, and Encouragement

3a. **Conditioned Helplessness** The comments of interviewees in this study about their confidence and motivation seems to provide strong evidence that a "condition" similar to the learned helplessness phenomenon manifests itself in a pervasive manner among students from the sample population of this study. Thus the compounding effect of an apparent lack of intrinsic motivation towards mathematics and science among many students could serve to present a devastating barrier to achievement.

3b. **Self-Disclosure Limitations** As was found in the previous thematic category, students could not in retrospect, explain why they did not "behave" as they should have early in their academic careers. As a matter of fact, Karla specifically mentioned that she did not know why she didn't behave as she should have twice during one response. Thus she appeared to have been concerned about this issue, as has been the indication of other students.

3c. **Assumptive Mis-Perceptions** With the comments of Larry, in which he stated that he assumed that things would work out, it is again made apparent that students can be predisposed to taking their responsibility for planning for their academic development too lightly. Other evidence (interview comments and questionnaire results) suggests that this phenomenon is pervasive.

3d. **High-Achievement Stress** The problem of working and studying too much without breaks, as mentioned by Roselyn, has been found to be a detrimental one for some students, even if not necessarily a frequently occurring one. Students have been observed to have staunchly resisted any suggestions or advice that they control the problem, which has resulted in serious emotional problems in certain instances. Whether this phenomenon is more intense and/or pervasive among certain minority groups than among the general population or is pervasive enough to warrant broad attention is probably worth exploring.

3e. Self-Correction Capabilities The example of Deena, in which she corrected an apparently incorrect course of action, illustrates the point that an initial mistake need not become devastating. Furthermore, this example along with several others from the study, documents the need to give students the benefit of the doubt when their initial performance is not up to standards.

3f. Aspirational Limitations Perhaps a concomitant to students' apparent deficiency in intrinsic motivation is their lack of desire for "real" educational or academic development through the system of the institution. Although this phenomenon is not necessarily substantially more prevalent among minorities than among others, the impact could, in the long run, prove more devastating for the individuals, as well as for the groups, involved.

3g. There were several noticeable extended observations which emerged in this category and for which further attention is warranted. Among them were the following:

3g(i). Success Inducement The relationship between confidence and initial success seems to be a "catch 22" situation; one promotes the other without a clear indication of which should come first. However, it appears that if students could be induced or enticed to initially "behave" in a way that helps to bring about a certain amount of initial success, thus increasing their confidence, the desired subsequent academic results might become more likely.

3g(ii). Minority Protection Students' revelations that they were susceptible to becoming intimidated in class under certain circumstances along with the often repeated need for support and encouragement in the environment suggests that, for minority students at majority institutions, these factors need consideration in all facets of academic and educational development processes with which students will become involved.

3g(iii). Motivational Conditions The fact that Latisha's motivation to achieve could have been so strongly affected by the fairly sudden realization of the seriousness of her situation (or its precariousness) in society could potentially reveal a significant key to minority students' will to persist in the academic environment, and thus their intrinsic motivation. The research of investigators such as Sedlacek and Brooks (1976) on minority students persistence factors has provided important foundational information for further explorations of this concern.

3g(iv). Reality Confrontation The lack of intrinsic motivation and apparent "behavioral barriers" (which are explored further in other categories) in evidence among students appear to manifest themselves in ways which suggest that these phenomena need to be dealt with directly if some students are to begin achieving within a reasonable length of time after arrival on campus (e.g. prior to the end of their second year on campus). That is, it seems that perhaps "something needs to happen" or "something needs to be done" rather than depend solely on instruction and academic support, regardless of quality or "innovativeness," of the effort to meet students' needs. For example, the experience of Latisha, as described above, suggests that perhaps some type of "reality confrontation" might have been appropriate.

3g(v). Self-Directedness Reinforcement That some students from the sample population have not exhibited the "learned helplessness" outlook on performance, such as Candice and Patrice, seems to deserve attention. Within minority groups there would appear to at least exist a viable need to conduct explorations to determine any possible significant factors which contribute to or affect students' dispositions away from or toward this kind of phenomenon.

4. General Study Skills, Habits, and Strategies

Specific detail about students' study habits and strategies are explored extensively and thoroughly in the presentation of other thematic categories. This section presents a brief look at students' overall attitudes and dispositions toward their academic work.

Principal Observation 4A--Study-Skills Readiness

Based on their comments, students initially exhibited poor study habits and deficient study skills and they apparently learned effective strategies over time (i.e. several terms) and through extensive experimentation rather than as a result of initial suggestions or other forms of inducements. That is, even though students might have been given extensive directions on the use of various techniques and strategies, the internalization of these directions appeared to be difficult at best and even a painful process for some. Thus for many students, the necessary progress towards becoming effective learners occurred only after their academic development had been limited by the initial use of familiar but ineffective or self-defeating strategies.

That students grossly underestimated the amount and quality of effort needed for academic success was documented in the previous thematic category. Thus students' behaviors would reflect their misconceptions. For example, Candice state that initially she studied only two to three hours per night, whereas Terri usually studied only between the hours of 8:00 p.m. and 12 midnight. Terri also mentioned that she initially did not have a strategy in mind for getting work done during week-ends, other than perhaps doing that which was due by the following Monday, a sentiment shared by Tiesha. Kreisha related her mistaken belief that she did not need a plan of action for studying because she had

never needed one before. And Rachael provided some insight into the extent to which students might be entrenched in their behavior patterns when she observed that she stuck with the study methods that she had used in high school despite having attended a Drew Program summer orientation workshop and enrolled as a Drew student from the outset, thus gaining extensive exposure to various techniques and strategies for elevated academic performance.

Because students often failed to develop their own plans of action, they would unwittingly develop bad habits and study practices. For example, Margaret described a specific instance in which she realized that she had to control herself when studying when she stated that:

Controlled Study

I found it doesn't pay to study all night before a test. It was one test we had in [Math] 082 and I had it down pat. I knew it but I kept on studying it. I don't know why but I kept on going over it, and I knew it. But when I got to the test I couldn't remember anything.

Levon, who had also attended a summer orientation workshop, related the fact that, even though he couldn't explain why, he did not initially study for his mathematics course everyday and that he had decided to continue doing things his way rather than attempt to adhere to suggestions from faculty and staff members. Cora mentioned that she never previewed the material in the textbook, as was the case with Kyra who stated that she did not preview material because she was convinced that it would not aid her in learning the material, and Shirley who believed that simply mechanically working problems was sufficient. Finally, Sauncha expressed the sentiments of several interviewees when she revealed that she did not really read the textbooks for understanding. Rather, many, if not most students, simply used the textbook as a source of examples for which solutions were provided.

The comments of Linda and Patrice about their adaptations to the realities of the study/learning skill level needed in college contain statements which both summarize the

sentiments of many other students and highlight specific elements of the struggles involved in the transition process itself. While discussing the behavioral changes which she had made and the length of time involved, Lisa stated the following:

Strategy Adjustment

It (the adaptation) did, it really did take a while. I don't think it was that I was blocking out studying or anything, it could have been friends, it could have been new activities to do, new things to do that were just keeping me from studying. But it's like now I can take a book - say I'm going to study - and not need any pencil and paper, no kind of equipment, but just sit and read and study the book. I know how to do that now, whereas first year [it was] like "Okay now I've got my five different color highlighters and my six packs of paper." No, it doesn't take that. It just takes a little bit of time and patience and whatever you need, and you can study; you really can. I mean study to learn, not study to [just] pass the test. Study to learn and recall.

Patrice revealed that, although she was devoting the time required, she experienced difficulty in getting the desired results when stated that:

Results Attainment

For me the big obstacle was learning how to study. I've never been the type not to study. I've always studied, it doesn't bother me. I've always put in the time and I was willing to do that. But it's just that I did not know how to study, I didn't know what to study. I mean it would be like a teacher would say - you know teacher give hints - and he was like "Well I'm mostly going from my notes" and things like that. And I'd read the book and then look over his notes, things like that. You know, little things like that would really mess me up and it showed in my grade. And it was really discouraging at first - it was like I'm studying and I'm studying and it's not coming off. And that was a big adjustment because in high school I guess it was really different, you just go from the notes and a little bit of reading and that was it. Here you really have to know how to study because it's so much material.

After making these comments, Patrice remarked that it took her over two years to reach the level at which she began to get the kind of results which reflected the time which she had been devoting, further indicating the need for vigilance over time in order for students to make the necessary strides toward developing sound study/learning skills.

As was the case with Patrice, students quite often found that their approach to preparing for their course work was woefully inadequate and the need to identify

successful methods and strategies became apparent early on. Fortunately for some, the identification and incorporation of strategies which worked for them occurred relatively early in their academic career.

Principal Observation 4B--Success Factors

Successful study strategies included frequent breaks, diversity in study activity, and consistent review. Student found that they did not gain as much from their efforts if they "forced the situation " by insisting on studying for only certain courses at designated times of the day and/or studying for too long at one "sitting" without taking breaks. They also found that consistent and thorough review was essential for improved performance.

As mentioned in the previous category, Regina would initially stay awake until the early hours of the morning without a break in an attempt to get all of her assignments completed. She later began to take breaks as well as discontinue the late hours rather than continue to force herself as she had done, and her comments on this matter revealed a great deal about students' perceptions about it and the kinds of mistakes in judgment which are often the result. After commenting that she was no longer "staying up until 2:00 or 3:00 in the morning trying to get things done," Regina made the following observations about the idea of taking breaks and her difficulty in initiating this strategy:

Taking Breaks

It's (taking breaks) hard to do. I tried to keep up and try to go over things but there was always something else to do. Now, I might look over things five minutes before class just to see if I can catch something. It's helped a little in my geometry class - helped some. But it was hard to start. I never took breaks before because I felt it was a waste of my time. But then I found out that half the time I'd sit there and wasn't really thinking about the book anyway. So now when I just sit there and my mind starts wandering I take a break.

Regina also mentioned that by taking a break she would often be able to see her mistakes after returning to her work.

A description of the kind of extensive review and preview which Shirley incorporated into her daily routine in an attempt to improve her understanding and retention

of the course material highlights another strategy which several students mentioned as effective. In response to being asked about some of the methods which she began to employ after she realized that she was not progressing academically commensurate with the time which she had been devoting to studying, Sheila provided some revealing detail with the following comments:

Review and Preview

What I do, I not only read the material but the next day and the next day I still go back and review. I'm the kind of person that forgets and if I don't go back and review the next day, I will forget it. I go back and review and I'm constantly doing the problems over and over and over again. I stay ahead of the class; instead of doing the assignment that [instructors] assign that day, I go ahead and do the next day's assignment and on that same day I go back and do the assignment that was assigned on that day. ...That way I stay ahead of the class and if I have any problems - some homework I didn't understand and whatnot I would put a question mark under the number and then I would go back the next day and ask [the instructor] how would I do this problem.

Larry devised a study plan which incorporated both the idea of taking breaks and elements of a strategy which included diversifying the repetitions of his work. According to him, Larry would study for each course about 50 minutes, take a break, then study each of them again. He would also make sure that he devoted some time to each course each day, which Larry found demanded discipline on his part. By adhering to these strategies he found that he no longer needed to cram on the night before exams and he claimed that his grades improved accordingly. Melvin, on the other hand, would approach his studies according to the dictates of his schedule. Yet his description of his approach also revealed elements of both diversity and review, as well as a disciplined disposition. In response to being questioned about how he scheduled his study time, Melvin gave the following summary:

Functional Schedule

I usually don't write too much down as time schedules go. I usually put like ... the first week of classes I get the feel of going to my classes and see what times I have open to do homework. I knew, like in math, I have afternoons open so I do math right after class. When I finish math I would do my ATL homework, which was usually writing papers or doing some

reading. I would do probably that next or do some homework for another class. Then I would probably go to dinner; then do some homework after that. If I had a class to go to I would go out to class, then come back and do some more homework.

Melvin's description of how he might schedule his study time during a typical term appropriately points to the final principal observation of this category. It is concerned with the manner in which students controlled or failed to control the way in which they would make use of available time to advance themselves academically.

Principal Observation 4C--Managing Time

The effective management of time was also something which students had to adapt to over time, through experience and experimentation. As was previously mentioned, first year students typically took the availability of time (including time on week-ends) for granted and did not attempt to get most out of it. Perhaps this phenomenon was related to their underestimation of the amount of work and effort which would be demanded of them for academic success. Furthermore, their initial unawareness of the fast pace of the courses in which they were enrolled was probably a factor.

Candice mentioned that after she realized that she was not devoting sufficient time to studying she began to start studying earlier in the evening, do certain assigned readings in the afternoon, and work more on the week-end in an attempt to improve her performance. Terri commented that the need to repeat Math 109 forced her to realize the importance of putting in a sufficient amount of time, whereas Shirley found that, unlike during her high school days, she could no longer depend on simply devoting large amounts of time to studying without a concern for the quality of its use, including the proper scheduling of activities. Lolita's concern about "wasting time" lead her to put more effort into managing it and Evelyn wanted to become more "efficient" in her use of time.

As Kyra described her study patterns for various classes it became apparent that she had thoroughly thought through her situation to determine which method of scheduling the use of her time would suit her needs. She supplied the following detail when asked about her study patterns during her first year:

Planned Patterns

I studied math every single day, I remember that. Some classes, I had on Tuesdays and Thursdays, so the classes I had on those days, I would study for them on Monday and Wednesday. The classes I had on Monday and Wednesday and Friday, I would study [for] the days before, unless [there] was something major that was due that really needed more time. Then I would do that everyday until it was completed. Weekends, I would study math one day over the weekend. If I didn't have a test or an assignment due [for certain classes] or a lot of reading to do, I probably wouldn't do homework over the weekend in those classes.

The approach of Melvin toward the use of time on the weekend was to view it in terms of when to study rather than what to study. According to him, he would "take a break" on Friday night and Saturday morning and resume studying during Saturday afternoon and continue through Sunday night as needed.

Unlike Kyra and Melvin, many students did not have a defined study pattern early in their academic careers. Rather they came to realize later that they were going to have to get more out of available time if they were going to progress at all, especially as they began to get into more advanced courses. After Marie made this adjustment she observed that **"I feel like I'm, more established now, my habits are much better, I know how to organize my time much better to get the best out of it, what's better for me, what points I should emphasize."** As Larry continued to discuss his study behaviors during his interview session, it was obvious that he too had made time use adjustments which he concluded had made a big difference in his performance. According to him, he would study for exams **"way ahead of time."** On the weekends he would study for at least a couple hours on Friday, then some on Saturday, and a lot on Sunday. If an exam was impending during the following week he would attempt to **"tie up loose ends"** maybe two days before and just review on the night before the exam. He also made outlines and he observed that he was confident that if he followed through on the patterns and habits listed here he would make at least a 3.0 in any course in which he was enrolled, despite the fact that he had struggled academically during his first two years or so on campus.

Summations - General Study Habits and Skills

4a. **Pervasive Resistance** The apparent difficulty in internalizing behavior appropriate habits for academic success among students is evidently pervasive as well as serious. Furthermore, the resistance to establishing certain habits appeared to be quite intense among some students -- an observation which was made in the previous thematic category and is further explored in category 8.

4b. **Dramatic Changes** The relative small amount of time initially devoted to the preparation for their courses by students, as indicated on the questionnaire, suggested that students would need to make dramatic changes in order to become successful. This is also explored in category 8.

4c. **Planned Time Use** The confrontation with the need to effectively arrange for the use of time devoted to their studies was also problematic for students and is explored in category 8.

5. Adjustment to and Experiences In Studying Mathematics

Due to the scope of this thematic category it has been subdivided into four subcategories; i) **Cognitive Adaptations to the Study of College Level Mathematics**, ii) **Drew Math Sections vs. University Sections**, iii) **Academic Development in Mathematics**, and iv) **Adjustment To and Performance In Calculus**. Because the study of mathematics and the corresponding development of critical cognitive skills are central to establishing a solid foundation for the continued study of the science, this section will also form an important bridge to the explorations of the subsequent thematic categories of this chapter.

i) Cognitive Adaptations to the Study of College Level Mathematics

The need to make a rapid adjustment to studying mathematics in college is common to all students. However, the situation for certain minority groups differs in two important respects; all but a very few will begin their study of mathematics at the precalculus level and the cultural dimensions of their situations often cause the adjustment process to become

more difficult. The first of these concerns was highlighted in Chapter II (and is addressed in the Summations section of this thematic category) and the second is embedded in the following exploration.

Principal Observation 5A--Behavioral Adaptations

As students discussed their experiences in trying to adapt to the study of mathematics at the university, a host of concerns surfaced, some expected and others more subtle and/or involved. The pace, the amount of study time needed, the need for consistency in study habits, the emphasis on story problems, the need to avoid mistakes, the compactness of the material, and the demand for a high level of understanding of concepts were among the items mentioned by students during these discussions. The seriousness and complexity of the problems confronted by students were amplified by the fact that even when students were made aware of the situation facing them through regular communication and repeated reminders, it often appeared to be difficult for them to internalize this awareness in ways that brought about significant and consistent positive changes in their behaviors. And, as observed in the section on their high school experiences, these students, for the most part, had been accustomed to simply doing mathematics homework without becoming engaged in meaningful learning in the process. Consequently, even among those students who did study consistently and were making a sincere effort to do well, sustained progress was often retarded because they often were not doing those things (such as reviewing often, studying examples for detail, reading the text for understanding, and organizing the material) which were found to be critical to students' academic (or learning skills) development. Again, that was often true despite repeated urgings from Drew Program staff members and the deliberate incorporation of measures into the learning system (e.g. review sessions, tutorials, and counseling) which were intended to facilitate students' development of the essential skills and habits.

Regarding the study habits needed for the successful study of mathematics, Terri mentioned that her being unaccustomed to studying mathematics everyday presented problems for her, and Sauncha expressed herself on this issue by stating that **"I found out I needed to do math everyday."** As an indication of the increased amount of study needed, Makeda indicated that she probably doubled her study time between her first mathematics course and her last one. And Levon and Charlotte referred to the pace of mathematics as primary concerns. While explaining why she had to repeat Math 108, Lolita provided a brief summary of some of the initial problems confronted by students with the following comments:

Inconsistent Effort

I wasn't used to the quick pace. Instead of doing homework every night like I should have, I think I missed a couple of nights and then tried to catch up and study in the same evening [although I had] a test the next day. This wasn't feasible. Also the length of the test was a problem and some of the problems (on the test) were foreign.

Latisha expressed the opinion that, although she was consistent in doing her work, the fact that she was simply getting the problems done without attempting to actually learn the material eventually hindered her progress in mathematics. Lora concluded that the **"stupid little mistakes,"** had hindered her whereas Karla pointed to the fact that on her first math exam the instructor **"had five [sections] condensed into 10 problems"** as an example of a hurdle which she had to overcome, and Roselyn and Levon cited word problems as presenting difficult challenges for them. Larry observed that the lack of discipline had been a major problem for him and his discussion of this issue contained references to other factors which he apparently had concluded would have assisted his progress toward the successful study of mathematics. According to Larry, **"Had I known to concentrate and do the homework everyday, see the instructor whenever I had problems, and do the even [as well as] odd problems, I would have done better. I think it comes down to discipline again."**

Tiesha and Evelyn were among those students who concluded that the root of their overall problem was lack of preparation from high school. As Tiesha explained it, when she was in high school her teachers let her get through the math courses with a B average despite the fact that **"they didn't teach, they didn't teach me any concepts or anything,"** and she mentioned that she came to expect that she would follow a similar pattern in college. Evelyn compared her high school experience to what she found the situation to be in college and in the process she provided a good summary of some factors mentioned by others while giving an overview of what it took for her to adjust to studying mathematics in college. She concluded that:

Study Demands

[Mathematics] was much more detailed in college. They would present the stuff to you in high school and you would do the [homework] problems. But in college you have to go beyond doing the problems in order for you to succeed in the class. You could take notes from the lecture and do the homeworks, but you still have to go a little bit beyond. ...I have to listen to the lecture, go over my notes, read the book, go over the notes in the book, do the problems, and then try to remember all this stuff so that I could do well on the exams. And that was something totally different for me. It wasn't a very hard adjustment for me, but it was something you have to adjust to doing.

Principal Observation 5B--Placement Disappointment

Several students who placed into Math 082 (Intermediate Algebra) allowed their negative reaction to their placement, which they considered to be beneath their level of preparation, to affect their attitude about (and consequently their behavior in) the study of mathematics at the university. Furthermore, some students who began with Math 108 (College Algebra) and were advised to switch to Math 082 after further diagnosis of their situation during the term, also had a similar negative reaction and refused to cooperate. Thus, because they often would not "behave properly," their initial progress as students was correspondingly negatively impacted. On the other hand, several students who began with Math 082 did not exhibit these "hand-ups" and through their effort and initiative were able to make the kind of progress as students which resulted in their being able to reach their long term goals and often outperform many students who had placed higher than they had as well.

Andrew stated that he was only interested in getting to Math 108, which was required for his major, and he thought that Math 082 would be a pushover. Thus, despite evidence to the contrary, he was never convinced that he had to work hard in the course and did not pass it as a result. Deena mentioned that her casual attitude about the course caused her to receive a D in it while Cora and Sabrina commented that their underestimation of the course resulted in less than desirable performance outcomes. Kyra revealed that she was disappointed with her placement because she had always done well in high school and thought that she would have placed higher. Larry expressed similar sentiments which were grounded in the fact that he had taken mathematics courses through pre-calculus in high school. However, at least four students who commented on this issue stated that they had

no negative opinions about placing into Math 082. Three of the four subsequently performed well (with one continuing into medical school and another qualifying for graduate studies) and the other one performed fairly well.

Principal Observation 5C--Math 108 Distress

Math 108 was especially troublesome for the interviewees of this study, as has been mentioned as being the case for students at the university in general. For those who began their study of mathematics with this course, the sudden confrontation with the host of adjustments necessary for success in mathematics along with the added burden of starting with a course as compact and demanding as Math 108 was especially challenging and distressful. This appeared to be true regardless of students' high school preparation and/or mathematics background. The fast pace, the need for consistency in approaching the course, the large amount of homework, the depth of understanding demanded, the need for precision and organization of course work, and the level of problem solving skills needed were among the host of problems and concerns mentioned by students as affecting their ability to successfully compete in Math 108.

While giving her opinions about studying math 108, Linda pointed to the need for students to have a proper prospective about the course, including an outlook which prompts consistency in effort. In response to being asked about the most difficult aspects of studying Math 108, Linda made the following comments:

Consistent Effort

[Studying Math 108] really wasn't [difficult]. That's why it's such a shame people don't do better in it; I myself for that matter. It was basically a step one, step two, step three procedure. The hardest part was sticking to it, the keeping going with it. It's so easy; you do good on that first test then you lag off for the next couple days. You've got to stick with it, even if it means day after day.

When asked what she thought was the single most difficult aspect of studying the course she immediately stated that doing word problems was most difficult for her and that it bothered her that, on the other hand, some foreign students whom she knew seemed to be so proficient at doing them.

As Patrice discussed her experiences while taking Math 108 during the first of two times that she was enrolled in it, she provided a revealing summary of what it's like to

confront this course at the university while echoing the sentiments and describing the shared experiences of many students. She gave the following account:

Retarded Results

Well, when I first took it the details and things like that, I just didn't get. My teacher was foreign and coming out of high school I was used to my teachers pointing out everything and going a lot slower. And when I took [Math 108] in the university (as opposed to through the Drew Program) the first time [the instructor] went so fast, he didn't point out a lot of things. I could barely understand him and I studied a lot in the class. And on the first test I thought that I did a good job on it, but I did terrible. That's the way things went on and on, and I went to see him a couple of times but the concepts did not sink in. When I took it again I'd say the last part of 108 helped me when I repeated it but the first part of 108, when I repeated it it was like learning it brand new, like I hadn't seen it before. I mean I didn't learn anything because I didn't learn any concepts. I didn't know what I was doing, I was more or less trying to memorize it. With math you cannot do that.

Patrice went on to mention that when she repeated Math 108 with the Drew Program things went a lot better due to the awareness she had gained and the efforts of program staff members to insure that students knew what would be expected of them in order to perform well in mathematics courses. This issue (Drew math Sections vs. others) is further explored in the next subset.

ii) Drew Math Sections vs. University Sections

Although there was no planned attempt, during interviews, to explore the differences between students' perceptions of and experiences in regular university sections of mathematics with those of the Drew Program's sections, the fact that several students from the research sample had taken one or more regular university sections of mathematics prior to taking a Drew section prompted some students to discuss their feelings and opinions about the two situations. In the process several issues and concerns were uncovered and/or highlighted which appeared to be important to further understanding the nature of students' experiences with mathematics at the university and thus identifying factors which are critical to their success with it.

Principal Observation 5D--Impersonal Atmosphere

Students perceived the regular university sections of mathematics as having an impersonal atmosphere where their concerns were secondary at best and where they were neither encouraged nor supported. Some students even spoke of being intimidated in these sections. Furthermore, students reported that they were not made aware of what was expected of them nor of what it would take (behaviorally) for them to become successful students in the courses.

As was the case with Patrice, several students found that the confrontation with mathematics in the regular sections was not only frustrating, but for some, carried emotional baggage which could have proven devastating in certain instances. For example, Lolita mentioned that her first experience with mathematics caused feelings of inferiority and maybe even outright incompetence. Anthony and Karla revealed that the conduct of their instructors and the attitudes of some of their classmates resulted in their becoming intimidated -- Karla detailed her instructor's strong opinion that anyone who scored below a certain level on the first exam did not belong in the course.

The comments of Linda and Nyla about their experiences in regular sections of Math 108 provided fairly detailed yet descriptive accounts of what it was like for students as they faced the realities of their situations in these sections. In each instance it appeared that the student was so totally unprepared for what occurred that she was rendered virtually helpless as far as coping with the situation was concerned. Linda's description, though lengthy, yielded significant insight into one student's view of the journey through a foreign situation with its resultant frustrations and bewilderment. Her account went as follows as she discussed life in one of the large lecture sections of Math 108:

Reality Confrontation

It was sheer hell. Excuse me, it was. I was thrown into a large section. I remember this day vividly. Me and a friend of mine who came up here from high school with me walked into the lecture [room] at Wells [Hall] about 10 minutes late. The lecture room was packed and there were people already standing at the door taking notes. So Steph and I, we took out our pencil and pen but decided there was no way we were going to get down front, so we just took a squat somewhere and sat down. Then the teacher, he started doing a problem. I guess a girl in the front asked him "would he explain a problem?" So he started doing the problem on the board. He

worked a long problem. It was an extremely long math problem and the very next step that he wrote down was x equals three. And I don't think I'll ever forget that in all my life. Now, nowhere in that little set did he either explain it, write it out, do the problem out, solve the problem -- he just gave the answer. And right then and there I knew, there's no one to explain.

So then we went from there to tutors, the tutors the university supplies. Was it the same situation? Yes it was. I walked into the math [help] room, the tutor session room. The same people that were in that lecture, every last one of them was in that room with about three tutors. And I was like "well gosh if they're all here they must be getting some type of help so at least let me try and stay." I hunted down a tutor for half-an-hour to get help, and when he finally came down I sat down and I asked him if he would help me. This is what he said; "I did the same problem for the girl over there. Ask her how to do it." She was a student like me, she had just learned how to do the problem herself. I was just so upset. That whole term I was like, "there's got to be a better way." I know I'm not dumb and I can handle math--I four-pointed all math classes in high school, from elementary algebra on up through geometry, trig, whatever. I was just so disillusioned by the whole system. I just thought there was no way I'd ever make it here. I almost didn't come back (after fall term) to Michigan State.

Nyla's account of her experience yielded additional insight into students' perceptions about typical encounters with the graduate teaching assistants who typically teach all pre-calculus recitation and individual course sections as well as with their peers. Again, it is the impact on and perception of the student herself which is the key outcome, regardless of the extent of the accuracy of her report. As Nyla discussed her adjustment to Math 108 after having taken Math 082, she mentioned that her feeling of being intimidated by other students caused her to become reluctant to ask questions in class and she went on to say: Reluctant Student

I got like that. I got to the point where my questions, if they were really bothering me, I would go up to the TA after the class was out and ask him the questions. Most of the time I would ask somebody I already knew. My roommate at the time already had 108 so I would ask her to help me with my homework.

When asked how she became intimidated by other students her response was the following:

Unresponsive TA

Because it would be sometimes the TA, the way he would explain it, he might not thoroughly explain it like "Well I don't have time to waste on something this simple." It just would make me feel like "Okay you should already know this, that's not that hard to understand." I know it's not

always true but like if other people don't ask a question it makes you think they already know it, but lots of time they don't. They don't want to ask [questions] themselves. When a TA writes something on the board and he'll say "Okay, are there any questions?" If they don't wait long enough for somebody to raise their hand - like they'll wait a couple of seconds for somebody to raise their hand, then they'll go on to the next thing. So there wasn't as much opportunity to ask questions during class anyway. But it seemed like the atmosphere made me feel that way.

Principal Observation 5E--Drew Benefits

Students generally appeared to think highly of the personal attention given to them in a programmatic situation. They were appreciative of the extra effort which was exerted in and out of the classroom to assist them with their understanding of the course material as well as the handling of other matters of concern to them or to program personnel. Furthermore, several students seemed to have been of the opinion that among the benefits of participating in the Drew Program were the development of learning strategies for mathematics, sciences, and other courses, and an awareness of the extent to which discipline is important for real academic progress.

As Nyla discussed her general experiences in mathematics and her encounter with the Drew Program she included comments which revealed her opinion of the overall benefits of having become involved with a process which was specifically directed at meeting the academic needs of enrolled students. She had taken two terms of mathematics prior to enrolling in the Drew Program and the following discussion is about her experiences and perceptions beginning at the point when she found out about and enrolled in the program. She stated that:

Drew Outcomes

I took 108, then I had to take 109. Now, 109, I found out about [the Drew section] through another student that went to add it and I thought it was a good idea. She told me how to get into the class and everything. That was a totally different experience, as far as other classes, simply because I was used to being in a class where maybe I was one, maybe the only one or one of two or three blacks in the class. I no longer had to deal with a foreign accent, because most of . . . , a lot of the science classes--the TA's are foreign. To me that's an extra burden because you have to decipher their accent along with trying to learn the material and sometimes that gets to be a pain. Lots of time I feel like if I had an American teacher I could do better in the class, not in all classes but in some.

Also I found that when I took 109 through--see I didn't take 108 through the Drew Program, so when I took 109 I found it to be more demanding. I

really know that from being in the Drew Program I learned more discipline with my study habits. Also it was during the time of my first year as an RA and that also demanded [that I] really budget my time. That, by taking the course from Drew, helped me study more because I didn't procrastinate as much. Plus, I got to know the students better in the class. We used to study together and I got to be around more people who want to study. It's different if you're around other people who don't have the same classes as you or whatever, and they get to waste more time. You will tend to waste your time being with them. But if you're with other people that have the same stuff to do then you'll go on and get your work done.

Tiesha and Lolita provided further detail on the differences between the Drew mathematics sections and the regular university sections as they described their experiences in mathematics. Tiesha had earned a 1.5 (D+) grade in a Drew section of Math 108 and decided to repeat the course in a regular university section under the assumption that she would fair better in it. The following comments were made after she had not only repeated Math 108 but had gone on to take Math 109 (which she failed) and then sat through both courses once more in order to finally grasp the material. In retrospect she revealed her perceptions as follows:

Section Comparisons

In the university [section] I felt that the teachers didn't really work with you at all. Whereas with Drew the teachers work more with you and they give you more problems. It may seem like you have more homework, but they teach you. Whereas with the university you have a TA, he comes in, he lectures and he doesn't have any office hours. Everything is...the problems are not really related to what he teaches. Whereas in Drew, [the instructor] makes you really think, so by the time of a test you can figure it out. You can say "well I saw this before; we did this; and I know how the problems will be worded." With the university it's on a standardized level; you either pass or you don't, and teachers don't work with you. So I got stuck in that and I'm like, you know, "where do I go now?" and even though I got a two point (a C grade), "let me go on to 109." So I went on to 109 but I was fooling myself because I didn't know the principles of 108 and you need the principles to go on to 109.

Lolita also repeated Math 108 but she repeated in a Drew section after having been enrolled in a regular university section. During the period of time that Lolita was going through this experience several other students were in a similar situation because at the time the Drew Program continued to enroll students who had previously taken regular university

mathematics course sections. Informal conversations with these students revealed that many of them shared the sentiments which Lolita expressed with the following comments:

Drew Arrangements

I probably made changes [in approaching the course] the second time around because of the way the class was structured with [the Drew instructor]. When I had 108 with him we did have the Problem Sets and he did give us more homework. And I think also in the Drew Program what you stress in that you teach more than what the university teaches. And again, that perhaps makes for a better understanding of the material. Whatever the case, it worked and I enjoyed Math 108. Because the first time the D put a damper on things. And I had those same feelings of inferiority and maybe incompetence. It didn't last for long, but at first it was like "I'm stupid, I flunked."

Finally, the comments of Sean on this issue were interesting in that he began the discussion with the intent of explaining why he thought that not all students needed a full year of exposure to the academic development activities of the Drew Program's Mathematics Learning System. Instead, he actually got into a discourse on the Drew system itself, and he made only a couple of brief references to his intended point. Sean, who was an excellent student from the very beginning and appeared capable of successfully competing in honors sections of most university courses, made the following observations in response to being asked, towards the end of his interview session, if he had anything to add which had not been explored, about the experiences of students:

Drew Provisions

Just one thing. For me as an example, I didn't know how exactly I would have adapted to say, like jumping into university [Math] 111 instead of Drew 108. But I think the way the Drew Program is structured and what it tried to do in orienting people, orienting students to that jump from high school to college, it's not necessary for everybody. For the first two terms I think that [the Drew instructors] try to be a lot more thorough and I guess you provide a little bit more interaction. Of course there are the Drew Study Sessions and the Drew tutors and the supplements, and that's all there for the student and [the Drew instructor], as opposed to university. Basically the way it's set up [the Drew Mathematics Learning System] is designed to take students from high school level and put them into university level, but integrate it. Kind of make them aware of the process and say "okay you're going to do this and we're going to help you get through it," as opposed to just jumping in, which is what most people do. [That's] good because I think a lot of people would just be out there without it. But it may not be necessary for a whole year for many of the students.

iii) Academic Development in Mathematics

In order to improve on their performance in mathematics courses, students described a variety of strategies which they were either using all along or adopted over time. The comments and opinions reported on this subject reflect students' perceptions of what had or had not contributed to their development in the study of mathematics.

Principal Observation 5F--Behavior Patterns

Students reported that it was important to try and keep up in their courses, review often, take notes, and study from them, and consistently do the homework if they were to perform well in mathematics courses. They also developed specific patterns of behaviors in preparing to meet the demands of the courses.

Most students mentioned the need to review as a key strategy which made a difference for them. Among those students who mentioned it as being a prominent factor in their success, Saucha reported that she would review those concepts most which gave her the most trouble; Patrice stated that she would make it a point to review extensively on weekends; and Evelyn mentioned that she found herself reviewing more and more as she progressed in her study of mathematics. Of the students who pointed to multiple factors as having been virtually equally important, Deena indicated that, in addition to reviewing extensively, the fact that she found "a very studious person" to study with and her improved note taking were helpful. And Saucha thought that it was important to her that she studied everyday and rely more on her notes to complement her efforts at reviewing often.

Charlotte and Sean gave detailed accounts of how they approached preparing for mathematics courses. Their accounts provided some useful insight into what some students perceived to be appropriate, as well as some adjustments which they might have made. When asked to describe what she would actually do when she studied for her mathematics class, Charlotte stated that:

Study Practice

Well for the first...082 and 108, when I got home I would take the notes out form the class and when I started doing problems, if I had trouble I would refer back to the notes and problems that were looked at during the class period. That's basically how I'd do my homework. I'd go through the problems and when I'd have problems I would look back at the notes and refer to them.

Charlotte went on to mention that once she got into Math 109 her methods were no longer functional because she was confronted with mostly new material for the first time. Further, she pointed out that she needed to record more of what was going on in class in her notes for future reference. As she put it:

Taking Notes

I take a lot more notes, even in math. A lot of times when you're in a math class you just like write the problem down from the board. But now I write down what the TA is saying. Like if the TA says a sentence, he might make a comment about an equation. It's just like [there aren't] any numbers or anything in the sentence, but I just write it down, make a little note to go along with it, and point arrows to it. I do that a lot, and that seems to help.

Sean, who was an excellent student, made the following comments about what he had done to prepare for his early mathematics classes at the university. Many of the elements of what other students had pointed to were included in Sean's comments but the scope and comprehensiveness of his summary indicated a more mature grasp of what it would take for sustained success in mathematics. In response to being asked to outline some of the things that he did to study for his mathematics classes, he gave the following summary:

Course Preparation

Well of course you go to class and take notes. I try to do the homework every night because since you get homework assigned every night you get a new concept every day. It's easy to fall behind. So I try to do the homework night by night. As far as the tests go we usually have homework like two days before the test. For me, maybe two days or so before the test I start reviewing all the notes. Sometimes I would try working back through some of the problems, especially through some of the harder problems. You guys (Drew Program instructors) always threatened to put them on there so I would do that. As far as using the book, mainly, it might not be the best practice, but I try to jump into the

homework, maybe because it was a kind of review. I just jumped into the homework and if I had any problems I'd go back and read through the notes and through the chapter to see if there were any hints or examples there that you could use for the homework. That's basically it.

Perhaps the information which proved to be most helpful to understanding the adaptive processes of students in mathematics was the insight gained from the experiences of students who had not initially performed well and/or were not "behaving" as they should have been but were able to make the adjustments needed. Among those students for whom this was true, Nyla found that associations and study sessions with other students were quite helpful to her. As she stated:

Peer Influence

I didn't actually get serious - serious into studying -- this is honest -- until my sophomore year winter term, the term I took 109 in the Drew Program. I met other students with the same interests as me -- like Pam. She was already in Med-Tech. Plus they seemed really serious at studying. A lot of times the people you're around, that you spend most of your time with, you're going to do the same things with them. Because they were serious into their studying, it helped me to go on and be serious too.

Lolita found that she needed to become more involved with her classes and do those things, such as planning ahead and asking questions, which were essential for improved performance. She described her approach to studying for her class, as she repeated Math 108, with the following comments:

Approach Adjustment

I think that I would start studying before the night before the exam. I would get the homework done and if I had questions I would ask [the instructor] or get some help from the helproom and try to get my questions cleared up before the test came around. So I think I was more conscientious with my study patterns and doing my homework.

Shirley found herself in a situation where she needed to repeat two courses. She concluded that her problem had been that she had been relying on memorization rather than trying to learn the material. Thus, as she repeated those courses she decided to make changes in her approach to preparing for them which were designed to insure that she

stayed on top of the material and actually learned it. When asked to provide some specifics about what she did, Shirley gave the following summary:

Review and Preview

What I do, I not only read the material, but the next day and the next day I still go back and review. I'm the kind of person that forgets and if I don't go back and review the next day, I will forget it. I go back and review and I'm constantly doing the problems over and over and over again. I stay ahead of the class; instead of (just) doing the assignment that [the instructor] assigns that day, I go ahead and do the next day's assignment and on that same day I go back and do the assignment that was assigned on that day. That way I stay ahead of the class and if I have any problems - some homework that I didn't understand, one problem I didn't understand and whatnot - I would put a question mark under that number and then I would go back the next day and ask [the instructor] how would I do this problem.

Principal Observation 5G--Exam Preparation

According to students' discussions on what they did to enhance their performance on exams the following were crucial; early preparation, consistent and repeated review of the material, and a constant effort to keep up with the course material. As students commented on what they did to assist their efforts it became evident that their strategies were such that improved learning and retention of the material were the likely results.

As far as the in-class exams during the term were concerned, the comments made above with reference to students' approaches to preparing for classes in general apply, for the most part, to their preparation for exams as well. For example, Lolita's efforts to start studying before the night before exams and to get her questions answered are both important for successful performance on exams. Lora also mentioned that it was important for her to begin preparing early for exams as well as use her notes effectively. Candice stated that she found it necessary to review continuously and extensively in order to do well, whereas Tasha made mental or written outlines of the material to flush out important ideas and spent extra time on more difficult problems. Her discussion on this was in regards to her preparation for exams in calculus courses. She stated that :

Preparation Strategy

Usually for exams I would go over each section. They each would have a different topic or kind of concept. I guess it was like an outline I made basically in my mind. If not, I'd write it down -- what we were studying, what the point of the section was -- and then I'd know how to do the problems from it. And I'd always go back to my homework, the problems that I had the most trouble with at the beginning or I never did get right, the hardest problems. I made sure I knew how to do those for each section.

Roselyn thought that her effort and ability to keep up with the class were key for her and her discussion of this issue included reference to preparation for the final exam, a topic for which some students were also asked to address during interviews. She summarized her thoughts with the following statements:

Staying Abreast

I found that when I keep up with the syllabus, the assignments, and with lectures, what happens if you'll find, ... Because a lot of students complain and say we don't really have that extra week [off] before finals like other schools have, a study week they call it. But I found that when you keep up with the schedule, you do find yourself having a study week, although you have to go to classes. Just keeping up, because if you do the homework problems at the night time, you review them, I find that my understanding is much clearer than rather than trying to do it at the last minute... There were times for certain exams when I'd gotten behind, and when I went to the exam I wasn't as confident with the problems.

Kreisha also believed that keeping up all term was the key to performing well on the final exam, as did Margaret, who also thought that continual review during the term was important, whereas Kyra noted that the instructor developed Problem Sets assisted her efforts to prepare for the final. Lolita stressed the importance of starting preparations early in the term and she offered a few additional tips when she allowed that:

Early Start

I will usually put a lot into classes hoping that I will not have to bet my life on the final. It's a horrible feeling to be dependent on the final. So I try to start like [two weeks] before the final. I found that it does no good to stay up all night long the night before the final -- you should prepare all along by going over notes, getting together with friends, etc. I try to study with people who are in the class, that really helps. I like to study on my own but then I like to come together, depending on the class.

Patrice also emphasized the need to start early in preparing for the finals, as well as the importance of actually learning the material throughout the term. When asked to give her views on preparing for finals, Patrice gave the following response:

Effort to Learn

Yeah that was another problem for me was preparing the finals. Because during the first two years I did a lot of memorizing and that is just not going to work for finals -- you have to learn. And so my finals, a lot of times, did not come out very well. This year the change that has come from that is that because I am learning the material now, then finals aren't as bad. It's more or less just a review. And like after my last test in a class, I will start reviewing a lot for the final or maybe even a little bit before then, about two weeks in advance. But it wouldn't be as bad because it was like I knew the stuff, especially in calculus it builds, so it's not as hard.

iv) Adjustment To and Performance In Calculus

One of the primary objectives inherent in the operation of the Mathematics Learning System of the Drew Program was to prepare students for the successful study of calculus at the university. Thus a key concern of this study was for the quality of students' experiences while studying it. Consequently students who had been enrolled in one or more courses in calculus were asked to comment on their experiences in these courses. Based on their comments, it appeared that, generally speaking, students were not initially prepared to successfully study calculus, and often did not expect to need to do those things, such as read the book for thorough understanding, which were necessary for success in studying calculus. Furthermore, the structure of the information presented in calculus presented adjustment problems for many students.

Principal Observation 5H--New Experiences

Many students found calculus to be "an entirely new type of thing." That is, they thought that the material was not only a big step up from College Algebra and Trigonometry, but a new, and in some cases very unexpected, experience as well. Thus students found that adjusting to studying it was often much more difficult than they could have anticipated. Several students mentioned that the Drew Math 290 course had helped with

the transitions to studying calculus by introducing them to what calculus was like and much of what they needed to do in preparing for it.

Evelyn probably expressed the sentiments of many students as she gave her thoughts about studying calculus with the following comments:

Difficult Confrontation

To me [calculus] was a totally different approach to math, and it was something that I had never expected until I took [Math] 290. Some of the concepts, I had a real difficult time trying to comprehend because it was something totally different and I didn't know how to apply it. There it was really difficult for me throughout the whole term right up to the final. But I did okay, not as well as I would liked to have done.

Other students, including Latisha, who called it "an entirely new type of thing," Roselyn, who said that it was "new theories," and Regina, who called calculus "a whole different level of math," expressed opinions similar to those of Evelyn. However, neither Roselyn nor Regina (who stated that she expected what she found) appeared to have been unsettled by the experiences of studying it. As Roselyn put it:

Smooth Adjustment

I didn't find a big adjustment. It was just basically new theories. After you understood the theory, I found the rest of your problem is solving the rest of the [steps in] the problems. Just going back to your algebra and trig. It seemed like it was a new thing.

Apparently Roselyn was able to do whatever was necessary to understand the concepts and ideas of calculus and apply this understanding in solving the problems found in the course(s), whereas many other students (based on interviews and questionnaire responses) found it more problematic to carry out this process.

Lillian was one of the students who did not find the adjustment to calculus to be a smooth one and her discussion of this concern reveals many of the specifics on why she thought this was true for her. She commented that:

Getting Lost

The biggest adjustments in going to calculus after [Math] 109, or even 290 [are] the pace, the type of information, and the way [the instructors] gave it.

For instance, they will take a long theorem to try to get a simple point across. Calculus is not that difficult once you learn the formulas and learn how to judge to use the [calculus concepts], and then solve the algebra after you do the calculus. It's easy to get lost in a professor's calculations and the math. If you have never seen calculus before, you don't know what is most important. So while he/she may be on a derivation you have lost track of him getting to a simple formula and lost the point. I wish they would say "try to get the derivation but if you can't don't panic." Maybe tell you to just sit back and listen, sometimes that is best.

Thus apparently Lillian concluded that she needed more guidance about what the instructor's intentions were and how the information given fit into the overall scheme of things than she apparently had been given.

Sean was also one of the students who recognized the adjustments needed in order to successfully study calculus, but it appeared that these adjustments were more routine for him than for many students. Sean, who did not take the Drew Math 290, gave the following account of his perceptions about calculus:

Complex Entity

It seemed like, to me anyway, the concepts were more than a little bit different [from Math 108 and Math 109] and calculus seemed to be more complex. After you got into it and learned all the beginning theories, all it was was application and no more memorization. The first few concepts were kind of - well you've got to learn this and learn this theorem and learn that and learn this application and learn this kind of thing. So it seemed kind of more difficult at the beginning. I think that was mainly because it was so different. The formulas ask you to do different things. It was integration, differentiation, and then apply this and that instead of some kinds of rules like you had in algebra, where the same things gets applied in a different way, kind of.

Two students who provided specifics about the impact of Drew Math 290 on their adjustment to the study of calculus were Sharina and Annette. According to Sharina the effects were realized at the beginning of the course, or as she put it, **"the transition [to calculus] wasn't bad, but 290 only covered up to a certain point. And the points it covered, it covered well. After that, that's when I ran into some difficulty."** Annette gave a more detailed account of her opinions about the effects of the course as she discussed her adjustment to calculus. She stated that:

Challenging Transition

It (studying calculus) was a challenge but it wasn't... . What I'm trying to say is that I took the 290 course so I at least had an idea of what calculus was. [Calculus] went into it in more depth so I had to get help on that. Taking the 290 course helped a lot with that. One important thing about a class is to start off right; and never being exposed to calculus, I don't know what I would have thought. Some of the examples that you gave in the 290 class helped a lot in understanding what calculus was all about, some of the theory behind it. You didn't go into it in-depth, but I didn't know what point of tangency meant before I took 290.

After being asked to comment on her transition to the study of calculus, the response of Cora, who made steady progress as a student of mathematics due to consistent efforts, was actually a summation of her opinion on the significance of Math 290 to her preparation for calculus. Cora related that:

Drew Math 290 Advantages

The first term in [calculus I] was fun. I liked it. Without 290 though, I probably would have flunked. If we hadn't gone over the first background material (in Math 290), like with the definition of derivative, I would have been lost. They jump right into it. A lot of friends felt that 290 was a waste of time. And they took [calculus] right along with me because they had to repeat it. But I did well, and I found it easier than [Math] 108. But because of 290, I didn't have any major adjustments to make. You also need your background from 108.

The friends that Cora mentioned did not take Math 290. They might have been students who had not participated in the Drew program.

Principal Observation 5I--Adjustment Factors

The perceived abstract nature of calculus, its cumulative structure, the need for good visualization skills and a thorough comprehension of the theory, and the integration of ideas and concepts were among the expressed concerns which affected students' adjustment to calculus.

Sharina's expression of her feelings about calculus as a course was found in her statement that "things weren't as concrete." And Makeda appeared to express a similar sentiment as she questioned the relevance of calculus in response to being asked to reveal

some of the thoughts which she had about calculus when she was enrolled in it. She responded with:

Finding Meaning

Why am I doing this and what does it mean? You know, you integrate and I was like "what is this for?" When I first got in there I was like "take the derivative? Why? How can taking the derivative give you the slope? You know, how?" Then like, say, after doing word problems and after taking [Math] 113 (the second course in calculus) and looking back on [Math] 112 (the first course in calculus), its kind of registered in my mind.

Several students referred to the cumulative structure of the course content of calculus with the expression that "things build." For example, Rachael stated that "with calculus things build, you have to know the section in order to go on." And Lillian included this sentiment in her explanation of the fact that she found it difficult to focus in on the central ideas of the course. She also mentioned the pace and the unfamiliarity of some of the content as concerns when she stated that:

Cumulative Structure

Yea, when I first got into calculus, I wasn't sure about what to write down and I wasn't able to listen to much. With the pace in 112, especially since for many the information is unfamiliar and you have to learn it fast and well. You have to know the beginning material, because it builds. You'll have to use it later. I found with all four calculus courses, the beginning is called on later and one course builds you for another.

Candice referred to the need to visualize and understand three dimensional illustrations when she revealed that **"when you start talking about 3D and some other concepts, I got lost."** And Lillian, when asked about the most difficult aspect of studying calculus for her, responded by pointing to the need for thorough comprehension of the material and mastery of the language when she made the following observations:

Thorough Comprehension

The feelings that I knew something really well and not knowing it as well as I thought [was difficult to adjust to]. I already had good habits, but the improvement in my calculus grades came when I began to go in-depth with the material. One of the hardest things was to get involved with the

language of the math and decipher it carefully. The language of the 108 book and calculus are similar because they try to prepare you, but it's not the same. In calculus they'll give you the material but you're going to have to hash through it a few times to really know it, and go back over the material several times. In 113 I used to go back and just think things through again. That's a mental chore that takes getting used to, even if people have to struggle with trying to memorize things in 108. With calculus you have to develop your thought process, even if [the material is] computational. So getting over the fear and the laziness was the most difficult for me.

Principal Observation 5J--Success Prescriptions

Several students were able to point to specific measures which they took to enhance their performance in calculus. It appeared that the key ingredient in students' activities was dialogue with others, whether personnel from the instructional staff or peers. Sound study practices, such as reviewing often and using study time effectively were also important.

Makeda thought that a strong foundation in algebra was critical in studying calculus because "in an actual problem there'd be only a couple of steps of calculus and the rest is algebra basically." To improve her grasp of the material, she would review the concepts after each chapter. Candice, on the other hand, found that having good instructors and the willingness to ask questions as needed were important to her. Roselyn echoed this opinion and provided additional insight into her views on this topic as she discussed her experiences while studying calculus. After she mentioned that she found that you must understand the theory first, and after that it **"just goes back to your algebra and trig,"** the following conversation ensued:

Interviewer: I think you hit the key right there, the theory, understanding the theory. How did you gain an understanding of the theory?

Roselyn: It seemed like it was just a new thing, like history or some kind of science. It's more like memorizing the theory, but you couldn't just memorize the problems. Once you memorize the theory...

Interviewer: You mean by reading it, studying?

Roselyn: Yes reading, and what I didn't understand, the professor, what he did was a big part because he would explain,...

Interviewer: Right, paying close attention in class. Did you ever see the instructor much in calculus classes?

Roselyn: Yes, I went to the office very often. (She laughed after making this statement.)

Interviewer: When I asked how did you gain an understanding of the theory, that's part of it.

Roselyn: Yes, that helped a lot, just explaining the theory of it. His explanation gave me an understanding and how to apply it.

Interviewer: That's exactly what I want to dig out. What did you do as a student to gain an understanding of the theory, which in turn is what probably contributed to your being able to deal with the calculus.... Did you find yourself making many changes as you progressed in your study of math?

Roselyn: Before, when I first started out, a lot of times, I would just look at the examples and go from there in the book or something like that. But I started going over it with the professor, the theory too.

Annette agreed with both Candice and Roselyn when she revealed that she would often go to her professor for assistance and that she thought that he was a good professor. She also reinforced the opinion of Lillian when she mentioned that "reading the language was something I had to get help on." As further evidence of the importance of consulting with others in calculus, Tasha, who experienced a few problems in adjusting to calculus and performed very well throughout the sequence, also mentioned that she would seek assistance (usually through tutors) when she felt the need for it. She further pointed to her ability to draw as being important to her success. Latisha stated that she studied with her peers and attended review sessions in her attempt to do well. Thus there was a definite tendency for students to engage themselves with others in an exchange of dialogue in order to promote their understanding and development in the study of calculus.

Although dialogue with others appeared to be essential for many students, other forms of study practices and behaviors were also found to be important to some students as well. For example, as she explained what she did once she decided that she had to make a

stronger commitment to doing what was needed for success in calculus, Lillian revealed some strategies which she found quite helpful. She stated that:

Preparational Strategies

I would close myself off and study and review and I had a pretty good review pattern. Every few days I would review from a certain part and then once a week, I'd review from the beginning of the course. The mental part of it was the best -- I'd think about it a lot. Also my professor would give me verbal exams and he'd help keep me on my toes. I'm still in the process of developing a real sound method of doing that.

Finally, Larry seemed to have been incorporating virtually all of the ideas and strategies mentioned by others as he described his experience in, and approach to, studying calculus. He claimed that the following represented the keys to his efforts to achieve in calculus:

Assistance Seeking

My first calculus class wasn't too bad. I was nervous, and at that point I had good time management. And I said that if I had any problems I'd get a tutor. I said I would do whatever I had to do and I would stick to it like that. It was difficult the first couple weeks, but the reason I got through that was because I was more scared than anything else. And if I had any problems I would go [to the instructor] and ask [for assistance]. Also I'd get into a study group. And I would not wait until the last minute. I would do the homework every night and if I had any problems I would do all the problems I could do that night. I would do the even and odd problems.

Questionnaire Results and Discussion

As shown Table 19, the predominant problems that students experienced while studying Math 108 was related to the amount of work that was demanded by the course (24 of 67 responses). Twenty-seven of the sixty-seven responses given were related to strategies for effective learning of the material and/or the ability of students to effectively tackle word (or story) problems. Nine students apparently did not experience problems, while four of them thought that the instructor was inadequate, and three listed Logarithms as a major source of their difficulties. Other specific topics listed included Inverse Functions, Inequalities, and Equations. Other factors included attitude, language, and the textbook.

TABLE 19. Major Problems with Math 108

<u>Problem</u>	<u># Responses</u>
Studying Enough, Keeping Up, Amount of Homework	24
Detail (Stupid Mistakes), Learning Skills, Test Taking	16
Word/Story Problems	11
None, Few, None Listed	09
Understanding Instructor, Lack of Attention	04
Logarithms	<u>03</u>
Total	67

It should be noted that virtually all of these students had taken Math 108 through the Drew Program, even though several of them were repeating after having taken it through the university's regular sections. Thus there were only a few comments that related to impersonal atmosphere, lack of attention, or problems with instructors.

When commenting on the problems that they faced, some students were able to get right to the point, though in a general sense. For example, one student stated that **"I didn't go to class nor keep up with the class so it reflected in my grade."** Others mentioned specific problems related to studying and/or learning such as the student who gave the following comments:

Homework/Exam Connections

The problem I most encountered with Math 108 was in applying the homework material to the examination materials. The examinations were sometimes set up in ways that was somewhat confusing as compared to the way the material was covered in class. This caused feelings of insecurity while taking the exam, that I had otherwise thought myself prepared for.

Another student mentioned problems with exams when she stated the following:

Test Anxiety

On the other hand a different student viewed the situation as one which demanded that students experience the "real learning experience" while studying the course, something The major problem I found in taking Math 108 was that I panicked before the tests. I would know at least how to set up the problems, however I had myself so worked up and anxious over the

test that I lost a lot of time simply trying to remember how to do a problem. I also had problems keeping up with the material at times.

which would likely address the problems of the two students just cited. Her views were expressed as follows:

Essential Learning

The pace at which the class was taught [was a major problem]. I also had to actually learn the things that I should have [learned] in high school when I just memorized them for tests. But overall I had a good instructor which accounted for a great portion of my success in 108. Also I found the time required for 108 to be a big adjustment.

As Table 20 indicates, half of all students who responded to the question on adjustments to calculus (#13) found that the radical difference between calculus and previous math courses and/or the need to get an-indepth understanding of the concepts/ideas of the material to be paramount, thus corresponding to the views expressed during interviews. As one student put it **"My main problem was that it was an entirely new type of thing yet it required the student to have a firm grasp of algebra skills."** Responding to the need to understand the concepts another student stated that:

Understanding Crucial

The problem that I encountered was an understanding of the concepts. I didn't understand them to the end of the term. It was different from the other math courses. I found out that to study calculus, you have to do more actual work to understand concepts.

Accordingly, a third student, who actually performed very well in calculus, expressed an interesting view on this concern when she related that:

Strategic Learning

It took more time to understand the concepts. I had to get used to not always understanding why something was done a certain way. I accepted just learning a method or formula and stopped asking why.

TABLE 20. Adjusting to Studying Calculus

<u>Adjustment</u>	<u># Responses</u>
New Type of (Math) Course, Understanding Abstract Concepts	15
No (or few) Problems, Enjoyed Course	9
Very Demanding	4
Three Dimentional Work	<u>2</u>
Total	30

One student made comments which suggested that he thought that it was important to get a broad understanding of concepts while making important connections. He stated that the study of calculus **"required a clear understanding of all the concepts involved, not just the particular subject being covered."** Another student seemed to have found a way to address this problem as she pointed out that **"I had to go back to previous sections and even review trig. in order to do the work.."** Finally the only specific topical content listed in response to question #13 were story problems and maximum/minimum problems.

Table 21 gives the results from students' responses about the Effort that they Exerted on selected mathematics study strategies, while Table 22 gives their responses about the Importance of some Sources of Assistance made available to them. In each case the ratings were done on a scale of 1 to 5. The most immediate observation is that the rankings for first Math versus Last Math in both tables were the same, and that the standard deviations were fairly large in both tables as well. Table 21 shows that students exerted the most effort on notetaking and keeping their work organized, while the least amount of effort was exerted on outlining course material and previewing subsequent sections of the textbook prior to their presentations in class. Table 22 reveals that students thought that Review Sessions were most important to their success in studying mathematics, while assistance from a roommate or friend (a non-programmatic source) was least important. It is interesting to note that group sessions with other students did not play any more

prominent a role among students from the research sample during their last mathematics course than it did during the first one, despite the fact that several students made comments during interviews to indicate that studying with others became more important as they progressed academically. Finally, it might be noted that the importance of problem-solving sessions might have ranked as low as it did because these had not been as well integrated into the Mathematics Learning System of the Drew Program as the other support sessions had

Table 21. Effort Exerted on Selected Mathematics Study Strategies

<u>Strategy</u>	<u>First Math Course</u>	<u>SD</u>	<u>Last Math Course</u>	<u>SD</u>
Take Notes in Class and Studyt them	4.13	1.11	4.47	.95
Keep Organized Ntbk/Binder	4.07	1.07	4.55	.72
Do Assignments Daily	3.66	1.17	4.02	.93
Read Textbook & Study Examples	3.62	1.12	4.28	.87
Review Over the Weekend	2.75	1.17	3.41	1.18
Work on Problem Sets Early and Often	2.56	1.04	3.38	1.16
Review Previous Material	2.40	1.30	3.33	1.20
Read Sections Before Class	2.29	.98	2.88	1.05
Do Extra Work (Even numbered exercises)	2.24	.90	2.98	1.25
Outline Material	2.02	1.21	2.93	1.24
Skim Over Subseq. Sections	2.00	1.00	2.43	1.23

Table 22. Importance of Various Sources of Assistance For Mathematics

<u>Source</u>	<u>1st Math Course</u>	<u>SD</u>	<u>2nd Math Course</u>	<u>SD</u>
Review Sessions	3.80	1.20	4.32	.94
Instructor Office Hours.	3.15	1.32	3.92	1.22
Study Sessions	3.08	1.37	3.85	1.28
Tutoring	2.97	1.31	3.68	1.32
Group Sess. w/Other Students	2.97	1.31	3.55	1.24
Problem-Solving Sessions	2.90	1.25	3.43	1.30
Assist. Roommate/Friend	2.67	1.34	3.05	1.32

Summations - Adjustment To and Experiences In the Study of Mathematics

5a. **Deficient Preparation** When Lolita remarked that the length of the exams in Math 108 and the fact that some of the problems on them were foreign to her were barriers to her performance she was most likely indicating her lack of preparation for the exams. Students have often been found to complain about the length of exams because their level of preparation was not such that they could arrive at solutions in the most efficient manner. Likewise, they often fail to recognize that certain problems fit a certain problem type due to the fact that their understanding of the material was not thorough enough.

5b. **Condensed Material** Karla actually said that there were "five chapters condensed into 10 problems," but she most definitely meant five sections. Even so, many math exams will cover up to eight or nine sections or more which might come from more than one chapter. However, students often become frustrated due to the large amount of material involved coupled with their uncertainty about what the instructor will emphasize on exams. Until they become better at organizing and condensing the material themselves, as well as focusing in on what to expect, they continue to experience this type of trouble.

5c. **Deficient Learning** When students mentioned that they initially "just did the homework" they were pointing to one of the fundamental problems among new students in mathematics -- the fact that they simply have never learned how to learn mathematics. However, the bigger problem for staff personnel involved in special efforts to assist students in developing their academic learning skills appears to be that of getting students to do those things which they need to in order to foster their own development as learners -- a concern which is explored in other thematic categories.

5d. **Getting There** Math 082 does appear to present problems for many talented minority students. On the one hand many are deficient in certain areas or skills and thus need to be enrolled in a course which gives them the opportunity to improve on deficient areas. On the other hand, they have often completed curricula programs in high school which were considered demanding, with mathematics content which sometimes extended into calculus. Thus they often find themselves in the dilemma of facing the prospect of "wading" through three or four courses of mathematics before proceeding on to their real mathematical objective, which is calculus.

5e. **Mathematics Processes** Patrice pointed to one of the reasons why students have not previously learned how to learn mathematics when she stated that she was accustomed to her teachers "pointing out everything" that she needed to know. Thus students often become accustomed to mathematics as being a process of simply following the directives of the teacher, memorizing a lot of facts, and doing mathematics as a series of rules rather than a process of reasoning and the application of principles to a variety of concepts and ideas.

5f. **Mathematics Presentation** Linda's account of her experience in a lecture/recitation section of Math 108 highlighted many of the more obvious problems with this system. It is postulated that one of the fundamental

problems inherent in college mathematics generally, as currently presented, is that instruction is not designed within a learning development system--something which is especially crucial at the lower levels. That is, exposure to the critical issues relevant to the ability to learn mathematics apparently has not been a principal concern inherent in curriculum development and instructional design. Thus, for example, Lisa's unawareness of the fact that when the instructor wrote "x equals three," it was her responsibility to find out how he arrived at this answer if she did not know, was most likely not considered in the instructor's preparations for the presentation.

5g. Repeat and Grow Tiesha's revelation that she only got a 2.0 grade her second time around was a retrospective acknowledgment that her performance was lacking relative to her development as a student. That is, she had grown to realize that a relatively low repeat grade, though a passing one, often indicates that students have not gained as much as they need developmentally and that they will most likely again experience trouble in future courses until some further development occurs. Thus students are routinely urged to approach a repeat course as a challenge in their development of improved and enhanced academic learning and performance skills rather than as a "necessary evil." The one goal inherent in this disposition is the earning of a 3.5 or 4.0 grade if possible, or at least a 3.0 grade in order to gauge one's progress in the desired direction.

5h. Language and Mathematics Charlotte's comments about taking notes even if "there aren't any numbers or anything in the sentence," apparently points to the importance of language in the study of mathematics.

5i. Different Dispositions The need to intensely investigate the differences in disposition between students like Roselyn, Regina, Tasha, and Sean who do not appear to hesitate in doing those things which are beneficial to their performance enhancement, and other students who apparently possess certain behavioral barriers, would certainly seem to exist.

5j. Behavior Barriers Concomitant to the comments in 5c and 5i about students' disposition to "behave properly", it has been noted that students are often aware that they should do the things mentioned under Principal Observation 5(iii)B but often find it extremely difficult to get into the habit of doing them.

5k. Dual Problem Lillian's comment about the instructor taking "a long theorem to try to get a simple point across" seems to again point to the dual problem of a system which does not consider the students' view, coupled with the students' lack of academic and mathematic maturity. Whereas, the instructor was probably trying to present a total perspective on the idea being presented with its inherent structure parameters, conditions, etc., Lillian apparently did not recognize this fact and hence did not appreciate its significance.

5l. Self-Induced Efforts Cora's conclusion that the Math 290 course had proven helpful to her should be viewed in consideration of the fact that by the time that she enrolled in the course she appeared to have become enthusiastic about studying mathematics and thus put forth the kind of self-induced effort which often leads to continued progress and achievement. Regarding this issue, the underlying premise in the design of the course is

that when students take advantage of the opportunity provided to enhance their development and performance in the study of mathematics and science they will eventually succeed if the effort continues. However, for many minority students, the disposition to "behave properly" appears to be problematic. It is postulated that the inherent effects of oppression creates a more intense problem for many students from the affected minority populations than that which might be experienced by others. This phenomenon is explored more fully in Chapter VI.

5m. Dialogue Critical That dialogue with others was a key ingredient to students' development in the study of calculus could very well demonstrate both the importance of language in the study of mathematics, especially for calculus and higher levels, and the need for extensive dialogue in the process of learning by members of oppressed minority groups.

5n. Real Learning Lillian's comments about reviewing extensively, thinking about the material, and having her professor give her verbal exams illustrated three crucial elements in the process of real learning; adequate practice and familiarity with the material, reflection on the ideas involved, and engagement in dialogue for thorough comprehension.

5o. Inclusive Understanding It is likely that the student who noted that, in the study of calculus, it is important to understand "All of the concepts involved, not just the particular subject being covered," intended to emphasize the fact that there is a need to include a consideration for a host of ideas, principles, and topical content and be able to apply them appropriately when learning the course material and/or solving problems. This observation highlights a potentially crucial transition point for students in their study of mathematics and science. Experience has clearly shown that students, for the most part, do not arrive at the university having experienced this level of learning to any great extent. Thus the possible implications for educators, researchers, and program planners emerges.

5p. The recognition by one student that she had to conform to the idea that in the higher level calculus courses it is not always possible to get a thorough understanding points to another potentially important transition point for students. Whereas some students might have been accustomed to being able to get an in-depth understanding of the course material, at a certain level they might find this to be increasingly more difficult. Thus the need to more fully understand the effects of this phenomenon on students is likely.

6. Adjustments To and Experiences In Science Courses

Most of the students who were included in this study as well as those among all student who have ever been enrolled in the Drew Program were planning a major in one of the science disciplines or in a discipline for which mathematics and science were important

to its foundation. Students, who for the most part began their study of science at the introductory levels, were apparently confronted with an academic system in which the courses were not very conducive to their academic development in either their structure or the instruction received. Thus they often found their road to academic development and progress in the sciences to be rocky at best and this fact in turn affected their preparation for more advanced courses. This section documents students' reactions to their experiences and situations.

Principal Observation 6A-Inadequate Courses

Students reported that the impersonal nature of entry level science courses, their non-accommodating structure, the poor quality of the instruction, and the lack of provision for attention to their academic needs were hindrances to their performance and development in these courses. Furthermore, they held strong opinions about the need to change as well as the unfairness of this situation.

Marie and Lora both expressed the opinion that they did not like the fact that the introductory chemistry class was taught through audio tape and that they preferred a more traditional classroom atmosphere. Tasha and Lolita voiced even stronger complaints about this course in their initial reactions as they called chemistry on tape "a big joke." Lolita went on to go into detail about her opinions on why this class was a problem for many students like herself, and why an instructor is needed, when she stated that:

Instructor Absence

I think because math and science required so much time, they are technical and for me they just don't come that easily. Now I have some very technically astute people here, maybe some geniuses here. But I'm not, and I think that if I were to take those courses over again I would want an instructor there. Especially if you've never had the material, just assume that people know certain things and that if you put it on tape they'll understand and [they'll] be able to get to the helproom. I just think I would have gotten more out of Chemistry 140 (previously Chemistry 130) and 141 if I had somebody there. I really do...

When asked to explain why she had experienced trouble with chemistry, Kyra, who had just finished discussing the fact that she was a very diligent student, did not

hesitate in giving her direct opinion about how bad the chemistry tapes were and why she thought so. The conversation with her went as follows:

Terrible Tapes

Interviewer: You said that you had some trouble with chemistry. Do you have any thoughts about some of the reasons why you had trouble with chemistry?

Kyra: Have you ever listened to [the preparer's] chemistry tapes?

Interviewer: No.

Kyra: It's very vague, he doesn't explain it very well at all. You can't ask a tape questions.

Interviewer: So again it goes back to the impersonal way of handling instruction.

Kyra: It was just terrible. Listen to those tapes. If you ever have some time just go and listen to them. It was terrible and I ended up having to repeat that course.

Interviewer: That was 130?

Kyra: Right. When I took it for the second time I took it with the TAC class (which has a recitation format). That was a small group with an instructor, so I did much better. I did totally better.

It was apparent that Kyra and others had concluded that the class format of Chemistry 130 had a negative if not devastating, effect on their academic progress. Both Margaret and Evelyn revealed that the specific way in which the structure of the courses hindered their performance was that they did not always have the initiative to listen to the tapes as they should have and then follow that up by getting questions answered when needed. Thus students' disposition and degree of self-discipline at the time were apparent crucial factors in determining their performance outcomes. Larry had definite thoughts on this issue, including his own opinions about what the inherent problems with the chemistry courses were. He gave this account of his position:

Impersonal Approach

I think they could do something different about the Chemistry [class]. The department should develop some other type of approach to teaching

freshman chemistry because I feel it's impersonal. If you're not used to tapes and T.V.'s and this and that when you first start I think it turns the student off, especially a black student. I don't mean to insinuate being spoon fed or anything. I just don't think that was the proper application of material. It didn't come across right. This guy comes on the tape, you don't know if he's dead or alive. He sounds one way and that's all he tells you. I just think there should be a better way of doing it.

In addition to Larry's reference to them, T.V. classes were mentioned by Saucha, Kreisha, and Sherri, as having been particularly counter-productive to their academic development. According to Sherri, her Computer Science class "lacked structure" and "the T.V. people talked to fast." Thus Sherri apparently thought that the T.V. class lacked much of the "structure" of traditional classes, such as provisions for feedback, on which students had come to depend. A similar sentiment was shared by Evan, Anthony, and Tasha, regarding the introductory physics courses. Evan stated that he found that the teaching assistants for a self-paced course were not helpful, and since they were responsible for answering students' questions, he felt that he was "short changed." Anthony also found T.A.'s to provide little assistance in self-paced sections and reported that he enrolled in a lecture section as a result. Tasha disliked the format of a self-paced course which, according to her, demanded that students take a required number of quizzes to be eligible to earn a good grade. After explaining that she decided to take the non-calculus based sequence despite having done well in the calculus sequence because she was "chicken" and **"didn't want to ruin my grade point,"** Tasha gave the following explanation of her feelings about the course:

Inappropriate Format

I felt like the reason you get a good grade or bad grade in that series depends basically on how many tests you take, how many quizzes. So I didn't take as many as is required to get a good grade, but the ones I took I did excellent on. So I was upset because I felt like I had learned a lot and I knew the material, but I found out that I should have been taking as many quizzes as possible in order to get a good grade.

Principal Observation 6B--Non Relativeness

Students sometimes found it difficult to relate to the material in science courses, perhaps due to cultural factors as well as the "inherent abstract nature" of the courses themselves. Whatever the causes, students seemed to have believed that this situation should have been considered in some form within the academic system in which the courses were found.

As with calculus, the integration of various concepts and ideas in some science courses often presented problems for students. Anthony thought that this aspect, along with the inherent assumptions which must be correctly flushed out in problems and the way in which the student is expected to view the working of them, were barriers to his comprehension. He revealed these opinions when he stated that:

Information Assumptions

Math has certain rules and formulas. Certain problems in Math are straight forward. They just give you a problem and say compute, whereas in Physics they give you a long story problem and you have to sit down and understand what they mean. You have to think of which formula to use, which group of formulas you can use to derive your answer from. A lot of things you have are assumed, a lot of problems -- you do them one way and you don't get the answer, the prof will tell you you should look at it this way and let's assume this happened.

Patrice concluded that **"Physics is a very abstract thing to me"** and her description of her perceptions of the factors which contributed to the problems which she confronted while studying it reflects some of the frustrations expressed by Anthony. As she expounded on her views of the experience of taking physics within a special unit in the College of Natural Science, she revealed that:

Unrealistic Expectations

A lot of the times with [the special unit], a lot of the teachers think that students should be able to handle a harder work load or harder concepts. And they would give you a problem set. I mean there were times when our T.A.'s couldn't even do the problems on our tests and quizzes because they were so hard. And that I had a problem with as far as [the special unit] was concerned, a lot of the times the teachers expected so much.

Unlike Anthony and Patrice, however, Larry claimed that Physics was a favorite course and that he was able to comprehend the material, primarily because he could

"visualize it." He seemed to be suggesting that the information in the course became clear to him when he stated that:

Concept Identification

Physics seemed to make sense... When you went over the formulas, etc. I just got into it. I could visualize it more. When he explained the formulas and stuff and pulleys and all that, I could just visualize it easier so that when it came time for the test, I just... I could identify the concepts.

When listening to the remarks of Makeda regarding her thoughts on what the outcome of instruction should be for students, it's evident that she believes that the instructional system should be designed such that most students would gain the kind of comprehension and understanding which Larry was able to find. Makeda was of the opinion that instructors should be able to **"relate the material to students"** and offered students a tip which she thought could help them further their own understanding as she gave the following discourse when asked what she remembered about her experiences in chemistry:

Content Demystification

The way it's taught. It's taught like it's so hard. The professors make it seem like, you know, OK this is so complicated. And it's going to take you a while to learn it. You know, the way they come off. I personally think that any subject, there is an easy way to present it. Not necessarily in layman's terms, because you want to know the terminology of course. But I think there's got to be a better way for the profs to relate the material to you. And also I think they (students) need to - and I found this out through friends - to stress consulting other courses which relate to the topic that course is covering.

Questionnaire Results and Discussion

According to Table 23 students most frequently mentioned problems related to studying Chemistry, especially in relation to the use of audio tapes in Chemistry 130/140, when commenting on their experiences in Chemistry and/or Physics while at the University. However a substantial number of the total also stated that they either liked Chemistry or experienced few problems. On the other hand only a third as many students

stated that they liked Physics as stated that they experienced problems with it. And, as with mathematics, a number of students found that the inadequacies of the instructional staff were the source of their problems.

One student expressed the sentiments of many when she revealed that:

Worst Experience/Non-Remembrance

Chemistry at MSU was the worst experience I have ever had at a university. It was boring and difficult. I had a hard time retaining the material. In fact I can't remember anything from those two courses I took.

TABLE 23. Experiences in Chemistry or Physics

<u>Experience</u>	<u># Responses</u>
Problems with Chemistry Class and/or Audio Tapes	12
Liked Chemistry or Experienced Few Problems	07
Problems with Physics	06
Problems Due to Instructors, TA's or Tutors	05
Liked Physics	02
Total	32

Another student echoed these sentiments and she made comments that point to the problems resulting from this situation that extend beyond the introductory courses themselves. She ascertained the following:

Unacceptable Audio/Non-Preparation

The introductory chemistry courses are a joke in that the average [student] is unable to really learn from the voice on a tape. With the inability to ask questions immediately it is no wonder that organic chemistry (the course at the next level) gives students such a hard time.

A third student, who was a very good student, also recognized that her own views about the situation were crucial as well. She concluded that:

Uninteresting Material/Attitude Change

The hardest thing for me concerning Chemistry and Physics was that I did not find the material interesting, thus it was hard for me to concentrate. I found that my difficulties in these and other courses can be attributed mainly to my attitude. Once I changed my attitude, and told myself that "it is only another class and not in any way more difficult," life became easier and the courses that I once thought would be difficult were easier.

A fourth student, who was also an excellent student, made comments which confirm an earlier observation that even for good students the situation is relative to the study of the sciences is often tenuous. He related the following:

Unacceptable Prof/Course Scare

My first Physics class was a turn-off for me. The prof taught as though the whole class was use to doing Physics. All he did was derive formulas on the board and did experiments. My first Chemistry was scary because I had to teach myself and I figured I wouldn't know where to start. Corresponding to this students' comments about Physics, a fourth student mentioned that she thought that professors expect that students have had much more prior preparation than she believes that they've had.

Responding to the specific structure of introductory Chemistry courses at the university especially the use of audio tapes, one student gave the following views:

Professor Needed/Mathematical Tools

Chemistry 140 and 141 are two courses I didn't particularly care for because of the tape system. I felt that I needed the classroom atmosphere to get [the] professor-student rapport one usually gets. My math here at the university did provide the necessary tools I need for the chemistry and also the physics courses I had taken.

A second student gave a specific recommendation for the structure of these courses when she suggested the establishment of minority sections of them with study/review sections modeled after those in the Drew Program Mathematics component. She also thought that there was a need for an atmosphere of support and caring.

Among those who commented about their likes and dislikes regarding chemistry and/or physics courses, one student expressed mixed feelings when she stated that:

Chemistry-Physics Dilemma

I generally like and do well in Chemistry classes. I am having a problem with [a second year course] though. I hate Physics, although I have good professors. My professors have been very enthusiastic, but Physics is still a blackhole to me--dull and void.

Thus this student's opinion of Physics is in direct contrast to that expressed by the student cited earlier who thought that the profs were uninteresting. The comments of another

student reveal that she also had positive impressions of physics instruction and entry level chemistry courses. However, they also demonstrate the problems experienced by students as they move to higher level courses. Her comments were as follows:

Personable Profs/Tough Transition

I found, on the average, the physics profs to be very good. They were very personable and covered material well. I took Inorganic Chemistry 130 and 131. It was more or less a self-taught course. I liked that and did good in all my Inorganic Chemistry courses. Once I got to Organic Chemistry things were different. The transition was difficult for me because the prof didn't explain material very well. The recitations got me thru.

This same student also gave favorable views about the instruction that she received in physiology, although she prefaced her remarks by indicating her belief that this situation is atypical at the university. She stated that:

Caring Profs

I also feel that the average prof at MSU is not genuinely concerned with the students. My profs in physiology displayed [a concerned disposition] best I think. They really cared about us comprehending the material and were very accessible (i.e. office hours, by phone at home during the evenings, etc.).

Summations --Adjustments to and Experiences in Science Courses

6a. Initial Barrier The problems which students reported in science courses were, for the most part, those which they confronted during their first year – a period of time when they apparently need quality instruction and guidance the most. Thus the impact on students was probably exacerbated due to students' lack of capability in handling these problems in a very mature manner. This circumstance could evidently prove devastating for many students.

6b. Student Indignation Some students seemed to resent the impersonality of the academic structure itself. That is, apart from the perceived negative impact on students like themselves, they appeared to resent the fact that the institution would have them confront such an impersonal structure in the first place. Perhaps the cultural dimension of their views were being manifested with this view. Makeda's comment that instructors should be able to relate the material to students illustrates an example of an opinion which was most likely counter to common practices in the sciences at post-secondary institutions.

6c. Cultural Burden Larry's inclusion of the qualifier "especially a black student" when he discussed the perceived injustice of the instructional system, apparently illustrated his belief that black students are unduly burdened by this system. Hence, he apparently perceived a cultural difference which he believed would prove significant, and in this instance damaging, to students.

6d. Mature Decision Anthony's decision to enroll in a lecture section of an introductory Physics course in order to receive better instruction represented a level of decision making maturity which was not found to be common among students initially.

6e. Cultural Subtleties Anthony's discussion about experiencing problems in determining what the underlying assumptions are in physics problems highlights another learning barrier which is perhaps more restrictive for minority students due to cultural differences. Minority students are likely (due to cultural factors) to be unfamiliar with many of the subtleties of the majority culture which are contained in the language and are, therefore, unable to get as thorough an understanding of grammatical statements as they need, especially in courses like those in physics, chemistry, and mathematics, in which the statement of problems (and indeed the solution) is so precise and exact.

7. The Learning Experience and Problem-Solving

A critical factor which affected students' academic development in mathematics and science was their ability to learn effectively and solve assigned problems well. Because these skills are applied over the broad range of students' academic experience, a substantial amount of overlap will be found between the results included in this category and those found in the others.

Principal Observation 7A--Self-Defeating Behaviors

Students' ability to learn was initially affected by their application of inappropriate study strategies and their misappropriation of time devoted to learning. They reported that as they began to do things such as review the material more, use their notes and the textbook more effectively, and plan for more effective use of their study time, they found that they were learning better and, in turn, performing better in their courses. Prior to any substantial improvement in their ability to learn, however, some students apparently needed to mature and/or "personally transform" in disposition before they could "behave" in a way that lead to effective learning. Patience appeared to be a key ingredient in this process.

When asked about her initial discipline, study habits, and use of time, Rachael gave a retrospective response which provided insight into the incorrect perceptions that students sometimes have about the effectiveness of how they are approaching their preparation for courses, including the use of their time. Her response was that **"Now looking back, I know I didn't use my time wisely. Then I thought I was doing well here until I took a test and I found I wasn't doing well."** After being asked to identify the course which she was referring, Rachael further elaborated on what she was and was not doing initially by stating:

Misleading Perceptions

Any course I was studying; like I did in high school. I would come home and do some of the problems or read and then put it away, not really studying it or learning what it's all about. We were tested more often here than in high school, so you have to learn more and put it all together so I could put it back on the test. It was not something to learn but just something to do.

Evan mentioned that at first he refused to review for understanding, and, in retrospect, Walter realized that he had not been asking questions as he should have been to promote his learning. Shirley revealed her underestimation of what it would take to learn when she stated:

Mechanical Approach

I thought reading the material (in the textbooks) right before doing the problems... I thought it was unimportant because as long as I did the problems and understood at least mechanically doing the problems and I got the right answer, that that would be enough. And I thought I could just regurgitate what I had learned just by doing the problems when the exam time came around.

Lillian's description of her review strategy as presented in the previous category represents one strategy to improve one's learning of course material. Anthony commented that he began to rely on good class notes more as a way to improve his comprehension and Monique pointed to her improved use of the textbook in the form of reading ahead to the

next section, and working through examples rather than just reading them as examples of what she began to do in order to learn more effectively. Along those same lines, Larry gave an account of his views on one strategy which he found helpful and why when he said that:

Extended Effort

I would do the odd and even problems. I learned that just trying to do what was [required] wasn't going to get it done because those problems didn't show up on the exam. And so you learn you can practice all you want, but they're going to show you something entirely different and you have to apply the concept.

He followed up these comments by describing what it was like when he began "to see patterns" as he improved his understanding of the course material, and thus really learn the material. This description is included after Principal Observation 7C.

Sherri and Melvin were among those who mentioned that their studying with others was helpful to their learning mathematics courses. Sherri pointed to the support that those who studied with her gave each other as being important to their sustaining their efforts to actually learn the material and, in turn, earn better grades. Melvin mentioned the fact that students with whom he studied would often assist each other by correcting one another and pointing out problem solving strategies and solutions to each other. He was able to give a specific example of how working together and assisting each other was valuable to the process of learning when he made the following comments:

Collaborative Assistance

It was helpful, because when we were reviewing for the Math 082 final, some of the people in class, we studied together and I helped them with some of the problems. That helped me to review for the final even though I was showing them the problems that I already understood.

Principal Observation 7B--Course Effects

The format and instructional approaches used in various courses appeared to affect the quality of the learning experience for many students, especially early in their academic careers. Students' attitudes and dispositions also appeared to be significant contributing factors as well.

Berniece gave a fitting description of the view of many courses from a student's vantage point when she commented that:

Impersonal Structure

I [have taken] Chemistry 140 and BS 211. I think mentally I wasn't ready for them. I didn't like chemistry. It was frustrating because I'd turn to the tape to ask it a question and it didn't answer me back. It was very impersonal, and I didn't like it. I also didn't like BS 211 because it was [a T.V. class]. He would go over things; I was lucky to be in the section where he was and he would answer a question, but ten to one I didn't ask. We had a lab with a TA where we could ask questions and I went for a few weeks and then after a while I became frustrated.

Thus Berniece's initial frustrations coupled with her admitted unpreparedness for the task at hand apparently lead to a lack of effort and persistence in these courses.

Evan gave his description of what he perceived to be the inherent problems with the format and instructional approach in a physics class which, he contended, presented problems for the class in general. According to him:

Non-Supportive Instructors

With this class I'm wondering about [the instructor's] motives, because he said he's not going to work any problems in class. Basically, physics is being backed with theory and he said the TA's aren't going to help you with the problems. So if you're confused in the first place, you don't even know how to begin, you're flunking. The mean in there now is low and most students are confused, and he doesn't work any problems in class. You're supposed to make the headway and if you get stuck, they'll give you hints to what to do. He wants you to dive into the problems and then ask for help if you get stuck.

Evan went on to mention that the previous physics course did not present similar problems for him because **"you could see the formulas in use and you knew where and how to apply the formulas. And also, from concepts in the class, you could pull out what you needed."** Hence it was probable that his frustrations in the

second course were partially the result of his having experienced trouble in understanding the concepts and ideas of the course.

Linda made comments which point to the need to consider the structure, format, and instructional approach of course offerings as crucial factors which affect students' ability to learn effectively while describing her adjustments and experiences as she repeated Math 108. Regarding her perspectives on the relevant factors involved, Linda gave the following analysis:

Impersonal Courses

Everything was so foreign to me when I came here -- the way they did the learning on the overhead and "the pit" with the five hundred students watching. That's the kind of thing you can't easily adjust to when you come from... . Like I came from classrooms of about 25 or something. My graduating class was 110. I was very aggressive there but I didn't know how aggressive I could be until by second term at Michigan State. you know [the Drew Program staff] made it seem like the impossible dream comes to reality. I don't know if it was the fact that our classes were smaller; that [the instructors] were black and I could relate to that.

The remainder of Linda's discussion actually pointed to what she perceived to be some of the positive outcomes of the Drew Program experience. She revealed that:

Drew Camaraderie

...So I really think it was the smaller group, the fact that I had friends actually having the same problems as me. We could go home and study together. We (the Drew students) weren't so far away from the whole math system. [The Drew Program] always has the study session, the tutor sessions. There were people we'd talked to earlier in the week who we could relate to, that we might see on campus, walking. If it wasn't but "How do you do those so and so problems?" or "How do you do this or something?" You know, it really helped.

Linda also mentioned the program's emphasis on students' planning for the use of their time as being an important factor.

Tasha was of the opinion that students themselves could assist their efforts by taking it upon themselves to sort out the information in their courses for effective learning and retention and remembering that whatever they learn at any point in time might be useful later on. In response to being asked what advice she would give to new students which

could enhance their preparation for courses, Tasha mentioned the necessity of being aware of the cumulative nature of science and mathematics courses and went on to give the following suggestions:

Managing Learning

So that's the main thing, that once you learn it you can't forget it. And to keep good notes. That's the one thing I stress; notes, review packets. That's what I make for each test, the review packets. That's what I study for the final. And then I always keep those around for the next term, because you can use them in physics or whatever.

As Larry explained what it took for him to learn calculus, the latter part of his explanation also provides insightful information for students who must adjust to course in science and mathematics. According to him, he came to the following realization as a result of trying to improve his classroom performance:

Understanding Concepts

I think that's a general key that I learned throughout my classes here -- you have to understand the concepts. You can't expect to see the same problems [on exams]. You know, it's not going to be exactly the same, you have to get the idea, the idea behind [the course content]. If you get the idea behind it, then you can apply [the idea] to any problem, and then you'll be consistent throughout your answer.

Principal Observation 7C--Learning to Learn

Students' experiences with the process of learning and learning to learn lead to a range of emotional reactions; from frustration due to the consequences of not having previously developed sound learning skills to being highly elated over the satisfaction found in the realization of a meaningful and fulfilling experience with learning. Most students required an extensive developmental process in the acquisition of good learning strategies and virtually all of them seemed to need to extend this developmental process well into their study of more advanced science and mathematics courses.

As Shirley described what she remembered to be the most difficult aspect of making the transition from high school to college she actually documented a major problem faced by students relative to the learning experience. As she put it:

Memorizing Effects

Like I said, I was memorizing instead of really learning. And I didn't realize that until I came here. Until -- it's kind of sad -- until a couple of months ago I didn't realize that because the material I had learned from before, when I say it again it didn't really click. I was familiar when I looked at it for a while but I should have known how to do it without having to go back and read it over again.

Patrice supported the sentiments of Shirley when she commented that her first two years of college were "terrible" because of not having learned how to learn. And Sean referred to students' inadequate approach to their students as being problematic to learning when he stated that:

Laxed Preparation

You can't just take notes and leave them and then go ahead the next day and take notes and maybe look over them just a little bit and then by the time the test comes around be prepared to take it. It doesn't work that way.

Charlotte and Larry were able to describe their views of what it is like to find real or meaningful learning experiences in their respective science and mathematics courses. According to Charlotte the material in her biology class would **"sink in further"** and she was able to perform better because she would retain the material better for exams. She also mentioned her experience in a mathematics class, in which the instructor insisted that students learn the theory rather than simply shift symbols around, as leading her to really learn mathematics for the first time. Larry stated that once he **"finally began to concentrate in his course and develop a time management program,"** he found that he began to "see patterns" which helped him understand and retain the material better. He was outwardly enthusiastic as he gave the following summary of his discovery:

Pattern Recognition

Some kind of way there is a pattern to [the course content] where you can arrive at the answer some way if you understand the idea and concept behind it. So I began to think like that. Then I began to study like that, where I noticed patterns. I began to look for patterns. And the biggest example of that was when I took Biochemistry 401. This course, I was told would kill anybody, and I was determined not to flunk that class. So in that course I made a lot of notes, cue cards, and everything. I would not go to

bed until I understood the lesson of the day. And with that course I began to see patterns. You have to learn formulas and different pathways and I began to see patterns that way. So it was just a way to learn the material easier, just look for patterns. Therefore if you threw a problem at me that was not exactly like number 18 in the book I would know how to do it.

Other students also outwardly indicted their elation over experiencing the satisfaction of a "real" learning experience after having had to struggle, some for two years or more, to simply stay afloat at the university. For example, Lillian was asked to comment on her feeling regarding her experiences in calculus, for which she was able to get into the habit of thinking reflectively about ideas and thoroughly sorting out information. Her response revealed an interesting view of what that type of experience could mean to students. In Lillian's words:

Mental Outlook

It (the experience of probing deeply into information and ideas) trains the mind and I look at things differently than I used to. I think the calculus gave me a more disciplined way of approaching problems. I wasn't much of a conclusion jumper but just the way I think about news or information is processed differently.

Thus the effect of Lillian's experiences apparently extended greatly beyond mathematics or science courses and into her broader outlook on life experiences generally.

Principal Observation 7D--Problem-Solving Enhancement

Students' experiences with the enhancement of their problem solving skills and abilities also encompassed a range of emotional dispositions. Many students reported that they initially found it difficult to recognize important subtle information and cues which should have been extracted from the statement of problems. Thus they were not getting the kind of clear picture of the problems which would have allowed them to correctly identify the "innerworkings" of them and devise successful strategies for finding solutions. However, it seemed that students were often reluctant to try strategies which possibly could have assisted their problem solving development. Furthermore, their attitudes about and behavior toward programmatic efforts to enhance their problem solving skills, such as instructor developed problem sets and problem solving courses, often reflected a somewhat ambivalent outlook in that students would initially resist the very in-class and out-of-class measures which were

designed to assist them. Many students seemed to realize, in retrospect, that there were benefits to be gained from certain practices which they initially resisted, although they might not have seen evidence of progress until sometime into the future.

Melvin's comments about his misconceptions about the significance of word problems in mathematics while in high school highlights part of a crucial aspect of the problem confronting many students initially. After being asked about his opinion of doing word problems, Melvin recalled his thoughts on this concern from high school and stated that:

Problem-Solving Avoidance

High school teachers usually; they would teach me how to do the problems. I kept telling myself that after I finish this in high school I won't have to do any more story problems. A lot of kids kept saying as long as you take math you'll take story problems. I just would try to avoid story problems because I didn't understand how to do them.

Thus Melvin commented that once he began taking mathematics courses he found that he was severely lacking in his ability with word problems and he realized that he would have to struggle with them in order to become more efficient at solving them. However, he, along with several other students, found it to be a frustrating experience to say the least. For example, Charlotte mentioned that to her it was like **"just sitting there looking at words and numbers"** without any clue as to what she should do. Regina found that she **"wasn't getting the full picture"** of the problems and she stated that if something wasn't explicitly written in the problem she wasn't sure of what she should have assumed nor what information she should have "pulled out" from the statements given. And Nyla expressed a similar view when she mentioned that, while taking Math 108 for the first time, she **"had not developed any kind of method"** for solving word problems and she didn't know "how to really weed out the information to set [them] up."

As Evan explained why he found it necessary to substantially increase his study time over what he had done in high school, a portion of his explanation actually included a partial explanation of why students often have difficulty in solving word problems.

According to him, **"In college you learn the concepts but they change the problems around so you have to incorporate more than one concept just to solve one problem."** Thus Evan found that his high school method of simply becoming familiar with the basics in order to give back to the teacher that which was sufficient to arrive at solutions to non-complex word problems would no longer suffice.

Evidently many students were in need of substantial development in their problem solving skills which, in turn, would require some type(s) or performance enhancement measure(s). One student was able to describe what this kind of experience was like for her as she responded to being questioned about any changes which she had noticed regarding her own study of mathematics. During her reply, Sherri began to expound on her experiences in a Math 109 class (a non-Drew minority section) in which the instructor's methods in the classroom apparently assisted her with her abilities with word problems. Sherri stated that:

Behavior Inducement

We got to turn in homework daily so we didn't get behind and we got points for it, which was an incentive. Also I was always ahead of the lecture because she (the instructor) gave a quiz everyday on the preceding [section]; so you had to know. It wasn't easy either. There were problems for which if you didn't read you wouldn't know how to do them. For exams I studied so much and I started liking story problems. At first I shunned away from story problems because I felt I wouldn't get the right answer anyway. Gradually I started to like them. I started to learn what she was looking for and she'd show us how to attack a problem. Later on I looked forward to story problems because I was no longer afraid. I just figured I'd relax.

Sherri also mentioned that her studying right after class with groups of other students was an important contributing factor to her progress as a student in this course.

As a part of the effort to assist students with their development of sound problem solving skills and abilities, Drew Program mathematics sections often incorporated the use of instructor developed Problem Sets. They were designed to induce students to probe more in-depth into the concepts and ideas of the topical content of the courses and apply problem solving strategies to a variety of course related problems. These included standard

type mathematics word problems which are often more complex or involved "an extra twist" in their construction and solution. Students were told to work on them over the course of usually a ten day to two week period of time and were given suggestions on how to incorporate their work on them into their daily study routines. Students' responses to this process often revealed a great deal about their dispositions toward this type of effort to assist them with their skills development in problem solving and thus mathematics and science generally. Those responses were also found to reveal a great deal about the prospects and possibilities for problem solving enhancement among students as well.

It has been observed by Drew Program staff members that students often resist measures, like the incorporation of non-textbook problem solving assignment, which were perceived as venturing away from the norm by students, and the comments of some students indicated this to be true regarding instructor developed problem sets. According to Andrew he realized, in retrospect, that he did not approach his work on problem sets correctly because, at the time, he wasn't really trying to "learn" the course material, Kyra revealed that she "hated them" at first but later found that they helped her prepare for the final exam. Monique commented that initially she would procrastinate when attempting to work on problem sets but that later on she began to start work on them immediately. As a result she claimed that her work on them helped her overcome her anxiety about solving problems. Krista also found that she procrastinated because of the time that working on them demanded. However, she reported that eventually she found that they helped her prepare for exams. Cora also initially felt that work problem sets **"took up a lot of time,"** and she found them to be helpful as long as she did not let the problems "pile up." Her major concern was that the time that she devoted to Problem Sets would **"hurt [her] study time for other courses."**

Lolita was one student who mentioned the inclusion of Problem Sets as one of the principal features of the Drew Program which contributed to her development as a student in mathematics. Candice gave her opinion of one of the outcomes of her work on them

when she revealed that, "Well, after I got done with them I was glad. They made you think because sometimes you have a problem like that difficult which you [will] see on the final. They made you think better for [final exams]." Shirley expressed her views regarding the benefits of problem sets as she gave her retrospective perception of them with the following comments:

Homework Completion

I think [they're] excellent because [they] help you to stay up on your homework. Whereas if [the instructor doesn't] assign anything the student can just go home and wait until about two days before the exam and study. But if you have some problems to do you're more than likely going to do all the problems and then just pick out the ones he wants you to turn in. You're constantly keeping up with your homework. By doing that you have a better understanding.

After a further probe into Shirley's work on problem sets and views about them, several keys to some specific ways in which problem sets apparently proved beneficial to her emerged. Shirley observed that:

Reflection Inducements

In a way I didn't mind doing them. Some of the problems [the Drew Math instructors] assigned were really difficult and they required time to think. I found them to be necessary because [they] gave me a chance to really think about what I was doing. [They] let me know if I was really doing the problems right. Was I really thinking when I was doing the problems or was it just mechanical thinking -- just doing them? His problems were clearly difficult and they required time to think about it. You couldn't do them over night.

Hence Shirley evidently concluded that the inducement toward reflective and introspective thinking that resulted from her work on Problem Sets was significant to her problem solving skills development, and consequently her mathematics learning skills development generally. She went on to explain that she was able to experience these benefits only after she extended the extra effort needed to read and thoroughly comprehend the statements of the problems and as she began to take breaks "to collect herself" whenever she found it difficult to concentrate.

Perhaps a good indication of the effect of Problem Sets on students and some potential advantages to working on them were revealed in the comments of Sean, who was a very disciplined and mature student as a freshman. After being asked to give his opinion about Problem Sets and his approach to working on them, Sean responded by stating that:

Learning Aide

As far as approach, it was basically the same way as with the homework -- starting on them and if I got stuck or if I didn't understand a part I'd go back to the notes or go back and try to pull out whatever section or sections it was dealing with. That was basically about it. Doing them, I didn't really like it when I got them, but looking back at them they were helpful because, unlike the homework which stuck to one section, in one chapter, the Problem Sets more or less spread everything out so it kind of got you to look at more than one concept at a time, kind of like preparing you for a test sort of. So you had to use everything, not just one or two sections.

Students' comments about the Drew Program's Problem Solving course also revealed some insight into their dispositions toward engaging themselves in performance enhancing problem solving development activities. For example, Alvin B. disclosed that he initially formed a negative opinion of the course because it was required rather than due to any prior knowledge about it, and that he, consequently, did not fully participate in it. In response to being asked for his retrospective impressions of the course, Alvin made the following remarks:

Attitude Effects

I know, in my own particular experience, I didn't really want to take the class, but it was mandatory to take the class so I didn't have a good positive impression of the class. So, therefore, I didn't take heed to everything that was said because of the negative impression. I think that was the main fault right there. The class was mandatory to take and I didn't know what the class actually was all about, but just because I had to take it.

Another student, Cora, provided some specifics on some of her concerns about the structure and content of the Problem Solving course. According to her:

Developmental Concerns

Problem Solving was OK, although I didn't really like it. I think it's OK as far as the story problems [were concerned] because you'll face them throughout math. But I think it could have been structured better. I think

some [problems] were a bit too abstract and they could have given easier ones to lead you up to the harder ones. It depresses you if you can't figure out any of the problems.

Thus Cora didn't seem to have been disposed to resist the work demanded for the class but she did have her own beliefs about it and how it might have been improved.

During the interview with Roselyn a discussion of the problem solving course emerged within the context of discussing her development as a student in the sciences over her first two years of college. She had mentioned on her questionnaire that she used "their" strategies in a Physics class and was questioned about what she meant by that statement. The conversation relative to confronting problem solving situations in a Physics course and her willingness to devote herself to it. The conversation developed as follows:

Course Benefits

- | | |
|--------------|--|
| Interviewer: | You said (as found on the questionnaire) "when I took my first Physics class I used their strategies." You said "their" strategies meaning the strategies... |
| Roselyn: | Of the [Drew] Program. It was the Problem Solving course that went along with the (pause). |
| Interviewer: | With the Drew Program? |
| Roselyn: | Yeah. |
| Interviewer: | Oh. So that helped you. You felt like that helped you? |
| Roselyn: | Oh tremendously. Because that was one of my weakest areas; problem solving. |
| Interviewer: | So are you saying that the things done in that class just sort of helped when you took Physics. |
| Roselyn: | Yes it's a lot of work and it took a lot of time, but I was there and it seemed like it was extra. |

Thus Roselyn's last comment not only indicated that she was willing to work hard in the class but her remark that the work appeared to be extra also conceivably documented one reason why some other students might have resisted it.

Questionnaire Results and Discussion

Although students were not asked to comment specifically about learning and/or problem solving on the questionnaire, other than with regards to study strategies, habits, skills, etc., some students did make comments about the Drew Program which were quite revealing about their opinion on the impact of processed of the program on their development as learners in the environment. The first example cited below actually speaks to the value of the program in generally assisting students with their negotiation through the university. Three others are directed toward the more specific impact on the authors' progress in learning how to learn and function successfully academically. And the final one gives an interesting view about a possible inadequacy in the functioning of the program.

I really like the Charles Drew Program. It has been very helpful to me. I met people who are willing to help black students at this university. Without these few I think that a lot of students, who, if they hadn't interacted with these individuals would be somewhat lost. I for one. I have learned more about this university, its function, what it offers and what it doesn't offer, its standards and lots more just from being in this program. I have also found out about different individuals who are here to help you, and who can give one a little insight on various things whether its academics or personal issues. Finally, I feel that if I had not found out that this program existed and I had not taken this Math 108 course and B.S. 405 (the Drew Program Problem Solving Course at the time) I would still be lost, just like my first term here. This program has been very well executed, it shows in the overall G.P.A.'s of former students in the past (from my understanding). And all of the people involved are individuals who know what they're doing. And if it weren't for some of those involved with the program being helpful, caring, and influential, some of us probably wouldn't be in the university right now.

For the most part [I] have a favorable impression of the Charles Drew Program and MSU. As I completed my undergraduate education I have learned how to study and earn good grades. . . . It is my sincere belief that Michigan State University is being done a great service by programs like Charles Drew. After I got involved with the Drew Program my study habits increased and I was able to keep up with the assignments. This program also helped me to become a better problem solver. When I took my first physics class I used [the strategies of the program's Problem Solving course] and I was able to solve the problems easier.

I felt that the "Charles Drew Program" benefitted me tremendously. Even though I did not pursue a career in math or the sciences, I finally gained a workable background of the material, which I lacked in the past. I know that if I had taken the regular university section [of a mathematics course] I would have been doomed. A lot of time and interest was devoted to helping the students.

The Drew Program was very helpful but the structure of the program wasn't structured [in a] "must do" type of setting to make me want to do better. That way a lot of the push had to come from the students and I somehow lacked the drive needed to be very successful in the program.

Summations - The Learning Experience and Problem Solving

7a. Learning to Learn The fundamental barrier to acceptable academic performance to surface in this category appeared to be students' unawareness of even the most rudimentary practices associated with effective learning. Actually they did not even seem to be attempting to learn at all. Rather they simply desired to find the "tricks" associated with getting good, or at least decent, grades. Thus, by the admission of some, students would often reject certain suggested practices and view them as being unnecessary or irrelevant to their goals. Consequently, they would initially deny themselves the opportunity to experience the growth as students which they apparently so badly needed.

7b. Principles Application Tiesha's discussion about applying principles when doing mathematics brings attention to one of the fundamental concerns associated with the effort to promote students' development in the study of mathematics; that being how to assist students in acquiring this skill. Of course when engaging in educational programming for students with definite behavior barriers, this antecedent problem would apparently need to be confronted concurrently.

7c. Crucial Adaptation Based on his own comments, Larry was apparently out of touch with the learning experience initially but was able to eventually adjust his course and make several behavior adaptations which resulted in improved learning and performance. Among the concerns for student development programmers, getting students to adopt the prerequisite dispositions which would prompt them to do that which was necessary, and the feasibility of attempting to accelerate students' adaptations would seem to be the more obvious ones.

7d. Initial Survival Berniece's statement that she "wasn't mentally ready for it" in reference to the introductory science course in which she had been enrolled might have been the most revealing of this study regarding the structure of the academic system at the entry levels of course offerings. That is, the combination of patterns such as the impersonal structure of these courses, the heavy use of T.A.'s in them, and the very content of many of the courses themselves, apparently serves to defeat the purposes and needs of many students, whether minority or majority. That any

student would survive a host of these type of courses and proceed to perform well later on, in the absence of an academic support unit, would appear remote at best.

7e. Inaccurate Perception Evan's description of his experiences in the physics course represents an example of a crucial problem regarding efforts to induce students to improve their own performance. Whereas the instructor's intent in this instance was most likely directed at prompting students to think through the principles, concepts, and subtle ideas found in the content of the course prior to or while attempting problem solutions, students will sometimes interpret this attempt as an example of his or her contempt for them. Thus some form of intervention would appear to be necessary to alleviate this problem.

7f. Mature Learning Shirley's remark that, after she began to take breaks while working on Problem Sets, she was able to perform better represents one of the many behavioral factors associated with a more mature approach to learning. Evidently (on the basis of the findings of this study) students often find it very difficult to reach this level of maturity and thus realize the resulting benefits. Larry's being able to "see patterns" in his course content after making substantial changes in his approach to academics represents another example. Efforts to clearly identify ways of inducing this level of maturity are apparently needed.

7g. Unfulfilled Expectations The results from the interviews revealed that there exists a definite difference between the initial academic skill levels of students and the levels expected by university faculty members, and furthermore that this difference is vast indeed. For some students the situation apparently seemed to be almost unreal.

7h. Further Benefit Lillian's comment about calculus training the mind points to a possible positive student outcome from the study of calculus, aside from the mathematical gains themselves. This observation could also contain a number of important implications relative to the educational enhancement of disadvantaged and/or culturally different populations in society.

7i. Problem-Solving Ignorance Melvin's thinking that he might not have to do any more word problems after high school might be reflective of the fact that the importance of problem solving to the very process of education (and indeed to society generally), and to science and mathematics education in particular, has yet to be instilled in high school students on a broad scale. Correspondingly instruction in problem solving development most likely remains unsatisfactory as well.

7j. Student Inducements Sherri's description of her experiences in a special program mathematics course section in which students were required (or induced) to adhere to a fundamental principle of learning (the preview of new course material) illustrates the prominence of the issue of choice vs. non-choice in student enhancement programming. In this instance Sherri believed that the policy employed in the section was helpful. However, programmers would necessarily need to consider the long term effects -- i.e. will students eventually engage in performance enhancing practices of this

type on their own once they are not in the special program course sections or not?

7k. Proper Strategies It was evident that some (or perhaps many) students found positive benefits from Problem Sets. However, the key was found in getting them to approach their work on them appropriately -- or once more getting students to "behave properly." Again this issue apparently becomes critical for programmers of student enhancement efforts and projects.

7l. Rewarding Result Students' comments about the inducement toward reflective thinking as a consequence of their work on Problem Sets illustrates an example of a definite positive (and important) outcome which students could realize if only they would overcome their initial resistance to approaching them effectively.

7m. Essential Elements Andrew's comments about the problem solving class was indicative of an attitude often observed among students towards this course. That is, the non-traditional structure and pedagogical approaches taken in this course caused some students to initially resist it. However, as the review of the literature has revealed, the development of enhanced problem solving abilities demands creativity and the willingness to deal with novel (or non-traditional) situations -- dispositions which apparently are not easily induced among those from oppressed populations, at least not in the academic arena

7n. The observation by one student that the Drew Program was not structured to force her to do those things necessary for sustained academic growth points to another crucial concern for program planners; finding the most appropriate balance between inducing desired behaviors among students through encouragement and incentives and implementing policies which students must adhere to if they are to continue as participants in the program's processes. This concern is especially crucial for programs aimed at educationally disadvantaged students and/or those from groups in society which have been socially and culturally oppressed in light of the many factors which have been previously explored.

8. Major Changes in Students' Habits and Strategies

A key and crucial aim of this study was to delve into the adaptations and transitions made by students as they progressed in the university's academic system. That students from the sample and research populations of the study generally begin their matriculation on campus in possession of a complex mix of academic deficiencies and motivational problems (especially in consideration of the institutional expectations and the lack of a student development focus in its curriculum and processes) dictates that an intense effort is made to determine specific changes in students' habits and strategies in confronting

the academic challenges which make substantial differences in their performance outcomes. Furthermore, it became apparent that the need existed to determine the nature and effect of changes made by students.

Many of the students interviewed had attended the university for three or more years. Therefore several of them, if not most, had made many substantial changes in their approach to academic matters and most likely had experienced a number of personal transitions which further affected and interrelated with their outlook and behavior. Therefore, by determining what the changes were, why students made them, what their experiences were like, and the perceived and actual effects of the changes made, it would appear that a more thorough understanding of the problem of this study would be gained. Furthermore, several implications for the enhancement of student development processes, as well as further research directions, would conceivably emerge.

Principal Observation 8A--Non-Existent Strategies

Students consistently reported that, in retrospect, they had not been doing many of the things which are generally considered to be key elements in the practice of sound study habits and strategies. The reasons often varied but this condition appeared to be pervasive across academic backgrounds and/or levels of preparation.

Students' initial behavior patterns were explored extensively during the presentation of their adjustment concerns. That students were not behaving as they should have been, whether due to ignorance or otherwise, was thoroughly documented. As students discussed their behavior changes they pointed to several specific behaviors which, though routinely expected for success in the academic environment, had not been incorporated as regular practices by them. For example, Walter revealed that he had not been asking questions to clarify information or attending instructors' office hours. Evan described his neglect of basic preparation activities for Math 108 during his first attempt at it by stating that, **"the first time I took 108, I thought it would be like high school. You read the book, do the problems and take the test... I didn't go to any**

review sessions; I didn't think they'd help." And Melvin and Candice mentioned that they weren't making use of available time as they should have been; Melvin by doing homework only during the evening hours and Candice by not studying very much during the weekends.

Marie and Larry cited their tendency to procrastinate as hindrances to their early progress as students, a problem which was also a concern of Levon who revealed that he was not initially doing his math homework everyday. When pressed to explain why that might have been the case, Levon paused for a few seconds, then responded by stating that **"I don't know. I guess I can't really think of a specific reason. Sometimes I would have other homework to do and I'd try to put it off for a day or two and come back to it when it came closer to the test."** Thus Levon apparently had not, at that time, developed a proper approach to handling his assigned work. In a related revelation, Linda commented that she was not managing her time properly when she was enrolled in Math 108 the first time but that the requirement to develop a time management schedule when she repeated the course in Drew Program made a difference in her performance. Hence, the fact that the TMS was a requirement could have been a key factor for Linda as well as for many others, especially if they were predisposed not to do those things which they should have been doing because they weren't forced to, as was the admitted situation for Deena.

Principal Observation 8B--Incorporating Techniques

The predominant strategic changes made by students were directed at condensing and/or organizing the course material for better understanding and retention of it. These changes included improved strategies for notetaking, the use of index cards, reviewing and previewing course material more often, and using the textbook more effectively.

Andrew, Monique, and Charlotte all mentioned that once they began to listen to the instructor better, and take better notes they performed much better, as was the case with Lora who realized substantial improvement in her performance when she began to make

notes while reading her assignments. Lora also commented that she began to prepare early for finals while reviewing for them often. Deena also mentioned extensive review and improved notetaking as making a difference for her as she repeated Math 108. Charlotte and Rachael stated that they began to maintain two separate notebooks, one for lecture notes and one for homework assignments, whereas Makeda would copy her notes over an index cards. Makeda was able to explain in detail how this process was of benefit to her learning when she stated that:

Notecard Use

The [index cards] help me because they make me think I've concised all my materiel into this small card as opposed to a stack of notes and pages to keep flipping through. Once I've put the concepts I need to learn on note cards, it's easier for me to teach myself because I'm quizzing myself and I'm not as tempted to flip the card as I would be to look down the pages to see the answer. So it has helped me discipline myself when it comes to studying.

Candice and Evelyn also cited their use of index cards as key factors which contributed to their eventual success in mathematics and science courses. Carolyn observed that she used them to write out formulas and certain ideas in calculus courses. And Evelyn revealed a strategy similar to Makeda's which she found generally helpful when she commented that:

What I started doing when I had lots of chapters to read for certain courses, I would take notes and put them on notecards. That way I wouldn't have to take so much time reading over and over and I could concentrate more on learning the concepts instead of just constantly reading it over. So I was taught a notetaking technique. So that helped a lot. (One of the Drew Program's directors) helped me with it.

Shirley was cited in a previous category as revealing that she would consistently backtrack and re-do problems while reviewing as well as working ahead of the class to insure an adequate understanding of the material. Karla and Candice both mentioned a strategy in which they would put a star next to those homework problems which were difficult to solve so that they would remember to go back to them and/or get assistance when needed. Candice also cited her efforts to seek assistance as soon as possible when needed and to become very thorough in preparing for exams as being crucial to her

performance. Levon and Larry each give descriptions of strategies which they eventually incorporated which were comprehensive as well as detailed and thus provided good examples of specific behavioral measures which students can take to help insure improved academic performance. After being asked to provide some detail about what he did once he made changes in his approach to studying mathematics and science, Levon gave the following account of his actions:

Strategies Integration

I try to keep up a lot more and I try to go over all my material at least twice. I'll go over it before the test, and then, like a week before the test, I'll go back and really study it. I would study my notes and see how the problems were done and then I would read the section in the book, and then try to understand how they did the problems in the book. And, like for the exercises for that section, I would look back over my homework and I would try to do some more... I would do the problems again and then I would check the answers, and then look at the homework to see if I changed it.

Larry revealed a plan which seemed to include an overlapping spiral approach to organizing and learning course material and involved sectioning it off as well. According to Larry:

Spiral Sectioning

I would break the material up into series. Say, for example, I would have six chapters to cover. I would break it up into series. I would study two chapters, series one; another two chapters, series two; I would break it up into phases. Phase one, phase two, phase three, like that. Once I mastered phase one, I would go on to phase two etc. Then once I've gone through all six chapters I would go over it again, go over it again repeatedly... A few days before an exam I would highlight areas I was still having trouble with. The next night I would concentrate on another part. Then I would concentrate on the last part and tie it all together. In other words I'd break it into small parts, then tie it all together.

Similarly, Sherri mentioned that she would **"take each section and break it apart"** as she reviewed the course material for a mathematics course.

Principal Observation 8C--Resource Utilization

Several students made behavioral changes in their approach to learning mathematics and science which reflected a desire to gain a more thorough understanding of the course material by making better use of the

institutional resources made available to them and/or by working with other students. These behaviors included attending study/review sessions more consistently, using instructors' office hours more often, and organizing and/or participating in group study sessions.

Among the students who mentioned instructor's office hours as being important, Sherri stated that while in Math 110 (Finite Mathematics, usually taken by Business majors) she attended practically all of her instructor's office hours. Tasha stated that she began attending office hours more often because as she progressed in her study of mathematics she found it increasingly more difficult to rely on peers for assistance. She also made other observations about studying calculus that prompted changes in her approach to class preparation which were quite revealing regarding the necessity of certain practices. In explaining why she began to do things which she originally was not doing while studying calculus, Tasha made the following comments:

Calculus Preparation

I remember that when I got into calculus [more and more] of the people that I know who I used to seek outside help from didn't know what was going on as much, so they couldn't help me. Therefore I began seeking help from the things that were already set up, like the office hours, from the class. And as far as the book, I found that, usually like in 108 and 109, even if I didn't read beforehand, everything was explained so much that I could pick up on what was going on. But when I got into calculus, a lot of time [the instructors] assumed that you had already read that section, so they could jump in the middle somewhere rather than going through all the introduction of what was going on. So unless I wanted to be lost in the class, I would try to read, if not immediately beforehand I'd always read right after the lecture.

Evan also revealed some specifics about what made a difference for him as he began to make more use of review sessions. He was among several students who pointed to the increased use of programmatic academic support activities (as previously cited in other categories) as crucial to his development and he gave an example of how this approach helped when he claimed that:

Boardwork Benefit

In taking 109 and 108 the last time, the review sessions helped a lot and I continued with them. We worked out things on the board. That's how it was at home (in his high school). You would work out things on the board

and you tried harder to get it right or you would be embarrassed. I think that's better.

The resource strategy most often mentioned by students as being critical to their success was group study sessions. Among those who cited it, Melvin, Nyla, and Patrice all began to employ this strategy once they were participants in the Drew Program. Walter stated that he found studying in groups was much better but he did not mention when he began to involve himself in them. But Sherri observed that she began to participate in group sessions while enrolled in Math 109 (through a different minority program) and she also provided some detail about them when she stated that:

Group Effort

Before exams we (she and others in the class) have big study groups. We'd get the chalkboard downstairs (in her residence hall) in the [Black] Caucus room and start to do problems. Usually it was four to five people but a few wouldn't talk so I'd be at the board all night.

The last comment by Sherri left the impression that she would often carry a large portion of the responsibility for the group sessions, perhaps including assisting the others more often than they appeared to assist her. Melvin and Latisha seemed to feel that their efforts to assist others would help them by forcing them to gain a better understanding of the course material. And, like Sherri, Latisha commented that she would get together with others in the dorm. But unlike Sherri, she would get together with others who were enrolled in the same course, not just the same class (or particular course section), as was the case with Sherri. On this point however, it should be noted that Sherri was enrolled in a minority section of her course at the time, whereas Latisha was enrolled in a general university section of her's -- thus again pointing to the significance and a consequence of minority status within the institution.

As she discussed the changes she made, such as not procrastinating and getting assistance when needed, while repeating Math 108 in the Drew Program, Lolita suggested

that studying in groups was a key to everything that she did and she also provided a good description of how this process would unfold itself as well. According to her:

Group-Study Discovery

Something else that I discovered is that you should study with a group. So that's when I started getting together with friends in the class and we would go over homework assignments. And also questions that we might have or go over problems and study together. That was something that I think I discovered. That was the first discovery that I think I made -- of group studying. I've tried to do something like that ever since.

Principal Observation 8D--Time Use

Some students made changes in their study patterns in order to make more effective and efficient use of the time which they were devoting to their preparation for courses. These changes included studying immediately after classes rather than waiting until later in the day, varying the time of the day that they would study, being more consistent with certain habits (e.g. getting studying done by a certain time of the night), making good use of time on weekends, and beginning their preparation for the final exam earlier in the term (or quarter).

Students' management of time in course preparation was explored extensively in the category on general study strategies. In this section further insight on this concern is presented and students' comments reveal additional detail about their views and their reasons for, as well as the consequences of, their changes. For example, Terri commented that she was prompted to cease **"leaving things until the last minute"** when enrolled in Math 108 because the tests in the course covered about double the amount of material covered in Math 082. Marie also discontinued her habit of procrastinating and then cramming for exams. As a result she observed that **"I feel like I'm more established now, my habits are much better. I know how to organize my time much better to get the best out of it, what's better for me, what points I should emphasize.** She also concluded that **"Cramming doesn't help at all. It's best to get a little bit at a time instead of trying to get it all at once."**

Levon also found that once he re-assessed his use of available study time and made desirable changes, he became more organized, or, as he put it, **"I became a little more structured."** Patrice revealed a strategy in which she would try to be prepared for her exams at least a day before they were scheduled, and then review and further **"pull the material together"** immediately prior to the exam. And Rachael mentioned that, after having previously approached final exams as if they were routine in-term exams, she began to prepare for her finals in calculus over several days and that she and her study partners developed a strategy in which they would study for two hours at a time, take a break, and then study for a different final for a while before returning to their study of calculus.

Melvin and Larry gave descriptions of their strategies for the use of time which outlined several key features of documented performance enhancing measures available to students. Melvin gave a concise summary of his overall approach to planning his "academic development schedule" for the term by stating that:

Time-Use Strategy

The first week of classes I get the feel of going to my classes and see what times I have open to do homework. I knew, like in math, I have afternoon open so I do math I would do either my ATL homework, which was usually writing papers, or doing some reading. I would do probably that next or some homework for another class. Then I would probably go to dinner then do some homework after that. If I had a class to go to I would go out to class (that evening), then come back and do some more homework.

Larry's description of his use of time was focused more on what he might do on a typical day and included more detail on the specifics of his behavior. After commenting on the "heavy transition" which he made during his second and third years, Larry gave the following account of his strategies:

Sectioning Time-Use

I devised a study program where I would take each course and I would study at least a certain amount of time for each, each night. I would study 50 minutes per courses take a 15 minute to one-half hour break, then go back for another 50 minutes each. And I got to the point where I would spend at least 45 minutes minimum going over it. It got to the point where I didn't have to cram. I got to the point where if I had an exam on Thursday I

would study that Friday before the week-end... I realized that the trick to it was that Friday. If you only put in a couple of hours, it doesn't matter as long as you put it in. Then do some on Saturday and a lot on Sunday. And then just study casually throughout the week. And maybe a couple days before tie up all loose ends, maybe go and see the professor and straighten it all out. And then the night before just review and I should have it down solid.

Thus, in addition to repetition and recycling through the course material, Larry's approach appears to involve a great deal of looking ahead and planning for specific actions.

Questionnaire Results and Discussion

During the presentation of category 5 (Adjustment To and Experiences Studying Mathematics) Tables 21 and 22 displayed the Effort that students Exerted on selected study strategies and the Importance of Various Sources of Assistance respectively for their first and last mathematics courses. The determination of correlation coefficients revealed that there was a significant difference ($p \leq .01$) in both Effort Exerted on selected strategies and Importance of Sources of Assistance among all items in each table between that reported for the first mathematics course and that reported for the last mathematics course. Thus, the data suggests that there was a definite pervasive change in students' behaviors and overall approaches to studying mathematics, and perhaps other course disciplines, as they progressed in the academic system.

As can be seen from Table 24, when all of the responses to question #17, on the changes that students made in their approach to studying mathematics and/or science, are tallied they tend to virtually fall into four discernable categories. In addition, two students stated that they began to write down what the instructor said as well as what she/he wrote while taking notes. Among the responses which were given only once were the following; copy the notes over, take more breaks, study with friends in the same class, study alone, attend class everyday, talk through the concepts, and go to the helproom more often.

The fact that so many students pointed to their effort to understand/learn the material, along with the adoption of certain enabling behaviors/strategies, as a major change for them suggests that, for the most part, students were not attempting to actually learn the material initially, something that has been previously documented both in the literature (e.g. Linn, 1982) and in these findings (Principal Observation 8A). Thus from an educational programming standpoint the question becomes one of how to get students into a dispositional mode in which they are willing and inclined to engage in the proper experimentation needed to identify those behaviors and strategies that will work for them. The comments from the students cited below suggest that in one way or another students

TABLE 24. Major Changes in Studying Mathematics and/or Science

<u>Change</u>	<u># Responses</u>
Attempt to Understand, Ask Questions, Seek Assistance	23
Study More/Harder/Regularly, Try to Keep Up, Discipline	22
Review/Preview, Read Text, Study Strategically	13
Use Notes/Index Card, Outline/Organize Work	11
Total	69

had to develop a very strong desire to learn the material and/or do well in the course before they were willing to engage in such experimentation. As their comments are presented, the commonality of their transformations and strategy adoptions becomes clearly evident.

Beginning with those changes which are more broadly behavioral in nature, the comments cited have been arranged to reflect increasing specificity in strategies, culminating with two examples which ran the gamut and one which gave examples of how the instructor can induce desired behaviors through his/her course policies. The first student cited gave the following response to the question at hand:

Consistent Work

One major change that I have made is doing my homework everyday, keeping up with the class, and reading my material before class.

This student stated that she made the change because she **"found that this helped to improve my grade."** The next student became more serious while taking steps to gain a better understanding. According to him:

Serious Commitment

I take the science courses now more seriously. My freshman year I didn't commit as much time studying as I do now. If I'm having problems understanding the course material, I immediately talk to the instructor for a better understanding.

The next two students mentioned the importance of discipline and scheduling (with review/preview) respectively. The reasons given for the change by the second student reveal specifics about the outcomes of her effort. The remarks of the first student were as follows:

Consistent Discipline

I have realized that when studying for math and science classes, one must be VERY DISCIPLINED and STUDY CONSISTENTLY. I also realized that if one has any questions, they should be answered. BEFORE any new material is started.

The second student stated that **"I put myself on a schedule and review that night's and the previous night's assignment, and make a sincere attempt to do the next night's assignment."** Her given reasons were even more revealing about her actions as she remarked that:

Scheduled Preparation

I put myself on a schedule because it allows me to set time to get not only math done, but my other homework as well. So that way I won't be two days behind the next day [in class]. And this way I'm constantly learning and ahead of the class, and by the time exam time comes around I don't have to cram because I'm already prepared. And this way you are always LEARNING.

The next two students not only gave similar responses to the question but they also stated that the reason they made the changes they did was because had they not done so they would not have had a realistic chance of getting accepted to medical school, which they were both able to accomplish. The first students' comments reflected real growth in her view of her situation as she revealed that:

Matured Perspective

I have become more dedicated, and changed my methods and approaches to classes. I have learned to balance things better, and have learned to prepare myself for times when I have three tests in one week in a manner that I won't have to cram or pull all nighters. ...
I have also gotten to know myself better as far as limitations go, and as a result certain things automatically change.

The other student's response also reflected a desire to be well prepared as he stated:

Preparation Strategies

First and foremost I changed the number of hours that I studied. I studied two hours per course a night everyday. I began to prepare for exams ten days in advance. I would do all the problems, then go to the instructor for help. Mainly I developed "discipline".

Another student outlined her behavior changes in a way that not only made it clear exactly what she did but specifically why she made each change. Thus her response facilitates a transition from those responses which were broadly behavioral to those which gave more detailed strategic efforts. Her outline of major changes were listed as follows:

Aggressive Action

1. Managing study time and improving studying techniques.
2. Speaking out when I don't understand a problem or concept.
3. Using the available resources such as: tutors, professors' office hours. . . to gain better control of the material.

Her reason for these changes were also outlined as above:

Wise Adaptation

1. [I] chose to manage study time more efficiently because a lot of my time was being wasted studying for hours and not really knowing the concepts or retaining the information.
2. [I] chose to speak out when I don't understand something because, many times, that same problem performed in class would be on the next test or quiz. It only took an extra "5 or 10" minutes to ask someone and it was more than worth it when test time rolled around, or even in doing homework.
3. I used to try and do everything alone, figuring that I could do it by myself, and that I didn't need anyone. However I wised up and began to work with other people, and it benefitted me as well as others tremendously.

The next four responses cited represent those in which more specific changes were mentioned. The first one gives one reason why classmates are important:

Essential Notes

After the first math class, I found that it was easier for me to take more notes in class and use class examples instead of going strictly from the book. Because once I got home and tried to do the exercises just like they were in the book I'd find myself somewhat confused because the prof wanted the exercises done the way he/she showed us, not the book's way.

The second response included multiple strategies that reportedly helped the student

"understand better and do better on [her] tests." She noted that:

Strategy Combinations

The changes I made from my first math class to others were; I started keeping formulas or index cards asked questions, studied on a regular basis, reviewed materials on a constant basis and not cram the night before the test, and went to the professor's office hours.

The third student also mentioned multiple strategies and her reasons given provided some revealing detail about one of those strategies (use of other references).

First, her list of changes included an interesting remark about listening in the classroom:

Aligning Strategies

Organization of my notes. Making sure that they are neat and clear. To listen to what the professor is saying as well as (pay attention to) what he is writing. Using the office hours provided. When I don't understand something, use other references.

Her discussion of her reasons for making the above changes included the comments below:

Quality Resources

Organization is the key to everything. ... I also have found that using other references is very important. Also knowing where to get them. What usually happens is that I find a book that explains the subject or method much better. The most important thing that I learned about math and science is that it's not the quantity of time spent on your studies, it simply is the quality of it.

The next student relayed what she did as she progressed to higher level calculus courses, as she completed the basic calculus sequence. She stated that:

Read and Seek

I tried to read the text material either before the lecture or immediately after. Many times, my questions were answered before I had to ask. I also went to the prof's office hours everytime I could. And I signed up for a tutor for a few calculus classes since my friends could no longer help. I learned to seek help more from outside sources (people I didn't know).

The first of the two responses which were comprehensive and exploratory suggests that the student had found value in experimentation with ideas even when the payoff is not apparently immediate. She gave the following account:

Seeking Solutions

Changes: Since my first mathematics class, I have attempted to study more for the math class. I have also tried new approaches (study the material that is at the beginning of the chapters [while progressing to further topics in the chapter]) even though they have not always worked. Similarly, I try to study my science courses everyday as well as use notecards for learning.

Reasons: The use of notecards has proven to be beneficial to my learning. I understand the concepts better this way. Also, I thought [that] by studying at the beginning of the chapters I would comprehend more. This, however is not always true. In the case with math, I think that I didn't expand my resources totally, especially for calculus.

The next student offered some revealing remarks about dispositional changes relative to the intricacies of real learning while explaining her reasons for the changes which she'd made. She related that:

Learning Enhancement

Changes: I learned to ask more questions in class to problems or lecture materials that [were] unclear to me. I also found myself spending more time doing homework daily and attending study sessions offered by the [Drew] program and [the Office of Supportive Services]. Moreover, I adopted a common concern of wanting to learn and not procrastinating.

Reasons: I developed a sincere interest of not wanting to waste any more time not studying, but to develop skills in time management. This enabled me to budget my time and actually enjoy math and science. I started to see the difference in my learning abilities when I would ask questions to uncertain lecture material and assignments [rather than] waiting 'til I got home and found it hard to do my homework. I felt [that] doing my homework daily would keep the material that I had learned fresh in my mind, rather than waiting a couple of days and then try to go back and do homework problems. I felt [that] my time was being well used now.

The final response was actually a description of what one student experienced after she switched mathematics sections and found that the behavioral inducements which were inherent in the strategies used by the instructor actually assisted her academic development. Thus we have at least one example of a student's view of the value of instructors' attempts at trying to get students to do those things that are needed behaviorally, as well as facilitate their learning through classroom techniques. This student gave the following description:

Since my first mathematics course I've switched professors and my last math professor made us turn in homework daily. She gave quizzes everyday on the lecture to be [covered] and she also listed your grade on exams in the rankings of the grading scale for everyone to see. These were added incentives to do well. She also wrote out each lecture and gave us copies so we could pay close attention to her instead of trying to take notes to follow her.

Summations - Major Changes in Students' Habits and Strategies

8a. Mandatory Experimentation It appeared that students needed to experience a period of experimentation with various approaches to confronting their academic work before they were able to make sustained progress rather than following a certain prescription or prescriptions for success. Again the existence of possible implications for student development programs becomes evident.

8b. Great Progress Students' records revealed that some students cited under Principal Observation 8B made substantial improvements in

performance and some who had mediocre performances initially even progressed to finish among the better students in their peer group.

8c. Essential Notes Improved notetaking ability appeared to have been a key element in students' progress. This observation is interesting in that students often initially concluded that this skill was unimportant to the study of mathematics and some apparently refused to attempt to improve on their abilities with notetaking early on in their academic careers.

8d. Reading Comprehension Tom L.'s remarks about the need to read the calculus for understanding contain obvious implications for mathematics faculty and program planners who are or will be involved with the preparation of students for the study of calculus, whether through the curriculum, the instruction, approach(s) used, or through the design and implementation of complementary student development/enhancement support activities.

8e. Diversity Needed The need for variety and breaks in students' routines appeared to surface from the results presented under Principal Observation 8D.

8f. The comment by one student about listening to professors while attending to what they write on the board highlights a most important academic development concern for students; acquiring skill at doing both things simultaneously in a way that maximizes understanding while recording (usually through notetaking) the information in the most effective manner.

9. Personal and Institutional Barriers and Student Retention Factors

This thematic category is divided into two subsets. The first subset, i) **Personal and Academic Problems**, deals with barriers to academic development and advancement that depend on the student, what she or he brings to the campus environment and the consequences of or outcomes from her or his behaviors once here. The second subset, ii) **Institutional Barriers and Racism**, addresses those issues and concerns which were viewed by students as having been the result of the institution's character and structure, including the perception of an environment which permitted racism.

i) Personal and Academic Problems

During the presentation of the thematic category **Adjustment to College**, several varied personal and academic problems emerged which appeared to hinder students'

adaptation to the collegiate environment and its academic demands. These same problems and others often serve to affect students' prospects for sustained progress in the institution after the initial adjustment period as well. In addition to reviewing some previous examples, a few additional examples of students' personal and academic problems which potentially had a negative affect on their ability to successfully move through the university's academic system and reach their potential as students are presented here.

Principal Observation 9A--Personal Encumbrancies

As was previously documented, students' personal situations often served to interact with and sometimes compound any academic problems which they might have faced. Certain problems continued to plague students as they attempted to negotiate the institution's nuances and advance in their studies. Very often students' ability or inability to confront these problems became a critical determining factor in their success or failure.

As Berniece discussed her experience, under category 2, of having problems confronting the tremendous amount of responsibility that had been thrust upon her it became apparent that this situation had exerted a profound impact on her as a student and a person. Furthermore, as she pointed out, she wasn't able to grow in the environment as she would have liked, or seek out her niche on it, until she fully accepted responsibility for her actions and began doing what she thought was best for herself rather than what she thought others (father, mother, etc.) wanted for her. Several other students expressed similar views at some point or points during their conversation and/or while answering one or more questions on the questionnaire. For some students this was a short term problem which was resolved to a great degree during the first year or so, while for others it lasted much longer. Such was the case with Lolita's problem of over committing herself to non-academic activities which, according to her, continued throughout her college career she performed fairly well academically in spite of it.

There were several instances in which students mentioned that personal problems, such as those involving family members and/or friends, had significantly affected their academic progress at the university. In some instances they were willing to reveal them, as several proceeding and proceeding examples demonstrate. In other students felt uneasy about divulging their problems and they were not pressured to do so during the interview process. However, some students indicated or intimated that their problems had seriously affected their ability to adjust and/or grow adequately and thus lay the kind of solid foundation needed for their chosen curriculum program. Consequently the short term result was that students might not have been able to pursue their chosen major with a corresponding long term result of not being able to realize future goals without serious sustained intervention of some form.

Principal Observation 9B--Academic Inadequacies

Students' academic deficiencies coupled with apparent culturally related behavior barriers (relative to the institutional character and structure) sometimes hindered their advancement towards doing those things which would have contributed to their making sustained progress toward sound academic development and advancement in the institution. That is, in addition to the initial deficiencies themselves, some students who perhaps could have made strides toward academic fulfillment at certain intervals in time during their academic careers apparently "blocked" because of certain dispositional restraints which contributed to their inability to gain realistic perspectives on their situations. Consequently these students were often unable to recognize and build on their strengths while working to strengthen their weaknesses in a manner which would lead to steady sustained growth and development within the institution.

Among examples of students previously cited, whose lack of preparation for the academic demands of the university hampered their academic adaptations, were Marie, who believed that her perception of her less than adequate high school preparation negatively affected her confidence and motivation; Cora, who was among those who simply did not know how to study; and Patrice, who described her first two years of college as being especially frustrating because, despite her continued efforts, she made little substantial academic progress. Due to these types of perceptions and experiences of students some of

them will, at times, doubt themselves to the extent of attributing inappropriate factors to their academic status or viewing their situations erroneously. These types of attributions and views would, in turn, sometimes affect students' overall perceptions of the academic development process itself. For example, Rachael commented that she felt that she was "behind" academically because she might carry a twelve credit hour load when others were carrying fifteen, or she might have earned thirty credits by the end of the year whereas others would have earned forty-five. Thus, in her view **"it seems as if you'll be behind forever."** And Andrew revealed his opinion that students are often under undue pressure to immediately prove themselves when he stated that **"I think most students are pressured to be a success. Not just progress, such as saying 'well I'm progressing', but it's like succeeding."** He went on to elaborate on why this situation might exist when he observed that:

Student Pressures

You have pressure getting into your college; you've got to have a certain grade point average and you have to have it by a certain amount of credits. So sometimes you say "Oh I can't take 082 because I can't handle that, I need to take 108 to get in my college." The pressure of success, the means of success or getting into your college.

Thus Andrew pointed to one of the crucial problems which has been observed to surface when students confront the decision making process involved in trying to complete the prerequisite requirements for their majors; that being their unwillingness to take appropriate actions needed to solidify their academic foundations for their chosen curriculum programs. For example, when Shirley was asked to comment on her hesitancy to repeat Math 082 upon being advised to, she gave the following response, which revealed the kind of internal struggle which students often experience in this situation :

Reluctant Repeater

What comes to my mind is that it's nothing that -- don't take this wrong -- that you could do, that you couldn't have done. I had to be part of my own -- it had to be the willingness of me. I had to sit down when you were telling me that I should take 082 over again. After I had gotten off the phone with you, my mind was saying I need to take it over again but I have

to go further in math. I could take it later on. Then the other half was saying "You might need it, you need to take that." I was constantly telling myself "No, you don't want to do that because it's going to put you further behind, and that's years... that's another year added on." I was saying I can't do that.

Shirley went on to observe that she later came to realize that the quality of her work and her GPA were much more important than the length of her stay at the university -- one of many realizations which students need to come to in order to gain a proper perspective about their academic development and long range goal acquisitions.

i) Institutional Barriers and Racism

In the section on students' adjustment to college, many of the initial institutional barriers, such as problems with registration, inappropriate scheduling, and the impersonal environment (with large classes, courses on TV, etc.) were explored. Many barriers apparently continued to plague many students as they attempted to progress in the institution. Some students complained about their experiences in certain courses which were prerequisites to their intended majors, but not, in their view, well conceived or relevant to their other interests. Other students were disappointed with the quality of advice which they received from university staff members who were in a position to influence their decisions, such as academic advisors and counselors from various academic and non-academic units within the institution. Other perceived barriers emanated from the financial aids office and the residence halls system among others. Furthermore, students' perceptions of and confrontations with the compounding effects of cultural/ethnic differences and racism would sometimes surface to the extent of revealing certain consequences which might otherwise have gone undetected, though remaining affective and even disorienting for some students.

Principal Observation 9C--Bureaucratic Environment

Some students related experiences, opinions, and perceptions which suggested that they viewed the campus environment as a large bureaucracy in which their interests were either not considered at all or were subjugated to the larger interests of the bureaucratic system itself. For some, the culprit appeared in the form of apparent incompetence of institutional staff personnel, whereas for others it appeared in the form of staff members' doubt about students' abilities or indifference about their development as students.

During the presentations of previous thematic categories, several barriers to student's development in the university's academic and social systems have emerged. For example, Tasha pointed to the lack of attention to insuring that students were made thoroughly aware of the specific content and expectations of various majors as a problem; Roselyn revealed her experience of having been inappropriately scheduled for a sequence of courses which she neither needed nor desired; and Kreisha, among others, cited the problems which she found in her dormitory. As a further example of how these types of problems might continue to affect students' prospects for sustained academic progress, Makeda explained how bad advice about repeating courses impeded her ability to make up for poor performances in two courses. She commented that:

Non Advice

I had zero pointed (failed) a couple of classes last year. And that following term my advisor didn't advise me to repeat those classes right away to get those zero points off my GPA. She just kept having me take more classes, which was just bringing my GPA down because those zero points were still there. I got them off last term (a year later) and my GPA went up. And I just wish I'd done it earlier, if she [had] told me that.

Though competence as an advisor or counselor is apparently important to minority students just as it is for all students, the comments of several students suggests that advisors' confidence in and respect for them is perhaps even more important to many minority students than to others, as the examples of Lora, who confronted a doubting advisor in a pre-professional counselor's office, and Roselyn among others have revealed. Another example was that of Nyla who, after remarking that she seldom turned to advisors

or counselors during her freshman year, and thus was not aware of some crucial information about the academic system or the inappropriateness of some of her actions and strategies relative to her academic development, went on to cite her misgivings about the advising system generally. After her initial remarks the conversation with her went as follows:

Frustrating Experience

Interviewer: You seem to be saying you had had an experience with advising in some way in your freshman year? Was it because you felt you got a bad schedule or bad advice?

Nyla: It wasn't freshman year when it happened. Freshman year I wasn't taking anything too serious anyway. I was in [the] James Madison [Program]. It was my sophomore year and last year.

Interviewer: Was it some bad advice you got or was it the attitude of...

Nyla: Attitudes plus...it was mostly advisors' attitudes and they were negative. Like to say "Do you really think you can handle this major?" Things like that.

Interviewer: That is interesting. You're certainly not the first student who has told me that.

Nyla: It depresses me because when I talk to other blacks, maybe they're in Engineering or something like that -- there's this guy I think (his name). I think -- and they're telling me "you should go see so-and-so." Like they had the advantage of having a minority person advise them. It seemed like they had an edge I never knew. I never took the time to find out either. I didn't know of anybody who was in a position to help me who was a minority that I could go to. So I was on my own more or less.

Interviewer: I don't know if this happened before you got into the Drew Program, the staff can sort of talk to students about virtually anything dealing with the College of Natural Science.

Nyla: My worst experience was with the [Office of the Dean of Student Affairs in the College of Natural Science].

Nyla did not elaborate on the details of this last experience and the conversation turned to the significance of her experiences with advisors in relation to other past experiences of hers.

During students' first two to three years on campus they are usually enrolled in courses which are either general university requirements for graduation or are prerequisites to their intended majors. As has been documented, students often find the quality of many of these courses to be much less than desirable in either the quality of presentation of the material, the course content, or both. Furthermore, some students have suggested, either during the interview or on the questionnaire, that the very design of some of these courses have as one of their primary functions a filtering process which eliminates a certain percentage of students in order to control the number who would proceed on to the upper division in the various majors. Thus many students refer to these courses as "weeder courses." When Latisha was asked to explain what she meant when she referred to "weeder courses" at the university she not only explained what she meant but gave her opinion on why they existed and their consequences for students as well. Latisha stated that:

Defeating Results

Well I just say that most of the classes like your math and I stuff that your college (in which students' prospective majors are found) says you have to have, you know, x number of math classes, accounting and all that. Usually people just don't do well in there. You know, they're usually large classes, on a tape, or TV. It's just not good at all. People usually end up doing bad. Their GPA's are lowered and they're too busy trying to repeat these to ever really get into their college (or major) until after four years are over.

The non-academic factors, such as the dormitory situation and dealings with administrative procedures of the university can often become crucial to students' prospects for continued academic and social advancement as academic factors. Accordingly, when Evan was asked if there were any factors other than motivation which might have affected his initial performances at the university, he immediately responded as follows:

Financial Impediments

Money wise, financial aid was an aggravation. Being from (a Carribean Island), I can't understand why when something is important to you they send it all the way home and they know you have to be in school. That delays your financial assets. And you have to spend time straightening it

out when you shouldn't have had to deal with it. Now they haven't sent my BSL for this year and it may not be here this summer. I work 15 hours a week. I was in the karate club, but I had to drop that because of financial reasons and time.

Thus in the opinion of Evan, his financial problems, which he viewed as resulting from the deficiencies of the financial aids office, directly affected the quality of his non-academic life, which, in turn, could have drastically affected his academic life as well.

As far as the situation in the residence halls is concerned the experience of Nyla, though possibly an extreme example, illustrates the delicate position in which students can find themselves. After Nyla was asked to reflect on her experiences at the university (she was a senior at the time of the interview) and comment on any problems which surfaced, she began to discuss a serious problem with her living arrangements which evidently had a profound impact on her as a person and a student. The ensuing conversation began with the following comments:

Roommate Arrogance

Nyla: I took me practically the whole year to adjust. When I first got there I had a series of roommate problems and my attitude after that was that I did not want to stay. I had wanted to be back home and attend a junior college but my parents made a deal that I would stay for that year and at the end of the year I still didn't want to stay here then I could go home. My first problem with roommates was I was in a triple with these two sophomore white females who had planned to live together the first year they just took it upon themselves to move me out after I went home one weekend. I had not really had problems like that.

Interviewer: Was there any reason that you know of that they did that?

Nyla: Because they didn't want me in the room. They moved me down the hall into this room with a handicapper -- I lived in Case (Hall) -- and they moved me in with a handicapped girl.

Interviewer: What I don't understand is how can two students decide that they're going to move another student out?

Nyla: I wanted to move out of the triple, so we had talked about that already. The thing about it, it was really crooked because the R.A. had to sign the papers and stuff like that. How they got the papers and everything taken care of I

don't know. My mother had to call up here and she and...
I got out of it at least, but it was a bunch of bull.

Interviewer: I imagine so. That just doesn't seem...

Nyla: I was not...it was crooked, it was all crooked.

From there Nyla went on to discuss her adjustment experiences academically.

Principal Observation 9D--Cultural/Racial Oppression

Interviewees from the research sample definitely recognized cultural difference (in terms of minority status and/or gender) and racial ignorance as important factors in determining the quality of their experiences at the university and particularly respective to the science curricula. Furthermore, when students were asked to comment specifically on perceived racism and/or sexism within the institution, students' responses indicated that some detected both subtle and overt forms of racism but that little or no perception of overt sexism was evidenced.

That subtle dimensions of culture and ethnicity do affect the quality of minority students' experiences in a majority institution has been explored in the form of students' responses regarding the structure, content, form/presentation, and instruction found in various courses, their experiences with advisors and other staff personnel, and their experiences in residence halls and other areas of the campus environment. That is, minority status is often a crucial factor in very subtle ways which fall short of what is generally considered to be overt racism. For example, when asked to comment on her thoughts regarding the experiences of minorities and women who studied the sciences, Annette remarked that there is a need for more minorities and women in the science fields and that it was up to them to persist in these areas in order to make things better. Thus Annette apparently viewed the situation as one in which minorities and women needed to become more involved rather than one in which accommodations or changes were needed to attract more of them. However, the responses of Latisha and Patrice suggested that the subtle effects of minority status might deserve some attention. Latisha commented that she became well aware of her minority/female status when she got into class and "there are a lot

of white males" there. According to her, she would sometimes become somewhat intimidated at first by this situation. And as she discussed her experiences in science courses, Patrice observed that as she progressed in them she realized that she would be less able to depend on getting together with other black students as much for support, thus decreasing her opportunities for gaining a more thorough understanding of the course material through collaboration with her cultural peers.

Whereas the experience of Nyla in confronting a difficult situation in the residence halls was not presented as an example of overt racism, Larry described an experience which, in his view, was undoubtedly due to ignorance about social and cultural differences. He gave the following account of what happened:

Roommate Racism

I had problems with my roommates my first year. I was staying with five guys in one room (in the dormitory) and I was the only black. We had racial problems in that room and it really took its toll on me. I really tried to get along. This guy who was from a small town and he was just nervous around blacks. I tried to get along with him and tried to get along with some of the other guys. And they tried but they had problems getting along with blacks. They were intimidated by me. There were a lot of misconceptions, misunderstandings, and they didn't know what blacks were like. And at the same time I think I also had those misunderstandings, but I was more willing to extend an olive branch, more willing to talk to them, trying to learn.

When Larry was asked what he meant when he said they were intimidated by him he responded by stating that:

Racial Ignorance

They would hide their things; they were afraid that I would steal from them. One night my roommate called us all together and told us that he had to leave because he was nervous. He said he came from a small towns with frogs chirping in the background and all this.

Students perception of racism certainly extended beyond the residence halls of the university. For example, when Rachael was asked to comment on whether or not being black in a predominantly white environment had an impact on her motivation or confidence as a student, she responded by stating that:

Lowered Expectations

Yes, but more now (she was in her third year) than in the beginning. Because in the beginning I couldn't see it (racism) like that because during my freshman year I had Drew math; I took minority ATL. I couldn't see it as well as I can now. Now in my classes there aren't a lot of minorities and people look at me like, "What are you doing here?" And even our teachers don't think that we can do it. You know, they'll explain extra if you ask a question.

Thus, although Rachael did not report on any hostile acts of racism she perceived the attitudes of students and the actions of instructors as reflecting a racist demeanor.

Evelyn also made statements to the effect that she perceived a definite attitude of racist leanings among university faculty members and she also gave an example to support her contention. When asked to comment on her thoughts about racism and/or sexism on campus, Evelyn first remarked that she had never experienced discrimination as a result of being female, then explained her perception of racism, and followed that with a personal example. On her perceptions she observed that:

Racial Scrutiny

When you have a white prof and you're a black student in class [professors] not only can physically know you because of your color but once they obtain that eye to eye contact they constantly watch you to see what you do. It seems as though, even though everything is based on your student number, somehow it seems like they know this is the black one and that can become kind of intimidating sometimes.

Evelyn then went on to cite a personal experience of hers with the following discourse:

Unusual Attention

I got to the point where I can work around it. A good example... right now I'm in this dietetics class and it's only about 25 to 30 people in the class and two blacks. It seems that [the instructor] can just point me out. Like on the first test, most people in the class did extremely bad but I did extremely well. It seemed like she knew that right away. And when we took the next test -- it's like I always sit in front of the class to take my exams because I don't want anyone to say "she's cheating." I kind of looked out of the corner of my eye and she was literally standing right there in front of me. And I felt like she's [standing] there watching what I write down wondering whether [I] knew the answers or not. And it seemed that when I looked up at her she would walk away. And so that's how I got that impression.

Evelyn also went on to remark that she definitely believed that there existed a noticeable, apparently cultural, difference between white professors and black students, although not as apparent with all faculty members. According to her **"A lot of professors do it more noticeably probably than they think. It's more like they look and say 'well we wonder if she can do something'?"** An example of what Evelyn was referring to might have occurred in the experience of Regina, an experience which she described as she explained why she decided to switch her major from Computer Science even though she was taking courses in it at the junior level at the time. According to her:

Discouraging Professors

None of the profs in the Computer Science department were encouraging me to try, they were encouraging me to leave. Like one time I had a death in my family and I was out for a long time. And when I came back I was sick as well, but I still tried. I had done five out of 6 programs -- we had to do six to pass the course. And I did like 5 1/2. I did half of the one program. He wouldn't give me a break, you know. He just said you didn't do it and you're flunking. And that was the turning point. And I was like.... Then he didn't even believe I had a death in the family. He said "I don't even know for sure if anyone died." You know, stuff like that.

At a different point in her discussion about racism, Regina described a sequence of events and her perceptions of student relationships in her junior level mathematics course which reveal a lot about the delicate situation of minorities studying mathematics and science. Regina evidently believed that her white peers did not respect her ability because of her ethnicity, as she provided the following details:

Disparaging Disposition

One girl in my [Math] 334 class... and everyday no one would say anything to me. I was the only black person in the class. That was fine with me. I did my work on my own and if they didn't want to speak, fine. And when I suddenly got the second highest test score in the class everyone just suddenly wanted to be my friend. They never said hello to me before. And now they're like "What did you get? What did you get?"... I figured they wanted me to tell them a lower grade than [they received] so they could go "Ha ha, I got higher than you." So I might as well get them frustrated.

And then the other day she (the girl mentioned in the first sentence) comes up to me -- I didn't think she realized what she did but it insulted me. She came up to me and says "Well have you got a job yet? And I said "Yes I got a job." She goes "You do?" And I said "Yes I'll be working at [a major

corporation]." And then she said "Well how did you do that? Through the minority career thing? Because when I went over there (to Placement Services) they (the corporation which hired Regina) weren't hiring." I said "I didn't get my job through the minority career fair." She automatically thought that, because I was black, the only way that I could get a job was through the minority career fair.

Questionnaire Results and Discussion

Based on Table 25 it is interesting to note that, unlike students' opinions on their problems adjusting to the university, when asked to state the major problems that they experienced while acquiring their prerequisite requirements for their major, students overwhelmingly pointed to institutional barriers rather than personal ones (36 of 50 responses). Leading the way were problems due to the quality of advising and/or instruction followed by problems with the courses themselves. Problems related to the students themselves (personal problems) ranking third then study/learning skills/habits, poor academic preparation and the "weed out" feature of the prerequisite courses.

Table 25. Problems Acquiring Prerequisite Requirements

<u>Problem</u>	<u># Responses</u>
Ineffective Advisors and/or Professors (TA's)	21
Courses Not Interesting and/or Poorly Structured	11
Personal Problems	10
Inadequate Study Habits and/or Learning Skills	09
Poor Academic Preparation from High School	05
"Weed-Out" Courses	04
Total	50

Among the students who commented on the advising and/or instruction the following five are representative.

My main problem was my academic advisor. If I could do it all again, I'd never [have] gone to see her. My high school preparation was adequate, but my attitude towards studying (in the beginning) coupled with poor advising affected my G.P.A. at times.

I felt that I was poorly advised by [a student advisor assistance program]. My advisor had me repeating quite a few unnecessary classes that [were] not really needed for my major. Being that I was having trouble in my sciences, I felt that my advisor should have told me about other options that may be available to me. But I don't totally blame her though, and I do take some of the problems that existed. Now I'm in a new major with a new advisor (almost too late for me). I am doing just fine!!

I think there should be more black counselors and advisors for the population on campus. The reason being [that] I feel that the relationship between a black student and black advisor would be a lot better. I think the student would feel less alienated. Also I feel that a black advisor would be a lot more open, honest and caring about the students' academic standing in the university.

I have had problems with the professor. Sometimes I feel they do not have the proper qualifications or [are] not interested in the quality of learning (for the students). Advising has also been a problem.

Many times I ran into TA's who really didn't know their material or didn't really care to help. Some professors were experts in their field but couldn't communicate to an undergraduate audience. The entire Physics Department is a joke, I feel. The independent study classes could offer so much more. I thought they would allow me to explore physics in a way that interested me. HaHa! It is instead a lesson in formula memorizing and quiz taking.

The next two responses speak to the structure of the courses themselves. One is directed at the pace of some courses, along with comments about the inadequacies of prior preparation, and the other at the perceived intent of some courses.

My major problem was trying to understand the material brought to me within the time frame set forth by the instructor. Also, I had, and to some extent still do have, problems taking multiple choice tests. In high school I never received instruction on how to take tests, and high school never taught me how to learn.

I feel that at Michigan State University the majority of prerequisite courses are of the "weed-out" type and I have a real problem with this. It is discouraging, and frustrating, and very expensive and time consuming in the situation of most students. Rather than be of the utmost support to you because the material is abstract, they hinder you by placing you in large classes with foreign professors.

The next two responses are representative of those who perceived lack of support among professors and/or low expectations of some students by faculty/staff members.

I find that teachers [in] my college try to discourage a lot of black students, who have the potential to do extremely well, by cutting them down in classes or not responding to their comments in class itself. Maybe [it is] not as a result of any racial dislike but because of personality limitation on their parts.

The first thing I encountered with the business school when they found out that I was placed in [Math] 082 and not [Math] 108 my first term. They made me talk with a counselor about my career path and tried to talk me out of trying to get into the business school because of my "low aptitude in math". I feel that the Drew Program was a great program, not only because of the personalized class structure but the way that the material is related to practical things. Too bad they don't have more programs like that.

In the final four examples students commented on what they perceived to be general nuisance factors relative to students development at the university and/or they proposed measures that they thought should be taken to assist students with their efforts to survive and progress in the system. The first example is directed at the advising experience as the student pleads for more expertise and concern among advisors themselves:

Experienced Concern

I think students should have assigned advisors with experience in advising the students properly and have these advisors take a little personal attitude towards their students.

The next example addressed the issue of the proper use in instruction as one student advocated the following:

Content-Appropriate Assignments

Reduce or eliminate "unnecessary" homework assignments that can confuse and take up important time that could be used constructively on other problems or other course material.

At least one student commented specifically about and gave her opinion on the language barrier among some foreign teaching assistants when she stated that:

Language Problems

One thing that is very initating was in my organic labs the TA's were foreign and hard to understand. This is also true of my [Math] 108 class in [the] university [section]. That kind of language barrier makes learning that much harder. If I pay for a class I have a right to understand what a TA or professor is saying.

The last example refers to the desire to gain a broader knowledge about courses in relation to the requirements for various majors on campus as the student made the following appeal:

Course Awareness

I wish I would have known earlier on exactly what the courses were like that different majors required. I feel I was lucky in finding something that interested me, but I could have ended up searching for a while.

Summations--Personal and Institutional Barriers and Student Retention Factors

9a. Absence of Concern In Principal Observation 9(i)B the insert (relative to the institutions' character and structure) is in reference to the documented fact that majority higher education institutions do not inherently include considerations for minority student status and these students' particular needs and concerns in the design and operation of their overall academic systems.

9b. Controlling Problems For minority students the critical question seems to be to what extent can their personal problems be controlled or at least dealt with? Furthermore, would it be productive to try to do so?

9c. Making Decisions How to deal with students' inappropriate decision making is another critical question. Should students be "forced" to generally do what is viewed as best for them (e.g. enroll for twelve credits vs. fifteen or sixteen credits, or repeat courses when it is called for) or should this behavior be "induced" through repeated urgings, some form of incentives, or some other way(s)?

9d. Special Measures Whether minority students should be "sheltered" through special sections of introductory courses and other measures to assist them in coping with the environment is an apparent critical questions which also needs to be addressed at majority institutions.

9e. Success Anxiety Regarding Andrew's comment on the pressure to succeed, it has, on several occasions, been observed that students who are overly concerned about succeeding immediately often are unable to make sound judgements about their development as students and/or make steady progress as students until they successfully confront their anxieties.

9f. Minority Advocates The concerns raised by students regarding the curriculum and instruction at the University appear to suggest that the minority question raises serious political questions as well. That is, to what extent should the advocates of minority students fight for changes which they view as essential to minority student development and enhancement?

9g. Repeating Courses Makeda's experience of not repeating courses due to poor advice has also been observed to present problems for students on several occasions. For example, on one occasion a student from the Drew Program was told by an advisor from a different support unit that she should not repeat Math 108 right away and instead take some "easy" courses to bring her G.P.A. up first. However, a Drew Program Staff member happened to intervene just before the consequences of this action materialized and was able to convince the student to repeat the course immediately. Afterwards the student appeared relieved that she followed the latter advice and she was openly appreciative of the staff member's intervention efforts. As a further note on this issue, the importance of students repeating courses which are central to the core foundation needed for students' intended majors is clear.

9h. Critical Advice Generally the importance of quality advising, as with other forms of support services, would certainly seem to be more critical for minority students than for others, due to the myriad of other problems (some due to institutional inadequacies and others due to Students' personal situations) which they confront. This observation in turn, contains implications for other concerns related to efforts to insure sound academic development and enhanced performance among minority students.

9i. Cultural Conflict Students' reference to the "weedout" nature of courses at the university points to one of the fundamental conflicts between minority students and the environment on college campuses. Because students apparently view themselves as clients of the university who expect the institutional processes to be supportive of them, they often exhibit surprise and dismay at finding that this isn't necessarily the case.

9j. Collaborative Opportunities Patrice's view that the relatively small number of black students in her major decreases her opportunities for peer interactions points to the inherent problem which exists when only a few members of a specific ethnic minority group are enrolled in the institution and/or in certain curriculum programs. The fact that student members of these groups might not find interaction with majority group members to be potentially helpful to them would appear to be worthy of further investigation as well.

9k. Opposite Perception The perceived racist attitudes of students and apparently condescending (or patronizing) behaviors of professors by Rachael might be an example of the type of opposing view underlying many disputes which often surface between white Americans and certain minority

groups over the existence of racism. Whereas Rachael, and perhaps many other students, might view what she perceived as clear examples which document institutional racism, many whites might not view them as such in the absence of any hostile actions or malicious intent.

9l. Non-Support Regina's perception of lack of support in an academic unit points to a critical issue for those who are responsible for providing support services for minority students -- to what extent is intervention which involves the environment in, and the functioning of, the various academic units feasible.

9m. The observation of one student that her advisor should have informed her of other options illustrates a potentially critical problem in the advising process of institutions in which the various academic programs function virtually independently and students are urged to choose a specific curriculum path early in their matriculation. Students will likely find it difficult to get a very comprehensive awareness of the variety of choices available to them, thus decreasing the opportunity to find out which path is most suited to their interests and aspirations. This is especially crucial for many students from the target population of this study because of the apparent need to explore for themselves as they grow in and adapt to the campus environment while coming to terms with their own identity in the larger society.

9n. The student who commented about her perception that instructors in her college often discourage black students made an interesting observation when she noted that their actions might have been due to "personality limitations on their parts" as opposed to direct racism. There are at least two noteworthy aspects of this observation. First, if what she has conjectured is true, the outcome is, nevertheless, the same for affected students. Secondly, if limitations on the part of some faculty members prevent them from being able to relate adequately to students from certain groups in society, or to students generally, then this would appear to be a problem which should be addressed institutionally.

9o. The example of the student who experienced a lack of confidence in her ability to pursue a particular major because she began her study of mathematics below the level deemed appropriate again highlights at least two important considerations. First, whenever this attitude prevails it could become a self-fulfilling prophecy in that students might not be supported as they need to be, thus decreasing their opportunities for success. Furthermore, the existence of this attitude among faculty/staff likely prevents those who possess it from adequately exploring effective ways of enhancing the affected students' overall development towards their goals. It should be noted that several students from this study who began their study of mathematics at the level given in this example have gone on to become successful, including gaining admission to medical school or graduate school.

10. A More Mature Perspective and Personal Development

When students enter the university they vary in their outlook and approach towards their situations both personally and academically. Some are exceptionally mature about academic matters from the beginning, whether they are as mature socially or not. Others are not as mature as one would like, neither academically nor socially. However, students definitely grow and develop as they progress through the higher education system (Perry,) and many minority and/or disadvantaged students are able to grow extensively in the environment when provided with appropriate opportunities (Fleming, 1984; Stikes, 1984). From the comments of the interviewees of this study, it was evident that some students' mature outlook on their situations at the university, along with a mature approach to academic matters by some, contributed to or resulted in a more even adaptation to the environment and perhaps their mere survival in the environment in certain cases. Other students were able to develop a more mature perspective over time, especially when they were willing to create opportunities for growth by taking advantage of the resources and opportunities available within the institution.

Principal Observation 10A--Mature Outlook

Some students' appeared to either possess or acquire a philosophical outlook on their situations socially, academically, or both, which significantly exceeded that of their peers in maturity as well as practicality. Apparently this outlook, which was manifested relative to social confrontations in the environment, attitudes towards and dealings with the academic enterprise, and personal dispositions among others, was often responsible for some students being able to experience substantial growth in the environment and correspondingly realize greatly enhanced academic progress.

Kyra's attitude that her classes always came first and Kreisha's ability to seclude herself in the dormitory were previously cited examples of students adapting dispositions and behaviors which probably assisted their efforts academically, though that is certainly not a given. Students in this study often pointed to actions or attitudes which reflected a

"think for yourself" mentality as being a key ingredient in the academic setting. For example, Patrice reported that she finally realized that it was important to do whatever was in her best interest and not pay attention to what others might think. Terri, Annette, and Tiesha expressed similar views on the issue. Terri's position grew out of her experiences of having been instilled with doubts about her ability to handle Math 108 as a result of what others had said about it. She provided the following insight on this concern:

Peer Influence

I learned a lot as far as not listening to other people, like other students, because they'll make you afraid of taking the class as far as saying "oh it's too hard, it's too hard." I learned that you just get in and do the best you can. I knew that from the start but when you start listening to people that are really good in something and they're saying "Oh it's hard, it's hard; a lot of people are failing it. One oh eight is..." What do they say? -- "One oh eight is a weed out class." That sort of makes you think about it -- "Wait a minute, this person got a 4.0 in math in high school and here they're saying it's a weed out class and they're not doing good." But it really depends on the students and I learned that you really don't listen to anybody. Just go in there and do your best.

Annette's comments were partially in reference to the importance of listening to and taking heed of the suggestions of program staff members in order to progress as a student. However, some students apparently find it difficult to think about and follow the dictates of their own situations due to being unduly concerned about "keeping up" with other students. Tiesha found that she was forced to come to grips with this concern and she commented about it as follows:

Self Directed

I think a lot of students come up here thinking that since their friends are taking 15 or 16 credits they should [also]. But I came to realize that I can only take 12 to 14 because I work and because I need the time to really look at the material and go see the teacher. I only can take 12 credits. Taking anatomy and [Math] 290 would be like committing suicide.

Besides peer pressure, students sometimes confront the pressure of trying to live up to the expectations of the significant others in their lives. This situation can apparently lead to their being stifled to the extent of preventing them from sorting out their own feelings and

desires and creatively planning for their futures. Berniece described her experience with this as she revealed that she necessarily needed to confront and deal with it before she could go forward in directing herself towards her own desires. As she put it:

Self Fulfillment

I was living up to everyone else's expectations. [I was] fulfilling my father's dream, and everyone else's. I never stopped to think what I wanted and what I was capable of. I found I really wanted to work with children and there was no need to go through the whole drawn out process [of going to medical school] just to work with children and still not get the interaction I wanted. After looking at various majors I think going into child development, which is a more direct approach. It is not as financially rewarding as medicine but I know it is something I would enjoy doing. It is something I could feel good doing and gain experience now by student teaching or maybe working in a preschool or dayschool. Also the decision of not rushing to get out of school in four years [has helped], and I'll graduate when I'm ready and in a pace that's comfortable. And if someone doesn't like it, too bad.

As far as their academics were concerned, Karla's advise that students must try even though there were no guarantees reflected a kind of mature outlook which has been observed to be absent and/or difficult to come by among many students. An apparently complementary outlook to that of Karla was expressed by Annette when she commented on what, in her opinion, were the keys to a successful transition to university life by stating that:

Initial Patience

Well some things that helped me were patience and also the desire to learn. If you come here and you're not starting out where you want to or expected to, you have to be patient and if you want to learn... In order to go on farther, you've got to start out somewhere. [If] that's where they say you should start out then that's what you have to do. You have to not be -- I don't want to say stubborn but you have to want to do it. What you put into it is what you're going to get out of it, no matter how much you know or how much you don't know.

Annette went on to comment that students need to be honest with themselves first and then decide on what's best for themselves.

As Nyla reported on the outcome from her experience in the dormitory, as cited in the previous section, she revealed an example of the positive result which might materialize

when students attempt to gain something and grow through their experiences regardless of the seemingly initial unfairness of them at times. At the time of the interview Nyla had actually become a resident assistant in the dormitory herself and she credited her previous experience with helping her learn to handle herself in social encounters. As she put it:

Experienced-Based Growth

The reason I think it turned out that way was because after I decided I liked it here I tried to use those experiences to work to my advantage as far as dealing with people. I ended up living in that handicapper suite for about three weeks, close to a month fall term. I had encountered some experiences there. One of the girls was really handicapped bad, and a couple of times something happened and I was the only person there to help her. When I was interviewed -- it wasn't until I was interviewed that I thought about it that way, really in depth, when I was going through the R.A. process and it really could have strengthened me, by going through that.

Lolita also found that she could turn the circumstance of her situation to her advantage and as she discussed her views on this subject she revealed a great deal of insight into some cultural considerations which often affect minorities and perhaps deserve close scrutiny.

Lolita remarked that:

Cultural Strength

I think I've used [minority status] to my advantage. I think being the type of person I am I'm very positive and self-motivated. I think I'm real strong willed and those three characteristics in themselves... any negative experiences that I've had I've turned them around and made them look more positive. I think my faith in God has a lot to do with that. It really does.

It seems as though if you're intelligent, and especially if you can articulate - I guess if you can talk and cross your t's and dot your i's it's like you're a novelty. So many people have come up to me and have said "Oh you'd be ideal in a court room" or "And your friends are articulate too," as if I can't have articulate friends or as if I can't talk like this. But I think it has worked for me and I wouldn't have it any other way. It has been a positive experience.

Lolita went on to reveal that her parents were educated, and that she had attended private schools and grew up in predominantly white neighborhoods, which, according to her, contributed to her being able to cope more easily in a predominantly white environment

than many other minority students. She also related her beliefs about minorities confronting their status in society as well as her insightful observations regarding the capabilities and potential of many from the minority population who might not function as mainstream American would like. According to Lolita:

Cultural Difference

I think in all situations you have to learn how to play the role so to speak. You have to be political. And unfortunately a lot of people who might not have had the experiences that I've had..., of course they're not going to sound like a doggone dictionary -- sometimes I think I sound too formal. But unfortunately it's a disadvantage and I don't think it should be because I think they're just as capable if not more capable than I am. And it's probably only because my parents spent the time to send me to the schools that they did. And also because they are educated people themselves and they talk like this.

Principal Observation 10B--Experiencing Enhancement

Some students discovered a variety of techniques and study strategies to which they attributed their improved academic performance. Although these techniques and strategies demonstrated maturity and insight into how to experience meaningful learning, many of them were basic to the educational enterprise itself. However, the real significance of students' revelations appeared to have been the process involved in their discoveries and the overall impact which these revelations had on students.

As reported in thematic category 8, students often made changes in their habits as they progressed in the campus environment. Most of these changes appeared to occur after students realized that they necessarily needed to find ways of engaging themselves in behaviors which were more appropriate to actually learning rather than simply going through the motions as many students do early in their academic careers. One such example was that of Andrew who discovered the importance of trying to really comprehend course material through improved listening abilities and note taking. The following were his comments in response to being asked about some of the things which he eventually did to improve on his learning:

Attentive Listener

Yes, I do take notes in class, but now in class I have learned to listen and try to understand more. I listen and understand even if I don't get all the notes. I think that's most important. If you just have the notes and take that home and don't understand what you have down, that's defeating the purpose. I believe, if you can, get the understanding in class, plus take notes if possible at the same time. When you go home you'll be much more prepared to do your homework correctly.

Besides in-class engagement, students often found that the extent to which they could control their out-of-class behaviors and find performance enhancing activities and strategies often meant the difference between success and failure. Annette, who had given indications of a mature outlook by remarking that she wanted to study science because she enjoyed exploring things about the human body, mentioned that it had been critical to her that, even as a freshman, she was able to avoid the many distractions of campus life and concentrate on her studies. Melvin and Larry also made remarks which suggested that they too found that their ability to control and creatively use available out-of-class time were important factors which contributed to their academic development and enhanced performance. Patrice and Regina both found that they necessarily needed to discard self defeating habits such as pushing themselves beyond human capacities by continuing to stay up late at night in order to study and forcing things when they weren't getting any positive results. As a consequence of the changes which she made, Patrice concluded that **"I know I do a lot better on tests now if I have a decent amount of rest the night before. I know the things that I have to do to get the grades that I want."** As an example of a student engaging in a performance enhancing out-of-class activity, Makeda reported that she found out from a friend that it was possible to significantly improve one's performance by using university resources beyond those which were included as part of the course requisites. To illustrate her point, she related that during the term of the interview she had checked out a couple of biology books from the library in order to improve her comprehension of photosynthesis.

Lolita and Tiesha gave retrospective descriptions of their actions within, and beliefs about, the academic system which apparently revealed highly mature outlooks borne of practical experiences coupled with in-depth reflections on these experiences. Lolita, who had repeated Math 108, commented on what she learned from the experience when she observed that:

Controlled Persistence

If I had things to do over again I wouldn't have gotten involved as quickly as I did, because at the time I became vice-president of the [Black] Caucus and I was in Ebony Reflections. And Math 108, you need to give it a lot of time, consistent time. And you have to persevere. I don't think I really did that. So I would definitely sit down with my math everyday and go over class notes on a daily basis. And if I had any questions, I'd ask these questions the next day in class. I would also try not to miss any math classes -- I didn't miss that many times but I probably shouldn't have missed any.

Tiesha's revelations about her experience of having sat through some classes from her freshman year again during her sophomore year also brought out many of the subtle factors critical to a meaningful learning process. Tiesha concluded that she had not gained all that she would need in knowledge or skills in these courses before proceeding further. Thus she sat in on them for the learning experience only, with no prospect of being rewarded with a grade. As a result, Tiesha was apparently able to focus in on those critical subtle dimensions of information comprehension and mastery which could conceivably be overlooked by those who are mostly interested in the course grade. When asked to comment on what her experience was like, Tiesha related that:

Self-Rewarding Learning

Usually when you take a class and you're paying for it, you're usually taking it for your major -- just to get it out of the way. But I had to realize this is for my benefit and I could have to use math no matter what, wherever I have to go, whatever subject I may go into. The experience was different because I really wanted to learn. I didn't look at anybody else's grades. I didn't look at anybody; nobody was at my level anyway. Most of them were freshmen. It was just that I looked at the principle. I started all over. I started taking one day at a time, and started going over the information everyday instead of going over it [just on] the day before [an exam]. I started going to the teacher more and whatever picky little things I didn't understand I made sure I cleared that up. I don't care if it was; if it sounded

really silly. Even the silliest thing I picked up on, I made sure I got it answered, because it could affect me on a test. That was the basic thing; I really wanted to learn. It benefitted me to because I felt that I could do [Math] 108 even though I didn't get the grade. It's not on my transcript - a 3.0 or a 3.5 - but I know it's in my mind. I know I can use it. I know that I can do 108 work.

When the investigator in a study of this type is close to the circumstances surrounding its subjects and the context within which they function, he or she is in a position to detect subtle aspects of the subjects' situation which otherwise might have gone unnoticed. So it was with this study in that the investigator personally knew most of the interviewees and other students who participated in the study as first year students. Thus, as the investigation proceeded and students were observed and interacted with during later stages of their academic careers (with some coming at the very end) their growth and development emerged and became evident. Among the observances which were made was the tremendous change in disposition as well as behavior which had occurred among many of the interviewees. Of course the natural maturity of students in the collegiate environment has been noted and thoroughly documented. However, among students from the sample for this study, a sort of transformation had apparently taken place which often appeared to transcend the expected maturity which naturally follows normal growth and development in the collegiate environment. This transformation is described and explored in the next Principal Observation.

Principal Observation 10C--Transformation Experience

As students grew and correspondingly altered their attitudes about, and approaches to, the academic enterprise they were often found to experience a profound transformation in the process. For the students from the population sample of this study (minority and, to varying degrees, educationally disadvantaged) it appeared that this transformation experience was frequently crucial to their academic development and performance enhancement. That is, some students seemed to have found it quite difficult to make substantial and sustained progress as students prior to the experience itself. Among the outcomes of this transformation experience, students were observed as being able to; more creatively confront the

challenges of the academic enterprise, express themselves better (in terms of content as well as articulation), more broadly view their circumstances and alternatives, and establish a belief in themselves and their decision-making abilities in directing their courses of action.

Berniece's discussion about her need to live up to her own expectations rather than those of others, Andrew's admission that he realized that he should have taken advantage of the support made available to him during his freshman year, and Margaret's remarks about how she came to like mathematics and thus put herself into it as a result of having been a student in the Drew Program were among the many examples of changes in disposition, attitude, and behavior which occurred among students as they encountered the environment of the university. Some were extensive as well as substantial. For example, Patrice mentioned several changes in outlook and behavior within one passage of her discussion of what it was like after she "transformed." To summarize; Patrice cited her new found strategy of not unduly pushing herself when she was just not in the mood to study, her termination of so many late night sessions, her realization of just what it takes to get good grades, and her acquired ability to block out the opinions of others as she made her decisions about academic matters. Other students' changes resulted in specific outcomes. For example, Regina mentioned the fact that her change toward taking breaks more often when studying allowed her to see the mistakes in her work more readily.

As cited in the thematic category on confidence and motivation, students most often cited the desire to improve their academic performance as the major reason for the changes in their desire to do those things which would bring about better performance. And while some students could pinpoint the actual time period during which they altered their behaviors and made specific changes, Tiesha was also able to describe what the process of making the decision to alter virtually her entire outlook on her academic situation was like, what lead up to it, what many of the details involved were, and how she felt after deciding to make the necessary dispositional and behavioral changes. To set the stage, Tiesha was in the process of commenting on what happened after she decided to take a university

section of Math 108 after having received a 1.5 grade in the Drew section. She had just mentioned that even though she passed the university section with a 2.0 grade she still felt "incapable of doing math," and she continued by revealing that:

Reality Confrontation

I said, "Since I got a two point let me go on to 109." So I went on to 109 but I was fooling myself because I didn't know the principles of 108 and you need the principles to go on to 109. So it proved itself when I took 109. I couldn't do the math. Even though I was full of the studying I didn't clean up my act; I didn't clean up my studying habits. I didn't go back and look at what was wrong; I was still doing the same. I was still waiting until 9:00 to study; I was still [preparing for exams] on the day before the test. So the same problems kept coming up.

Finally, I got really mad at myself and I had to realize that.... I went to go talk to somebody, which I should have talked to somebody long before. But I would just say "Oh they don't know what they're talking about." So when (one of the Drew Program's Co-Directors) suggested that I start over I was really -- I didn't want to do it but I had to think about [the fact that] this is in my best interest. [It's] not a matter of my taking the credits, paying for them, getting a grade. It's a matter of me learning and getting it in my mind so I can be able to use it in the future. I felt much better because it was less pressure on me too because I wanted to learn.

The desire to learn, as cited by Tiesha, was perhaps the most critical transformation outcome mentioned by several students. For example, Shirley, who was previously quoted about the alterations in her study strategies, included comments about the fact that at first she was just putting in the time to do her homework before deciding to attempt to actually learning the course material. Patrice, who was also previously quoted on this issue, described the torment which she experienced for over two years due to having devoted enormous amounts of time to her studies before she made the behavioral changes needed to begin to really comprehend what she was studying. Similarly, Linda described what it was like to finally find out what it was all about to actually learn the material rather than simply going through the motions of being a student. In each of these instances, as with others, students appeared to have been tremendously relieved that they eventually arrived at the point that they understood learning and how to learn as well as their place in the academic environment.

Once students arrived, so to speak, one outcome was that they often were able to see specific ways in which the "little things" that they did could enhance their own cause. For example, Nyla realized that, among other benefits, studying with others helped her "go and get it done" rather than procrastinate with her work. Other students mentioned factors such as using the textbook appropriately, the effective use of resources, and the strategic use of time when studying. About this last item, Tiesha made the following observations as she described her actions while attempting to really learn mathematics:

Daytime Studying

I think a big factor -- a lot of students don't take for granted is that you should do your homework in the daytime. The best time is the daytime, because if you do it at night you're too tired, it's time for you to go to bed. You need your rest, so it's good that you get your math homework done in the daytime because [the time is there] and if you want to go back to another problem you can always go back to it later. And you will feel better about it and your mind will be concentrated on the work.

Tiesha's conversation then turned to another important outcome factor for students, one which contained elements of the need to become more independent as well as reflection and ponder over the course material in order to allow the principles, concepts, and ideas to really sink in -- in other words, to engage in practices which induce meaningful learning.

Tiesha continued with:

Reflective Concentration

Another thing I found is that I would isolate myself from people, get myself someplace where I could really concentrate. Math is something that you really have to read over and keep looking at and find out what are they asking for specifically. That was one thing I would do. I would always isolate myself from people and try to just figure it out -- what are they really asking about, -- especially on word problems. If you can tackle the word problems, you basically -- I think you can tackle a lot of things.

Tiesha's last statement might have been her most profound in this passage, considering the level at which students must function in order to succeed at doing mathematics word problems and scientific problems generally.

Karla also made some revealing statements on her beliefs on the essential dispositional and behavioral ingredients involved in successfully studying mathematics which reflected a definite mature outlook. When asked to comment on her views about and experiences in mathematics which might apply to being a student generally, Karla had the following to say:

Determined Effort

Students have to realize in math you aren't going to get any more than you give. If you put forth the effort to do well by studying at least two hours a day in math or the sciences, and when you have problems go see a prof or go to a review session, and just give an effort.... If you flunk and you tried, at least you can say you tried and that's a whole other ball game. But that's better than not trying at all. That became clear after [Math] 108 that winter (when she did not pass). After I looked at what I put in and what I got out of it, I realized that to be true. So whenever I get down or lazy I think of that.

Because Karla was in her fourth year as a student she possessed a foundation built upon a great deal of experience to rely on in developing her views. Indeed, it appears that the experiences that students have are critical to their being able to formulate more mature views and outlooks on their situations. Thus the urgency to provide appropriate experiences upon which students can build becomes apparent and evident. If so, many students might more rapidly develop more mature dispositions and more consistently engage in performance enhancing behaviors and gain a more realistic, as well as mature, perceptive on academic matters generally. On the issue of grades, for example, Tiesha, who apparently experienced a certain level of the transformation process sooner and more decisively than many others, indicated the perspective which she had gained as she gave the following response when questioned about how she felt after repeating Math 109 and receiving her new grade:

Self-Fulfilling Reward

I felt good. I felt really good because I deserved that grade. I worked at it and I knew that this is the grade I deserved. I did not deserve a 3.5. I did not deserve a 4.0. But I deserved a 3.0 and I really worked at it. I may have done enough work that a 4.0 person would have done. But no matter what, it wasn't a 2.5, it was a 3.0. I just felt really good about it.

Both Tiesha and Larry made comments which reflected the kind of perspective on their situations and confidence in their abilities which not only demonstrated a high degree of maturity but the kind of outlook on what the results of their efforts should be, which represents a sort of ultimate outlook for students. In response to the investigator's comment that it must have been tough to make the dramatic changes which she had made, especially as soon as she did, Tiesha revealed the following viewpoint:

Transferred Outcomes

Since I've learned how to tackle my math problems, math period, I can apply it to my other classes too. I see my grades going up. Instead of me having 1.5's, now I have 2.5's and 3.5's in my classes. A 2.5 might not seem good to somebody else but coming from a 1.5 it means a lot. Especially now when you're not flunking anything, you're always passing. It... you really feel good about yourself and you really feel that you can accomplish something. I think that's important, to try to solve the problem as early as possible.

Larry's comments revealed a kind of supreme self-confidence in his abilities which, if accurate, probably indicates a status which all students should probably strive to attain as testament to their arrival academically and, at least in part, an ultimate outcome of their transformation. He made the following comments on the results of his having changed his overall approach to confronting the academic environment.

Loftiest Self-Expectations

It's built my confidence where I know eventually I can make it now. Whereas before I felt, well I think I can make it, and well I'm not disciplined and I'll just procrastinate. Now I know I've actually done it; I know I can guarantee myself, if I really stick to it really hard, I know that I can really learn the material. There's nothing wrong with me, and now I know that I shouldn't have any problems. That's the reason why I've got to the point where I at least know that I can make [at least] a 3.0 in every class now. My last couple of years here, that's how I've been doing it; where I would not tolerate anything less than that. And if I just stick to that type of program, and pattern myself like that, and prepare myself, and make a study guide, outline each chapter....

Summations - A More Mature Perspective and Personal Development

10a. Enthusiastic Interviewees As students expounded on their discoveries about the realities of their situations in the environment many exuded

genuine enthusiasm and some were outwardly excited and/or exhilarated about doing so.

10b. Personal Victory As an example of the above observation, Berniece's description of her experience in finally looking at what she really wanted to do appeared to suggest that the experience had released a certain kind of energy which allowed her to set goals personally chosen for herself and then work enthusiastically toward reaching them. Thus the implication for her further development became evident.

10c. Persistent Achiever Annette's comments were certainly borne of experience. She began with Math 082 (which is a remedial course) and never appeared to have any hang-ups about that fact nor doubted her ability to achieve in the environment and reach the goals which she had set for herself. Most likely her subsequent success (she successfully completed two terms of calculus and proceeded to post baccalaureate studies) was aided by her attitude and desire.

10d. Insightful Observation Speaking from the vantage point of a minority person who had been provided with tools necessary for survival in the majority environment, Lolita's observation about the capabilities of others of her cultural heritage not only revealed an apparent mature insight on her part but, if she is accurate, they contain a host of implications for programmers who are concerned about developing the talents of students from diverse backgrounds as well.

10e. Crucial Skill Andrew's discovery of the importance of sound listening skills and a determined effort to comprehend the course material while in class illustrates the kind of skill which is apparently critical to students' performance enhancement. However, the ability to listen well is obviously not easily induced and thus prompting its development among students would apparently pose problems for programmers.

10f. Transformation Inducements Regarding the identified transformation, which in certain instances appeared to resemble that described by Azibo (1983), several questions arise concerning students' academic development. For example, should programmers intentionally attempt to include provisions for inducing the desired transformation among students? If So, how? And what does the literature say about this issue?

10g. Grade Relativeness Tiesha's remarks about her lack of confidence after earning a 2.0 (C) grade in Math 108 points to the relativeness of grades generally. It has been observed that students too often think of grades in absolute terms. Some will overemphasize the importance of consistently earning high grades while others are too quick to accept mediocre grades. In either case students often only think of the quantitative process of arriving at a grade without sufficient attention to the qualitative aspects of them. The likely result is that students will find it difficult to gain a proper perspective about grades relative to their academic situations.

10h. Desire to Learn A concern related to gaining a proper perspective on grades is one regarding students reaching a maturity level at which the desire to learn precedes the desire for good grades. On this issue, Tiesha's

statement that she "wanted to learn" might have been the most profound statement of the study.

10i. Confidence Transition The last comments by Larry in which he revealed that at first he had many doubts about himself and later on he found that he apparently could do whatever he set out to do, probably represents the relative feelings of a large portion of educationally disadvantaged and/or minority students who persist beyond the first two years or so of college. Although Larry's confidence in himself, if accurately reported, is most likely far superior to that of others, a similar kind of dramatic change in disposition has been observed quite often among students from the research population of this study.

11. Advice To New Students

Students' comments about what advice they would give to students who were new to the college environment reveal what they believe to be the critical factors which contribute to students' overall academic success. Furthermore, their retrospective opinions most likely represent views which were arrived at after thoughtful reflection on their mistakes as students as well as those behaviors which they found to have contributed to their progress in the system. Thus the responses of interviewees regarding their advice should provide useful information about important factors in student development generally as well as the academic adaptation process in particular. These responses were found to fall into two categories; those relating to students' dispositions towards their studies, and those which relate to behavioral patterns in the environment. Principal Observation 11A addresses the former whereas Principal Observation 11B addresses the latter.

Principal Observation 11A--Self-Directed Effort

Based on the responses of some interviewees, entering freshmen need to put themselves into their work and give their best effort, become independent in making decisions about their actions, become aware of the nature of the course material, and have confidence in their abilities.

Karla would have students put forth a determined effort by engaging themselves in proper behavioral strategies in the belief that the effort to achieve success is paramount and,

regardless of the initial outcome(s), results will eventually follow. Evelyn concurred with this view as she advised new students to do everything to the best of their abilities.

According to her **"every time you don't work to the best of your ability a goal is not going to be met."** She would further warn students about the potential perils of depending on other students for advice and urge them to be careful about whom they listen to. And Melvin would advise students not to let friends sway them away from their studies when they have work which needs to be done. About the coursework at the university, Tasha observed that students must be aware of the cumulative nature of course material as well as the courses themselves. For example, she pointed out that the material towards the beginning of Math 108 will be found later in the course and, furthermore, the concepts found in courses like Math 108 are also found in higher level mathematics courses as well as in other courses such as Physics. Finally, Kyra made a direct statement about her beliefs about students' abilities and what students themselves should believe as she immediately stated that **"I think the most important thing is that anyone can do math"** upon being asked to what advice she would give to incoming new students.

Principal Observation 11B--Informed Action

Interviewees generally concluded that, in order to promote their academic development as students, new students needed to become familiar with the campus and its resources, become serious students by consistently working on assignments, devote large amounts of time to their work, extend the effort to get questions answered, and employ proper planning for the use of their study time.

When asked to give his opinion about what it is like to come to a large university campus and adjusting to its environment, Melvin gave the following response:

Environmental Familiarity

Well at Michigan State campus is kind of large. In the summer it took me quite a while to get used to where different buildings were, how long it would take me to get from one class to another, and getting used to having a large class compared to high school. You meet a great number of people in

a short period of time. If you're not used to it you might be a little confused the first couple of weeks trying to understand "What should I do?" You probably [should] talk to an upper classman; ask them how they adjusted to certain problems you're facing now.

Thus Melvin would have students become acquainted with the surroundings while seeking out the experiences of those who have gone before them in order to adjust to the situation.

Sean, on the other hand, emphasized the need for students to be serious about their work and be prepared to accept the postponement of certain desires in the interest of academics.

According to him:

Serious Approach

Unless [students] are particularly brilliant or are intent on taking a light load, they're definitely going to have to use some serious study skills. I think that's about the main thing. Some of that other stuff is going to have to wait. If the classes call for [hard work] you've got to do it.

Sean went on to point out that he was not suggesting that students should study as if they were in graduate school but that they should be careful about being serious enough to remain in good standing and progress in the system by doing whatever it takes and not "blowing it off."

The most frequently given advice related to the need for consistency and diligence in study preparations. To begin with, Melvin urged students to be prepared to do their work without the kind of continued prodding from teachers and/or parents which they might have received in the past. As he put it:

Self-Directed Action

[New Students] should probably get into a habit of doing their homework without having the teacher have to check it every day. When you get up here the teachers are not going to ask to check to see if you did your homework or tell you to do this assignment this night.

Lora's advice on this issue was that students should keep up with assignments and study at least two hours per night for each hour of class. Terri concluded that students should begin their preparation for exams in mathematics courses early enough to allow time for sufficient

mastery of the material and Sean would advise students not to procrastinate because otherwise they will find themselves repeating courses unnecessarily.

In addition to being serious and consistent, some students thought that the amount of time which students would devote to academic work was crucial as well. For example, Latisha exhorted students to put in as much time as needed to become successful and not underestimate the academic demands on them at the university. And Terri was quite direct about the need for students to devote time to their studies when she gave the following advice about studying mathematics:

Extended Time

Put in the time. Put in the time. I say that over and over again because, I hate to say.... Like if I stand back and say "Well look at what I could have done if I would have just studied maybe one more hour or something." I hate to do that. But I would say "put in the time 'cause cramming is not good because you're going to have to take the finals and...."

After students have established the proper self induced behaviors and approaches to their work, some interviewees would suggest that they proceed to further solidify their status as students by seeking sound clarifications when questions arise, but the use of sound planning strategies, and by seeking out potentially helpful resources. Levon suggested that students should get questions answered as soon as problems arise or a lack of understanding develops. Similarly, Lora urged new students to immediately ask questions if they do not understand something. About the issue of planning ahead, Terri related her experience of initially studying for exams in different courses one at a time rather than preparing for them simultaneously as an example of the kind of practice which students should avoid. As part of the process of proper planning and organization of the course material, Tasha would have students keep good notes and develop review packets or outlines. Regarding the use of resources, Terri would exhort students to **"get to know the instructors and find out about tutors or group sessions that you can get into."** Melvin concluded that upperclassmen were valuable resources for younger students. As he put it:

Upper-Class Insight

Some of the people that are juniors and senior that I know -- some of the classes that I'm taking -- they can give me some insight on what the class is like, what teachers that are okay to take, and which teachers are more demanding as far as requirements.

Questionnaire Results and Discussion

While making additional comments about their experiences on campus and/or their impressions and opinions of those experiences, several students made comments which were actually directed at students who might be new to the collegiate experience. The following examples are representative of those comments. The first four speak directly to students' disposition to do what it takes to get the work done.

I have learned that it is very important to stay on top of your classes whether they are in the science field or the social science area.

I believe a student [has] to learn to do what he/she should do at the right time. Also a student must want to learn or be taught.

I have learned a great deal of things since I entered MSU in the Fall of '81. Some were good and some were bad. But most of all I learned "not to put off [until] tomorrow what I can do today."

Michigan State is an excellent university but a student must get themselves prepared for studying and working in order to graduate because it is a big school and in order to make it out it will take determination.

The next two examples address the need for aggressiveness in action among students.

The main way to succeed here is to not be afraid or ashamed to get help when it's needed. Talking with counselors, the professors (even when they act like they don't want to be bothered) and keeping up as much as possible.

I couldn't stress it more, you have some very rude, selfish (I've got mine so you try and get yours the best way you can) people around this campus. If you want help or if you want to be informed, you had better be aggressive and go out and seek, because unlike [a well known] cliché "Nothing Comes To Those Who Sit Up (or Sit Down) and Wait."

The following comments were directed at the mechanics of preparing to negotiate through the university's academic system:

Awareness Effort

I think all freshmen need to be told exactly what's ahead of them when they first come, from enrolling to dropping and adding. How many repeat credits they can have, what's expected of them. Everyone should talk to the dean of their college before actually taking [prerequisite courses] for that major or [before] even deciding on that major. I took too many courses that I didn't need. This advice especially goes to first year college students like me.

The comments in the next two examples relate to the minority experience on campus. The first one is addressed to students who might be suspicious of the racial attitudes of faculty/staff members. It contained the following advice:

Beyond Perceptions

To get over [the perception of racism among faculty members] I would encourage all students to kind of view their profs, counselors, etc. with an extremely open attitude. And realize that it is the material [that] you want to understand, the good grade you want to receive, and nothing [else] more or less!

The other student who directed comments at minority students specifically spoke to need for them to assist each other. He stated that:

Cooperative Efforts

Minority students need to communicate amongst each other as far as the different minority tutorial services available. Too many times we tend to become "hard" or selfish" instead of sharing and being just as academically competitive as other racial groups.

The final example points to the need for students to carefully consider the long term consequences of their decisions about majors and curriculum programs at the university. The student who made the comments had made a decision to major in Medical Technology with the idea that the student would actually attend medical school after graduation rather than work in the med tech field. However, at the time of the completion of the questionnaires there was some doubt that this student would realize that goal and the

thought of actually having to pursue a career in med tech appeared not to have been a pleasant one. However, it turned out that the student was eventually able to get accepted into medical school after all. The thoughts of this student were revealed as follows:

Alternate Major

I didn't have too many problems during those [early] years. I'm having problems now. Sometimes I wish I'd majored in Engineering instead of Med. Tech. and applied to medical school with an Engineering major. If you are unsuccessful in being admitted to medical school, [you] can find a job with one of the Engineering companies and have a good salary with benefits. Medical Technology the salary is low and the job is boring. Also, there is little chance for a promotion in Med. Tech.

Summations - Advice to New Students

11a. Cumulative Curriculum Tasha's observation that students need to be aware of the cumulative nature of course material not only addresses the concern for one area of learning skills development among students, it highlights a potential curriculum problem as well. For if, as some student have stated, some entry level courses (e.g. in Chemistry) don't seem to be adequately directed at preparing students for the next level, then students are likely to be placed at a serious disadvantage anyway. Thus, although a student might have attempted to adapt to the need to learn material cumulatively, this effort might not lead to success in certain instances, hence possibly seriously hindering that students' academic development.

11b. Informed Action The advice given that students should see the dean of their college was likely given in consideration of the fact that each college of the university has an office which handles student academic affairs, and it is usually housed under the auspices of the Dean's office. First and second year students often make extensive use of the services of these offices as they plan for their intended major. However, there are no assurances that the personnel in those offices will be able to give advice to students that's tailored to their individual circumstances, especially in situations where students are themselves uncertain about their future intentions.

11c. The last example cited points to the need for creative approaches to view students' situations and exploring various options for accommodating them and their desires/intentions. For it is possible that a substantial portion of the students could benefit from such action.

Answers to Research Questions

Question 1: What are the critical factors in students' academic backgrounds which affect their ability to adapt to the academic demands of the university, especially for the study of mathematics and science?

Regarding the statistical evidence, the strongest individual predictor of students' initial performance at the university was ACT Comprehensive Score (ACTCOM). There was a significant correlation ($p \leq .01$) between ACTCOM and all of the initial performance variables considered (First MTH GRD, First CEM GRD, First Term GPA, Second Term GPA, First Year GPA). High school GPA and ACT Natural Science were good predictors of all but Second Term GPA, ACT Math all but First Chemistry Grade, and MSU Arithmetic Placement Test Scores all but First Chemistry Grade. MSU Math Placement Test Scores was a predictor for only two variables (First CEM GRD and First Term GPA) and MSU Chemistry Placement Test Score was not a predictor for any of them.

Based on students' comments during interviews, there were three factors cited that were found to affect students' academic adaptations at the university; 1) the lack of challenge in the curriculum and instruction of their schools, along with the low level of intensity of the work; 2) the small amount of study time demanded of them outside of school; and 3) the lack of development of appropriate strategies and habits for effective study at the college level. Furthermore, it is likely that many students were affected by all three factors simultaneously and that the interaction effects served to compound the resulting adjustment problems faced by students, thus leading to many of the situations discussed by students in category 2.

Question 2: What do students need to do behaviorally in order to develop the required academic skills for the successful study of mathematics and science at the university?

Correlation coefficients which measured the strength of relationships between the pairs of variables given in hypotheses 46 and 47, indicated that the null hypothesis should be accepted in each case. Thus there was no indication, according to the statistical analyses performed, that students' efforts on individual strategies and sources of assistance were responsible for their performance in mathematics or science courses. Furthermore, correlations between Math GPA/Science GPA and the combined score for effort on study strategies and importance of sources of assistance were not significant, nor was there a significant correlation between students' study time upon completion of the questionnaire and their math or science GPA.

One possible implication of the above findings is that they serve to add credence to the position that performance enhancing behavior is a dynamic process that is not easily separated into component parts. Thus, it is likely that students achieve quality performance as a result of arriving at a set of behavior practices (perhaps through extensive experimentation and/or over an extended period of time) that works for them, and these practices could vary a great deal from student to student, thus further analysis would be needed to delineate and adequately understand them. However, the results from the interviews and questionnaires did provide clear evidence of what students themselves believed about what was important. These results seemed to be grouped into five categories:

- 1) Organization of Course Materials (Study/Learning Skills)
Review/Preview Course Content, Read/Study Textbook, Take and Organize Notes, Use Index Cards, Engage in Specific Study Strategies, Listen Attentively.
- 2) Consistent Effort and Disciplined Approach
Study Everyday, Restrict Non-Academic Activities, Get Proper Rest, Plan and Prepare Properly.

3) **Effective Use of Time**

Study as Soon as Possible After Class, Vary Study Time and/or Courses (more than one per day), Take Breaks, Limit Late Night Sessions, Use Time Wisely on Weekends.

4) **Use of Available Resources**

Attend Instructor's Office Hours, Attend Study Sessions, Ask Questions Often, Seek Outside Assistance when needed, Form Study Groups, Find other Resource Materials, Make use of University Learning Services.

5) **Self-Directed Behavior**

Become Informed about the Environment, Get to Know Key People, Become Sound Decision-Maker.

Question 3: What are the motivational factors which determine (or at least have an influence on) whether students do those things or not? That is, why do some students do them and others do not?

Based on the comments of interviewers it was evident that students' limited self-confidence was a significant factor which often affected their behavior. Many students seemed to have found that, despite their initial efforts in the environment, the pace of progress was much too slow, at least in their view, and they often became quite frustrated. Furthermore, once the initial novelty and excitement of being in a new environment subsided, some students seemed to have found the entire experience to be difficult at best and even depressing, thus further exasperating the situation.

Students' comments about their experiences over the first few terms on campus suggest that positive reinforcement and support in the environment (especially from key staff personnel) was especially helpful to their desire to persist and do well. In view of the findings in the literature, it is likely that their status as minority students in a majority environment contributed to the importance of these factors for students. Encouragement from and the interest of significant others in students' lives (family members, friends, former teachers, etc.) was often crucial as well.

Students were sometimes affected by factors such as the weather, financial aid problems, and roommate problems, as is the case with college students generally. However, when the compounding effect of minority status is taken into account, the situation can become much worse, especially when the problem in question is itself racial or viewed by students as being racial.

There were a number of students from the research sample who appeared not to have been negatively impacted by their minority status nor to have had any serious problems with motivation. That is not to suggest that these students did not confront some of the same obstacles as others, or experience some of the same problems as did others. They simply were able to adjust to the situation more readily and handle situations as they developed. In observing these students, the characteristic that seemed to have been most important among them was that they possessed a sense of being in control of their own destiny and did not view the actions of others (university personnel or other students) as having the kind of impact on them as did some other students. Hence they were not likely to be hindered by the learned helplessness phenomenon in or out of the classroom as some others appeared to have been so affected.

Question 4: What are the self-reported reasons why some students eventually do those things which are necessary when they were not originally doing them? Furthermore, what are the psycho-social dynamics of this transformation process and what are the subsequent effects on students and their academic achievements?

As stated in the presentation of findings for category 8, there was a definite pervasive change in students' habits between their first course and their last one. As students responded to the former question above, the reasons given were often in terms of dispositional outcomes, such as "tired of wasting time." However, it was possible to categorize their responses into four groups; a) the desire to improve their academic

performance; b) the desire to learn more effectively, and/or comprehend course material better; c) the desire to avoid mismanaging (or misusing) time; and d) the desire to reach long term goals, such as attending medical school. It seemed that, in most cases, students simply reached a point where they realized that real changes were necessary if they were going to make significant progress academically at all. For those students who were able to make the desired changes the benefits seemed to have become clear fairly readily and the experience of learning itself became a much more positive experience.

The effects on students upon making desirable behavior changes, and experiencing the transformation process described, were often dramatic, as well as extensive. For some, it seemed that this process included some unpleasant experiences (such as conflicts with others), some profound mistakes in judgement, and significant academic or non-academic setbacks along the way. There were at least four primary outcomes which surfaced:

- 1) Students were able to see specific ways in which the "little things" that they did or specific acts that they undertook could enhance their development and performance as students. For example, some mentioned that they finally clearly understood the importance of asking questions and/or attending instructor's office hours, and therefore were more prone to do so.
- 2) Some students seemed to realize a strong sense of self-fulfillment during the transformation period, which appeared to increase their confidence in their ability to do well while further inducing, or which further induced, performance enhancing behaviors among them.
- 3) As a result of the transformation process, students seemed to be able to more creatively confront the challenges of the academic (as well as non-academic) enterprise, express themselves much better, more broadly view their circumstances and alternatives, and establish a firm belief in themselves and their decision making abilities in effectively directing themselves and their course of action for the future.
- 4) It was evident, based on their responses and comments, that once students experienced the transformation process that led to profound changes in their behaviors, dispositions, habits, and outlooks on their situations, they became much more reflective in their reasoning and developed enhanced approaches to problem solving generally.

Question 5: What are some of the adjustment variables and institutional factors which affect students' ability to grow and develop academically and socially and how do they affect students and their capacity to make sustained progress within the institution?

Student Centered Adjustment Variables

According to students' comments during interviews and their responses on the questionnaire, the following were crucial adjustment variables among students:

- 1) **Study Strategies/Habits and Management of Time** - Whether students engaged in sound strategies and followed appropriate habits or not seemed to be the most compelling factor in their adjustment. And their ability to improve on these over time was apparently most important to their prospects for the kind of academic progress that they needed to experience for future success as well. Their ability to develop appropriate time management skills was also closely aligned to their prospects for real sustained progress.
- 2) **Expectancy Misconceptions** - As explored in category 2, this concern often appeared to have had profound effects on students. Because their expectations were often so out of line with the reality of the campus environment, simply coping with the situation sometimes became virtually unbearable. It seemed that a key development factor among students was whether or not they could successfully confront this matter, either through their own efforts or with assistance from faculty/staff members or friends/significant others.
- 3) **Accepting/Managing Independence** - The ability of students to accept and manage their newly acquired independence in the environment appeared to have been in direct correlation to their successful adjustment to the institution. Based on their comments, students seemed to view the size and complexity of the university as important to this concern.
- 4) **Engagement in Appropriate Behaviors** - Because the students in the research sample came from culturally different environments (note variable 6), they were often unaware of and, perhaps more importantly, seemed to find it difficult to engage in many behavior appropriate actions, that are necessary for success in the overall campus environment as well as in the study of mathematics and science. In the larger environment these would include actions related to interactions with university staff members (e.g. in residence halls), and rapport with classroom instructors. In the study of mathematics and science these would include the engagement in exploration, experimentation and repeated review while studying and reading the textbook, and studying examples while doing homework exercises. Although these latter behaviors actually fall under the category of student strategies/habits and students generally often need to develop a disposition towards them, it is postulated that among many minority students the capacity to actually engage in them prior to experiencing a certain degree of "dispositional transformation" is much more problematic, and that the related cultural dynamic is the primary reason.

- 5) Communication Skills - Students' facility with communication in the spoken and written language surfaced as an important adjustment variable as they commented about their experiences. Not only was it crucial for them to develop the ability to effectively communicate and/or read and study textbooks well, but many students apparently found that they necessarily needed to learn to effectively listen to instructors and others if they were to progress as well.
- 6) Minority Status/Cultural Background - Students' minority status and/or cultural background appeared to affect students on different levels. For some the large impersonal environment and lack of a "personal touch" in the processes of the system was in direct contrast to their previous experiences and real adjustment problems emerged as a result. For others, their status as minority students sometimes appeared as an overriding factor in their encounters with others in the environment, thus tending to create a kind of dissonance that could prevent these encounters from becoming positive events in students' experiences. Consequently, some students were likely to develop negative, or even unhealthy, perceptions of the environment itself, which, in turn, could very well impact negatively on their academic performance.

Institutional Factors

As students attempted to adjust and adapt to the campus environment and its processes, certain characteristics of the institution itself were found to be crucial factors in determining the quality of their experiences. Among the more prominent were the following:

- 1) Initial Encounters - The extent to which the institution had considered the quality of students' initial transitional experiences was apparently important to students from the research sample. When, as some students mentioned, their initial encounters with university staff members were not pleasant, some students became negatively impacted. However, when these encounters were viewed as a friendly and/or supportive, students were more likely to become encouraged and determined to move forward. Thus the importance of the ability or will of the institution to control this aspect of students' adjustment experiences is made evident.
- 2) Impersonal Touch - The size of the institution and its reliance on large lecture classes, classes taught through the use of electronic media (audio tape and TV), the seemingly "weed out" function of introductory courses, and the apparent uncaring and/or non-accommodating attitude of instructors and TA's were evident as being major concerns of students.
- 3) Inadequate Courses - The apparent poor quality of introductory courses, especially in the sciences, at the university affected students on at least two

important levels. First, since students often viewed them negatively, the quality of their initial experiences on campus was likely to have been diminished accordingly. Secondly, these courses were not likely to adequately fulfill the crucial role of facilitating students' academic transition from high school level work to college level work and/or prepare them sufficiently to compete successfully at the next level.

- 4) **Poor Advising** - Along with inadequate courses, students were reportedly often confronted with the problem of a poorly functioning advising system. According to students, not only did they often receive poor advice about academic matters, but the appearance of a condescending, or even racist, attitude among some faculty/staff members served to compound this problem.
- 5) **Non-Academic Concerns** - Students' adjustment to the institution was often impacted by factors such as problems with roommates, financial matters, personal/social problems and adjustments, and the bureaucratic nature of the institution itself. Thus the extent to which these concerns were addressed in the environment was crucial to many of them.
- 6) **Absence of Systematic Development** - The fact that the operations of the academic system of the institution was not centered on identifying and comprehensively addressing students' academic and personal needs appeared to be problematic for many students. Because of its bureaucratic structure and lack of a coherent design for the promotion of student development, students were often left vulnerable in the environment and prone to failure without intense intervention. Again, due to social/cultural factors this concern seems to be much more crucial to ethnic minority students (at least for those groups targeted in the study) than to others.

Question 6: What are some of the significant correlates (both statistically and practically) of student achievement among members of the research sample?

Table 26 shows that students' first term GPA correlated most highly with the other performance variables listed, indicating the importance of students' initial performance to their later success at the university. The MSU Mathematics Placement Test score, the ACT Comprehensive Test score, and the ACT Mathematics test score all were found to correlate highly with the performance variables as well, that is with the exception of TECH GPA. A significant correlation was found between high school GPA and two of the four variables (MTH GPA & SCI GPA) while MSU Chemistry Placement Test score did not correlate with any of them. TECH GPA was arrived at by considering courses, such as those in engineering and business, which are not science courses but are mathematics and/or science

related. It is possible that the courses considered require a diverse set of skills, many of which might be acquired along the way, for high achievement and that students entry profiles are not as important.

When Table 26 is looked at from the point of view of the performance variables, Mathematics GPA stands out as being highly correlated with all of the background variables except MSU Chemistry Placement Test score, and students' Science GPA was found to correlate with all but the Chemistry score as well. Students' GPA thru Math 290 (the Drew Laboratory Pre-Calculus Seminar) was found to be significantly correlated with all but High School GPA and the MSU Chemistry score. Finally, the MSU Chemistry Placement Test score did not correlate significantly with any of the performance variables

Table 26. Performance Variables Correlation Matrix

	<u>MTH 290 GPA</u>	<u>MTH GPA</u>	<u>SCI GPA</u>	<u>TECH GPA</u>
HS GPA	.18	.31**	.31**	.04
ACT M	.24*	.40**	.32*	-.10
ACT C	.42**	.37**	.33*	.03
MSU M	.42**	.29**	.34**	-.07
MSU C	.04	.02	.11	.13
FT GPA	.68**	.65**	.61**	.27*

*Significant for $p < .05$
 **Significant for $p < .01$

Question 7: What are the implications of this study for minority students' educational development and enhancement, overall student academic development, and student assistance and retention programs at past secondary institutions?

Implications related to the above areas of concern are presented in Chapter V.

CHAPTER V

CONCLUSIONS, DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

The conclusions of the study were organized around four broad themes which were derived thorough condensing the eleven thematic categories as presented in Chapter IV. They are concerned with students' adaptations to the campus environment, their academic adaptations and adjustments, their personal development, and their academic development.

The summary discussion was organized around seven categories, primarily in accordance with the ordering of the presentations of Chapter II, but with some realignments made in order to enhance the flow of the discussion. The combination of broad scope, depth, and comprehensiveness of the study demanded that a discussion of it should include an attempt to synthesize the enormous amount of foundational content with the many findings and conclusions which resulted.

Following comments about the relevance of the study to current issues in education, the varied implications of the study are presented according to the areas of concern listed in research question 6. In addition to issues and concerns of special interest to the educational development and enhancement of minority and/or disadvantaged students, several implications important to the educational process generally were presented. Similarly, the recommendations, includes several which are directed at overall curriculum innovation, delivery of instruction, and student development, as well as those which are of more specific concern to the focus of the study--minority students' educational development and performance enhancement in mathematics and science.

Conclusions of the Study

Because the results of this study were arrived at principally through the use of subjective quantitative information, although with the assistance of Quantitative analyses, the conclusions themselves are often based on subjective interpretations. However, every attempt was made, both in the compilation of the information and in the subsequent analysis of and reporting on it, to accurately sort out students' responses for factual evidence. In some instances a large percentage of the sample made the same or similar comments on particular items of concern, whereas in other instances, a smaller proportion of the total sample made any comment at all on particular items. In either case, the conclusions reported here were drawn only after careful scrutinization of all available information and data.

Students' Environmental Adaptations and Personal Adjustments

1. Students from the research sample were very much unaware of the culture of the college environment. Furthermore students' low expectation of what would be expected of them, coupled with their low initial confidence (apparently often due to assumptions about their minority status) made their adaptation to the college environment difficult.
2. Students were generally unaware of the need to exercise close control of the use of their time and establish a disciplined approach to their daily functioning in the environment. Thus they often found it difficult to accept the responsibilities which corresponded to their newly acquired independence and they decreased their opportunities for initial personal growth as a result.
3. Students perceived their minority status as a liability in the environment, primarily due to cultural differences between themselves and the majority campus population. Consequently, negative encounters in the environment tended to adversely affect their adaptation to it more dramatically than otherwise might have been the case.
4. Students apparently needed a great deal of encouragement from those in positions of authority in the institution, especially staff personnel within the academic structure. Encouragement from significant others in their lives was also found to be critical to students as well, especially in instances where students were depressed over their situations in the environment.

5. Students' initial motivation, if any, was most likely due to the novelty of the situation in which they found themselves. Perhaps due to this fact, along with the stress of college life and their minority status, a definite pattern of decreasing motivation over the course of the academic year was found to exist among students in the study.

Students' Academic Adaptations and Adjustments

1. Upon entry students possessed a host of academic skills deficiencies which contributed heavily to their academic adjustment problems. They were primarily due to irrelevant and/or non-challenging pre-college educational experiences. These deficiencies, along with students' unawareness of the academic demands of the college experience, resulted in exceedingly low expectations of the behavioral requirements for academic success. On the other hand, students had unrealistic expectations of the extent to which institutional staff would consider their needs and make provisions for meeting them.

2. Students' initial encounters with and experiences in the academic system of the institution were critical to their prospects for successful adaptation.

3. The perceived poor quality of academic advising was seen by students as being especially problematic to their academic adjustments.

4. As a result of prior experiences students had little awareness of the real learning experience. Consequently, they would not accept the need for certain sustained behavioral efforts to develop needed cognitive abilities and skills.

5. Of all the factors that impacted students' ability to adapt academically, perhaps none were more crucial than the extent to which introductory courses were designed to foster their transition to successfully competing at the college level. This is especially important if the proposition that academic enhancement efforts are most effective when integrated into and/or coordinated with the course offerings is accepted.

6. Grades were the primary motivation for students' efforts toward their academic work. Thus, until they gain a more mature outlook, the prospect of simply making progress in the system, instead of quickly earning high grades, was not a very strong motivator for students.

Students/Personal Development and Institutional Factors

1. The bureaucratic structure and impersonal atmosphere of the campus were seen as barriers to their progress in the system by students. Furthermore, interactions with university faculty/staff were often viewed as hinderances rather than as helpers.
2. For minority students it is evident that the extent to which the social/cultural backgrounds can become "connected to" their campus experiences is a crucial factor which impacts their ability to experience high quality transitions in the environment.
3. Students perceived a lack of consideration and respect for cultural differences on the part of faculty/staff of the university. Thus their ability to adjust and function successfully in the environment in spite of this situation was apparently a significant factor in their prospects for sustained personal growth.
4. Students' outlook on their situations and their ability to become self-directed in their actions were critical to determining the extent to which they would realize substantial growth and maturity in the environment. Furthermore, some students were found to necessarily need to experience a form of psychological transformation process before they were able to function as demanded in the environment.
5. Students perceived a definite pattern of racism in the institution, both in and out of the classroom. Racism was seen as being manifested in both attitude and action by the majority population in the view of some students.

Students' Academic Development and Performance Outcomes

A. General

1. There existed definite requisite patterns of behavior and ways of approaching the academic experience in order for students to progress in their studies. These included effective time management, consistency in effort, review and preview of course material, organization of information, and variability in study schedule.
2. Students needed to internalize the need for using sound study/learning skills and engaging in the above performance enhancing behaviors and efforts before they could make sustained progress as students. That is, they could not simply go through the motions of behaving in certain ways primarily due to external inducements, or conduct themselves as in the past if they were to experience substantial academic growth.
3. Students were generally not aware of, and often found it difficult to internalize, the need to exercise prudent and thoughtful judgement about decisions regarding their academic development.
4. Definite psychological barriers to behavioral alterations existed at significant levels among students. Awareness among students, or prodding from others often

did not result in substantial and sustained behavioral changes prior to students' having experienced a sequence of academic setbacks and even painful episodes.

5. Students, for the most part, perceived academic support personnel of the university, such as academic advisors and counsellors, to be generally incompetent at meeting their needs, especially regarding cultural considerations.

B. Mathematics

1. Students' opinions and attitudes about their initial status in mathematics was crucial to the quality of their early experiences with studying it.

2. The need for consistency in study habits and the development of desirable study skills was especially important among students in this study.

3. In order to progress in the study of mathematics, students apparently need to engage in particular practices such as note taking, early and often review and preview of the course material, listening carefully while in class, organizing the course material, and attending instructors' office hours. Certain practices, such as collaboration with others, further enhances students' prospects for substantial progress and growth.

4. The structure of the academic system in which mathematics courses are taught had a profound impact on students' ability to achieve and grow academically. Quality personal attention from instructor and teaching assistants was found to be particularly important to students from the study.

5. For many students calculus seemed so different from their previous mathematics courses that adapting to studying it became much more difficult than in the usual progression from one mathematics course to the next one. Thus, the transition to successful performance was often achieved only after students experienced a determined effort to arrive at performance inducing behaviors and strategies.

6. Based on the remarks of many students, intervention efforts, such as the Drew program's Math 290 course, facilitated the transition to calculus but it did not eliminate the need for continued diligence on their part if they were to succeed in studying it.

7. Students found that specific behaviors, such as engaging in dialogue with other students, attending instructors' office hours, and reading and carefully studying the textbook for comprehension of ideas, were not only desirable but practically essential for success in calculus.

C. Science

1. The impersonal structure of science courses, especially at the introductory levels, was the principal concern of students regarding their study of science. Correspondingly, the lack of provision students' academic development was

pervasive. Chemistry on tape was a primary culprit, with TV classes and the self-instruction format in some courses following as undesirable.

2. Students perceived the content of science courses to be unnecessarily abstract and difficult for them to relate to it. The extent to which this perception was culturally based was unclear.

3. The classroom instruction in science courses was perceived to be woefully inadequate among students. Furthermore, the instruction and content of courses often did not adequately facilitate students' transitions from one course or level to the next one in students' curriculum programs.

D. Learning and Problem Solving

1. Students, for the most part, needed to learn how to learn within the academic system. The process involved a host of adaptive behaviors and dispositional adjustments along with a consistent effort over a substantial period of time (often two year or more) was required. Patience and a willingness to explore and experiment with ideas and suggestions appeared to be key concomitant factors.

2. Due to cultural factors and the educationally disadvantaged backgrounds of many students, the emotional elements involved in the students' adaptation to the process of the real learning experience was especially critical to the students in this study. Very often a consequence was that students would actively resist the very measures, such as review sessions and problem-solving enhancement activities, which were intended to assist them with the development of sound learning and problem-solving skills.

3. Once students actively engaged themselves in performance enhancing behaviors the benefits were often not only substantial but even dramatic.

4. Although students often recognized that they found it difficult to alter their behavior/study patterns, they generally could not determine, in retrospect, why this was so. Furthermore, when they made needed changes there were no observable set of specific events or circumstances which prompted these decisions, other than the more ominous factors such as natural maturation and/or the strong desire to improve course grades.

5. A mature approach was found to be important to the development of improved study/learning skills. Students reported that as they adopted certain patterns of behavior, such as getting adequate rest, they were able to progress more evenly.

6. Just as with personal development generally, many students needed to experience a form of transformation process before they were able to adapt their behaviors and academic approaches to the realities of functioning successfully in the institution.

Summary Discussion

Minority Students' Previous Experiences

The lack of connectedness between students' previous in-school and out-of-school experiences (Dewey, 1938, Phillips, 1978), most likely restricted the quality of the learning experience for students included in this study, thus contributing to the existence of academic skills deficiencies among them. Furthermore, the extent to which students were implicated in the processes and curricula schools (Morris, 1966, Butler, 1966), was questionable at best. The quality of or even existence of extra-curricular in-school activities which would allow students to "release subjectivity" (Morris, 1966), as well as the quality of their "excursions and projects beyond the walls of the school" (Butler, 1966, p. 119) most likely affected students' capacity for self-expressions. And students' report of a lack of challenge at their high schools corresponds to the findings of Malcolm, et al. (1976) who noted that minority female scientists had listed this fact as a principal barrier to their advancement in college.

Students' comments about their previous experiences gave no indication of any problem posing emphasis in the curriculum and instruction of the schools which they attended. Thus students were likely to have been denied the opportunity to engage in a transforming educational experience as advocated by Freire (1970) for those who have been socially or culturally oppressed. Consequently their prospects for even personal and academic development once on campus was likely affected as well.

The dynamics of culture were found to be critical and pervasive throughout the study. Students' comments suggested that virtually from the moment that they arrived on campus they harbored feelings of hostility or conflict (Smith, 1980). Yet if Sue (1981) was correct in his position, when minority students attempted to adjust to the majority culture they were likely to experience a kind of ambivalence which could result in further internal conflict. The key to this process is that the majority culture in this instance is the dominant

culture of a society within which blacks and other minority groups have been culturally oppressed. However, within majority institutions, no evidence was found to suggest that the academic processes of these institutions either dynamically considered the consequences of social/cultural oppression, such as the lack of opportunity for creative decision-making in minority communities (Norman & Atlas, 1978), or the need to consider cultural relevance, as explored by Cole & Brunner (1971).

The effects of cultural oppression was evident in other ways as well. For example, students in this study experienced a great deal of difficulty with the comprehension of language in their academic pursuits. Bradley (1984), Cuevas (1984) and Moore (1982), among others have documented the problems which many minorities have with language acquisition and interpretation, especially in academic settings. Compounding the problems for minorities is the fact that attention to cognitive style preferences, as explored by Kornbluth & Saban (1982), Cohen (1969), and Valverde (1984), is apparently rarely given in the academic processes of majority institutions. This situation is especially critical relative to the study of mathematics and science due to the highly analytical nature of the disciplines in these areas and the need for students to express themselves creatively as well as perform from a field-independent posture. Furthermore, differences in life experiences, such as that which results from the reality of life in black communities, in which the virtues found to be conducive to studying the sciences are often contradictory to functioning in those communities (Young, 1981), would apparently exacerbate the situation as well. The effects of gender experiences for females and (Wolfe, Pedro, Becker, & Fennema, 1980) should also be considered.

Learning and Problem Solving

The fact that students were found to be woefully unaware of what a real learning experience was like, or of the need to become self-directed in the environment in order to promote their academic development, was in direct contrast to Klausmeier's (1975)

assertion that valuing one's independence and autonomy is important. That learning further demands an inclination towards decision and selection, and experimentation (Butler, 1966) should be viewed in light of the finding of Norman & Atlas (1978) regarding the diminished opportunity for this activity among many minority group members, as well as the field-dependent cognitive style preference of many minorities (Valverde, 1984). This is especially crucial in light of the finding of this study that culturally related emotions of students significantly affected them as they attempted to adapt to the academic learning skills demands of the institution.

Concomitant to students' needs to learn how to learn, was their need to develop sound problem solving skills and capabilities. In addition to Bayles' (1966) attention to the need for reflective thinking, a key ingredient was the degree of students' disposition toward self-direction, or as Anderson (1980) described it, "internal locus of evaluation." Furthermore, Anderson's conclusion that being "in touch with [one's] own feelings and thoughts" and the desire "to shape [one's] own environment rather than allow [oneself] to be shaped by it (p. 124)," and Terman's (1956) finding that productive gifted children were free from feelings of inferiority, are especially crucial to minority populations in which the effects of oppression often inhibit the ability to develop these attributes. Finally, students' resistance to efforts to assist them with their ability to develop their problem solving capabilities, as discussed by Brouwer (1984), apparently affected some students to the extent that they needed to experience a form of profound transformation (similar to, for example, that explored by Azibo (1983) and Cross (1973) prior to any sustained progress toward becoming the kind of problem-solvers which they are apparently capable of becoming.

Adaptations to the Institutional Environment and Student Maturation

The results of this study lead to the conclusions that students from the research sample of this study were generally unaware of and ignorant about the culture of the

(predominantly white) college campus, tended to perceive the campus as a hostile environment, had low initial expectations of themselves, perceived their minority status (or cultural difference) as a liability rather than an asset, needed strong encouragement from academic personnel and significant others in their lives, and found that their motivation toward functioning in the environment decreased over the course of their first year on campus. That students were experiencing more problems adapting to the campus environment in general during the eighties than they were during the seventies was documented by Koplik & DeVito (1976). Among minority students the situation has apparently been exacerbated by the difference in expectations between minority students and university staff (Gibbs, 1973), the hostile perception of society and lack of self-disclosure among students (Stikes, 1978; Jones, 1979; White, 1984), subtle discrimination and racism (Smith, 1979; Webster, Sedlacek, & Miyares, 1979), student alienation (Suen, 1983), and a shortage of advocates for students (Taylor, 1978). Consequently, many minority students experienced cultural conflict which further renders their adaptation to the campus environment difficult (Maestras, 1977; Gibbs, 1974).

Gibson (1973) and Jackson (1978) were able to identify factors which contributed to the successful adaptation of minority students despite the barriers confronted. Gibson concluded that successful adaptors had two of the following; prior friendships with black students at the university, high school friendships or experiences with white peers, strong self-images, or positive attitudes about the institution. And Jackson found that students needed to identify with institutional resources intended to assist them and become involved in the environmental processes in order to reduce the perception of a hostile environment. Thus these findings suggest that minority students need to either possess a strong personality profile (which would permit them to assert themselves in the environment) or find accommodating experiences as a prerequisite to successful adaptation

Academic Adjustments and Transitions

Regarding academic adaptations, the students included in this study were found to not only possess a host of academic skills deficiencies but had unreasonable expectations of the extent to which the staff of the university would assist them as well. This combination often led to extremely frustrating initial experiences and low initial achievement among students, which, based on the findings of Griffore & Griffore (1982) probably exacted a heavy toll on their self-concept and on their confidence in their ability to control their academic success. Thus, Scott (1981) and Hardeman (1983) asserted the urgency of the need for faculty and staff members at predominantly white institutions to consider the culturally based motivational and development concerns of minority students in the academic processes of these institutions.

Maxwell (1979) and McDermott, et al.(1980) concluded that majority institutions generally do not meet the academic need of minority students very well. And Fleming (1984) found general feelings of dissatisfaction among black students, which they often attributed to "a lack of institutional support, negative interactions with instructors, and feelings of abandonment (p. 167). Thus the positions of Scott (1981), Cohen (1969), Gordon (1976), and Neame & Powis (1981), which essentially suggest that success among students is dependent on mediating factors such as motivation and personal support, become crucial considerations for minority students' academic adjustments.

Among the specific barriers to students' academic adaptations explored in the literature and which were detected to one degree or another from the results of this study were; interpersonal skills deficiencies (Sedlacek & Brooks, 1976), motivation, language, inappropriate view of education, and unreasonable optimism about potential success (Stikes, 1984), and psychological restraints, such as those related to the learned helplessness phenomenon (Mark, 1983). The findings of Mingo (1984) and Kulik, et al.(1983), that special programs to assist disadvantaged students with their initial adjustments and academic development were found to be effective during the early years of

their existence but soon faltered, suggests that finding long term solutions, especially in the mathematics and the sciences will be difficult to say the least.

As far as students' adaptation to the study of mathematics is concerned, Edge & Friedberg's (1984) assertion that psychological factors affect students' ability to adjust to the study of mathematics (such as current findings that students' attitudes about their initial status in mathematics courses affected their behavioral dispositions) and Treisman's (1985) findings that the separation between black students' school lives and social lives, their lack of adequate study time, their insufficient collaboration with each other, and their insufficient use of support services were barriers to adaptation were especially relevant to the findings of this study. And students' complaints about the impersonal structure of introductory science course and the poor quality of instruction most likely could have been addressed through attention to some of the many measures discussed in Chapter II (and noted later in this chapter) which were intended to assist students with their development of the prerequisite cognitive skills needed by students.

Students' Personal and Academic Development

The results of this study indicated that students that the structure of the university was unreasonably bureaucratic and the environmental atmosphere was unjustifiably impersonal, that there existed an unexcusable lack of consideration and respect for cultural differences in the university's functioning, that both overt and subtle racism permeated the campus environment, and that the academic support personnel of the university were incompetent at meeting their needs. Other findings relative to students' personal and academic development included the following; students' dispositions about and outlook towards their status and circumstances in the environment greatly affected their potential for growth, there were definite patterns of behavior demanded of students if they were to grow as students, definite psychological barriers existed among students which impeded their ability to exhibit the required behaviors, and many students needed to experience a major

transformation in their dispositions and outlooks prior to realizing significant and sustained development and advancement as students.

Perry (1968) was able to characterize the nature of students' growth in the college environment, thus, in effect, further evidencing students' potential for growth. Stikes (1984) concluded that, among black students at a majority midwestern university whose experiences he investigated, "most students seemed to manifest potential for growth, and those who grew significantly improved their academic achievement (p. 58)," thus pointing to a positive correlation between personal and academic growth among black students. Fleming (1984) placed specific conditions on black students' potential for academic growth when she claimed that her study confirmed the premise that interpersonal support is essential for cognitive growth. Hence the finding that the students in this study found institutional support to be lacking becomes a crucial one.

Students' concern about the institutions' consideration or lack of consideration for their cultural preferences is also apparently more crucial than might initially appear in light of several of the positions taken by authors cited in this study. For example, Sedlacek & Webster (1977), Boyd (1981), and Smith (1981), were among those who concluded, in one form or another, that the overall quality of students' personal and academic experiences in the environment had a tremendous impact on their potential for academic growth. More specifically, Maxwell (1979) and Witkin (1976) pointed to cognitive style preference as a culturally determined aspect of students' disposition which deserves attention, while Cole (1976), Gordon (1976), and Cohen (1976) suggested that desired cognitive abilities can be induced among students. And Scott (1981) and Pelz (1976) proposed specific ways in which students' academic experiences could become enhanced by considering cultural dynamics. Similarly, Stikes (1984) asserted the position that education needs to relate more to the lives of students in order to promote their academic growth.

Trujillo's (1984) finding that some instructors reacted differently towards minority students than they did towards majority students in the classroom corresponds to the

perception of racism in the classroom among students in this study, thus negatively impacting the quality of their academic experiences. And Burrell & Trombley's (1983) finding that minority students preferred minority advisors is most likely related to the finding of this study that students perceived the academic support personnel of the university to be incapable of meeting their needs.

That students' outlook on their situation in the environment was found to be important to their potential for personal and academic growth suggests that counselors, advisors, and even classroom instructors would necessarily need to consider this important concern in order to enhance the quality of minority students' experiences--something which would seem probable only in majority institutions in which the commitment to minority students' advancement is exceptionally strong. An apparently concomitant finding was that specific patterns of behavior were required of students for academic progress in mathematics and the sciences regardless of their background preparations and entering profile. That is, students who possessed more impressive entry profiles, as well as those who did not, needed to attend to the requisite study and behavioral patterns if they were to succeed. Of course, the fact that all of the students in the study had participated in a special program could partially account for this finding since an inherent purpose of special programs, if they are to be successful, is to assist those who have deficiencies to overcome them and progress in the system. Johnson (1984) found that almost half of the persisters in a special program which he investigated were from the lowest SAT and ACT groups, suggesting that other mediating factors (perhaps motivational and/or behavioral in nature) were more crucial. A potential implication is that the conclusion by Braddock II & Dawkins (1981), that predicting black students' academic achievement at predominantly white institutions is problematic, could very well have been the result of their investigation's inattention to students' actual behavior patterns as they approached their academic pursuits.

When the finding that certain behavior patterns are required for sustained academic growth is considered in conjunction with the finding that certain psychological barriers to exhibiting certain behaviors often existed among students, it is apparent that serious implications emerge. For example, the implied difficulty in addressing the problems inherent in the conclusion reached by Hudesman, et al. (1985), that disadvantaged students need to change their orientation toward internal locus of control and develop improved management skills, is made clear. Perhaps close attention to the cultural dimensions of behavior as explored by de Charms (1982) and additional practical information gained from investigations into personal causation, such as those by Azibo (1983) and Parham & Helms (1985) are needed in order to design methods of inducing the kind of dispositional transformation which many students apparently need to experience before they are able to function behaviorally as they should.

Math/Science Performance Enhancement

Students in this study concluded that consistency in study habits and the adoption of specific study practices were essential if they were to progress in their study of mathematics and science. Indeed, Johnson (1981) found that students' amount of engaged time (e.g. acute attention to and active involvement with classroom presentations) and their perceptions of it were positively correlated with achievement in science courses. However, as Lin (1982) and DeBoer (1985) found, students are not necessarily inclined to conduct themselves in a manner which leads to either productive learning or academic growth. Among black students studying mathematics, Treisman's (1985) finding that they were not availing themselves of institutional resources such as free tutoring and teaching assistants' office hours points to the seriousness of the situation regarding their capability for advancement in the system. Furthermore, the conclusion of Wollman & Lawrenz (1984) that math ability is a good predictor of achievement among physics students as well as that of Atwater and Simpson and SAT-M was a significant predictor of achievement for

successful students in a special engineering program provides strong evidence that students' behavior in and approach toward studying mathematics could have a profound and pervasive effect on them as students in the system.

The extent of students' capability to function as they should for substantial and sustained growth has been found to be affected by various phenomenon as explored in Chapter II. The fear of success (Canavan-Gumpert, Garner, & Gumpert (1978); Fleming (1984), which, for minority students, is likely to be made more complex by the existence of culturally related behavioral barriers; science and mathematics anxiety (Greenburg & Mallow, 1982; Frankenstein, 1982), which are evidenced by, for example, students' fear of making mistakes; time management anxiety (Strang, 1981); and learned helplessness (Mark, 1983) were explored as potentially affecting students as they attempt to reach their academic goals. For minority students studying mathematics and science the effect of these barriers are likely to be compounded by cultural conflicts which can arise when they attempt to pursue an area of study for which the traditional academic processes are often contrary to or in conflict with their prior experiences in society (Young, 1981; Watson, 1977; Maestras, 1977; Smith, 1980). That the consequences of these debilitating phenomenon can become critical to the prospects for students' advancement in the sciences was evidenced by DeBoer (1984) when he concluded that the intention of science students to continue with science courses was directly related to the attribution to ability (as considered in the learned helplessness phenomenon) but not to gender, math aptitude, or performance in initial science courses.

The structure and functioning of the academic system in mathematics and science at the university were perceived to be seriously deficient in meeting the needs of students in this study. That is, other than occasional specific instances in which individual faculty or staff members (outside of the Drew Program) assisted them, students not only did not report many favorable opinions about the system and its functioning but their comments, whether solicited or unsolicited, were overwhelmingly unfavorable. Thus they did not

view the system as one which promoted their growth, and consequently their performance enhancement. Perhaps attention to and consideration of Page's (1984) call for approaching the situation from the students' point of view and having instructors make cultural considerations in order to meet the needs of a diverse student population could very well begin to address this problem. Or perhaps other measures, such as Covington & Tiballi's (1982) recommendation on applying Bloom's Taxonomy of Educational objectives in developmental mathematics courses or the use of writing assignments as proposed by Keith & Keith (1985) could prove helpful. Page's (1984) small group strategy is one example of how one might organize the mathematics classroom for more effectiveness. In the sciences, Kolz & Snyder's (1982) efforts to increase students' amount of time engaged in "real learning" in a chemistry class and Brouwer's (1984) problem-posing model of instruction in a physics course are two examples of efforts to assist students with their comprehension of the material. It is quite probable that, had students been exposed to serious efforts to meet their needs through the use of some combination of the various enhancement measures presented here they would have had more positive comments to make about their experiences in science courses, due to having experienced more enhanced academic progress.

Perhaps the clearest indications of the extent to which students' performance in mathematics and science-based programs of study have come from reports on the effects of special programs in mathematics, science engineering. In mathematics (Treisman, 1983) Math Workshop, which featured student centered work sessions for calculus students along with a variety of student support efforts, and (Goonsler, 1983) Quasi Modular Approach, which featured student tailored instructional and curriculum initiatives were prominent examples. And of course, the mathematics component of the Drew Laboratory, as described and explored extensively in this study is an example of a comprehensive effort to not only meet the needs of enrolled students, but also to continue to push forward in understanding the complex set of interacting factors which contribute to and/or affect the

problem of minority underrepresentation in mathematics and mathematics based disciplines, thus providing additional information to be used in further enhancing programmatic efforts.

Comprehensive, integrated special assistance programs in the sciences have not been found to be as prevalent as those in engineering. Rather, separate efforts in the various disciplines, as mentioned earlier in this discussion, seem to be the norm. However, (McDermott, et al., 1980) did report on an integrated effort, based in physics, but which employed interdisciplinary courses small classes, tutorials, and close monitoring of enrolled students. Regarding the overall concern for providing performance enhancement strategies for black students, (McBay, 1978) concluded that summer programs, learning resource centers, seminars, and small classes, were among the strategies which had been found to be successful at certain predominantly black institutions. Accordingly, a summer health careers program, which featured a preceptorship with local physicians, was reported on by (McGinnis, 1977), and an undergraduate research training program, which featured laboratory research and participation in a variety of seminars, was reported on by (Hamilton, 1977).

As was pointed out earlier, special student enhancement programs in engineering have proliferated over the years to a much greater extent than those in the sciences or mathematics. (Landis, 1985) was able to identify several broad features of successful programs, including comprehensiveness, being based in an academic unit, and a problem solving approach. Gordon (1975) explored more specific student academic development concerns and Williams (1981) and Coles (1983) were able to identify more specific factors with enhanced overall programmatic efforts, with Williams concluding that an active involvement in the academic processes was important and Coles finding a sound tutorial component to be significant. Among purportedly successful efforts were academic year programs reported on by Wine and Cooper (1985) and Bronery (1981), and summer enrichment programs reported on by Richards et al. (1981) and Carey, et al. (1991).

Relevance of the Study

As the study developed it became apparent that, due to the changing dynamics of educational issues in this country, the study's relevance extended significantly beyond the scope which was originally envisioned. At the present time this country is witnessing a fervent rebirth of interest in improving the quality of education for its youth, especially in the sciences and mathematics. One consequence of this state of affairs is that increased attention is being directed at program and educational processes which were originally designed for disadvantaged populations of society. Furthermore, interest in broad investigations which are directed at students' academic development while in progress seems to be on the rise as well.

Relevance to Minority Students' Educational Development

1. Partially as a result of the effort to gain a thorough understanding of the background to the problem of the study, the results and outcomes of the study have contributed to a more in-depth understanding of the issues and concerns related to minority students' preparation for college level work.

2. As pointed to in the statement of the significance of the study, a broad range of interactions among research variables was investigated in this study. Hence current attention to the dynamics of complex behavioral outcomes in the educational process was accommodated by this fact.

3. The attention of the study to the effects of social/cultural oppression on students' ability to function as they need to in the traditional educational environment should prove especially relevant to current efforts to gain a more in-depth understanding of minority students' motives (or lack of motives) to achieve in traditional academic systems.

4. The insights gained through the investigation of students' out-of-class behaviors should prove beneficial to gaining a better understanding of students' performance outcomes, especially in consideration of statements 2. and 3

5. The comprehensiveness of the study should prove very beneficial to those who are striving to meet the educational needs of minorities at all levels.

Relevance to General Education at the Post-Secondary Level

1. The attention to curriculum issues in science and mathematics should prove relevant to current concerns over providing more effective course offerings in these disciplines. Correspondingly, attention to issues related to the quality of the delivery of instruction, as well as the structure of the academic system through which it is delivered should prove especially timely.
2. The fact that the theoretical framework for this study consisted of a synthesis of theories and empirical evidence from a variety of academic discipline areas should contribute to a more thorough understanding of issues of importance to science and mathematics learning, and thus to a better understanding of students' experiences in attempting to pursue studies in these areas.
3. Currently there is a strong recognition in the academic community that in the future educational institutions will necessarily need to meet the needs of a much broader population of students. Thus the exploration of issues critical to programming for students' overall educational attainment in higher education institutions in this study should prove beneficial to this process.
4. The study has contributed to furthering the foundation from which to conduct research on a variety of issues and concerns related to students' academic development and enhancement generally, and minority students' in particular.

Implications

Implications for Minority Students' Educational Development

A. Pre-College Development

- 1) There is a need for higher expectations of minority students' academic performance among school personnel at the K-12 level, especially the senior high level. Likewise students should be provided with challenging, stimulating experiences to promote their growth.
- 2) There is a need to facilitate crucial connections between students' out-of-school and in-school experiences.
- 3) Students should have rewarding encounters with significant others in and out of school who can exert positive influences on them.
- 4) Schools, school systems, and communities in which a substantial proportion of the population is composed of minority students (as defined in this study) should implement a system of education which is grounded in Freire's "problem-posing" approach within the context of the minority experience. Indeed, there appears to be a need to develop a well grounded

theoretical and philosophical foundation for the education of inner city/minority/disadvantaged/culturally different citizens in this country.

- 5) High school students should be made well aware of what the college experience will really involve and how they can prepare themselves for it.

B. Collegiate Adjustment and Transitions

- 1) New students need to become thoroughly aware of the many factors that will be crucial to their growth and development in the environment, and what the expectations of them will be among faculty/staff members and others. It seems that this process should naturally become incorporated into whatever support structure which is provided for students, as well as in the academic offerings themselves where possible/feasible.
- 2) Students need assistance with learning to manage themselves in the campus setting, as well as with coping with being in an impersonal bureaucratic environment and confronting the cultural/social reality of being a minority student in a majority controlled situation. Student "burnout" and "spring fever" are also important considerations.
- 3) Intense work is needed among students on study/learning skills and habits, along with other crucial "college survival skills". This effort should be integrated into virtually every aspect of students' experiences (academic and non academic) and should extend over a period of at least two years (or more) for many students.
- 4) Because minority students seem to often exhibit the learned helplessness disposition, many will need special inducements to initially do those things that are required for academic success. Furthermore, students need to develop a strong sense of intrinsic innovation and a "field independent" disposition towards academics.
- 5) Allowances should be made for the transformation process, which has been identified in this study, to unfold among minority students and considerations made in the institution that not only recognizes it but promotes its occurrence and enhancement where it is found.

Implications for Overall Student Development

For underprepared majority students many of the same problems that confront minority students are likely to confront them as well, perhaps absent the compounding affects of some of the social/cultural inhibitors often found among minorities. Thus many of the implications cited above would apply equally well across the general student population to varying degrees. In any event it would appear that the following four are crucial.

- 1) At the pre-college level students generally should be made aware of, and should have more experiences which would better prepare them for the demands of college level work. More specifically, pre-college education should result in students becoming independent learners capable of directing their own academic development, with adequate guidance, upon graduation.
- 2) The academic advising system at the post-secondary level appears to require a major revamping, with the placement of advisors who are more knowledgeable about what is really important in particular curriculum programs on the one hand, and who are able to determine what is in the best interest of individual students on the other.
- 3) There seems to be an urgent need for high quality introductory courses in mathematics and science. It is likely that those institutions which do so could substantially increase the numbers of students who can succeed at higher levels. Furthermore, course development and/or restructure should be directed at facilitating smoother transitions as students move from one course to another or from one level to another in a particular discipline and, perhaps to a lesser extent, across disciplines. Concomitantly, courses should be designed to promote the "real learning experience" among students.
- 4) There appears to be a need for a more formal working relationship and coordination of efforts between and among student academic support service units, nonacademic support services, the residence hall system, and the academic system of the university. Because student development encompasses all four, students' progress could be enhanced by such an arrangement.

Implications for Student Assistance and Retention Programs

- 1) Assistance and Retention programs should provide for a quality early intervention effort in which contact and work with students is intrusive yet rewarding for them. This contact should begin as soon as students have been identified and they have committed to the university (i.e. while they're still in high school). If possible, orientation, diagnostic testing, and preliminary work with students should begin prior to the summer before students enter the university and some type of intensive program (perhaps involving their parents in some way) should be conducted during the summer.
- 2) Special attention should be directed at students' initial experiences and encounters on campus. Although students should not be shielded from the realities of the environment, their needs and concerns during the initial adjustment period (from one semester up to two years) should be accommodated in some way. Perhaps group sessions and other measures that allow students to sort out the situation among peers would be helpful.
- 3) Based on students' comments about their initial (non adaptive) behaviors, it is apparently important that special programs are designed to get students into a certain mode of functioning in the environment, including the development of effective study strategies/habits, good time management

skills, etc., so that their behaviors are performance enhancing rather than self-defeating. Consequently, students' choices and their ability to make decisions about alternatives might be initially restricted. Of course there must also exist an overriding concern for the importance of students learning to make their own decisions and direct their own development in the environment as well.

- 4) Provisions should be made to insure that students receive sound advice about academic matters from individuals who have a thorough working knowledge of the institution and who are skilled at finding highly effective ways for students to successfully negotiate through and manage themselves in the larger system.
- 5) The counseling staff of assistance and retention programs should thoroughly understand the dynamics associated with the history of social/cultural oppression of minorities in this country and how they might affect students and their ability to function successfully in the environment. Furthermore, the staff needs to be able to creatively find ways of addressing this concern.
- 6) Measures should be taken to incorporate the building of students' self-esteem into the advising, counseling, and instructional activities of special program efforts.
- 7) Throughout the operation of special programs a concern for students' development and/or enhancement of essential communication, problem-solving, and other crucial skills such as note taking and listening skills, should drive decisions about how the program will meet students' needs.
- 8) There is an urgent need for special assistance and retention programs to develop and/or operate a total learning system for participating students which incorporates a strong commitment to all of the above measures and concerns and which integrates the various components into a comprehensive and cohesive unit. Within this system, basic courses in mathematics and communications should be highly performance enhancing for students, and science courses should be made more culturally relevant and more transitionally sound. The advancement of students' problem-solving abilities should become a central concern throughout the functioning of the system. See Appendix H for an example of one way that a comprehensive learning system might be structured.
- 9) Provisions should be made by retention programs for the continued support for students as they make the necessary transitions in the environment including continued assistance in promoting their growth and maturity as they confront the many situations which will arise in their experiences. In particular, measures apparently need to be taken to induce the kind of transformation experience, as described in category 10, that many students apparently need to experience.

Recommendations

1. There is an urgent need to have urban schools, and other schools which have relatively large numbers of ethnic minority students, institutionalize strong concerns for cultural relevance and intellectual challenge in their processes. These processes should promote self-awareness and self-esteem among students and instill confidence in them while inspiring them to strive for academic excellence. Furthermore, a problem-posing approach, such as that advocated by Freire (1970), should be at the center any effort of this type. It was made quite evident that unless these efforts are dynamically undertaken to promote students' development in the learning of mathematics and science at the pre-college level the prospects for minority students will continue to be bleak.
2. Academic Support Systems at the university should be integrated into the academic mainstream of the institution, and behavioral demands should be placed on students, while a host of cultural concerns are strongly considered and addressed.
3. There is a need for the immediate design of introductory mathematics and science courses which view students as being capable of achieving academically at high levels and which are aimed at comprehensively preparing students for the further study of mathematics and science at the university, including the facilitation of their successful transition from one course to the next.
4. Cultural Relevance needs to be featured in the academic and non-academic processes of post-secondary institutions and efforts should be made to create a more culturally accommodating environment.
5. A well designed summer transitional program, which comprehensively considers the student development issues explored in this study, should be a component of any programmatic effort to promote students' successful study of mathematics and science at the post-secondary level.
6. Close monitoring of students should take place throughout their academic careers in college (due to the many transitional phases), and it should be fairly intense during their first two or three years on campus. Personal guidance and support should be continued as they progress in the environment.
7. There is a need for further investigations into the effects of being a member of a socially/culturally oppressed minority group in a majority academic environment, as well as more extensive investigations into a broad array of students' experiences and perceptions, including the identification of the distinguishing features of the dispositions and behaviors of "good" students.
8. Further investigative research should be conducted in which behavioral and other types of variables are controlled. Furthermore, students' experiences as they move through various transitions and experience the "transformational process", which was identified in this study, should be closely examined as well.

Final Remarks

Though this project has been demanding and even taxing at times, it is concerned with a problem with which I am deeply involved and about which I care tremendously. I truly cherish the moments that I spent with students in carrying out the project, and I wish all of them the very best. I also wish the very best to all students who have participated in the Drew Laboratory over the years, and it is my hope that in the future countless others will be able to realize the kind of dynamic and rewarding educational experience that students, faculty, and staff of the Drew Laboratory have shared for many years.

APPENDIX A

DREW PROGRAM QUESTIONNAIRE

Date _____

Please answer the following questions as accurately and thoroughly as you can. If you are not certain about your response, please answer to the best of your ability, but leave those spaces blank where you definitely do not know the answer. If you have a question, do not hesitate to ask for assistance.

1. Approximately how many hours per week did you usually study for all your classes in high school? (Circle one letter)

a	b	c	d	e
3-5 hours	6-8	9-11	12-14	more than 14

2. Approximately how many hours per week did you usually study at home for your mathematics class while in high school?

a	b	c	d	e
1-2 hours	3-4	5-6	7-8	more than 8

3. Prior to entering the university, what did you think of your preparation for college level mathematics/science?

<u>Mathematics</u>	a	b	c	d	e
	Poor	Fair	Good	Very Good	Excellent
	Poor	Fair	Good	Very Good	Excellent
<u>Science</u>	a	b	c	d	e

4. Please give the name of the mathematics and science courses that you took while in high school and give your final grade for each.

	<u>Mathematics</u>	<u>Grade</u>	<u>Science</u>	<u>Grade</u>
9th Grade	_____	_____	_____	_____
10th Grade	_____	_____	_____	_____
11th Grade	_____	_____	_____	_____
12th Grade	_____	_____	_____	_____

5. Did you develop a time management plan or schedule at the beginning of your first term? Yes _____ No _____ If yes, did you follow it throughout the term? Yes _____ No _____ Have you used a TMP since your first term? Yes _____ No _____

6. What were the major adjustment problems that you encountered at the university during your first term (or year)? (Please list)

7. How many hours per week did you expect to study before your first term began? (For all classes)

a	b	c	d	e
Less than 10	10-15	16-25	26-35	more than 35

8. How many hours per week did you (do you) actually study? (All classes)

First term	a	b	c	d	e
	Less than 10	10-15	16-25	26-35	more than 35
Now	a	b	c	d	e

9. Approximately how many hours per week did you usually study for your mathematics class?

First Math	a	b	c	d	e
	5-7	8-10	11-13	14-16	more than 16
Last Math	a	b	c	d	e

10. Prior to your first mathematics course, what did you think of your chances for doing well?

1	2	3	4	5
Very Slim	Slim	Fair	Good	Very Good

11. Prior to taking Math 108, what grade did you think you would receive?

a	b	c	d	e	f	g
0.0	1.0	2.0	2.5	3.0	3.5	4.0

12. Please discuss the major problems that you encountered with Math 108.

13. If you have taken at least one calculus course, please make a brief statement about the major problems that you encountered in making the adjustment to studying calculus.

14. The study strategies listed below are sometimes used by college students for mathematics classes. Indicate the effort that you exerted on each on the scale provided. Circle the strategy most important to you. Place an X next to the least important.

- a. Outline the assigned material content.

First Math	1	2	3	4	5
	Never	Sometimes	Usually	Nearly Always	Always
Last Math	1	2	3	4	5

- b. Do the assignments every day and try to keep up with the class.

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- c. Review the previous assignments before doing new ones.

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- d. Keep an organized notebook or loose leaf binder.

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- e. Work on Problem Sets early and often.

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- f. Take notes in class and study from them.

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- g. Read the textbook and study examples.

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- h. Review the course material over the week-end.

First Math	1	2	3	4	5
	Never	Sometimes	Usually	Nearly Always	Always
Last Math	1	2	3	4	5

- i. Do extra work (such as even numbered exercises).

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- j. Read each section before it is discussed in class.

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- k. Skim over sections to be covered later.

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

15. Listed below are some general sources of assistance for students taking mathematics classes. Indicate the importance of each one to you according to the scale given. Circle the source that is most important to you and place an X next to the one that is least important to you.

- a. Tutoring

First Math	1	2	3	4	5
	Not Important	Somewhat Important	Very Important		
Last Math	1	2	3	4	5

- b. Study Sessions

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- c. Problem Solving Sessions

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- d. Instructor's Office Hours

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

- e. Review Sessions

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

f. Assistance from roommate or friend

First Math	1	2	3	4	5
	Not Important	Somewhat Important	Very Important		
Last Math	1	2	3	4	5

g. Group Sessions with other students

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

h. Other - Specify _____

First Math	1	2	3	4	5
Last Math	1	2	3	4	5

16. How many times did you miss your mathematics class?

First Math	a	b	c	d	e
	1-3	4-6	7-9	10-12	over 12
Last Math	a	b	c	d	e

17. Please discuss any changes that you have made in your approach to studying mathematics and/or science since your first mathematics course and give the reasons why you made these changes.

Changes: _____

Reasons: _____

18. Briefly describe the major problems that you have encountered in attempting to acquire the prerequisite requirements for your intended major. (Include personal problems; problems related to the way things are done at the university, and problems related to previous preparation, as well as anything that you would like to mention.)

[illegible]

19. Please make any additional comments about your experience and/or impressions that you feel could be helpful. You might comment on the Problem Solving class and/or Chemistry (or any other course) here.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper appears to be a standard notebook or ledger page.

APPENDIX B

MICHIGAN STATE UNIVERSITY COLLEGE OF NATURAL SCIENCE

THE CHARLES DREW LABORATORY FOR SCIENCE ENRICHMENT MATHEMATICS PROGRAM

The Drew Laboratory at MSU was established several years ago in an effort to inverse the retention rate of minority students who intend to pursue majors in the biological and physical sciences as well as in science related fields of study, as is the case with certain interdisciplinary programs. It initially developed around a structured program in mathematics, and although efforts have been initiated and are being developed in other disciplines as well, most of the student enhancement efforts continue to take place in mathematics. The laboratory has evolved to include a structured, comprehensive process of student academic support through instruction and instructional support in mathematics, the sciences, and problem solving as well as advise/counseling, career preparation, seminars/workshops, and other enrichment activities. Participating students are expected to be fully involved in the process of the laboratory throughout their first two years on campus and they are encouraged to continue to make use of available services and resources of it thereafter.

The Mathematics Program is organized around a system of instruction and academic support (The Mathematics Learning System) which comprehensively and aggressively addresses the many academic development and performance enhancement concerns associated with students progression toward the successful completion of a rigorous science and/or mathematics based curriculum program. Issues germane to thoroughly understanding the problems confronted by minority and/or educationally disadvantaged students are considered in every phase of the operation of the program. The attached schematic diagram illustrates the operational flow of the program and identifies the staff relationships. Note that a definite set of developmental academic enhancement goals undergirds the entire process and serves as the overall impetus for all instructional planning and the provision of academic support.

Classroom instruction is provided through the Mathematics Program for all pre-calculus courses as well as the first calculus course. In addition to being required to regularly attend the instructional support sessions, all participating students are required to concurrently enroll in the Problem Solving course for at least two terms (quarters). Once students proceed beyond the first Calculus course continued support is provided in the form of supplemental Concept Review Sessions and peer tutoring for further mathematics courses as well as similar types of support activities depending on student needs.

Sequential Developmental Objectives

CHARLES DREW SCIENCE ENRICHMENT LABORATORY

COLLEGE OF NATURAL SCIENCE

Concept Review Sessions

Purpose and Goal:

The overall purpose of conducting Concept Review Sessions (CRS) is to guide students toward becoming good students generally and good students of mathematics and science in particular. The goal is to assist them in acquiring a portion of the academic foundation which they will need to function successfully in mathematics and science courses and curriculum programs at the university.

Philosophical Basis:

In order to reach the desired level of success with students, Facilitators of CRS's should:

1. Be concerned about the total academic and social development of students;
2. Believe that all students have the capacity to grow and develop to the extent of becoming good learners in the environment;
3. Believe that intervention efforts, such as CRS's can dramatically assist students to both acquire the skills needed for academic success and accelerate the rate at which they acquire them.

Primary Objectives:

In order to reach the desired goal, the following objectives have been found to be appropriate:

1. Promote students overall growth and academic maturity;
2. Help students develop their capacity to learn well in the general academic system as well as in the instructional setting of the Department of Mathematics and the College of Natural Science;
3. Facilitate the development of mathematical and scientific maturity among students;
4. Enhance students' capabilities with the cognitive skills which are crucial to the successful study of mathematics and sciences at the university.

Skills Development:

Students must master a host of skills and abilities if they are to become successful. These include:

- Reading Skills (reading the textbooks, studying examples, interpreting problems)
- Writing Skills (notes, problem solutions, etc.)
- Organizational Skills (outline, notebooks, time schedules, etc.)
- Study Strategies/Habits (what to do and when, consistency, establishing patterns)
- Reasoning Skills (abstract reasoning, general problem solving, textbook word problems)
- Analytical Skills (information analysis and management, concept recognition, logical connectives, etc.)

Strategies and Methods

The primary key to successfully conducting CRS's is planning. That is, Facilitators must decide on the strategy which will be used and activities to be conducted in accordance with the idea and skills that they desire to emphasize. The Facilitator's ability to get students actively involved in the process(es) of the CRS is essential. Dialogue between students and staff as well as among students is also important. As the following strategies and approaches are employed, students should be encouraged to engage in them in groups on their own as well.

The strategies and methods given here will be employed at various times and in various combinations. Facilitators must decide on how and when they will be employed according to the situation at hand and the outcomes desired.

Explore a set of ideas and concepts from the course through discussion and verbal exchanges with students;

Review certain principles and concepts with attention to understanding the relationship among them;

Discuss and demonstrate strategies for studying mathematics and/or science;

Have students go to the chalk board to derive solutions to selected problems;

Have students do seat work either from course materials or from Facilitator developed worksheets;

Observe and evaluate students work with attention directed at suggestions on how they might improve and/or organizational methods which they might employ;

Give in-session and out-of-session assignments which they must complete and hand in;

Review for exams;

Begin preparations for the final exam.

APPENDIX C

THE CHARLES DREW SCIENCE ENRICHMENT LABORATORY

MATHEMATICS PROGRAM

STUDENT STUDY GUIDE

1. Read important discussions of principles and concepts and study the examples in the textbook.
2. Go over your class notes and relate them to the discussions in the textbook. You might need to re-copy parts of your notes for clarity.
3. Work through the homework assignments by working all problems that you are able to do without referring back in the book first. Make note of those that you couldn't work out and refer back to the discussions and examples in the book and your notes to see if you can determine how to work the remaining problems.
4. Decide what you would like to discuss with a tutor during your next visit to a study session. However, guard against "giving up" on working the assignments simply because you know that a tutor will be available to assist you. Do as much as you can on your own before getting assistance.
5. Review previous sections that have been covered since the last exam. This will help you mentally organize the material and keep it fresh in your mind.
6. Study the section which will be covered at the next class meeting. You will be in a better position to understand the class discussion and gain more comprehension by doing this.
7. Plan to put in at least 2 hours per day studying for your mathematics course. Additional time will also be needed to prepare for exams, to review assignments, and prepare for the final exam. The following is an example of how to use your time. Note that even if you put in the maximum amount of time it only adds up to 2 hours and 15 minutes.

15-20 minutes:	Study book and notes
60-80 minutes:	Work current assignments
15-20 minutes:	Review previous material
10-15 minutes:	Read ahead in next section
8. As you study be sure to take breaks. In other words you probably do not want to try and study for 2 hours continuously. Of course if you find that you're able to concentrate well you might continue until you start losing your concentration.
9. Spend considerable time on the week-ends catching up and reviewing all previous material.
10. Begin preparing for the final exam early. After mid-term you should begin organizing your notes, reviewing all course material, and outlining the entire course.

MICHIGAN STATE UNIVERSITY

CHARLES DREW SCIENCE ENRICHMENT LABORATORY
COLLEGE OF NATURAL SCIENCE • OFFICE OF THE DEAN
E-37 McDONEL HALL
EAST LANSING, MICHIGAN 48824-1108

DIRECTORS:
Charles Thomson (517) 355-5174
Judith W. Krupka (517) 355-5174

ABOUT STUDYING COLLEGE MATHEMATICS

There are several important considerations regarding the study of mathematics at the university. The first and foremost consideration is that mathematics is required for all science and engineering students, not only because the content is necessary, but because the skills and abilities acquired through the study of mathematics are absolutely essential for the successful study of both biological and physical sciences. In other words, the importance of mathematics to the sciences lies with the more subtle skills -- such as organization and interpretation of data -- and abilities -- such as problem solving -- that are gained when students seriously pursue their study of the required mathematics courses and continually attempt to progress as learners.

A second major consideration is the level of background preparation. Very often students feel they should enroll in the highest level of mathematics course for which they are eligible (according to placement test scores) without questioning whether or not this is in their best interests. On this point, experience has repeatedly shown that it is much better to begin one course level below the course into which the student has tested than to risk being in a course that is advanced beyond the student's current knowledge or skills. This is especially critical for those students whose scores barely qualify them for a given course and/or whose standardized test scores (SAT or ACT) are relatively low. The amount of material covered in one term (9½ weeks) of a university math course is roughly equivalent to the amount covered in one year of a high school math course. At this pace, there is little time to make adjustments or catch up once the term has begun. In the case of Math 111, the amount of material covered is roughly equivalent to 1½ years of a high school math course.

A third important consideration for students of science and engineering is the fact that in addition to acquiring essential skills and abilities for the study of science, the pre-calculus math courses are critical in terms of preparation for the study of Calculus. Most science and engineering students will need to take a minimum of two Calculus courses as a basic requirement for graduation. Students will greatly enhance their chances of success in Calculus if they strive to develop the needed skills and abilities in their pre-calculus courses, and apply the same concentration to non-math basic skills courses such as English. These non-math basic skills include reading comprehension, sorting out detail, identifying subtle points of information, analysis of given data, and a high level of problem solving ability. In recognition of the fact that these skills require considerable application before they are fully incorporated into the student's repertoire, the Drew

Program offers a bridge course (Math 290) which is designed to assist students with the refinement of these skills and abilities, as well as familiarizing them with prerequisite concepts and ideas not covered in previous courses. Again, experience has shown that unless students have been conscientious about their development as students of mathematics previously, their chances of doing well in Calculus will be greatly diminished. A review of outcomes for students over the past ten years shows very dramatically that the decisions that students make (or fail to make) very early in their study of mathematics will have enormous impact upon their future status as students of science and/or mathematics. Because these choices are so critical in shaping student's options and choice of majors, including business, engineering, all of the natural sciences, and agriculture, and in turn have such a profound effect upon future career options, the staff of the Drew Program tries to do all that we can to see to it that students get off to a good start in their study of mathematics and science at this university.

Charles Drew Science Enrichment Laboratory

TIME MANAGEMENT SCHEDULE

Name _____ Course _____ Term _____ Year _____

Day/Time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
8:00-8:50							
9:10-10:00							
10:20-11:10							
11:30-12:20							
12:40-1:30							
1:50-2:40							
3:00-3:50							
4:10-5:00							
5:00-6:00							
6:00-7:00							
7:00-8:00							
8:00-9:00							
9:00-10:00							
10:00-11:00							
11:00-12:00							

CHARLES DREW SCIENCE ENRICHMENT LATORATORY

Student Information Form
(Confidential)

Name _____ Major _____ Student No. _____
 Address _____ Phone _____ Advisor _____
 Term _____ Year _____

Who recommended this program to you? _____

List all courses this term:

1.	_____	Section _____	# Credits _____
2.	_____	Section _____	# Credits _____
3.	_____	Section _____	# Credits _____
4.	_____	Section _____	# Credits _____
5.	_____	Section _____	# Credits _____
		Total	# Credits _____

Which mathematics courses do you plan to take in the future? _____

Which science courses do you plan to take after this term? _____

List all non-academic activities such as work, dormitory activities, clubs, etc.

1. _____ # hrs. per week _____

2. _____ # hrs. per week _____

3. _____ # hrs. per week _____

Total # hrs. per week _____

Do you plan to pledge a sorority or fraternity? _____

The Charles Drew Science Enrichment Laboratory

Student Comments
on
The Learning of Mathematics

Organization and scheduling

- When I came here I had to put myself on a schedule in order to get everything done.
- When you had us do charts of how much time we studied--that put it on paper; there's no way you can get around something that's written down. You can actually see where your time is going.
- When I started out in math here, that's one of the classes that helped me to start being more organized.
- Math helped me with my other classes too, as far as studying for my other classes.

Pace of Math 108

- It was a little bit fast, if you got behind it would probably take you four or five days to catch up.
- ...here, they move at such a rapid pace.
- It went really fast, that was my first thought.

Consistency

- I didn't realize the importance of it--being consistent. Now I know that consistency is the key.
- That consistency thing is really important, not only in math but in a lot of other things.
- I try to do the homework every night, because since you get homework assigned every night and you get a new concept every day, it's easy to fall behind.
- I learned that you just have to study every day....
- What you put into it is what you're going to get out of it.
- ...never let your friends talk you into taking too much time out as far as going out to a party or something.
- +It really wasn't difficult, that's why it's such a shame that people don't do better in it. The hardest thing was sticking to it. It's so easy, you do good on that first test, then you lag off for the next couple days. You've got to stick with it. even if it means day after day.
- I have to keep up with it...I have to keep reinforcing it.

Importance of concepts vs. working mechanically

- I try not to just do the problems mechanically, I try to get an understanding of the reasons why and so forth. I might not be able to do it mechanically on the test.

APPENDIX D

DREW MATH 290

COURSE DESCRIPTION

Drew Math 290 is a pre-calculus mathematics seminar which has been developed within the Drew Mathematics Program. It is designed to assist students with the transition from pre-calculus mathematics to Calculus as a course of study. Certain basic topics which are pre-requisites to a comprehensive understanding of the topics and concepts covered in calculus are either reviewed or introduced in the course. These topics include Plane Geometry (e.g. area of geometric figures and similar triangles), Analytic Geometry, Solid Geometry (e.g. volume of geometric solids), Functions, and Polynomials. Certain basic concepts from Calculus (e.g. Limits, Derivatives, and Continuity) are also covered. There is a heavy emphasis on problem solving, applications, and comprehension of the language of mathematics and science in this seminar.

Class Meetings and Format

Regular class meetings will be held on Mon., Wed., and Fri. at 11:30 a.m., and Work Sessions will be held on Tue. and Thur. at the same time. Study Sessions will also be scheduled at various times during the day. The course will be organized around units of study which will cover one or more of the topics of the course. Students will be given a general assignment for each unit (from the text and/or handouts) and each enrolled student will be expected to read and study a portion of that assignment prior to the next class session. The major portion of the class sessions will be devoted to discussions (including questions for clarification) on the current assignment and all students will be expected to participate based on the understandings gained through reading and studying the material. During the work sessions students will be given the opportunity to ask questions over the assignments. Problem Solving activities will also be conducted at these sessions.

Projects and Modules

Individual and group projects related to the topics of the course will be assigned to all enrolled students. These projects will be developed around Concept Modules which will explore certain topics and/or concepts and demonstrate the uses of these topics and concepts in "real world" situations. Some time will be devoted to projects and modules during work sessions.

Student Evaluation

The course grade will be determined according to students' performance on (in) the following: Exams (at least two), Classroom Discussions (based on how active the participation was), Problem Sets (probably two), Projects (probably two), and Homework. Thus in order to earn a good grade, it will be necessary for students to become actively involved with all phases and activities of the seminar.

APPENDIX E

MICHIGAN STATE UNIVERSITY

CHARLES DREW SCIENCE ENRICHMENT LABORATORY
COLLEGE OF NATURAL SCIENCE • OFFICE OF THE DEAN
E-37 McDONEL HALL

EAST LANSING • MICHIGAN • 48824-1108
(517) 353-5174

Dear

You have been identified as a result of a random sample that was taken among all students who have participated in the Drew Program since fall term 1980. We are asking that you complete this questionnaire and participate in an interview as part of a follow-up of former Drew students. We are specifically interested in your experiences as a student at the university as part of an effort to better identify areas in which we might need to direct our attention towards better meeting the needs of present and future Drew Program participants. As you complete this questionnaire, please keep in mind that it is important that you are thoughtful about your responses, especially where you are asked for a brief explanation or discussion.

As you are under no obligation to participate in this survey, your cooperation with this effort will be greatly appreciated. Furthermore, any information gained as a result of your participation will be treated with strict confidence and you will remain anonymous in any report of the results which might be compiled. Therefore, upon your consent to participate in this survey, you may assume that these stated conditions will be adhered to.

Thank you in advance for your cooperation.

Sincerely,



Charles H. Roberts, Coordinator
Drew Laboratory Mathematics Component

APPENDIX F

MICHIGAN STATE UNIVERSITY

CHARLES DREW SCIENCE ENRICHMENT LABORATORY
COLLEGE OF NATURAL SCIENCE • OFFICE OF THE DEAN
E-37 McDONEL HALL

EAST LANSING • MICHIGAN • 48824-1100
(517) 355-5174

To:

This is to follow up on my request to have you participate in a study which I'm conducting among students who have participated in the Drew Laboratory over the last few years. Since I have yet to get a response from you I am appealing for your cooperation for two reasons. First, you were selected through a random sample, thus you are one of only a portion of all students who have been asked to participate and represent all Drew students who were enrolled in the program during the time period that the study covers. Thus your participation is crucial to its success. Secondly, the extent to which the study is able to yield the desired results will help determine the extent to which we will be able to successfully meet the needs of future students.

With the above factors in mind I hope that you will agree to join us in this effort. I will be in touch with you soon to arrange for another appointment. In the meantime my number is 3-7736 if you would like to respond beforehand.

Thank you in advance for your cooperation.

Sincerely,



Charles Roberts

APPENDIX G

INTERVIEW PROTOCOL

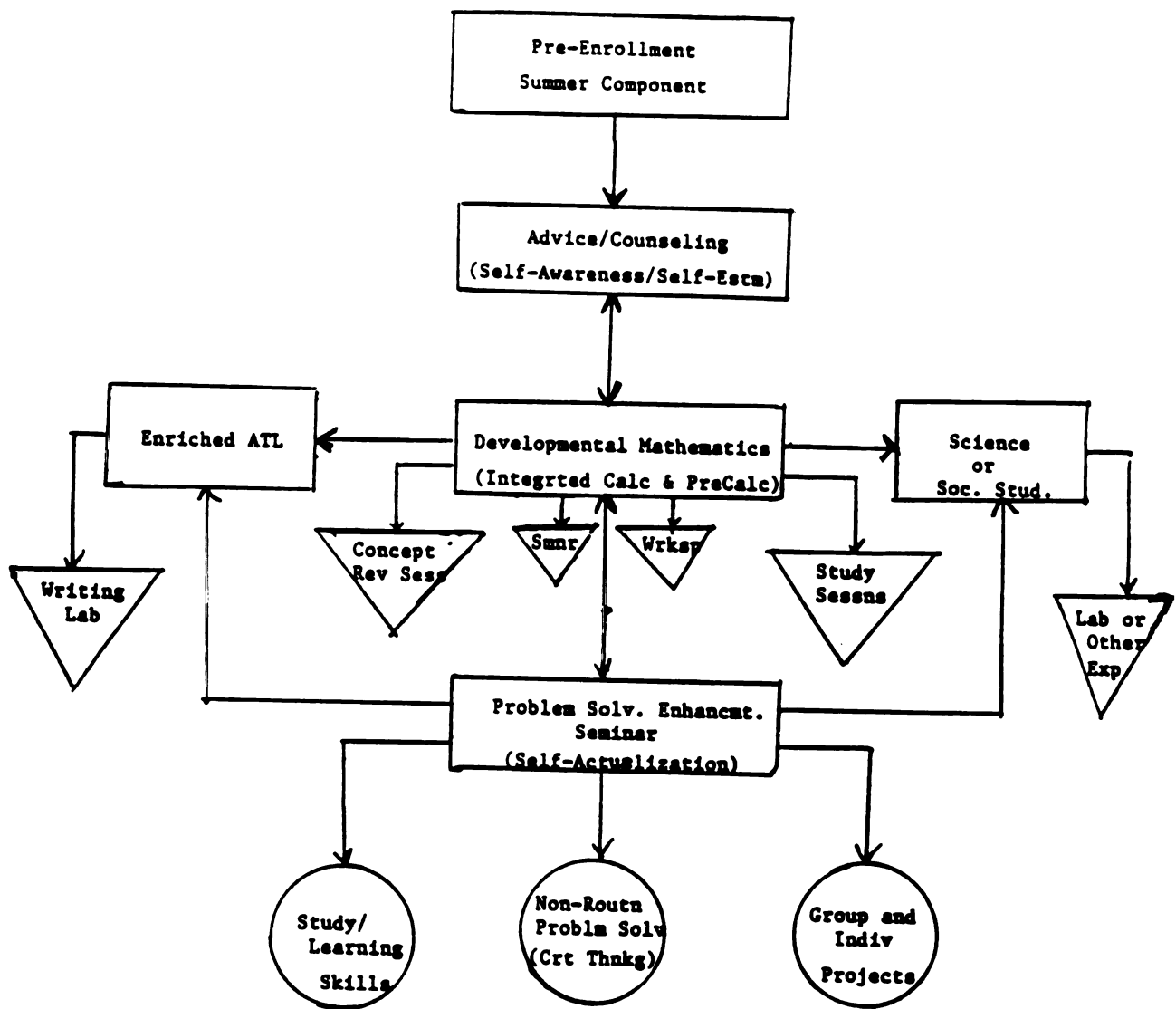
1. In making the transition from the study of mathematics in high school to study of it in college:
 - a) What aspects of this transition were you most concerned about prior to your first math course?
 - b) What aspects of this transition actually proved difficult to you and why?
 - c) What were your strengths?
 - d) In what areas did you need improvement?
2. Discuss the major problems that you encountered in adjusting to the overall demands of college matriculation.
3. Briefly comment on your initial motivation to do the things that you know you should have done or were suggested to do in order to succeed as a student.
4. Did your motivation to do these things change with time? If so, in what way? Comment on the events or experiences which brought about or had an impact on this change. If there was no change, why do you think that this was so?
5. What can you identify other than motivation that might have hindered your ability to function as you should have or wanted to function? Also, can you recall any factors in your experiences which were especially motivating?
6. (For those who have taken at least one term of calculus) Could you make any recommendations for improving the preparation of students for the study of calculus? If so, please expand on them.
7. Comment on your use of time during the first (or first two) term(s) at the university.
 - a) How structured was it?
 - b) What were your priorities?
 - c) What considerations did you take into account in making decisions about the use of your time?
8. What changes did you make (have you made) regarding the use of time since your first term and why did you make them?
9. Describe your specific study patterns for your courses in general and your mathematics courses in particular:
 - a) During the first term.

- b) Subsequent to your first term.
10. Comment on the reasons for any changes in your study patterns that might have occurred over time. What factors did you consider when you made these changes?
 11. Describe the strategies that you used in preparing for exams in mathematics courses. Comment on any changes that you made after your first math course and explain why you made these changes?
 12. Briefly comment on each of the following by comparing your behavior during your first mathematics course with what you did subsequent to it. Comment on the reasons for any changes.
 - a) Your use of the textbook (including reading ahead).
 - b) Your note taking strategies and your use of notes.
 - c) The extent to which you reviewed the course material and practiced doing problems.
 - d) Your strategies for getting assignments done.
 - e) Your approach to preparing for Final Exams or Exams in general.
 - f) Your approach to doing Problem Sets.
 13. Briefly discuss your experiences with and general impressions of Math 108 as a course. Include your strategies for adjusting to the demands of the course and recommendations that you would make to improve the mathematics curriculum at the level of Math 108 to facilitate smoother transitions for students. Also what advice would you give students who plan to take this course?
 14. Please comment on your experiences with Chemistry and/or Physics.
 15. Comment on your perceptions or experiences as a minority and/or female in the sciences.

APPENDIX H

A PROGRAM FOR ACADEMIC ENHANCEMENT

Student Academic Learning System Model



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BIBLIOGRAPHY

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