A STUDY OF THE EFFECTS OF AN ENGINEERING ORIENTATION COURSE ON HIGH ABILITY ENGINEERING FRESHMEN

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CRAIG DAVID LAUBENTHAL

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ABSTRACT

A STUDY OF THE EFFECTS OF AN
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By

Craig David Laubenthal

There is a concern in engineering education that engineering students have an insufficient understanding of engineering as they begin their college studies. Due to the nature of engineering curricula, student contacts are not available with engineering courses and faculty to develop this understanding until approximately the junior year. Engineering educators contend that such a lack of understanding contributes to student difficulties in choosing specific engineering majors, and to high engineering school attrition rates. Many methods have been tried to orient students to engineering including, in particular, freshman engineering courses. Beyond descriptive studies of student satisfaction, little evaluation of such courses has been conducted.

It was the purpose of this study to evaluate the effects of a ten week course in computer programming, containing presentations describing six engineering specialties, on high ability, first-term engineering freshmen at Michigan State University. Students in the orientation course were compared with a similar group of students taking a computer course with no orientation. Questionnaires

and interviews were used at the beginning and end of the computer courses for both groups of students.

Identifying the students receiving the orientation as the experimental group and those receiving no orientation as the control group, the following hypotheses were made:

1. The experimental group has significantly greater knowledge of engineering than the control group.
2. The experimental group is significantly more affected than the control group in identification with engineering as a career.
3. The experimental group is significantly more affected than the control group in desire for engineering as a career.
4. The experimental group experiences significantly more changes of major than the control group.
5. Control and experimental groups differ significantly in their views of required non-engineering courses.
6. Control and experimental groups differ significantly in their definitions of each of the

engineering fields available for study.

The results of the study showed no support for any of the six hypotheses. In addition to hypotheses, the following conclusions were drawn:

1. The orientation presentations as a whole were seen as helpful for understanding the work of engineers, but, when rated individually, were seen as only of moderate value.
2. The orientation presentations were seen as well integrated with the computer science content of the course.
3. The orientation course was seen as a fairly profitable and enjoyable experience.
4. Both experimental and control subjects were little concerned with major choice and understanding engineering as a career, and were predominately concerned with grades and academic success.
5. Students who completed the orientation course showed greater satisfaction in the interviews with their knowledge of engineering as a career than the students who completed the control course.

The results were discussed noting that previous studies were incomplete because student satisfaction was the only variable considered. The results of this study pointed out that student satisfaction with a course may be satisfactorily high even when the effects of the course are negligible.

It is possible that one reason why no effects were found was due to the lack of student concern for major choice and understanding engineering as a career. Students may have paid little attention to the orientation presentations because they were not concerned greatly with the content and knew they would not be graded on the material.

Implications were drawn for future research.

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By

Craig David Laubenthal

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DEDICATED TO

My Wife, Sally,

for her continuous

support and encouragement.

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CHAPTER I

THE PROBLEM

Purpose of the Study

It is the purpose of this study to evaluate the effects of a freshman engineering orientation course on high ability first term engineering freshmen. The findings of the study should aid in determining what, if any, changes should be made in such a course, and should provide the basis for further research recommendations.

The problem is to evaluate the effects of a ten week course in computer programming, at Michigan State University, which includes an organized presentation of orientation to engineering career fields. Students who had the orientation course were studied and compared with students in a similar course which did not include orientation to engineering. The objective of the examination is to determine the general effects of the orientation, and whether or not the orientation increased knowledge of engineering as a career, affected engineering major choices, and/or helped students to clarify their desire for and identification with engineering as a career. Evaluations are made of the orientation to engineering aspects of the course, and the impact of the course as a whole.

Need for the Study

There is a concern in engineering education that engineering students begin their college studies with an insufficient understanding of engineering as a discipline or career. In addition, these students evidence little understanding of their interests and abilities as related to achieving an engineering education or succeeding in the profession. (22)(23)(13)(3) Mathematics and science courses in high school do very little to promote this understanding although interest and success in mathematics and science often is a contributing factor in the student's decision to begin his studies in an engineering school. (13)(16) Upon beginning a college engineering program the student often finds that his freshman and sophomore years do little more than high school to improve his understanding of his chosen career. (9) The basic problem has been that until the student has grasped a sufficient amount of basic science and mathematics, the engineering courses are meaningless or beyond the student's ability to comprehend.

The nature of the engineering curricula causes the delay of the student from contact with both engineering course work and faculty. This delay is felt to be at least partially responsible for the high attrition rate in engineering schools which is particularly noticeable in the freshman and sophomore years. (9) (23) Also accounting for this attrition are several other factors, which include academic competition, insufficient ability (particularly in mathematics) insufficient motivation, poor previous education, low interest, the difficult curricula, and a wide range of other factors. This delayed entry into the course work of the profession is not unique to engineering but this fact does not obviate the need to solve the problem.

Attrition from engineering is not recognized as an entirely negative phenomenon. It often means the student has found that his true interests and/or abilities lie elsewhere. (11) A student's decision to leave engineering may be irrational if he never really has had the opportunity to understand the engineering field. There is also the possibility that a lack of understanding can lead to a lack of motivation or interest, and therefore, a lack of success in pre-engineering courses. (13)(4) It becomes difficult to determine which of the factors of ability, motivation, or understanding is at fault and in what proportions. It is also difficult to determine whether providing an understanding of a career is sound guidance practice, or "hard-sell" indoctrination.

Although attrition commands the most attention because of its direct relationship to the shortage of trained engineers, there is another concern in engineering education relative to the delayed understanding of engineering careers. Engineering students must declare a major in one of the engineering fields depending on the offerings in any one respective school. The time of this declaration ranges from the beginning of the freshman year to the end of the sophomore year depending on the particular institution. How this choice is made and whether the choice is best for the individual concerns engineering educators and students. (20) An inappropriate choice can mean a dissatisfied engineer and a detraction from the profession. A student unsure of his career choice may find difficulty in pursuing his program to the limits of his capabilities.

The problem of providing an early understanding of engineering for the student remains unsolved, although a variety of solutions have been tried with varying or unknown degrees of success. These attempts have included personal and group counseling, no credit and credit courses, career literature, seminars, lectures, engineers clubs, tours, visitations by practicing engineers, films, college open houses, demonstrations, and, no doubt, many other techniques. Although a combination of several techniques may be needed, the freshman engineering course has been given the greatest attention because of its potential of holding a captive audience, its continuing nature, the provision for early contact with the student as a regular part of his curriculum, and limited reports of successes with such courses. (14)(5) Only a few of the many attempts at freshman engineering orientation courses have been reported, and in most cases evaluation has been scant, unsystematic, or non-existent.

Research Hypotheses and Questions

The analysis of the effects of the engineering orientation course will be guided by several research hypotheses and research questions. The hypotheses listed below are restated in testable form in Chapter III.

Hypotheses

1. The experimental group has a greater knowledge of engineering as a career than the control group.
2. The experimental group is more affected than the control group in identification with engineering as a career.
3. The experimental group is more affected than the control group in desire for engineering as a career.
4. The experimental group experiences more major changes than the control group.
5. Control and experimental groups differ in their views of required non-engineering courses.
6. Control and experimental groups differ in their definitions of each of the engineering fields available for study.

Questions

1. To what extent do experimental group subjects feel that they have enjoyed the orientation course?
2. Do experimental group subjects feel that the orientation presentations were worthwhile?
3. Do experimental group subjects feel that the orientation presentations were well integrated with the computer science content of the course?

Limitations of the Study

The following limitations affect the generalizability of the results of this study:

1. The study is limited to 134 first term freshmen engineering students at Michigan State University (74 experimental and 60 control) who scored at the 60th percentile or better on M.S.U. engineering freshman norms of the College Qualification Test total score, and who chose to take the required computer course in their first term.

2. The study is limited to data gathered by means of interviews and original questionnaires designed specifically for the study.
3. The experimental and control courses were taught by two different instructors; however, the orientation treatment was administered by faculty not including either instructor.
4. Students were not registered in control and experimental courses randomly but the individual student chose that course that best fit his class schedule. Students were not aware of any differences between the two courses except the time schedule difference.
5. The study is limited to the course content of Computer Science 120 offered Fall 1968 at Michigan State University.
6. The study is limited to an evaluation of short term effects since the study groups were tested immediately following the completion of the courses.

Evaluation Criteria

This study is not based in theory but, rather is a practical evaluation of an educational program. Attention is given, therefore, to the criteria used to judge the degree of success or failure.

One very essential criterion of this study is knowledge gained by students of engineering as a career. Those receiving the orientation should learn more about the topic of the orientation than those who receive no similar education. To measure this criterion the student was asked to rate himself on the extent of his knowledge of engineering as a career.

In studying career identification as a criterion it is necessary to understand that a decreased identification with engineering may be just as important as an increased identification. If the engineering orientation is effective it will help students to better understand the nature of engineering, and, therefore, orientation effectiveness may not result in universal enthusiasm for the profession. Providing such an understanding will cause some students to identify more, and others less, with engineering, which should result in more realistic career choices.

Using identification as a criterion, orientation effectiveness should result in the experimental group having more frequent and more pronounced shifts in degree of identification with engineering than the control group between measurements of identification at the start and completion of the course.

"Desire for engineering as a career" used for a criterion represents the same situation as that noted for the "identification" criterion. An increased desire, on the whole, is not necessarily a positive effect. It is necessary to determine, therefore, if the experimental subjects experienced more frequent and more pronounced fluctuations in desire.

If the idea is correct, as pointed out in the Need for the Study section, that engineering students enter college with little understanding of engineering and its various branches, then major choices should be affected by the orientation course. With major choice as a criterion it is necessary to determine if there are more major changes (within engineering and out) among experimental subjects than among controls.

Although it is difficult to achieve, and could call for extensive subjective techniques, some evaluation must be made regarding the effect of orientation on student definitions of engineering. The orientation experience should change these definitions resulting in differences between experimental subjects and control group members. It is true that 'different definitions' are not synonymous with 'more accurate definitions' but this study was not designed to study the complexities of correct definitions of engineering.

An important issue for freshmen, in understanding engineering, is the area of certain non-engineering courses which are required before engineering courses can be taken. Due to some lack of agreement in engineering education regarding required courses, this area is difficult to evaluate. The orientation experience should, however, result in the experimental group exhibiting different understandings of the reasons why certain non-engineering courses are required when compared to the control group. As noted above, in reference to definitions of engineering, difference and accuracy are not equated. In both cases student responses to these criteria can aid in modifying the orientation to produce those understandings considered most accurate by engineering educators.

Additional criteria include satisfaction with the orientation course and satisfaction with the orientation presentations within the course. Although satisfaction alone cannot serve as a complete criterion, it is useful in combination with other criteria. A definite lack of satisfaction, on the other hand, would legitimately be suspect.

Definition of Terms

For this study the following definitions and descriptions apply:

1. Engineering Orientation Course:
   Computer Science 120 offered fall 1968 and containing an introduction to Fortran programming language, technical problem assignments to be programmed on a Control Data 3600 computer, and six lecture and film presentations distributed throughout the ten week term covering six of the engineering majors offered at Michigan State. Orientation presentations are each partially concerned with showing students example problems of those solved in each engineering field.
2. Control Course:
   Computer Science 120 offered fall 1968 and containing all the elements of the engineering orientation course including solutions to identical engineering

problems, but without orientation presentations.

3. High Ability Students:
   First term fall 1968 engineering freshmen scoring 150, 60th percentile, or better on the total of the College Qualification Test.
4. Knowledge of Engineering:
   The extent of knowledge a student feels he has of engineering as a career.
5. Identification with Engineering:
   The extent to which a student can see himself as one day becoming an engineer.
6. Desire for Engineering:
   The extent to which a student feels he desires to be an engineer.
7. Required Non-engineering Courses:
   Courses required for graduation in engineering but not unique requirements for any one engineering major, including math, chemistry, physics, English, and computer science.

Overview

This study is reported in five chapters arranged to provide a systematic presentation. In Chapter I the need and purpose of the study were provided along with research hypotheses and related evaluation criteria. Pertinent literature is reviewed in Chapter II, including reports of engineering orientation courses, attrition studies pointing to the need for engineering orientation, and other literature related to needs of students for orientation. The experimental design and methodology are described in Chapter III. This Chapter includes information on the samples, statistical hypotheses, and instrumentation. Chapter IV contains an analysis of the results from questionnaires and interviews relative to both hypotheses and research questions. Summary and conclusions follow in Chapter V, with a discussion of the results and suggestions for further research.

CHAPTER II

REVIEW OF THE LITERATURE

It is the purpose of this chapter to review the literature that is both directly and tangentially related to this study. The first section contains a literature review and an interview pertaining to freshman engineering orientation courses and related freshman engineering courses. In this section the present status and objectives of such courses are examined, and course evaluations are reviewed. The second section contains an examination of the literature pointing the need for freshman engineering orientation through an analysis of engineering attrition and major change problems. The third section involves a review of more general literature pertaining to orientation needs of engineering students and students in general, with some attention given to the content and design of orientation experiences. In the last section a discussion and summary are provided.

Freshman Engineering Courses

It is difficult to be sure how much is being done across the country by engineering schools to provide freshman engineering courses. Three different estimates given by Ryder, Landis, and Beakley and Price (21)(14)(5) conflict as to the number of such courses. A search of the literature to 1940 yielded such small returns as to make it appear that such courses have been relatively rare. According to Ryder, attempts at such courses have been, and still are, numerous, but the reporting has been rare. (21)

Ryder estimates that two thirds of all engineering schools presently have some form of freshman engineering course. (21) He notes that these courses are of three general types:

(a) Problem courses; students are given engineering related problems to solve through graphics, math, science, and logical procedures.

(b) Descriptive courses; descriptions of the engineering fields are provided along with career opportunities in engineering.

(c) Other courses; a large variety of such courses is included here along with combinations of the first two types and subject matter course work in engineering related fields such as graphics, math, physics, and computer science.

Ryder explains that descriptive courses are the least satisfying to students. Problem courses can be more satisfying but it is difficult to find problems that are both simple enough for freshmen and yet not so simple as to be meaningless. Problems should be abstract and continually updated. Ryder emphasizes that the objective of the freshman engineering course should be definition, not selling.

Landis surveyed all accredited engineering schools in the United States to determine the function of freshman computer courses.(14) Thirty-four useable replies were received from a questionnaire sent to all schools listing freshman computer instruction on the initial survey. The computer course survey revealed the following:

Schools responding with Freshman Computer Course (1967-1968)

Type of Course:	Course devoted to digital computation only	14
	Computing as part of a more comprehensive freshman course	20

....

Solutions to Elementary Engineering Problems	22

Self Evaluation of Course Success:

Highly Successful	13
Partially Successful	14
Not Successful	1

....

(14, Table I)

As Landis points out: "The reasons (for these courses) appear to be two-fold. One was to retain (or to reintroduce) engineering related course work into a freshman year which over the last decade had become more and more science and liberal arts oriented, and to provide a natural and integrated building block for subsequent engineering and mathematics courses. The second reason for favoring computing at the freshman level has been the high student interest in computers which, when properly developed, could serve to interest more students in an engineering career." (14, 1)

Beakley and Price provide the most comprehensive study of freshman engineering courses from their survey of 174 engineering colleges with E.C.P.D. - accredited curricula. Although only fifty-five percent of the schools responded, this is the most comprehensive survey reported. The following results are relevant to this review:

....

2. One or more of the following freshman engineering courses are required by 90% of the respondents:
Drawing or Graphics (85% of respondents);
Engineering Orientation (50% of respondents);
Introduction to Design (22% of respondents);
Engineering Problems (18% of respondents);
Engineering Lectures (15% of respondents);
and Engineering Analysis (9% of respondents).

3. According to 83% of the respondents, there was need for a course at the freshman level whose primary objective is the motivation

of the student toward engineering as a career profession. Most of the 83% indicated that they were attempting to satisfy this need by courses being offered. Most of the 17% who replied negatively did so with the explanation that the type of students who enrolled at their schools needed no motivation.

4. Eighty-four percent of respondents favored introducing freshman engineering students to principles of engineering design.

....

8. Suggestions were requested for the most desirable content of a required freshman engineering course. Listed below are the responses, in order of most desire-ability:

The engineering method of problem solving
Introduction to computers and programming
Introduction to design
Sketching and drawing
Work of the engineer
History of engineering
Unit systems and dimensional analysis
Slide rule instruction
General problem solving
(5, 829)

Several reports are available on freshman engineering courses that may serve to provide examples of some ideas which have been or are being tried. The courses described have not been well evaluated, as indicated by the limited attention given to evaluation in the reports.

New York University developed a fourteen week freshman engineering course that emphasizes learning by student participation.(20) The course is taught by engineering faculty to small groups of students, and consists of history of engineering, use of slide rule, graphical methods of handling raw data, and a variety of other problems and exercises exposing the students to each of the engineering departments on campus. At the end of the first offering of this course the students were surveyed, and the following conclusions were reported: (a) The majority felt they learned an appreciable amount of new material, enjoyed the course, improved their impressions of engineering, and felt the work load was reasonable; (b) A significant minority felt they gained identification as an engineer, felt their performance in other courses improved, (on the average) felt that each individual session helped to introduce them to engineering, and choose a departmental affiliation. The author, Rabins, points out in one of the guidelines for developing a freshman engineering course that, "career orientation must be continually stressed to point out what engineers in a particular discipline will be doing upon graduation." (20, 347)

Beakley and Price report on a freshman engineering design course at Arizona State University which is designed primarily to motivate freshmen. (4)(5) The course objectives involve giving the student a clear idea of the role of the engineer, the challenges of engineers and the skills needed. Students work as members of an engineering firm to generate design ideas, submit proposals of approved ideas, and compete for the position of Chief engineer. The company is engaged in the design of a useful product. (4) "Responses (to a survey of students who had completed the course) indicated that 72% felt that the project had a strengthening effect on their choice of engineering as a career, 15% felt that it had no effect, and 13% felt that it had a weakening effect." (5, 828) The authors conclude the following:

> A design experience in the freshman year appears to 1) generate interest and increase committment to engineering as a career; 2) forcefully present the challenges of engineering and a picture of the profession's role in today's world; and 3) emphasize the analytical skills and creative abilities that an engineer must acquire." (4, 197)

Earle reports on a course at Texas A.M. University described as "An Introduction to Engineering Design Through Graphics." (8) The course involves presenting engineering design, engineering orientation, and communication through engineering graphics in the freshman year. Project design, including graphics, is emphasized along with model building, oral presentations, question and answer sessions, working drawings, and contacts with visiting engineers. Earle indicates that the course was developed because, "Student opinion revealed that there was very little understanding of the function of the engineer as a member of a team concerned with social, legal, and business areas in addition to traditional engineering problems. In many cases, students could not give a valid definition of engineering." (8, 1107) The majority of the students who had taken the design course rated it as very helpful.

The Oakland University School of Engineering at Rochester, Michigan has a freshman engineering course involving design concept lectures and a design laboratory. The principles from lecture are applied to realistic engineering problems in the laboratory. The authors, Gibson and Boddy, report that the course is an effort to increase motivation and serve as an introduction to the profession with the hope that engineering enrollments may be increased through positive feedback to high schools, and attrition rates from engineering may be decreased. (11) The authors' evaluation comments indicate that students agree with the goals of the course and its timing in the freshman year. The success of the course is based on its giving students the necessary information and experiences to: confirm engineering as a major field of study; choose a major within engineering; realize new engineering careers; or, transfer to another field outside of engineering.

The University of Michigan has developed a problem oriented freshman engineering course covering most of the branches of engineering, and containing engineering orientation lectures. According to Goetz, Katz, Lady, and Ray, the following reasons led to the course development:

> For some years there has been a continuing discussion at the University of Michigan of the need for a freshman course in engineering. The need for students to have contact with faculty from the several professional departments was evident. A program consisting of mathematics, chemistry, physics, English and graphics did not seem to satisfy many students. Although a fraction of the students may have known which discipline they preferred to elect in their sophomore year, many were unprepared for this decision. (12, 1)

A survey of student opinion was used both to evaluate the course, and as a basis for revising the orientation material. The authors conclude that, "For many students, it (the course) can provide some perspective of engineering and initiate their understanding of some basic concepts in engineering." (12, ii)

Studies of Attrition and the Need for Orientation

Although this section deals with engineering attrition studies, it is not within the scope or purpose of this review to cover completely the vast amount of literature pertaining to attrition. It is the purpose here to examine several relevant attrition studies that specifically point to the need for freshman engineering orientation.

Menand points out that, "In college, clearly a good bit can be done to help the student orient himself to engineering education. Either through a formal course or through meetings and seminars with faculty, steps should be taken to describe the various fields of engineering and to relate engineering practice with engineering education." (16, 35) Menand's thoughts are in regard to his study of high attrition rates among engineering students.

The Engineering Manpower Commission conducted a longitudinal study of engineering student attrition over the years 1952 to 1962. (9) Although little is printed regarding the nature of the study or the number of engineering schools reporting, the analysis and conclusions are pertinent. The study points out that for most engineering students there is no perspective or contact with engineering, and no association with engineering students or faculty. Regarding successful programs for reducing attrition the study notes the following characteristics:

> (a) Better pre-selection, guidance, and orientation of students.
>
> ....
>
> (d) Programs designed to give the student perspective, an association with engineering, acquaintance with the faculty, and generally to bring him into the professional family. The purpose is to give him a sense of identity with and a pride in the fact that he is an engineer. (9, 7)

In regard to specific recommendations, the

Commission's report states that a freshman engineering problems course has been successful in some schools. "This usually reaches the pinnacle of interest when it involves instruction in computer programming...in the solution of engineering problems." (9, 10)

Augustine conducted an extensive study of freshman and sophomore engineering attrition at three midwestern universities. (1)(2)(3) He found that both students remaining in engineering and those who had transferred out agreed, "that more engineering courses should be offered earlier in their programs - during the freshman and sophomore years to stimulate and maintain their original interest." (1, 13) Among Augustine's recommendations resulting from his study are the following:

> 5. Engineering schools should recognize the unique needs of their freshman students and provide specific programs to meet these needs...
>
> ....
>
> 7. Engineering educators should be alert to the possibilities of reinforcing the commitment freshmen and sophomores have made to the program. Earlier introduction of academic work taught by engineering professors, greater flexibility in course scheduling, efforts to reveal future possibilities of an engineering career, and activities which help the individual student identify with the engineering school and other engineering students all deserve serious consideration....
> (3, 114-115)

Greenfield studied attrition among 112 first semester engineering freshmen at the University of Wisconsin. "When they entered the College of Engineering, only 53% of the total group, and only one-third of the students who transferred or were dropped at the end of the semester knew the kind of work they would be doing as engineers." (13, 1006) The need for an understanding of engineering is evident as Greenfield notes that high school students have "only very hazy notions about their future course of action and wander into an engineering program as the course of least resistance." (13, 1109)

Wiehe studied 425 engineering dropouts at the University of Missouri to determine why the students originally chose engineering, why they dropped out, and various relationships with dropping out. (23) He concludes that drop-outs would like more exposure to engineering problems and experiments earlier in their training.

Literature Related to Orientation Needs

As pointed out by both Fitzgerald (10) and McCann (15) it is well to organize orientation activities around natural college units in order that orientation can reflect a recognition of the unique needs of specific programs. This is relevant to the freshman engineering course as a means of providing recognition of the unique needs of the engineering program.

Caple points out the necessity of providing some motivation for the student "to ask what it is he wants, why he wants it, and how he is going to get it,..." (6,25) In this same vein Chervenik states that, "More information about which kinds of work activity may lead to the desired goals should be communicated to the student." (7,178) Both Caple and Chervenik would agree that the orientation or guidance activity should be designed to inform rather than sell or convince the student.

Pierson points to the effect of lack of information about academic and career areas on major changes.

> Four hundred and three Michigan State University seniors who were scheduled to graduate in majors other than those which they had selected upon entering the University were studied for the purpose of finding why they changed their majors and how they felt about having changed. Their responses to the questionnaire indicated that the primary reasons for changing were lack of information about (1) the extent of the curricular opportunities in the University, (2) the content of the courses in their original major, and (3) the requirements and opportunities in vocations related to their original choices. (19, 461)

It should be pointed out that these conclusions of Pierson's study depended on the students' recall of several years regarding their reasons for changing, and therefore, may not represent an accurate account.

Nadler studied personality factors among 432 science and technology freshmen at Case Institute and Northwestern University to determine the effects of compatible and incompatible major choices.(18) He divided the students into "practical men" and "theoretical men" on the basis of personality. According to Nadler, "Practical men who chose engineering curricula, or theoretical men who chose science curricula were considered to have made compatible choices." (18, 226) The author points out that in the freshman year all the practical men faced an incompatible program. Even though the major choices of the engineers may have been correct, by Nadler's classification, the freshman year contained only theoretical courses such as math, chemistry, and physics. This "incompatible" experience could lead to decreased motivation and incorrect major changes by freshman engineers if no practical course work or orientation as to the practical future of the major is provided.

Meriam perscribes that the freshman engineer should receive both orientation to engineering and contact with the physical reality in engineering. (17) Wallace and Case similarly point out the importance for general guidance and orientation courses related to the field of engineering in the freshman year. (22)

Discussion and Summary

This review of the literature since 1940 covered the prevalence and nature of freshman engineering and engineering orientation courses, examples of such courses, including studies as to their effects, engineering attrition studies that point to the need for such courses, and other literature, showing the need for such courses for reasons other than attrition problems. No study was found describing a controlled experimental, quasi experimental, or thorough descriptive evaluation.

Several authors point to many attempts at providing freshman engineering, computer, and engineering orientation courses by engineering schools, although reports conflict as to the frequency and types of such courses. An estimate of the total number of engineering schools offering some type of engineering course in the freshman year would range from one half to two-thirds.

The principal objectives of such courses are: to motivate and sustain the interest of the freshman engineers; to provide an understanding or orientation to engineering and its various fields; to provide contact between the freshman and the engineering school, faculty, and students for the purpose of developing an identification with engineering; to provide a background for later courses; and, to decrease attrition where vocationally appropriate, and facilitate engineering major choice. A contradiction exists in the literature between the objective of reducing attrition from engineering as a primary objective and the objective of helping freshmen determine whether engineering is their correct choice.

The various writers point to a basic dilemma in engineering education that has resulted in the concern for special engineering courses in the freshman year. The entering student has never studied engineering in high school and, as a freshman and sophomore in college, does not contact the regular engineering course work. This separation from the student's chosen major is thought to contribute to high attrition rates, difficulties in choosing an engineering major, low academic motivation, and lasting dissatisfaction.

CHAPTER III

THE EXPERIMENTAL DESIGN

It is the purpose of this chapter to detail the methodology and analysis techniques of this study. Attention is given to the study sample, procedures, instrumentation, interview schedules, statistical hypotheses, statistical analysis, and a summary.

Population and Sample

The sample consists of 92.95 percent (132 students) of the population being studied. The population consists of 142 first term 1968 engineering freshmen at Michigan State University who scored 150 or higher on the total of the College Qualification Test (CQT-T) and who chose to take Computer Science 120 (CPS 120) in their first term. It might be argued that the population consists of a much larger group with characteristics similar to the population defined above; but, according to statistical sampling theory, the population must be limited because the CPS 120 group was not randomly selected.

A word should be said regarding limiting this study to first term freshmen with a CQT-T of 150 or higher. The College of Engineering enrolls only high ability first term freshmen in CPS 120 because it is felt that these students can adjust best to the extra study burden of the computer course. All freshmen are required to complete CPS 120 but lower ability students (those below a CQT-T of 150) are believed to do better after a term or two of college experience. First term freshmen are selected for this study because of the great similarity of their academic programs and their uniform lack of exposure to college. To obtain the purest measures of the effects of the course it is, therefore, most logical to study first term freshmen. The College of Engineering adheres to the policy of not forcing all of its high ability freshmen to take CPS 120 in their first term. The study group consists, therefore, of only those high ability freshmen who chose to take CPS 120, rather than the entire group that was eligible on the basis of CQT-T.

The Experimental Group (those taking CPS 120 with orientation) consists of seventy-two students with a CQT-T mean of 168.31 and a standard deviation of 11.62. The Control Group (those taking CPS 120 with no orientation) consists of sixty students with a CQT-T mean of 171.95 and a standard deviation of 10.97. Although subjects self selected themselves into the two sections of CPS 120 with no knowledge of the differences between the sections, the means of the two groups on CQT-T were found significantly different using a t test with an alpha level of .05. The difference between the means is only 3.64 points which, although statistically significant, is not felt to be practically significant for purposes of this research.

Procedures

1. Permission to conduct this study was obtained in the summer of 1968 from the Dean of Engineering and the Director of Computer Science. Contacts were made with the two instructors of CPS 120 to obtain their support and to plan the study.

   It was not possible to obtain the same instructor for both sections due to scheduling difficulties. Although the instructor difference between the two study groups may have had a confounding effect on the results, it should be noted that neither instructor provided orientation in his section of CPS 120, and that orientation presentations were given by faculty from the various departments. Statistical tests are included in Chapter IV to estimate the confounding effects of the instructor variable.

2. A pre-test questionnaire was administered to both sections of CPS 120 at the second class meeting of the term. (Completion time: twenty minutes)
3. After the pre-test had been administered sixteen students picked at random from each group were interviewed to obtain additional information and to study the validity of the questionnaire.
4. A post-test questionnaire was administered at the last class meeting of the term.
    (a) Post-tests for both groups contained all the questions from the pre-test plus additional questions focused on the course.
    (b) The post-test for the experimental group contained all the questions given the control group plus additional questions focused on the orientation presentations. (Average completion time: thirty minutes)
5. During the week before the post-tests were administered sixteen students picked at random from each group were interviewed to obtain additional information about the students' attitudes towards CPS 120 and to validate the post-tests. Unlike the timing of the pre-interviews, the post-interviews were scheduled before

the post-tests in order to control students into their interviews before the term break interrupted the school year.

Instrumentation

Three questionnaires were designed specifically for this study consisting of a pre-test instrument used with both the experimental and the control group, a post-test instrument used with the control group, and a post-test for the experimental group. All questionnaires were administered on a pilot basis, before adopting them for the study, to a small group of students to be sure the items were understandable. Although no conventional tests of reliability or validity were conducted, the information from interviews, pilot testing, and experience with engineering freshmen would give support to the contention that the instruments were reliable and valid for purposes of this study.

Pre-testing

The purpose of the pre-test was to elicit student attitudes and understandings regarding engineering and required non engineering courses in order to determine the sameness of the two study groups on essential variables before the treatment was administered. The first three items were designed to assess knowledge of, identification with, and desire for engineering as a career. The fourth item required the student to rate the general occupational opportunities of the seven engineering fields at M.S.U., while the fifth item asked the student's present choice of engineering major.

The sixth item was designed to elicit, in capsule form, the student's definitions of the engineering careers corresponding to the seven engineering majors at M.S.U. Using seven general categories of engineering work (including administration, design, construction, consulting and sales, manufacturing and operations, research and development, and teaching) the student was asked to indicate for each major the category of work in which he felt each type of engineer was most involved.

The last item called for the student to rate the truth of six statements regarding non-engineering courses including mathematics, chemistry, physics, computer science, and English. The six statements covered the broad range of ideas that students have regarding why they are required to take certain courses.

Post-testing

The purposes of the post-tests were to measure changes that may have occurred and to elicit evaluations of the CPS 120 courses. The seven pre-test items were repeated in the post-tests to measure differences between the study groups which could be accounted for by the fact that orientation was given to only the experimental group.

Items eight through nineteen were designed to elicit student evaluations of the CPS 120 course and instructor. Items twenty through twenty-three appeared in only the experimental group post-test and were designed to elicit evaluations of the orientation presentations.

Interview Schedules

Interviews were conducted on a pre and post basis, and consisted of broadly structured questions. The interviews were designed to elicit information relative to the study and additional information of concern to the College of Engineering which is outside the purposes of the study.

Pre-interviewing

The pre-interview schedule was identical for both experimental and control groups and consisted of five general questions. The first question was concerned with the student's career interest in engineering including how it developed, when the choice was made to study engineering, and how firm this decision is now. This question was designed to explore further the engineering career choice and validate the questionnaire items concerned with this topic.

Question two explored activities and experiences which led to the student's present understanding of engineering, how deficient the student felt his understanding was, and what, if any, plans he had to further his understanding. The purposes of this question were exploration and validation.

The third question asked the student what the College of Engineering could do for him. This information was desired to aid Engineering Student Affairs program development. Question four was also designed to aid program development; but it was also designed to determine the importance to the student of understanding and choosing an engineering career relative to other concerns he might have.

The last question surveyed the student's activities and interests while in high school. It was the purpose of this question to better understand the subjects, and thereby better understand the results of this study.

Post-interviewing

The post-interviews involved two different schedules. The experimental group received all the questions given the control with additional questions designed to probe student attitudes regarding the orientation experience. Both post-interview schedules also contained all the pre-interview questions.

The first question following the pre-interview questions asked the student what, if anything, he had gained from his courses since the start of the term relative to understanding engineering. An attempt was made to probe the effects of CPS 120 on understanding, identification, and desire for engineering. Information from this question could be used to further validate the post-questionnaires as well as to better understand the phenomena being studied.

Questions two, three, and four asked for evaluations of the CPS 120 course, instructor, and problem assignments. The purposes of these questions were better understanding of the study results and validation.

Question five was given to only the experimental group interviewees as it was particularly concerned with the orientation aspects of CPS 120. The comments to this question also served validation purposes.

Statistical Hypotheses

Hypothesis 1

Null Hypothesis: There is no significant difference between experimental and control groups in knowledge of engineering as a career.

Alternate Hypothesis: The experimental group has significantly more knowledge of engineering as a career than the control.

Hypothesis 2

Null Hypothesis: There are no significant differences from pre-test to post-test between experimental and control groups on:

a) frequency of changes in identification with engineering as a career; and,

b) degree of changes in identification with engineering as a career.

Alternate Hypothesis: The experimental group is significantly greater than the control group on pre-test to post-test shifts in:

a) frequency of changes in identification with engineering as a career; and,

b) degree of changes in identification with engineering as a career.

Hypothesis 3

Null Hypothesis: There are no significant differences from pre-test to post-test between experimental and control groups on:

a) frequency of changes in desire for engineering as a career; and,

b) degree of changes in desire for engineering as a career.

Alternate Hypothesis: The experimental group is significantly greater than the control group on pre-test to post-test shifts in:

a) frequency of changes in desire for engineering as a career; and,

b) degree of changes in desire for engineering as a career.

Hypothesis 4

Null Hypothesis: There is no significant difference between experimental and control groups in the number of major changes.

Alternate Hypothesis: There are significantly more major changes in the experimental group than the control group.

Hypothesis 5

Null Hypothesis: There is no significant difference between experimental and control groups regarding attitudes about required non-engineering courses.

Alternate Hypothesis: Experimental and control groups are significantly different regarding attitudes about required non-engineering courses.

Hypothesis 6

Null Hypothesis: There is no significant difference between experimental and control groups regarding definitions of the engineering fields available for study at M.S.U.

Alternate Hypothesis: Experimental and control groups are significantly different regarding definitions of the engineering fields available for study at M.S.U.

Analysis

The analysis of the data includes both descriptive statistics and statistical tests of the hypotheses. Descriptive statistics are presented in tables with explanations to make the results as meaningful as possible for the reader and to provide information regarding the research questions that is not statistically testable. With the advice of the research consultants in the College of Education and the Computer Laboratory at M.S.U., statistical models were adopted for this study that were the most powerful and appropriate for the data involved.

Decision Rule

For all tests of significance the following decision rule applies: Reject the null hypothesis (Ho); if the value of t, chi square, or F is equal to or exceeds the critical value for the appropriate degrees of freedom at an alpha level of .05.

Statistical Models

The statistical models used in the analysis of the data and the assumptions underlying their use are presented below with a discussion regarding the accuracy of these assumptions for the data.

Chi Square - Assumptions: Chi Square is used to analyze categorical or nominal scale data. The use of this test assumes adequate sample size, independance of observations, and an approximately normal population distribution.

Product Moment Correlation: Assumptions

As used in this study, no assumptions are necessary in describing the extent of linear relationship in sets of paired-score data. The correlation is used in this study to examine the possibility and extent of instructor as a confounding variable. Evaluations of the CPS 120 instructors and courses are correlated with the variables of knowledge, identification, and desire. If these variables correlate significantly with the instructor and course variables there is reason to suspect confounding.

Analysis of Covariance (ANCOVA): Assumptions

The use of ANCOVA assumes normal population distribution, equal population variances (homoscedasticity), independance of observations, parallel treatment group regression lines, and a linear relationship between the dependant variable and the covariable. This analysis is used to equate the experimental and control groups using the pre-test as the covariate. This procedure is valid to use when study groups have not had subjects randomly assigned as is the case in this study. The results of such a use of ANCOVA are correlational and cannot be interpreted as causal.

Discussion of Assumptions:

It is not completely proven that the assumptions for chi square and ANCOVA are met for the data in this study. It is, however, the opinion of the College of Education research consultants that the most essential assumptions appear to be sufficiently valid. The size of the sample and the choice of appropriate statistical models also gave support to accepting the assumptions.

Summary

A sample of 132 first term freshman engineering students are studied through use of questionnaires and interviews to determine the effects of an engineering orientation course. A group of seventy-two students received orientation to engineering as part of an introductory computer programming course while another group of sixty students took a similar programming course containing no orientation. All subjects scored 150 or better on the College Qualification Test. Reasons were discussed for studying high ability freshmen.

A pre-test was administered at the beginning of the course to determine study group equality and comparison data. Post-tests were administered at the completion of the course to determine changes and group differences on the variables. Interviews were conducted with sixteen students chosen randomly from each group both at the start and completion of the course to validate the questionnaires and obtain additional information.

The objective of the questionnaires and interviews is to determine the effect of engineering orientation on knowledge of engineering, desire for engineering, major choices, definitions of engineering specialties, and attitudes toward required non-engineering courses. Seven hypotheses and three general research questions were presented relative to the results of the study.

Analysis of the data was discussed, and it was indicated that the most powerful and appropriate statistical models are to be used. The .05 alpha level is used to determine the significance of differences between groups. Specific statistical models include chi square, product moment correlation, and analysis of covariance. Assumptions relative to these statistical models were discussed with support for the belief that these assumptions were adequately met.

CHAPTER IV

ANALYSIS OF RESULTS

The results are reported in this chapter in four sections. The first section contains results of the data pertaining to each of the hypotheses which are restated in a form specific to the questionnaire instruments used. The second section contains results relative to the research questions stated in Chapter I. The third section presents a discussion of the data analysis examining the effects of having different instructors teaching the two study courses. The final section contains the results of the interviews. Following these four sections is a summary to assist the reader in an overall understanding of the results.

Before analyzing the results of the data, the pre-test similarity of the two study groups should be noted. Of the fifty-six pre-test variables studied, the experimental and control groups were found to be significantly different, using chi square at the .05 level, on only two variables as noted in Table 11. This lends support to the assumption of equality of study groups in the experimental design.

Data Relative to Hypotheses

Hypothesis 1

Null Hypothesis: There is no significant difference between experimental and control groups in knowledge of engineering as a career as measured by subject self-ratings of the extent of understanding.

Alternate Hypothesis: The experimental group has significantly more knowledge of engineering as a career than the control group.

Table 1 presents the results of an analysis of covariance on the data for knowledge of engineering. The F value is not statistically significant at the .05 level making it impossible to reject the null hypothesis.

Table 2 presents descriptive data relative to the first hypothesis. Both study groups increased from pre-test to post-test in knowledge of engineering as a career. Neither group of subjects rated themselves much over 'moderate understanding' on the post-test.

Hypothesis 2

Null Hypothesis: There are no significant

TABLE 1. Summary of covariance analysis of experimental and control groups on knowledge of engineering

Effect	Adjusted Sums of Squares	df	Adjusted Mean Squares	F
treatment	1.184	1	1.184	2.97*
error	51.386	129	.398	

* Not significant at .05 level

Note: Pre-test used as covariate

Adjusted Means

Experimental	3.278
Control	3.084

TABLE 2: Comparison of knowledge of engineering for experimental (E) and control (C) groups

Item 1 Knowledge	Pre-test		Post-test	
	E	C	E	C
Almost No Understanding	11 15.28	1 1.67	2 2.78	0 00.00
Small Understanding	15 20.83	11 18.33	9 12.50	10 16.67
Moderate Understanding	28 38.89	30 50.00	33 45.83	30 50.00
Fairly Good Understanding	18 25.00	17 28.33	28 38.89	20 33.33
Thorough Understanding	0 00.00	1 1.67	0 00.00	0 00.00
$\bar{X}$ s	2.74 1.01	3.10 0.77	3.21 0.77	3.17 0.69

Note: In each cell, percentages are shown below corresponding frequencies.

differences from pre-test to post-test between experimental and control groups on:

a) frequency of changes in identification with engineering as a career as measured by subject self-ratings of the extent to which they can see themselves as one day becoming an engineer; and,

b) degree of changes in identification with engineering as a career as measured by subject self-ratings of the extent to which they can presently see themselves as one day becoming an engineer.

Alternate Hypothesis: The experimental group is significantly greater than the control group on pre-test to post-test shifts in:

a) frequency of changes in identification with engineering as a career; and,

b) degree of changes in identification with engineering as a career.

According to the chi square analysis presented in Table 3 it is not possible to reject null hypothesis a) at the .05 level. It is also not possible to reject null

TABLE 3. Comparison of frequency of changes in degree of identification with engineering from pre-test to post-test

Item 2	Identification with Engin. Increase	Same	Decrease	
Experimental	7 9.72	40 55.56	25 34.72	x^2=1.647*
Control	10 16.67	33 55.00	17 28.33	df=2

* Not significant at .05 level

Note: In each cell, percentages are shown below corresponding frequencies.

TABLE 4. Summary of covariance analysis of experimental and control groups on degree of shifts in identification with engineering from pre-test to post-test

Effect	Adjusted Sums of Squares	df	Adjusted Mean Squares	F
treatment	1.271	1	1.271	2.16*
error	76.028	129	0.589	

* Not significant at .05 level

Note: Pre-test used as covariate

Adjusted Means

Experimental	3.335
Control	3.532

hypothesis b) at the .05 level as shown by the analysis of covariance in Table 4. Both study groups tend to have more frequent shifts from pre to post in the direction of decreased identification. The overall results as presented in Table 5 show both groups have few responses at the low end of the identification scale on both pre and post tests.

Hypothesis 3

Null Hypothesis: There are no significant differences from pre-test to post-test between experimental and control groups on:

a) frequency of changes in subject self-ratings of the extent of desire to become an engineer; and,

b) degree of changes in subject self-ratings of the extent of desire to become an engineer.

Alternate Hypothesis: The experimental group is significantly greater than the control group on pre-test to post-test shifts in:

a) frequency of changes in desire for engineering as a career; and,

b) degree of changes in desire for

TABLE 5. Comparison of identification with engineering for experimental (E) and control (C) groups

Item 2 Identification		Pre-test		Post-test	
		E	C	E	C
Almost No Conception	1	1 1.39	0 0	5 6.94	1 1.67
Small Conception	2	5 6.94	5 8.33	7 9.72	5 8.33
Moderate Conception	3	23 31.94	14 23.33	27 37.50	22 36.67
Fairly Certain	4	32 44.44	35 58.33	26 36.11	24 40.00
Completely Sure	5	11 15.28	6 10.00	7 9.72	8 13.33
$\bar{X}$ s		3.65 0.87	3.70 0.77	3.32 1.02	3.55 0.89

Note: In each cell, percentages are shown below corresponding frequencies.

engineering as a career.

It is not possible to reject null hypothesis a) at the .05 level regarding frequency of changes as shown by the chi square analysis in Table 6. Also, the results for degree of changes are not significant at the .05 level as shown by the analysis of covariance in Table 7. It is, therefore, not possible to reject null hypothesis b). As was the case for identification, desire for engineering decreased slightly from pre-test to post-test for both study groups. In both measurements very few subjects from either study group responded in the 'small' or 'no' desire categories.

Hypothesis 4

Null Hypothesis: There is no significant difference between experimental and control groups in the number of engineering major changes from pre-test to post-test.

Alternate Hypothesis: There are significantly more engineering major changes from pre-test to post-test in the experimental group than the control group.

The chi square analysis in Table 9 shows few major changes in both study groups and no significant

TABLE 6. Comparison of frequency of changes in degree of desire for engineering from pre-test to post-test for experimental and control groups

Item 3	Desire for Engineering			
	Increase	Same	Decrease	
Experimental	14 19.44	41 56.94	17 23.61	x^2= 0.444*
Control	10 16.67	33 55.00	17 28.33	df=2

* Not significant at .05 level

Note: In each cell, percentages are shown below corresponding frequencies.

TABLE 7. Summary of covariance analysis of experimental and control groups on degree of shifts in desire for engineering from pre-test to post-test

Effect	Adjusted Sums of Squares	df	Adjusted Mean Squares	F
treatment	0.002	1	0.002	0.004*
error	64.288	129	0.498	

* Not significant at .05 level

Note: Pre-test used as covariate

Adjusted Means

Experimental	3.511
Control	3.503

TABLE 8. Comparison of desire for engineering for experimental (E) and control (C) groups

Item 3 Desire		Pre-test E	Pre-test C	Post-test E	Post-test C
Almost No Desire	1	1 1.39	0 0	3 4.17	0 0
Small Desire	2	1 1.39	1 1.67	3 4.17	5 8.33
Moderately Desired	3	30 41.67	23 38.33	28 38.89	24 40.00
Greatly Desired	4	35 48.61	31 51.67	32 44.44	25 41.67
Desired Exclusive	5	5 6.94	5 8.33	6 8.33	6 10.00
$\bar{X}$		3.58	3.67	3.49	3.53
s		0.71	0.66	0.87	0.79

Note: In each cell, percentages are shown below corresponding frequencies.

difference between the groups. It is, therefore, not possible to reject the null hypothesis at the .05 level.

The summary data in Table 10 presents the rank ordering of engineering majors. (For more complete information refer to Table 17 in Appendix C). The study groups are fairly similar in their ranking of the various engineering fields on the pre-test, but this similarity approaches complete agreement on the post-test with slight disagreements appearing in the ranks of only two of the seven majors.

Hypothesis 5

Null Hypothesis: There is no significant difference between experimental and control groups regarding attitudes about required non-engineering courses as measured by subject ratings of the truth of each of six statements related to why such courses might be required.

Alternate Hypothesis: Experimental and control groups are significantly different regarding attitudes about required non-engineering courses.

TABLE 9. Comparison of major changes from pre-test to post-test for experimental and control groups

Item 5	Major Choice		
	Changed	Same	
Experimental	9 12.50	63 87.50	$x^2 = 0.461$*
Control	10 16.67	50 83.33	

* Not significant at .05 level

Note: In each cell, percentages are shown below corresponding frequencies.

TABLE 10. Summary comparison of ranks of engineering majors for experimental (E) and control (C) groups

Item 4	Ranks			
	Pre		Post	
Majors	E	C	E	C
Agricultural	7	7	7	7
Civil	6	5	5	5
Electrical	2	1	1	1
Mechanical	4	3	4	3
Metallurgy	5	6	6	6
Chemical	1	2	2	2
Eng. Science	3	4	3	4

Of the thirty chi squares computed on the pre-test (Table 11) only two were significant at the .05 level. This pre-test similarity of the groups supports the experimental design. The post-test chi squares revealed only two significant at the .05 level making it necessary to fail to reject the null hypothesis. (Table 12)

Table 13 presents the pre and post means for each opinion statement on each course for the combined study groups. Although there was no significant difference between the groups, the overall trend for combined subjects is worth noting. With only three exceptions, the following statements gained in truth from pre-test to post-test as reasons why non-engineering courses might be required:

a) Mental exercise to develop thought processes

b) Part of an education; no particular application

c) An academic filter to remove all unqualified

d) Something engineers might find useful, but not usually a necessity.

The only statement that decreased in the truth ratings from pre-test to post-test was: 'A necessary tool in my future field of work'. Opinion was divided on 'A prerequisite to later courses', with a high percentage of subjects failing to respond or responding with "no opinion".

TABLE 11. Summary of chi square comparisons on pre-test measurement of attitudes toward required non-engineering courses for experimental and control groups

Item 7	Math	Chem.	Physics	Computer Science	English
Mental Exercise to Develop Thought Processes	6.193 4	1.110 4	5.650 4	7.018 4	11.147* 4
A Necessary Tool in My Future Field of Work	3.437 1	1.624 3	5.186 4	5.163 4	7.777 4
Part of an Education; No Particular Application	6.777 4	3.534 4	2.642 4	3.654 4	0.593 4
An Academic Filter to Remove All Unqualified	2.035 4	2.997 4	3.448 4	9.537* 4	5.669 4
Something Engineers Might Find Useful but not Usually a Necessity	4.325 4	1.638 4	4.342 4	1.399 4	6.650 4
A Prerequisite to Later Courses	2.387 4	2.420 4	5.591 4	1.055 4	1.710 4

* Significant at .05 level

Notes: In each cell, degree of freedom are shown below corresponding chi square values. Although each chi square table was 2x5, the degrees of freedom are less than 4 in those cases where no subject chose one or more response categories.

TABLE 12. Summary of chi square comparisons on post-test measurement of attitudes toward required non-engineering courses for experimental and control groups

Item 7	Math	Chem.	Physics	Computer Science	English
Mental Exercise to Develop Thought Processes	5.091 4	3.627 4	4.555 4	1.942 4	9.337 4
A Necessary Tool in My Future Field of Work	6.709* 2	5.120 4	1.354 3	5.862 4	5.931 4
Part of an Education; No Particular Application	8.508 4	4.440 4	1.928 4	7.854 4	6.888 4
An Academic Filter to Remove All Unqualified	1.432 4	1.663 4	1.182 4	3.052 4	4.825 4
Something Engineers Might Find Useful but not Usually a Necessity	3.901 3	5.206 4	8.958* 3	4.140 4	3.653 4
A Prerequisite to Later Courses	2.100 3	2.907 4	8.289 4	2.566 4	3.685 4

* Significant at .05 level

Notes: In each cell, degrees of freedom are shown below corresponding chi square values. Although each chi square table was 2x5, the degrees of freedom are less than 4 in those cases where no subject chose one or more response categories.

TABLE 13. Comparison of pre-test and post-test mean ratings of opinions regarding required non-engineering courses for combined study groups.

Item 7		Math	Chemistry	Physics	Computer Science	English
Mental Exercise to Develop Thought Processes	Pre	1.78	2.31	2.11	2.28	2.20
	Post	1.71	2.29	2.09	1.89	2.38
A Necessary Tool in My Future Field of Work	Pre	1.03	1.67	1.38	1.42	2.35
	Post	1.12	1.97	1.52	1.64	2.81
Part of an Education; No Particular Application	Pre	3.82	3.35	3.58	3.59	2.67
	Post	3.70	3.27	3.61	3.51	2.20
An Academic Filter to Remove all Unqualified	Pre	2.97	2.98	3.02	3.37*	3.57
	Post	2.75	2.60	2.81*	3.03	3.24
Something Engineers Might Find Useful but not Usually a Necessity	Pre	3.83	2.95	3.37	3.00	2.45
	Post	3.80	2.84	3.46	2.71	2.37
A Prerequisite to Later Courses	Pre	1.65	1.86	1.93	2.39*	3.23*
	Post	1.36	2.17	1.97	2.32	3.19*

* 10% or more "no responses" and "no opinion" responses.

KEY

1. Very True 2. Somewhat true 3. Somewhat untrue 4. Very untrue

Hypothesis 6

Null Hypothesis: There is no significant difference between experimental and control groups regarding definitions of the engineering fields available for study as measured by subjects indicating where, in seven categories of engineering work, engineers from each field are most greatly involved.

Alternate Hypothesis: Experimental and control groups are significantly different regarding definitions of the engineering fields available for study.

Table 14 presents a summary of the chi squares computed for hypothesis 6. The only field defined significantly different by the two study groups is Electrical Engineering. This being the case, it is not possible to reject the null hypothesis at the .05 level.

Data Relative to Research Questions

The three general research questions dealt with student evaluations of the orientation course. The

TABLE 14. Summary of chi square comparisons of experimental and control groups on definitions of engineering majors

Majors (Item 6)	Pre	Post
Civil	11.737 7	4.215 6
Mechanical	3.955 6	1.432 5
Electrical	6.097 4	11.119* 5
Chemical	3.801 6	2.910 5
Metallurgy	4.665 6	2.805 5
Agricultural	6.432 7	7.020 7
Engineering Sciences	5.211 7	6.345 7
All Majors	11.955 7	9.088 5

* Significant at .05 level

Notes: In each cell, degrees of freedom are shown below corresponding chi square values. Although each chi square table was 2x8, the degrees of freedom are less than 7 in those cases where no subject chose one or more response categories.

questions were:

1. To what extent do experimental group subjects feel they have enjoyed the orientation course?

2. Do experimental group subjects feel that the orientation presentations were worthwhile?

3. Do experimental group subjects feel that the orientation presentations were well integrated with the computer science content of the course?

Tables 15 and 16 present the data relative to course evaluation. Generally the subjects enjoyed the orientation course, giving it a mean rating of 3.68 on a five point scale. The orientation presentations were seen as worthwhile with a mean rating of 3.28. The students felt the orientation presentations were fairly well integrated with the computer course content as indicated by a mean rating of 3.17.

The highest ratings went to: "How much do you feel you have profited from this course?" (3.90); "How would you rate the overall value of the problem assignments for teaching you computer programming?" (3.94); and, "To what extent did these special presentations help you to understand what the work of engineers involves?" (3.74)

Subjects' ratings of how helpful each of the six individual presentations were for understanding the work

Key for TABLE 15

Items	Questions
8	To what extent have you enjoyed CPS 120?
14	How would you rate the overall value of the problem assignments for teaching you computer programming?
19	How much do you feel you have profited from this course?
20	How would you rate the worth of the orientation presentations?
21	To what extent do you feel the orientation presentations were well integrated, or seemed a natural part of the regular computer course content?
22	To what extent did these special presentations help you to understand what the work of engineers involves?

TABLE 15. Post-test data on experimental group ratings of CPS 120

Rating Scale	Post Experimental Items					
	8	14	19	20	21	22
Positive 5	25 35.21	23 32.39	25 35.21	10 13.89	10 13.89	16 22.22
4	17 23.94	30 42.25	25 35.21	22 30.56	18 25.00	30 41.67
3	16 22.54	11 15.49	13 18.31	21 29.17	21 29.17	18 25.00
2	7 9.86	5 7.04	5 7.04	16 22.22	20 27.78	7 9.72
Negative 1	6 8.45	2 2.82	3 4.23	3 4.17	3 4.17	1 1.39
No Response	1	1	1	0	0	0
$\overline{X}$	3.68	3.94	3.90	3.28	3.17	3.74
s	1.28	1.01	1.10	1.09	1.11	0.96

Note: In each cell, percentages are shown below corresponding frequencies.

TABLE 16. Data from post experimental group ratings of each individual orientation presentation

Rating Scale	Orientation Presentations					
	A	B	C	D	E	F
Very Helpful 1	20 27.78	6 8.33	14 19.44	22 31.43	12 17.14	18 31.03
Somewhat Helpful 2	30 41.67	37 51.39	23 31.94	33 47.14	23 32.86	25 43.10
Slightly Helpful 3	18 25.00	24 33.33	32 44.44	11 15.71	21 30.00	7 12.07
Not Helpful 4	4 5.56	5 6.94	3 4.17	4 5.71	14 20.00	8 13.79
No Response	0	0	0	2	2	14
$\overline{X}$	2.08	2.39	2.33	1.96	2.53	2.09
s	0.87	0.74	0.84	0.84	1.00	1.00

Notes: In each cell, percentages are shown below corresponding frequencies. Orientation presentations are not identified by name because this information is not relevant, and to avoid publishing ratings which could be related to specific faculty members.

of engineers ranged from a low of 2.53 to a high of 1.96 on an inverted four point scale. These ratings are somewhat in conflict with the results of the general rating given for all the orientation presentations. The value of the presentations for helping one understand the work of engineers is less when each presentation is rated individually.

Data Pertaining to Instructor as a Confounding Variable

Although not part of the regular analysis of the data, attention was given to determining the extent to which having different instructors for the two study groups affected the outcomes of the study. Table 18 in Appendix C shows that, of the twelve instructor and course rating questions, the experimental and control groups differ significantly in four chi square analyses at the .05 level. To further determine the effects of having different instructors, simple correlations were computed between instructor ratings and knowledge, identification, and desire; between course ratings and knowledge, identification and desire; and, between a composite of course and instructor ratings and knowledge, identification, and desire. (See Table 19, Appendix C) The object was to determine if there was a relationship between extraneous variables affected by instructor and the main variables of interest in this study. The correlations exhibit very little relationship with no significant differences between respective experimental and control group correlations at the .05 level. This data lends support to the contention that instructor is not a significant confounding variable, but this is not a firm conclusion.

Analysis of the Interviews

This analysis contains a summary of the interviews, grouped according to pre and post, and in the same order as the general questions described in Chapter III under Interview Schedules. It is not the purpose here to give numerical frequencies of various comments; rather, it is the purpose to provide the reader with major trends from the interviews.

Pre-Interviews

The comments in this section are selected from both experimental and control groups because no major differences appear between the groups in the pre-interviews. This fact lends support to the contention that the study groups were sufficiently similar. Also included in this section are the comments from the post-interviews. Some of this pre-interview information will be reported later under the section entitled Post-Interviews. This is done because student responses to certain questions could have been affected by having completed one term of college academic work and CPS 120.

The subjects recalled their initial interests in engineering occurred predominately toward the later years of high school, although the responses ranged from "always had this interest" to "haven't developed this interest yet". The actual decision to study engineering in college usually occurs late in high school. The causes of first developing an interest in engineering were often the same as the causes or catalysts indicated for deciding to study engineering. Career choice was affected by: positive experiences with mathematics and science courses, relatives and friends who are engineers, and teacher and counselor advice. Students almost unanimously felt their choice of engineering was firm although the particular field of specialization may not have been decided upon.

A great variety of activities and experiences were noted with regard to how students developed an understanding of engineering. These include: talking with relatives and friends who are engineers; touring factories and engineering schools; college and engineering society seminars and summer institutes; career literature and career days; and, practical experience with automobiles and computers. Students generally felt their understanding of engineering was inadequate, but plans to improve this understanding ranged from "no plans" to a wide range of detailed plans, including: college courses, talking to engineers, reading, and summer jobs.

Providing an understanding of the various engineering fields available was a minor service the College of Engineering could provide. Students were most hopeful that the College would provide a good engineering education, a good liberal education, and help with surviving academically.

The major concerns of these new freshmen surround the area of grades and academic success. Social and psychological adjustment were of next importance with career choice being of least concern.

The extra-curricular activities and interests of these students prior to college covered a broad spectrum from "practically nothing" to "total involvement". The most relevant finding was that these students were rarely involved with science or engineering clubs and science projects. Tinkering, experimenting, and inventing were also infrequently mentioned. Most frequently mentioned activities were: sports, clubs, student government, honors programs and societies, church and community activities, academic institutes and seminars, and music.

Post-interviews

Major results of the post-interviews are reported for the control group first, followed by those for the experimental group. Information of a specific nature relative to instructor evaluation is not presented as it is not appropriate to publish. It should be noted that this information has been supplied to the instructors for their review.

Post Interviews: Control Group

Control subjects, when asked how firm their decision was to major in engineering, evidenced some decrease from pre-interviews in their confidence with engineering as a major choice. This decreased confidence is not uniform as some students showed the same firmness as appeared in pre-interviews, while others were less sure engineering was an attainable goal even though it was still highly desirable. Overall, control subjects were less firm in their choice of engineering as a major.

Generally, control subjects felt that they had done little or nothing during their first term of college to develop a better understanding of engineering. Control subjects had more plans to develop this understanding and about the same amount of dissatisfaction with their understanding as appeared in pre-interviews.

Responses to the question regarding what the student would like the College to do for him were quite similar to pre-interview comments to this question. Students did offer a few more specific comments, such as "better text material" and "laboratory research".

The major concerns of the control subjects did not appear much different from the pre-interviews. The attention was again focused on grades with career choice as very secondary.

Control subjects felt that they gained little or nothing during their first term from courses regarding an understanding of engineering. What they did gain usually was based on successes and failures in their courses which provided them with an indication of their chances of succeeding in the engineering curriculum. Specifically, the CPS 120 course was seen as having no effect on understanding of engineering except in a few cases where the experience with CPS 120 either encouraged or discouraged majoring in Computer Science.

In evaluating the CPS 120 instructor and course, the control subjects offered a variety of suggestions for improvement. They felt the technical problem assignments were an effective and necessary method of teaching computer programming, but these assignments provided very little understanding of engineering.

Post Inverviews: Experimental Group

Experimental subjects expressed feelings very similar to those of the controls on firmness of their decision to major in engineering. Less confidence in engineering as a major choice was expressed along with unsureness that engineering was an attainable goal.

In regard to what the students had done during the term to develop an understanding of engineering, two-thirds of the experimental subjects mentioned the CPS 120 course. They also indicated greater satisfaction with their understanding of engineering than was indicated by control subjects. With this satisfaction came fewer plans than control group subjects had expressed for further developing their understanding of engineering.

The major concerns of the experimental subjects were with grades and academic success. This finding is identical with that for the controls as also is the finding that career choice is either very secondary as a concern or non-existent. This represents no difference from the pre-interviews.

Experimental subjects felt they gained a better understanding of engineering during their first term from CPS 120, but little or nothing from any other course. Contrary to the control subjects' opinions, the experimentals felt CPS 120 not only had relevance for choosing a Computer Science major but was also helpful in defining other engineering fields.

Evaluations of the CPS 120 course were very similar to those given by control subjects with specific suggestions offered. Instructor evaluations were different from those of control subjects. Although both study groups indicated an overall satisfaction with the instructors, there was clearly a difference in degree of satisfaction. The technical problem assignments were seen as only a little more helpful for understanding engineering than as seen by controls.

In evaluating the orientation presentations the experimental subjects generally thought most of the presentations were good and worthwhile. Suggestions were offered for modifying some or all of the presentations since several students noted that sometimes the technical content was too advanced and dull. One student pointed out that the presentations were particularly interesting to those concerned about major choice, but those not concerned knew they would not be graded on the material, and therefore, ignored it. Several students expressed a desire that the presentations explain engineering more comprehensively and in more depth. These same students also recognized the difficulty of this task in the short times provided with the structure of the class.

All experimental interviewees felt the presentations helped their understanding of engineering, but all qualified the degree of help as "moderate" and "fair".

The CPS 120 course, as a whole, was seen as more helpful than the presentations for understanding engineering. Students did not see the orientation presentations as affecting their choice of majors or changes within or outside of engineering.

Summary

The data were analyzed with chi square and analysis of covariance tests using a .05 confidence level. Tables were provided containing the results of the statistical tests and descriptive data. The data for all hypotheses failed to reject the null.

Data relative to the research questions revealed that students generally enjoyed the orientation course, found the orientation presentations worthwhile, and found the orientation presentations well integrated with the computer science content of the course. There was some conflict between ratings of the general value of the orientation presentations for defining the work of engineers and ratings given to each individual presentation. When rated separately, the presentations received lower ratings. Students rated the amount they profited from the orientation course, and the value of the problem assignments for teaching computer programming very highly.

Analyses of the data to determine whether having different instructors for the two study groups affected the main effect variables showed little confounding present. Although the total effect of having different instructors cannot be completely evaluated, the data support the contention of no significant instructor effects.

Analyses of the pre-test data and the interviews showed the study groups to be equated. Further analysis of interview results relative to specific questionnaire items provided evidence of the validity of the questionnaire instruments.

Pre and post interviews for both study groups were summarized. Further discussion of the interviews, including relating them to the data will follow in Chapter V.

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter contains a major summary of the study followed by a list of pertinent conclusions. A discussion is provided to integrate and interpret the findings. The final section contains implications for future research.

Summary

There is a concern in engineering education that engineering students begin their college studies with an insufficient understanding of engineering as a career and discipline. Many methods have been employed to orient students to engineering, including, in particular, freshman engineering courses. Little evaluation of such courses has been conducted.

It was the purpose of this study to evaluate the effects of a ten week course in computer programming containing orientation to engineering fields on high ability, first-term engineering freshmen at Michigan State University. Students receiving the orientation (experimental group) were compared with a similar group of students taking a computer course with no orientation (control group).

The following hypotheses were stated.

1. The experimental group has greater knowledge of engineering than the control group.

2. The experimental group is more affected than the control group in identification with engineering as a career.

3. The experimental group is more affected than the control group in desire for engineering as a career.

4. The experimental group experiences more major changes than the control group.

5. Control and experimental groups differ in their views of required non-engineering courses.

6. Control and experimental groups differ in their definitions of each of the engineering fields available for study.

Relevant literature was reviewed in three related areas, including: freshman engineering courses; studies of attrition and the need for orientation; and, literature related to orientation needs. It was noted that although reports are incomplete and somewhat conflicting, approximately one-half to two-thirds of all accredited engineering schools offer some type of engineering course in the freshman year. The primary purposes of such courses are motivation, understanding, and contact with students and faculty. There seems to be a conflict in that, although understanding and guidance are stressed, the "hard sell" is frequently practiced. Various writers point out that, due to the nature of engineering curricula, students have little contact with engineering until the junior year. This delayed contact is often felt to be responsible for high attrition, low motivation, difficulties in choosing majors, and lasting dissatisfaction in the profession.

The study involved a sample of 132 first term engineering freshmen at Michigan State University who scored 150 or higher on the total of the College Qualification Test. Seventy two students (experimental group) took a computer programming course containing lecture and film presentations on six areas of engineering. The control group had 60 students taking a similar course with no presentations on the nature of fields of engineering. Questionnaires and interviews were used at the beginning and end of the courses to gather descriptive data and test the hypotheses. An attempt was made to apply the most powerful and appropriate statistical models. The level of confidence was set at .05 for all tests.

The results of the study showed no support for any of the six hypotheses. It was found that experimental group subjects were, in general, favorably inclined towards the orientation course. There was some conflict between ratings of the overall value of the orientation presentations and ratings of the value of each individual presentation. When rating the presentations individually the subjects found them less helpful for understanding engineering than when rating the presentations as a group.

Although there was some concern that having different instructors for the two study courses might confuse an interpretation of the results, the correlation analyses showed little support for such a concern. It was noted however, that having different instructors may yet be a confounding variable.

Interviews revealed that subjects were not actively concerned about major choice or understanding engineering. Grades and academic success were the over-riding concerns. Experimental subjects indicated a greater satisfaction with the understanding they had gained of engineering than that indicated by control group subjects. Experimental subjects gave favorable evaluations of the orientation presentations but indicated the experience had little affected major choice plans. Subjects in the orientation course expressed an understanding for why more could not be covered in the short presentations, but there was general agreement that more was needed.

Conclusions

Within the limitations of this study the following conclusions can be drawn:

1. Students receiving the engineering orientation gained no more knowledge of engineering as a career than those who received no orientation.
2. Identification with engineering as a career was not significantly affected by the orientation course.
3. Desire for engineering as a career was not significantly affected by the orientation course.
4. The orientation course did not significantly affect major changes.
5. Attitudes regarding the rationale for certain non-engineering courses were not significantly affected by the orientation course.
6. Insignificant effects were reflected from the orientation course on definitions of each of the engineering fields available for study.
7. The orientation presentations as a whole were seen as helpful for understanding the

work of engineers, but, when rated individually, were seen as only of moderate value.

8. The orientation presentations were seen as well integrated with the computer science content of the course.
9. The orientation course was seen as a fairly profitable and enjoyable experience.
10. Students were little concerned with major choice and understanding engineering as a career, and were predominately concerned with grades and academic success.
11. Students who completed the orientation course showed greater satisfaction in the interviews with their knowledge of engineering as a career than students who had completed the control course.

Discussion

Although the results of this study relative to the hypotheses were not positive, one point is particularly important to note relative to previous studies. As noted in Chapter II, reported attempts to evaluate freshman engineering courses use satisfaction scales predominately to measure success. The results of this study show that satisfaction may be insufficient as a criterion. Students in this study were generally satisfied with the orientation course, but little effect of the course was detected by changes in the students' understandings, attitudes, opinions, and actions. Perhaps satisfaction is a necessary criterion, but it does not appear sufficient as the single evaluative criterion.

The interviews revealed one possible reason for the lack of specific effects of the orientation course. The students expressed very little interest in gaining a better understanding of engineering, or in choosing a specific engineering major. In most cases the students had already decided on engineering, and upon specific fields within engineering. This lack of relevant concern could contribute to little attention being given to the orientation, especially when it is considered that grades were not based on a knowledge of the substance of the orientation presentations.

The interview results confirm the findings of the questionnaires. The only apparent difference between interview and questionnaire results involved ratings related to knowledge of engineering. The questionnaire results showed no significant difference between experimental and control groups on the post-test in student self-ratings of the extent of knowledge of engineering as a career. The post interview asked the students to rate their satisfaction with their knowledge of engineering as a career. From this 'satisfaction' point of view the experimental group was significantly greater than the control. This discrepancy in responses could be an indication that the orientation course did positively serve to significantly affect students' feelings about their understanding of engineering even though this understanding was considered by them to be incomplete by relative standards.

Implications for Future Research

Within the design of this study only short-term effects were analyzed. Undoubtedly it would be best to conduct a longitudinal study encompassing the time period commencing when a student completes the course, and extending until he graduates. Actually, to warrant such an ambitious study it would be advisable to plan the orientation course for more extensive contact with, and involvement of the students.

It would also be advisable to study the effects of an engineering orientation course given the students at various times during the freshman and sophomore years. Perhaps students are most affected by such a course during the time period when they are also most keenly interested in understanding engineering and clarifying major choices. The first term of college may very well be the term of least impact since students are pre-occupied with unfamiliar academic demands. In order to contact each student at that time when he is most greatly concerned about the nature of his future career, it may be necessary to conduct a continuous orientation course in the first year or two of college.

This study was limited to high ability students. Future studies should be aimed at other ability levels as well. In addition to studying students selected out from the total on the basis of ability, it might also be worthwhile to look at the effects of an engineering orientation course on students of varying personalities and psychological needs. It may be that certain types of students have more need for such a course and will profit more than others. If some means could be developed to identify these students, special attention could be given them in the form of a course or other alternate programs.

The course involved in this study represents only one of the many types of programs for the orientation of engineering students. Other types of orientation courses should be more carefully evaluated to determine the best methods for informing the engineering student, early in his college program, about his relatively ill-defined career pattern opportunities.

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APPENDICES

APPENDIX A

The Questionnaires

Pre-test Instructions and Questionnaire
Experimental and Control Groups

Dear Engineering Student:

Attached to this letter is a questionnaire which the College of Engineering would like you to complete during this class today. The total questionnaire will take less than 15 minutes for you to complete, but the time you take will be a positive contribution to our understanding and serving you better.

Please read the directions for each individual item, and be sure to complete all items. Be as honest and frank in your responses as possible. There are no correct answers as we are interested only in your attitudes and understandings.

Your questionnaire should contain three pages. If your questionnaire is incomplete or you have any questions, please raise your hand and Mr. Laubenthal will assist you.

Be assured that your responses will be kept confidential. We ask for your name only to enable us to conveniently match this questionnaire with the Personal Data Form you filled out in Summer Orientation and a second questionnaire we will ask you to complete at the end of this term. No individual will ever be identified with his responses, and all questionnaires will be destroyed after data has been grouped by categories.

Thank you for your assistance.

Engineering Student Affairs

Date____________________________

Please Print

(1 - 6) STUDENT NUMBER__________ NAME____________________________
Last First Initial

I am presently enrolled in the College of:
______1. Engineering ______2. Other________________

1. _____(7) The extent of my knowledge of engineering as a career could be described as: (Check one)

____1. Almost no understanding
____2. Small understanding
____3. Moderate understanding
____4. Fairly good understanding
____5. Thorough understanding

2. ______(8) The extent to which I presently see myself as one day becoming an engineer could be described as:

____1. I have almost no conception of this.
____2. I have a small conception of this.
____3. I am moderately able to conceive of this.
____4. I am fairly certain of this.
____5. I am almost completely sure of this.

3. _____(9) The extent to which I presently desire to become an engineer could be described as:

____1. Almost no particular desire
____2. A small desire
____3. Moderately desired
____4. Greatly desired
____5. Desired exclusive of any other career

4. (10-17) Rank the following engineering fields according to how you perceive the general occupational opportunities, including advancement, job satisfaction, salary, etc. Give the engineering field offering the greatest opportunity a ranking of 1, and continue ranking each successive field with a higher number.

(10)____Agricultural
(11)____Civil
(12)____Electrical
(13)____Mechanical
(14)____Metallurgy
(15)____Chemical
(16)____Engineering Sciences

5. (17) My tentative choice of major in Engineering is now. (Check one)

____1. Agricultural Engineering
____2. Chemical Engineering
____3. Civil Engineering
____4. Electrical Engineering
____5. Mechanical Engineering
____6. Metallurgy
____7. Engineering Sciences: includes Computer Science, Systems Science, and Materials Science

(Please turn to page 2)

6. (18-25) Check the appropriate boxes below which indicate where you feel the engineers listed at the left are most greatly involved. Check only one box per engineering category.

	1. Administrative	2. Design	3. Construction	4. Consulting & Sales	5. Manufacturing & Operation	6. Research & Development	7. Teaching	8. About Equal Proportions
(18) Civil								
(19) Mechanical								
(20) Electrical								
(21) Chemical								
(22) Metallurgy								
(23) Agricultural								
(24) Engineering Sciences								
(25) All Engineering								

7. (26-55) An engineering student takes many non-engineering courses before he begins the courses of his particular major. Listed below are some of these courses along with a list of possible reasons for taking them. Using the key below, please rate each reason according to how true you feel it is for taking each course.

1. Very true
2. Somewhat true
3. Somewhat untrue
4. Very untrue
5. No opinion

	Math (26-31)	Chemistry (32-37)	Physics (38-43)	Computer Science (44-49)	English (ATL) (50-55)
Mental Exercise to Develop Thought Processes					
A Necessary Tool in My Future Field of Work					
Part of an Education; No Particular Application					
An Academic Filter to Remove All Unqualified					
Something Engineers Might Find Useful but not Usually a Necessity					
A Prerequisite to Later Courses					

(56-67) For the following items please place a check on the one blank that represents your best answer.

8\. ____(56) To what extent have you enjoyed CPS 120?

Very Much ___ ___ ___ ___ ___ Not At All
5 4 3 2 1

9\. ____(57) Were course objectives defined at the beginning of the term?

Clearly Defined ___ ___ ___ ___ ___ Not Mentioned
5 4 3 2 1

10\. ____(58) How well do you feel course objectives were met?

Very Well ___ ___ ___ ___ ___ Not Met At All
5 4 3 2 1

11\. ____(59) How would you rate the work load in this course?

Very Reasonable ___ ___ ___ ___ ___ Excessive Demands
5 4 3 2 1

12\. ____(60) How would you rate the way you have thus far been graded in this course?

Very Fair ___ ___ ___ ___ ___ Very Unfair
5 4 3 2 1

13\. ____(61) How would you rate the content of exams given in this course?

Very Fair ___ ___ ___ ___ ___ Very Unfair
5 4 3 2 1

14\. ____(62) How would you rate the overall value of the problem assignments for teaching you computer programming?

Very Effective ___ ___ ___ ___ ___ Not Effective
5 4 3 2 1

15\. ____(63) How well did lectures and reading assignments prepare you for problem assignments?

Very Well ___ ___ ___ ___ ___ Not At All
5 4 3 2 1

16\. ____(64) How open do you feel your instructor was to in-class questions and discussion?

Very Open ___ ___ ___ ___ ___ Not Open
5 4 3 2 1

17. ____(65) How welcome did you feel to see your instructor outside of class for assistance?

Very Welcome ___ ___ ___ ___ ___ Not Welcome
5 4 3 2 1

18. ____(66) How clear or understandable were the lectures by the computer science instructor?

Very Clear ___ ___ ___ ___ ___ Very Unclear
5 4 3 2 1

19. ____(67) How much do you feel you have profitted from this course?

Very Much ___ ___ ___ ___ ___ Not At All
5 4 3 2 1

(Please go on to next page)

(68-70)

20. ____(68) In the CPS 120 class this term several professors made special presentations relating to some of the engineering fields available for study at Michigan State. Indicate below your general impression of the worth of these presentations to you. Do not rate the problem assignments associated with each presentation, but only the presentations themselves.

Very Worth While ___ 5 ___ 4 ___ 3 ___ 2 ___ 1 Not Worth While

21. ____(69) To what extent do you feel the special presentations in this course were well integrated, or seemed a natural part of the regular computer course content?

Well Integrated ___ 5 ___ 4 ___ 3 ___ 2 ___ 1 Not Integrated

22. ____(70) To what extent did these special presentations help you to understand what the work of engineers involves?

Very Much ___ 5 ___ 4 ___ 3 ___ 2 ___ 1 Not At All

23. (71-76) Using the key below please rate each of the special presentations given in CPS 120 this term. Do not rate the problem assignments associated with each presentation, but only the presentations themselves. The ratings in the key pertain to the amount each presentation helped you to better understand the work of engineers. Use the appropriate number to rate each presentation.

KEY

1. Very Helpful
2. Somewhat Helpful
3. Slightly Helpful
4. Not Helpful

Presentations	Related Problems	Ratings
____(71) Agricultural Engineering	Prob. #2 Rainfall Amounts	____
____(72) Metallurgy	Prob. #3 Lattice Parameter	____
____(73) Chemical Eng.	Prob. #4 Neutron Activation Analysis	____
____(74) Mechanical Eng.	Prob. #5 Air-Water Rocket	____
____(75) Systems Science	Prob. #6 Systems Process Control	____
____(76) Civil Engineering	None	____

In the space provided below please indicate any and all experiences you may have had before taking CPS 120 with computers and/or computer programming. Please define as carefully as possible the nature of these experiences and the amount of time involved (Examples: a ten week course in Fortran at XYZ Junior College; built a a computer designed to do such and such; a two week institute at M.S.U.)

If you have had no such previous experience, write "none" in the space provided.

Post-test Instructions and Questionnaire
Control Group

Dear Engineering Student:

Earlier this quarter you completed a questionnaire similar to the attached form. To complete this study we need your reactions again. Do not try to remember your responses to the earlier questionnaire because it is important that you make your answers an honest and accurate account of how you feel and what you know now.

Please read the directions for each individual item and be sure to complete all items. There are no correct answers as we are interested only in your attitudes and understandings.

Your questionnaire should contain six pages. If your questionnaire is incomplete or you have any questions, please raise your hand and Mr. Laubenthal will assist you.

Be assured, as before, that your responses will be kept confidential. No individual will be identified with his responses and all questionnaires will be destroyed after data has been grouped by categories.

Please feel welcome to inquire about the nature and outcome of this study from Mr. Laubenthal in Room 116 Engineering Building.

Thank you for your assistance.

Engineering Student Affairs

Date________________________

Please Print

(1 - 6) STUDENT NUMBER__________ NAME______________________________
Last First Initial

I am presently enrolled in the College of:
______1. Engineering ______2. Other________________

1. _____(7) The extent of my knowledge of engineering as a career could be described as: (Check one)

____1. Almost no understanding
____2. Small understanding
____3. Moderate understanding
____4. Fairly good understanding
____5. Thorough understanding

2. ______(8) The extent to which I presently see myself as one day becoming an engineer could be described as:

____1. I have almost no conception of this.
____2. I have a small conception of this.
____3. I am moderately able to conceive of this.
____4. I am fairly certain of this.
____5. I am almost completely sure of this.

3. _____(9) The extent to which I presently desire to become an engineer could be described as:

____1. Almost no particular desire
____2. A small desire
____3. Moderately desired
____4. Greatly desired
____5. Desired exclusive of any other career

4. (10-17) Rank the following engineering fields according to how you perceive the general occupational opportunities, including advancement, job satisfaction, salary, etc. Give the engineering field offering the greatest opportunity a ranking of 1, and continue ranking each successive field with a higher number.

(10)____Agricultural
(11)____Civil
(12)____Electrical
(13)____Mechanical
(14)____Metallurgy
(15)____Chemical
(16)____Engineering Sciences

5. (17) My tentative choice of major in Engineering is now. (Check one)

____1. Agricultural Engineering
____2. Chemical Engineering
____3. Civil Engineering
____4. Electrical Engineering
____5. Mechanical Engineering
____6. Metallurgy
____7. Engineering Sciences: includes Computer Science, Systems Science, and Materials Science

(Please turn to page 2)

6. (18-25) Check the appropriate boxes below which indicate where you feel the engineers listed at the left are most greatly involved. Check only one box per engineering category.

	1. Administrative	2. Design	3. Construction	4. Consulting & Sales	5. Manufacturing & Operation	6. Research & Development	7. Teaching	8. About Equal Proportions
(18) Civil								
(19) Mechanical								
(20) Electrical								
(21) Chemical								
(22) Metallurgy								
(23) Agricultural								
(24) Engineering Sciences								
(25) All Engineering								

7. (26-55) An engineering student takes many non-engineering courses before he begins the courses of his particular major. Listed below are some of these courses along with a list of possible reasons for taking them. Using the key below, please rate each reason according to how true you feel it is for taking each course.

1. Very true
2. Somewhat true
3. Somewhat untrue
4. Very untrue
5. No opinion

	Math (26-31)	Chemistry (32-37)	Physics (38-43)	Computer Science (44-49)	English (ATL) (50-55)
Mental Exercise to Develop Thought Processes					
A Necessary Tool in My Future Field of Work					
Part of an Education; No Particular Application					
An Academic Filter to Remove All Unqualified					
Something Engineers Might Find Useful but not Usually a Necessity					
A Prerequisite to Later Courses					

(56-67) For the following items please place a check on the one blank that represents your best answer.

8. ____(56) To what extent have you enjoyed CPS 120?

Very Much ___ ___ ___ ___ ___ Not At All
(5 4 3 2 1)

9. ____(57) Were course objectives defined at the beginning of the term?

Clearly Defined ___ ___ ___ ___ ___ Not Mentioned
(5 4 3 2 1)

10. ____(58) How well do you feel course objectives were met?

Very Well ___ ___ ___ ___ ___ Not Met At All
(5 4 3 2 1)

11. ____(59) How would you rate the work load in this course?

Very Reasonable ___ ___ ___ ___ ___ Excessive Demands
(5 4 3 2 1)

12. ____(60) How would you rate the way you have thus far been graded in this course?

Very Fair ___ ___ ___ ___ ___ Very Unfair
(5 4 3 2 1)

13. ____(61) How would you rate the content of exams given in this course?

Very Fair ___ ___ ___ ___ ___ Very Unfair
(5 4 3 2 1)

14. ____(62) How would you rate the overall value of the problem assignments for teaching you computer programming?

Very Effective ___ ___ ___ ___ ___ Not Effective
(5 4 3 2 1)

15. ____(63) How well did lectures and reading assignments prepare you for problem assignments?

Very Well ___ ___ ___ ___ ___ Not At All
(5 4 3 2 1)

16. ____(64) How open do you feel your instructor was to in-class questions and discussion?

Very Open ___ ___ ___ ___ ___ Not Open
(5 4 3 2 1)

17. ____(65) How welcome did you feel to see your instructor outside of class for assistance?

Very Welcome ___ ___ ___ ___ ___ Not Welcome
5 4 3 2 1

18. ____(66) How clear or understandable were the lectures by the computer science instructor?

Very Clear ___ ___ ___ ___ ___ Very Unclear
5 4 3 2 1

19. ____(67) How much do you feel you have profitted from this course?

Very Much ___ ___ ___ ___ ___ Not At All
5 4 3 2 1

(Please go on to next page)

In the space provided below please indicate any and all experiences you may have had before taking CPS 120 with computers and/or computer programming. Please define as carefully as possible the nature of these experiences and the amount of time involved (Examples: a ten week course in Fortran at XYZ Junior College; built a a computer designed to do such and such; a two week institute at M.S.U.)

If you have had no such previous experience, write "none" in the space provided.

____

____

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APPENDIX B

The Interview Schedules

Interview Instructions

1. I will be asking you a few questions regarding college and your choice of major.

2. The information that you and other students provide will aid us in serving all of our students better.

3. To be of greatest value, you should try to answer as frankly and openly as possible.

4. The remarks you make will be held in strictest confidence, and only a summary of the comments of all those interviewed will be kept. No names will ever be associated with opinions or attitudes expressed.

5. This interview should not last more than 30 minutes.

6. Do you have any questions?

Post-interview Schedule

Control and Experimental Groups

1. How and when did you first begin to develop an interest in engineering as a future career?

    a) How and when did you actually decide to go to an engineering college?

    b) How complete or set is your decision to study engineering now as you are completing your first term?

2. What have you done and what experiences have you had leading to an understanding of what engineering is? (Cover both pre college and college)

    a) What, if anything, do you plan to do in the future to increase this understanding?

    b) How much do you feel you still need to know about engineering?

3. What do you want most that this college do for you?

4. What are your biggest concerns now at this point in your college career?

    a) Relative importance of major choice -

    b) Relative importance of academic matters -

5. Please survey the activities and interests you had during high school outside your regular course work. (Be sure the following are covered: science or engineering clubs or projects, tinkering and inventing, special or advanced courses or other educational programs.) Also survey activities and interests since coming to college.

Post-interview Schedule (cont'd.)

6. What, if anything, have you gained from your courses this term relative to understanding engineering and choosing an engineering major? (Cover CPS 120 including possible effects on desire and identification.)

7. What is your evaluation of the CPS 120 instructor?

8. What is your evaluation of the CPS 120 course?

9. What is your evaluation of the problem assignments?

    a) Did they help you understand the various fields of engineering?

    b) Did they help you learn computer programming?

*10. What is your evaluation of the presentations given by guest professors in CPS 120 this term?

    a) What do you think these presentations were intended to do?

    b) Did they help you understand the various fields of engineering?

    c) Did they or the CPS 120 course material effect your choice of major, and how?

* General question #10 asked of only the experimental group.

APPENDIX C

Supplementary Data

TABLE 17. Comparison of ranks of engineering majors for experimental (E) and control (C) groups

Item 4			Ag. Egr.		Civil Egr.		Elect. Egr.		Mech. Egr.		Metal. Egr.		Chem. Egr.		Egr. Sci.	
Pre	E	$\bar{X}$	6.53		4.83		2.61		3.75		4.17		2.47		3.64	
		s	0.98	x^2	1.45	x^2	1.45	x^2	1.60	x^2	1.51	x^2	1.40	x^2	2.16	x^2
	C	$\bar{X}$	6.42	3.92 df4	4.28	7.80 df6	2.47	7.10 df5	3.57	5.44 df6	4.57	5.74 df6	2.65	5.11 df6	4.05	4.67 df6
		s	1.08		1.66		1.66		1.63		1.51		1.33		2.08	
Post	E	$\bar{X}$	6.37		4.21		2.59		3.60		4.89		2.83		3.44	
		s	1.01	x^2	1.54	x^2	1.45	x^2	1.69	x^2	1.59	x^2	1.54	x^2	2.18	x^2
	C	$\bar{X}$	6.27	8.57 df5	4.63	8.48 df6	2.12	8.82 df5	3.48	5.46 df6	4.69	5.01 df6	2.72	1.60 df6	4.03	12.38 df6
		s	1.39		1.71		1.46		1.43		1.49		1.61		1.75	

No chi square significant at .05 level

Note: Ranks were computed on a 1 through 7 scale with the major receiving the smallest mean rank being first.

TABLE 18. Summary of chi square comparisons of instructor and course ratings for experimental and control groups

	Post-test Items			
	Items 8 - 11			
	8	9	10	11
x^2	3.699	14.191*	6.413	0.837
df	4	4	4	4
$\bar{X} - \bar{Y}$**	.45	.68	.33	-.05
	Items 12 - 15			
	12	13	14	15
x^2	1.083	16.905*	6.785	12.334*
df	4	4	4	4
$\bar{X} - \bar{Y}$**	0	.72	.41	.20
	Items 16 - 19			
	16	17	18	19
x^2	2.738	5.686	13.311*	9.196
df	4	4	4	4
$\bar{X} - \bar{Y}$**	.30	.47	.68	.58

* Significant at .05 level

** $\bar{X} - \bar{Y}$ is the difference between sample means. This value is only relevant where statistical significance was found. Means were calculated on a five point scale.

Note: Experimental and control groups are not identified to avoid publishing instructor ratings.

TABLE 19. Comparison of simple correlations between the main effect variables of knowledge of engineering, identification with engineering, and desire for engineering, and instructional rating variables for experimental and control groups.

Instructional Ratings (X)	Experimental		Control		Standard Scores
	r	Z	r	Z	
Correlated With Knowledge of Engineering (Y_1)					
Score 1	.012	.0100	-.128	-.1307	.78
Score 2	-.127	-.1307	-.072	-.0701	-.34
Score 3	-.050	-.0500	-.116	-.1206	.39
Correlated With Identification With Engineering (Y_2)					
Score 1	.318	.3316	.152	.1511	1.00
Score 2	.132	.1307	.070	.0701	.34
Score 3	.260	.2661	.130	.1307	.75
Correlated With Desire For Engineering (Y_3)					
Score 1	.270	.2769	.147	.1511	.70
Score 2	-.026	-.0300	.053	.0500	-.44
Score 3	.158	.1614	.119	.1206	.23

No standard score significant at .05 level

Notes: This analysis used a Fisher's r to Z transformation to determine if the two samples came from the same population or two different populations with equal correlations.

Score 1 - Course rating items 8, 9, 10, 11, 14, 15, 19.
Score 2 - Instructor ratings items 12, 13, 16, 17, 18.
Score 3 - Composite of Score 1 and Score 2.

TABLE 20. Summary of correlations for experimental (E), control (C), and combined study groups (EC) between post-test variables and pre-test covariates used in Analysis of Covariance tests

		Simple Correlation Coefficients		
		Pre-Item 1	Pre Item 2	Pre Item 3
(E)	Post Item 1	.55		
	Post Item 2		.65	
	Post Item 3			.54
(C)	Post Item 1	.47		
	Post Item 2		.54	
	Post Item 3			.54
(EC)	Post Item 1	.50		
	Post Item 2		.61	
	Post Item 3			.54

Notes: Each coefficient provides an indication of the extent of linear relationship between the main variable and the covariates. A linear relationship is necessary for Analysis of Covariance.

TABLE 21. Summary of t tests for homogeneity of regression line slopes used in covariance analyses

		Regression Coefficients	Degrees Freedom	t
Item 1	Exp. Cont.	2.070 1.853	70 58	-.0936
Item 2	Exp. Cont.	.563 1.208	70 58	.1814
Item 3	Exp. Cont.	.111 1.121	70 58	.1989

None significant at .05 level

Notes: Analysis of Covariance assumes parallel regression lines. This test for homogeneity of regression line slopes supports the assumption as each student t calculated indicates that sample slopes are estimates of a common slope.