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Perceptions and practice: A characterization of the first two years of undergraduate instruction in chemistry in Michigan state-supported colleges and universities

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PERCEPTIONS AND PRACTICE:
A CHARACTERIZATION OF THE FIRST TWO YEARS OF UNDERGRADUATE INSTRUCTION IN CHEMISTRY IN MICHIGAN STATE-SUPPORTED COLLEGES AND UNIVERSITIES

By

Albert George Krieger

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ABSTRACT

PERCEPTIONS AND PRACTICE:
A CHARACTERIZATION OF THE FIRST
TWO YEARS OF UNDERGRADUATE INSTRUCTION IN CHEMISTRY
IN MICHIGAN STATE-SUPPORTED COLLEGES AND UNIVERSITIES

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The purpose of this study was threefold: (1) to develop an Interview Survey Instrument based upon the recommendations given by the Committee on Professional Training of the American Chemical Society as the guidelines apply to the first two years of undergraduate education in chemistry as well as selected aspects of a quality education that had been identified by recent nationwide studies; (2) to develop an Interview Perceptions Instrument to determine the perceptions held by practicing professors of chemistry about the quality of instruction in chemistry at their own state-supported institutions as well as at other state-supported institutions of higher learning in Michigan; and (3) to use these instruments to analyze the similarities and the differences of the curricula in chemistry in Michigan state-supported colleges and universities that offer a minimum of two years of courses in professional chemistry that conform, more or less, to the guidelines established by the Committee on Professional Training of the American Chemical Society.

The Items and the item responses were written and

quantified to reflect a wide range of unique curriculum situations in the target population of state-supported colleges and universities in Michigan. Validation for the Interview Survey Instrument was provided by a panel of practicing professors of chemistry. Reliability was determined by the Kuder-Richardson Formula #20. The Interview Survey Instrument and the Interview Perceptions Instrument were administered randomly to a stratified-by-size selection of six state-supported two-year colleges and six state-supported universities.

Although significant differences were found in the faculty and the organization of the instructional units, no significant difference was found between the overall instructional programs in the first two years of professional chemistry in Michigan state-supported two-year colleges and the universities. The study revealed that the large majority of instructors of first- and second-year chemistry in Michigan state-supported two-year colleges and universities were adequately informed about the details of instruction in chemistry in other similar institutions to draw conclusions similar to those drawn by this study. A wide range of contact hours in lecture and laboratory were reported by the institutions in the study. Tuition and fees were examined to identify the range in tuition and fees levied. A high of $193 per-semester-hour and a low of $20.50 per-semester-hour were reported. The Course Placement Score used by the majority of the state-supported two-year colleges was found to be the ASSET scores while the state-supported universities were found to favor the use of the ACT scores. The Survey Instrument could be used by institutions seeking to identify the status of the instructional program in chemistry as well as used to identify weak features in their instructional program. However, research is necessary to provide benefit/cost weighting to the Instrument scores.

ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to the many people who have given generously of their time and talents throughout the duration of this study. I wish to thank Dr. Eldon Nonnemaker, my advisor and doctoral committee chairman, whose guidance, encouragement, and valuable suggestions have made this a meaningful experience.

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CHAPTER I

INTRODUCTION

Purpose of the Study

The purpose of this study was threefold: (1) to develop an Interview Survey Instrument; (2) to develop an Interview Perceptions Instrument; and (3) to use the interview instruments to analyze the similarities and the differences of the curriculum in chemistry[1] in Michigan state-supported two-year colleges and universities in Michigan which offer a minimum of two years of courses in professional chemistry.

Background of the Study

The transferability of courses in professional chemistry taken at state-supported two-year colleges and state-supported universities and transfered to other institutions of higher education has appeared to be based primarily upon the limited course descriptions found in college and university catalogs and upon the choice of textbook or textbooks used at the colleges. It might

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[1]The curriculum in chemistry will be evaluated primarily on the basis of: Committee on Professional Training, Criteria and Evaluation Procedures for Undergraduate Professional Education in Chemistry, American Chemical Society, Fall, 1983.

be assumed that course descriptions do not differ greatly from college to college[2] but at least three variables affect the superficial description of the instructional sequence:

1) some institutions have separated the lecture component of instruction from the laboratory component of instruction and the two components are offered as separate courses; 2) semester length courses are offered in some institutions while other institutions utilize term-length instructional units; and 3) there are a variety of instructional sequences utilized by the institutions which may provide essentially similar over-all instructional experiences but differ in the particular course titles and descriptions.

The Criteria and Evaluation Procedures for Undergraduate Professional Education in Chemistry were developed by the Committee on Professional Training of the American Chemical Society to provide a curriculum guide for a four-year curriculum in Chemistry; but not all state-supported universities in Michigan that offer a major concentration of studies in Chemistry offer an ACS-approved curriculum.[3] In addition, two-year colleges nation-wide have just begin to examine or reexamine their chemistry curriculum with the aid of curriculum guidelines developed to evaluate existing

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[2]This assumption was examined.

[3]"Committee on Professional Training 1986 Annual Report", American Chemical Society, Chemical & Engineering News, 65, (May 18, 1987), 59-66.

local chemistry curricula.[4] The curriculum guidelines permit examination of the initial two-years of professional education in chemistry with appropriate considerations given to the differences in financial support experienced by state-supported two-year colleges and state-supported universities. A primary thrust of the new guidelines has been to insure that the instruction in professional chemistry taken at two-year colleges will dove-tail with the subsequent instruction taken in baccalaureate-degree-granting institutions.

Importance of the Study

Enrollments in Michigan state-supported two-year colleges increased by more than 73 percent between 1970 and 1981; and the enrollments in these two-year colleges in 1981 comprised more than 40 percent of the total student enrollment in Michigan institutions of higher education.[5]

While this increased student enrollment in state-supported two-year colleges may have been due partially to the rapid increase in the growth of Michigan two-year colleges during that period, the shift in student enrollments from four-year institutions to two-year institutions

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[4] ACS Society Committee on Education, Task Force on ACS Involvement in the Two-Year College, Guidelines for Chemistry & Chemical Technology Programs in Two-Year Colleges, Experimental Version, American Chemical Society, Washington, DC, February 1987.

[5] Michigan Community College Association, The Impact of Community Colleges On Michigan and Its Economy, Lansing, Michigan, 1981.

has had the potential of creating increased articulation problems for those students who have sought high-quality instruction in professional chemistry in their local state-supported two-year college. This has been particularly true if the local two-year college has had real or suspected deficiencies in the chemistry curriculum. This problem was the focus of a study at a recent conference;[6] and recommendations have been made to alleviate the problem.[7]

By the Fall of 1985, the enrollment in Michigan state-supported two-year colleges had grown to comprise nearly 46 percent of the total state-wide undergraduate enrollment of all institutions of higher education.[8] It became apparent that there was a real need for more information concerning the relative strengths and weaknesses of the instruction in professional chemistry offered to students in Michigan's state-supported two-year colleges as compared to the instruction in professional chemistry offered to students in Michigan's state-supported universities. The data gathered by this study should be useful in alleviating the lack of common knowledge

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[6]Society Committee on Education, Critical Issues in Two-Year College Chemistry, Invitational Education Conference, American Chemical Society, Washington, DC, 1985.

[7]Mary L. Good, The Next 25 Years in Chemistry and Chemical Education: A Perspective for Two-Year Colleges, Two-Year College Chemistry Conference, William Rainey Harper College, Palatine, IL, April 25, 1986.

[8]Annual Survey of Colleges: Fall Enrollment 1985, College Entrance Board, New York, 1986.

concerning the status of instruction in the professional chemistry curriculum in the first two years of the undergraduate studies whether the instruction is received in a state-supported two-year college or a state-supported university.

Instrument Design

In light of the above-mentioned need for information concerning the details of instruction in professional chemistry in state-supported two-year colleges and state-supported universities in Michigan, a major purpose of this study was to develop an interview survey instrument and an interview perceptions instrument.

The interview survey instrument had to be capable of eliciting information in sufficient detail to permit a comprehensive evaluation of the quality of instruction in professional chemistry in a wide range of college environments. Further, if the interview survey instrument, with its selected indices and scales, was shown to be capable of obtaining valid and reliable data, an analysis of the data obtained with the interview survey instrument would not only reveal a differentiation of the currricula studied but would also insure the measurement of aspects of criteria that would be of singular importance to the foundations of quality instruction in a particular institution.

The interview survey instrument that was constructed included interval-scale items,[9] where appropriate, to evaluate easily quantifiable indices of quality instruction and ordinal-scale items[10] to measure less quantifiable indices of quality instruction. The indices were based primarily upon the criteria developed by the American Chemical Society for the four-year chemistry curricula but applicable to two-year colleges. The interview survey instrument was subdivided into the following subsections: 1) Organization of the Instructional Unit; 2) Instruction in First-Year Chemistry; 3) Instruction in Second-Year (Organic) Chemistry; 4) Faculty; and 5) Facilities and Instructional Resources.

The interview perceptions instrument was constructed with a one-to-five lesser-quality/better-quality forced-choice scale format to elicit the perceptions about instructional programs in professional chemistry at other state-supported two-year colleges and state-supported universities in Michigan.

A standardized interview procedure was developed to optimize objectivity of all measures made. Initial use of the interview instruments then clarified the usefulness of the instruments as well as yielded an initial estimate of the reliability of the instruments. Face validity and

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[9] Mary J. Allen and Wendy M. Yen, Introduction to Measurement Theory, Monterey, CA: Brooks/Cole Publishing Co., 1979, 188.

[10] Ibid, 184.

logical validity were determined by a careful definition of the domain of measures as found in the selected indices of defined quality instruction. Content validity was determined by submitting the interview survey instrument and the interview perceptions instrument to a panel of practicing professors of chemistry for expert determination.

Definition of Terms

The following terms and definitions were used throughout this study:

ACS--American Chemical Society

Two-Year Colleges--community colleges and junior colleges

Small-size Two-Year College--less than 2,500 students

Medium-size Two-Year College--less than 7,000 students but greater than 2,500 students

Large-size Two-Year College--greater than 7,000 students

Small-size university--less than 5,000 students

Medium-size university--less than 10,000 but greater than 5,000 students

Large-size university--more than 10,000 students

Professional Chemistry--that set of courses of instruction in the chemistry curriculum intended for chemistry, science and engineering majors as well as pre-medical, pre-dental and pre-pharmacy students, i.e. general inorganic chemistry and organic chemistry.

Instruction in Professional Chemistry--selected measures of the curriulum, facilities, and the chemistry faculty that are utilized in providing the desired lecture, library and laboratory experiences deemed the minimum requirements for quality professional training in chemistry by the ACS.

Analysis

As previously mentioned, the purpose of this study was to select indices of instructional quality from the ACS's Criteria for Undergraduate Professional Education in Chemistry, to develop interview instruments incorporating these indices, and to use these instruments to evaluate the instruction in professional chemistry in a sample of the population of state-supported two-year colleges and universities that offered a minimum of two years of instruction in professional chemistry.

Since the sample taken from the population of interest for this study was not large, the statistical measure of significance chosen was the t-test. This study concentrated on determining in which ways it could be determined that the instruction in professional chemistry differed in the state-supported two-year colleges and universities and in which ways the instruction was similar in the institutions studied.

Hypotheses

As previously mentioned, the purpose of this study was to develop an interview survey instrument and an interview perceptions instrument and to use these instruments to determine the extent to which the chemistry instructional programs in professional chemistry in the state-supported two-year colleges and the state-supported universities were alike.

The most specific hypotheses tested are as follows:

Ho_1: There is no significant difference between state-supported colleges and state-supported universities in Michigan in the Organization of the Instructional Units (which include the chemistry discipline).

Ho_2: There is no significant difference between state-supported two-year colleges and state-supported universities in Michigan in Instruction in First-Year Chemistry.

Ho_3: There is no significant difference between state-supported two-year colleges and state-supported universities in Michigan in Instruction in Second-Year (Organic) Chemistry.

Ho_4: There is no significant difference between state-supported two-year colleges and state-supported universities in Michigan in their respective Faculties (of Chemistry).

Ho_5: There is no significant difference between state-supported two-year colleges and state-supported universities in Michigan in their respective Facilities and Instructional Resources.

Ho_6: There is no significant difference between state-supported two-year colleges and state-supported universities in Michigan when all aspects of a quality education as measured by the interview survey instrument are compared.

Procedures in Data Collection

An initial examination was undertaken to determine the population of state-supported two-year colleges and state-supported universities that offered two years of instruction of professional chemistry. This population of state-supported institutions identified as having offered two years of professional chemistry was then stratified as small-size, medium-size and large-size institutions as described in the Definition of Terms section. An experimental interview survey instrument and an experimental interview perceptions instrument were constructed incorporating the selected indices of instructional quality. The experimental interview survey instrument and the experimental interview perceptions instrument were then evaluated by conducting an interview-evaluation in a randomly-selected state-supported two-year college from the population of state-supported two-year colleges as well as a randomly-selected state-supported university from the population of state-supported universities. These initial interviews were utilized to evaluate the appropriateness of the indices, for the addition, subtraction and modification of indices, and for the modification of item scales. The modifications to the instruments were made to insure that the indices and scales of the instruments permitted the quantification of the breadth and depth of information available about the instructional experiences in the chemical education programs and to insure that a meaningful analysis could be made.

Population

The population studied was all of the state-supported two-year colleges and the state-supported universities in Michigan that offer two years of instruction in professional chemistry.

Sample

The sample of the population of state-supported two-year colleges studied consisted of six state-supported two-year colleges with two samples each randomly-selected from the stratified population of small-size, medium-size, and large-size state-supported two-year colleges. The sample of the population of state-supported universities evaluated in this study consisted of six state-supported universities with two samples each randomly-selected from the stratified population of small-size, medium-size, and large-size state-supported universities.

Instruments Used in the Study

In addition to the interview survey instrument developed to measure criteria identified in Undergraduate Professional Education in Chemistry Criteria and Evaluation Procedures, and the interview perceptions instrument developed to measure perceptions about instructional programs in chemistry at other institutions, the Guidelines for Chemistry & Chemical Technology Progams in Two-Year Colleges were used insofar as the two criteria guidelines evaluated the first two years of instruction in professional chemistry.

Assumptions

The study of the first two years of instruction in professional chemistry was based upon the following assumptions: (1) The information necessary to determine whether there was a difference in the selected set of indices of instructional quality that measure curriculum, educational experiences and environments found in compared institutions of higher education could be adequately obtained by an interview method of evaluation; (2) Acceptable educational measurements were developed using the procedures followed in this study; and (3) The information necessary to determine whether there was a difference in instruction in professional chemistry in institutions of higher education would be obtained from a representative sample of the institutions of interest by random-selection from the total population of state-supported two-year colleges and state-supported universities which have been stratified by total student enrollment.

Limitations of the Study

This study was limited to a sample of state-supported two-year colleges and state-supported universities in Michigan that offered a minimum of two years of instruction in professional chemistry. Further, the conclusions drawn from the study directly apply only to that population of state-supported two-year colleges and state-supported universities in Michigan that offer a minimum of two years of instruction in professional chemistry.

This study may have also been limited by the particular choice of indices of instructional quality which were selected to measure the curriculum, facilities and the chemistry faculty that have been utilized in providing the desired lecture, library and laboratory experiences that are the minimum requirements for a program of quality professional training in chemistry as recommended by the Committee on Professional Training of the ACS.

Organization of the Dissertation

The general organization of the dissertation is as follows: Chapter II reviews the literature relative to the curriculum of instruction in professional chemistry and the need for evaluation of that curriculum; Chapter III describes the procedures used in developing and evaluating the indices of instructional quality and the ratio-scale items used to quantify the indices of the interview instruments; Chapter IV includes the analysis and interpretations of the study; and Chapter V reports the findings and conclusions of the study.

CHAPTER II

REVIEW OF RELATED LITERATURE

Several aspects of instruction in chemistry, and undergraduate education in general, which are directly related to this study are: recent studies of the integrity of the undergraduate curriculum; an upgrading and reevaluation of the undergraduate chemistry curriculum by the American Chemical Society; a new emphasis upon "writing across the curriculum;" a recognition that research is a desirable part of the undergraduate experience; renewed efforts to properly place students in academic courses commenserate to their abilities; and the development of an appropriate chemistry curriculum evaluative instrument.

This chapter is organized into the following sections: (1) Recent Evaluations of the Undergraduate Experience; (2) Evaluation of Departmental Curricula; (3) Recent Activities of the Committee on Professional Training of the American Chemical Society; (4) A synopsis of the "Writing Across the Curriculum" movement; (5) Undergraduate Research; (6) Testing and Academic Placement; and (7) Summary.

Recent Evaluations of the Undergraduate Experience

A panel established by the National Institute of Education released a report[1] which called upon colleges and universities to revitalize liberal education and to set higher standards for graduation. The report, written from a set of values and goals shared by the study group, made a series of recommendations for improving the quality of undergraduate education in order to enhance the learning and personal development for the greatest number of students of all ages. Under the heading of The Warning Signals, the panel noted that:

> "Accreditation standards for undergraduate programs often stand as barriers to the broad understanding we associate with liberal learning. For example, the guidelines of one professional accrediting association confine one-half to two-thirds of a student's baccalaureate program to courses in two areas."[2]

The panel made a set of seven recommendations by which to increase student involvement in their own education. These included such ideas as involving students in faculty research projects, independent study, classes held in the field, organizing group projects that utilize computers to analyze raw data, and student-written computer software specifically written for analysis of the raw data collected in a project. The underlying contention was that

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[1]Study Group on the Conditions of Excellence in American Higher Education, Involvement in Learning: Realizing the Potential of American Higher Education, National Institute of Education, The Chronicle of Higher Education, XXLX (October 24, 1984), 35.

[2]Ibid., 36.

students are more apt to learn content if the students are actively involved in the discipline.[3] Eight additional recommendations were made by the panel for the realization of high expectations.[4] This included the expectation that each institution should examine and adjust content and delivery of the curriculum to match the knowledge, skills and abilities the institution expects the students to develop, as well as the utilization of appropriate tests and measures of the knowledge, skills and abilities to be developed to insure public recognition that what is being assessed is college-level learning. In addition, the same recommendations reemphasized the desirability of integrating research as an active form of learning into the curriculum.

In recognition that accreditation agencies play a part of conditions necessary for excellence, the panel recommended[5] that:

> Accrediting agencies should hold colleges, community colleges, and unversities accountable for clear statements of expectations for student learning, appropriate assessment programs to determine whether those expectations are being met, and sytematic efforts to improve learning as a result of those assessments.

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[3] Ibid., Recommendations 2 & 3, 41.

[4] Ibid., Recommendations 11 & 12, 43.

[5] Ibid., Recommendation 24, 47.

Another study[6] of national importance is the study commissioned by the Association of American Colleges to examine the present state of curricula in American colleges and universities that lead to the baccalaureate degree. The committee studied the baccalaureate curricula, made recommendations for improvement, and called upon the academics to take the lead in restoring the coherence and reputation of the degrees. Nine elements[7] were identified and recommended as minimum requirements: (1) inquiry; abstract logical thinking, and critical analysis; (2) literacy: writing, reading, speaking and listening; (3) understanding numerical data; (4) historical consciousness; (5) Science; (6) Values; (7) Art; (8) International and multicultural experiences; and (9) study in depth. The recommendations for reform were emphasized by cautioning against the utilization of 'old' solutions such as establishing prescribed survey courses in literature and science, nor by the strengthening of distribution requirements, nor by adding multidisciplinary general education courses, but instead by suggesting that writing ability is a desirable outcome of the baccalaureate degree and is the responsibility of all faculty, not just members of the English

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[6]Committee on Redefining the Meaning and Purpose of the Baccalaureate Degrees, Integrity in the College Curriculum: A Report to the Academic Community, Association of American Colleges, The Chronicle of Higher Education XXLIX (February 13, 1985), 12.

[7]Ibid., Minimum Requirements, 13.

department.[8]

Further, the report suggests[9] that:

> The quality of the environment can be measured by emphasis on opportunities for active learning and evidence that students and faculty are engaged in a joint enterprise of discovery and growth. . . . that students should undertake a variety of pedagogical approaches . . . seminars, lectures, research, field study, tutorials, theses.

Great efforts were expended by the panel in an effort to convey what they mean by 'study in depth' with much emphasis that 'study in depth' supercedes the notion of 'a course of study,' 'major,' not merely 'subject matter.' Instead the report represents the essense of a baccalaureate education as the ability to argue about interpretations drawn from evidence.[10]

Lastly, the report treats the problem of accountability[11] with the charge that:

> The professors are fundamentally responsible and therefore charged with designing and monitoring the mechanisms of assessment. ...without some accurate sense of the progress with students are establishing skills and mastering capacities defined by the minimum required curriculum, a faculty can only guess at how well it is doing its job.

Further, the report uses the term 'scandalous' to depict the absence of institutional and social accountability on the part of American higher education . . . for

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[8] _Ibid_., 24.

[9] _Ibid_., 24.

[10] _Ibid_., 26.

[11] _Ibid_., The Problem of Accountability, 28.

their lack of knowledge as to whether the institutions are actually doing what they publically say they are doing.

Even more recent is the analysis of the survey taken by Sigma Xi in their New Agenda Project with an appraisal of existing college and university curricula, the present societal demands upon science, the problems of governmental and foundation research funding, and the changing nature of the scientific process.[12] Although scientists can and do disagree about many things, there was a 95% agreement within the respondents of the survey[13] with the proposition that:

> The word science is often invoked as if it meant a particular 'thing' comprised of scientists, public and private laboratories, publications, and government agencies. For me, however, 'science' connotes a process or procedure for making inquiries about our world and for evaluating the hypotheses these inquiries generate.

Ethical conduct and public understanding of the limitations of science was another concern expressed by scientist-respondents to the survey. Still another respondent called for commitment to an ethical standard and a public commitment to the protection of life and of society.

> "The reference to ethical standards also serves as a reminder that integrity in research and in reporting scientific findings is vital not merely because science is an interdependent activity in which mutual trust among scientists is essential, but because public trust in science has to be maintained.[14]

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[12] Sigma Xi, The Scientific Research Society, <u>A New Agenda For Science</u>, New Haven, CT 1987, iii.

[13] Ibid., 7.

[14] Ibid., 16.

A concern was expressed about the adequacy of school and college curricula to generate sufficient numbers of future scientists. This concern was not just about the training of future scientists, but also about the education that provided the basis of knowledge and understanding of those who would not themselves become scientists. It was felt that it is not sufficient that the educational program be adequate to train the scientifically-inclined student, but also to prevent scientific illiteracy in the general public.

> . . . if graduate students in adequate number and quality are to be available, this requires that they acquire and maintain an interest in science much earlier in their education . . . the future of scientific research depends on an educational process that can justifiably be described as "K through Ph.D."[15]

Illuminated by these studies cited, the liberal arts and the baccalaureate curricula may perhaps be summarized by:

> . . . an approach to education that encourages individuals to think of learning as an activity that can take place at any time and in a wide variety of situations. In this sense, then, we are advocating the importance of people learning from life and throughout life.[16]

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[15] Ibid., 25.

[16] Knapper, C., "What Should Future Teaching be Like?" The Teaching Professor, 2, (February 1988), 1.

And a criticism of existing curricula:

> We are very good at teaching students how to solve problems for which we already know the answers. The challenge is to teach them strategies for tackling the problems we've yet to solve.[17]

Evaluation of Departmental Curricula

The department in a college or university may perhaps be seen as a microcosm of the larger institution, and in that sense, the Evaluative Criteria for Accreditation[18] by a regional accrediting association do apply.

> 1. The institution (substitute departmental curricula) has clear and publicly stated purposes, consistent with its mission and appropriate to a postsecondary educational institution.
> 2. The institution (substitute department) has effectively organized adequate human, financial and physical resources into educational and other programs so that it is accomplishing its immediate purposes.
> 3. The institution (substitute department and curricula) is accomplishing its purposes.
> 4. The institution (substitute department and curricula) can continue to accomplish its purposes.

Dressel, et al[19] offers the study outline developed in connection with departmental reviews at Michigan State University, but also cautions that departmental reviews can neither justify excessive resources appropriation nor

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[17] Ibid., 2.

[18] Commission on Institutions of Higher Education, A Handbook of Accreditation, North Central Association of Colleges and Schools, Chicago, IL 1984, 14.

[19] Dressel, P., Johnson, F. & Marcus, P., The Confidence Crisis: An Analysis of University Departments. San Francisco: Jossey-Bass Inc., 1970, 156.

provide a simple formula which would enable every department to rank nationally. Using an approach to evaluation that transcends the discipline, Dressel[20] makes assurances that neither the discipline nor the student should be the sole basis for curriculum planning and evaluation by emphasizing measurable behavioral objectives.

> If students are expected to develop a degree of independence in pursuit of learning, reach a satisfactory level skill in communication, demonstrate sensitivity to their own values and those of their associates, become capable of collaborating with peers in defining and resolving problems, be able to recognize the relevance of their increasing knowledge to the current scene, and seek continually for insightful understanding and organization of their total educational experience, these outcomes must be specifically stated. (this writer's emphasis).

Hutton[21] has questioned whether colleges can continue to afford high quality laboratory instruction at the undergraduate level while Pickral[22] has reported the results of a national survey on the present use of chemical instrumentation in undergraduate chemistry in four-year colleges and universities. Expensive instrumentation and typically extensive student laboratory requirements in

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[20] Dressel, P., Handbook of Academic Evaluation: Assessing Institutional Effectiveness, Student Progress, and Professional Performance for Decision Making in Higher Education. San Francisco: Jossey-Bass Inc., 1978, 303.

[21] Hutton, W., "Report of the Fifth Biennial Conference on Chemical Education: Undergraduate Laboratory Instruction;" Journal of Chemical Education, 56 (JanCary 1979), 8.

[22] Pickral, G., "The Laboratory Use of Chemical Instrumentation in the Undergraduate Chemistry Curriculum," Journal of Chemical Education, 60 (December 1983), A338.

chemistry have been periodically reviewed when funding of chemical programs are viewed as too expensive.

Recent Activities of the Committee on Professional Training of The American Chemical Society

The American Chemical Society Committee on Professional Training revised the criteria for evaluating undergraduate programs in chemistry[23] with the release of the guidelines. The principle changes in the guidelines lie in the increased emphasis on computer literacy, information retrieval and with upper-level opportunities for self-instruction programs.

Additionally, guidelines[24] were in the process of being developed for chemistry and chemical engineering technology programs in two-year colleges. The experimental version of the guidelines for the two-year college followed in their essence the guidelines developed for the baccalaureate-granting colleges and universities, but made provision for the differences in funding, non-research faculty and missions of the two-year colleges. Perhaps the most recent change in the guidelines for baccalaureate-granting

[23]Committee on Professional Training, Undergraduate Professional Education in Chemistry: Guidelines and Evaluation Procedures. American Chemical Society, Fall 1983.

[24]ACS Society Committee on Education, Task Force on ACS Involvement in the Two-Year College, Guidelines For Chemistry & Chemical Technology Programs in Two-Year Colleges: Experimental Version, American Chemical Society, 1987.

institutions was the release[25] of the list of recommended journals in four classifications: (1) required journals of general usage; (2) publications readily available; (3) top priority journals; and (4) highly recommended journals. The minimum library holdings were considered to be journals in the first two catagories and an additional twenty titles from the third and fourth categories. These are new guidelines as the 1983 Criteria was non-specific as to the choice of titles. The recommendations for the two-year colleges[26] were non-specific by title but did recommend that there be ten current chemistry and related science periodicals.

Writing Across the Curriculum

"Writing Across The Curriculum" is a wide-spread educational movement intended to improve writing skills throughout the curriculum and is not restricted to previous examples of writing science papers for an English class. Instead, the movement is characterized by the emphasis upon the desirableness of writing as a means of expression and upon an improvement of writing style throughout the

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[25] Committee on Professional Training, "Recommended Journals," CPT Newsletter, American Chemical Society, Spring 1987, 2.

[26] loc. cit., Task Force on ACS Involvement in the Two-Year College, 32.

curriculum. Perhaps one of the better definitions[27] of "writing across the curriculum" is the following:

> Writing across the curriculum is a common sense concept that expresses what an undergraduate education should offer in the realm of training for literacy: many opportunities to write in all courses, serious attention to written work by instructors in all courses, a variety of writing experiences... short papers, quick papers, unhurried papers, reports, critiques, narratives. Like writing, other avenues to literacy... reading and speaking and listening . . . should find outlets and encouragement across the curriculum.

A survey of the literature revealed no less than fourteen articles in the Journal of Chemical Education expressing concern about the problem that students majoring in chemistry, and perhaps other sciences and disciplines as well, graduate with underdeveloped writing skills.

Of these articles, Stacy[28] and Zimmerman[29] have identified specific weaknesses, while Burkett and Dunkle[30] offered guidelines for improvement in writing style.

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[27]Committee on Redefining the Meaning and Purpose of the Baccalaureate Degrees, Integrity in the College Curriculum: A Report to the Academic Community, Association of American Colleges, The Chronicle of Higher Education, XXLIX (February 13, 1985), 24.

[28]Stacy, J., "The Communication Crisis," Journal of Chemical Education, 53 (September 1976), 537.

[29]Zimmerman, S., "Writing in Chemistry," Journal of Chemical Education, 55 (November 1978), 727.

[30]Burkett, A. & Dunkle, S., "Technical Writing in the Undergraduate Curriculum," Journal of Chemical Education, 60 (June 1983), 469.

Potera[31] made general comments about the problem. Additional papers by Carlisle and Kinsinger[32] and Melhado[33] as well as by Pyle[34] suggest methods for additional writing experiences, primarily by adding courses to the curriculum; and Varnes and Wetmore,[35] Goodman and Bean,[36] Olmsted,[37] Werner,[38] Steiner,[39] and Bailey and Merkowicz[40] all

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[31] Potera, C., "The Basic Elements of Writing a Scientific Paper: The Art of Scientific Style," Journal of Chemical Education, 61 (March 1984), 246.

[32] Carlisle, E. & Kinsinger, B.,"Scientific Writing," Journal of Chemical Education, 54 (October 1977), 632.

[33] Melhado, L., "Chemical Composition," Journal of Chemical Education, 57 (February 1980), 127.

[34] Pyle, J., "Contemporary Chemical Essays: Dealing With the Writing Problem in a Freshman Chemistry Course," Journal of Chemical Education, 59 (November 1982), 959.

[35] Varnes, A. & Wetmore, D., "A Novel Communications-Skills-Based Approach to the Instrumental Laboratory," Journal of Chemical Education, 52 (December 1975), 801.

[36] Goodman, W. & Bean, J., "A Chemistry Laboratory Project to Develop Thinking and Writing Skills," Journal of Chemical Education, 60 (June 1983), 483.

[37] Olmsted, J., III, "Teaching Varied Technical Writing Styles in the Upper Division Laboratory," Journal of Chemical Education, 61 (September 1984), 798.

[38] Werner, T., "Reflections on the Emphasis of Communication Skills in the Undergraduate Chemistry Curriculum," Journal of Chemical Education, 63 (February 1986), 140.

[39] Steiner, R., "Chemistry and the Written Word," Journal of Chemical Education, 59 (December 1982), 1044.

[40] Bailey, D. & Merkowicz, L., "Chemistry and English: A New Bond," Journal of Chemical Education, 60 (June 1983), 467.

suggest modifications of existing courses.

Rosenthal[41] however, made specific recommendations about how to improve the quality of laboratory reports after analysis of the difficulty of the various portions of the reports. Listing, definition and chronology were determined to be low-level. Medium-level difficulty were summary, classification and compare/contrast. Analysis and argument, along with scientific argument, were found to be at the highest level of difficulty. The recommendations were 1) to avoid short reports which would preclude an introduction section, an experimental method section, and a theory section as omitting these sections would lose an opportunity to write as well as to fully comprehend the experiment, and 2) to avoid using prepared data tables as the use of such tables eliminated the medium-level task of data organization. Although Rosenthal was primarily concerned with the improvement of the upper division chemistry laboratory report and the opportunity to develop good writing skills, it seems plausible to this researcher to expect that good writing skills might be developed in the lower division laboratory reports as well. Rosenthal suggests that explicit expectations and usable guidelines for form and content need be provided to the students.[42]

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[41] Rosenthal, L., "Writing Across the Curriculum: Chemistry Lab Reports," Journal of Chemical Education, 64 (December 1987), 996.

[42] Ibid., 998.

Returning again to the problem of public understanding of the methods of science, it would appear that if the goals of "writing across the curriculum" were partially achieved, some of the concerns of the scientific community might be relieved. Part of the problem has been identified[43] as:

> We have very few spokesman who can communicate with the public on their level of understanding and at the same time can understand scientists and the scientific process . . . and some scientists who have assumed the role of 'interpreters' are part of the problem because they tend to present a dramatic and oversimplified view.

Undergraduate Research

A new emphasis has been placed upon providing opportunities for undergraduate participation in research projects and although the practice has not yet become wide spread, the number of publications and papers being presented with undergraduates as co-authors is increasing.

The Council on Undergraduate Research sponsored a conference[44] at Colgate University in 1985 and was overwhelmed by the unexpected numbers of interested scientists, college presidents and deans. Although there are detractors to the movement to include undergraduates in scientific research, professor of chemical engineering

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[43] Sigma Xi, The Scientific Research Society, A New Agenda For Science, New Haven, CT 1987, 15.

[44] Worthy, W., "Undergraduate Research Gaining a Higher Profile," Chemical & Engineering News, 63 (August 19, 1985), 17.

Prasad Dhurjati[45] is enthusiastic. He says:

> Undergraduates bring a fresh perspective to his work. They are naive enough to ask questions that people who have been in the field a long time don't think to ask. The more people lose the ability to ask questions, the less likely they are to stumble on ideas.

And a reader[46] responded to the above article with:

> . . . it comes as no surprise that these students are fully capable, interested, and willing to participate in a meaningful research experience . . there is no substitute for allowing undergraduates to participate in a real research experience . . . it cannot be taught in a classroom or explained in a seminar. It must, however, be a worthwhile research endeavor, which does not mean washing test-tubes in a scientific laboratory or copying library articles for a professor . . .

In other papers, Doyle[47] outlined the historical arguments for- and against- undergraduate research but also indicated sources of funding for undergraduate research; and Yoder and Spencer[48] analyzed and reported the numbers of undergraduate research papers that have been published or presented. Sacco[49] was skeptical of undergraduate research

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[45]Mangan, K., "Undergraduate, Professors Collaborate on Research at More and More Colleges," The Chronicle of Higher Education, XXXIII (May 27, 1987), 1.

[46]Galsky, A., "Involving Students in Research Projects," The Chronicle of Higher Education, XXXIII, (July 1, 1987), 31.

[47]Doyle, M., "Research as Chemical Education," Journal of Chemical Education, 61 (October 1984), 854.

[48]Yoder, C., & Spencer, J., "The Status of Undergraduate Research," Journal of Chemical Education, 64 (February 1987), 163.

[49]Sacco, A., "Undergraduate Research: Myth or Reality," Chemical Engineering Education, 15 (Summer 1981), 121.

and reported that only about fifteen per-cent of the research was publishable. Peppas[50] and Krantz[51] were somewhat more supportive of undergraduate research and pointed out several benefits. Sanzone,[52] Sequin and Volk,[53] and Belliveau and O'Leary[54] outlined the wide variety of research topics pursued as undergraduate research at their institutions, as well as how they treated their chemistry research projects as liberal arts subjects. Additionally, Powers and Black[55] reported that faculty-student research played an effective role in the training of undergraduate students. Spencer and Yoder[56] reported on surveys of undergraduate research in the last decade.

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[50]Peppas, N., "Student Preparation for Graduate School through Undergraduate Research," Chemical Engineering Education, 15 (Summer 1981), 135.

[51]Krantz, W., "Undergraduate Research in Chemical Engineering," Chemical Engineering Education, 15 (Summer 1981), 137.

[52]Sanzone, G., "Undergraduate Research in Chemistry," Journal of Chemical Education, 54 (September 1977), 1977.

[53]Sequin, M., & Volk, S., "D.SEA," Journal of Chemical Education, 63 (February 1986), 144.

[54]Belliveau, J., & O'Leary, G., Jr., "Establishing an Undergraduate Research Program," Journal of Chemical Education, 60 (August 1983), 670.

[55]Powers, J., & Black, D., Jr., "Research in the Undergraduate College, Journal of College Science Teaching, V (January 1976), 171.

[56]Spencer, J., & Yoder, C., "A Survey of Undergraduate Research Over the Past Decade," Journal of Chemical Education, 58 (October 1981), 780.

Goodwin[57] reported on a successful synthesis project that provided specific undergraduate research experience as pursued at his institution while Bunnett[58] and Pladziewicz[59] and Mills[60] reported on surveys and symposiums on undergraduate research as chemical education. Although undergraduate research is not yet widespread, there is a great deal of interest in including such an opportunity in the undergraduate chemistry curriculum.

Testing and Academic Placement

The attempts to diagnose failures and to predict success of freshman students in chemistry has a long history. Martin[61] at Purdue University studied the performance of more than one thousand students enrolled in freshman chemistry and did an analysis to determine the

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[57] Goodwin, T., "Undergraduate Research as Chemical Education--A Symposium: The Total Synthesis of Maytansine," Journal of Chemical Education, 61 (June 1984), 511.

[58] Bunnett, J., "Undergraduate Research as Chemical Education--A Symposium: The Education of Butchers and Bakers and Public Policy Makers," Journal of Chemical Education, 61 (June 1984), 509.

[59] Pladziewicz, J., "Undergraduate Research as Chemical Education--A Symposium: Factors Important to the Maintenance of Undergraduate Research Programs," Journal of Chemical Education, 61 (June 1984), 515.

[60] Mills, N., "Undergraduate Research as Chemical Education-- A Symposium: Undergraduate Research from the Perspective of a Young Faculty Member," Journal of Chemical Education, 61 (June 1984), 513.

[61] Martin, F., "A Diagnostic and Remedial Study of Failures in Freshman Chemistry," Journal of Chemical Education, 19 (June 1942), 274.

factors that might cause failures in chemistry, as well as the ultimate failure to obtain a baccalaureate degree in eight semesters. His analysis of student failures in chemistry revealed that those students who failed in chemistry also failed in other subjects such as English and mathematics as well. His recommendation was to require those students who had failed in freshman chemistry to pass the elementary courses in English and mathematics before the student could repeat the chemistry course. His analysis of the student failures did not permit prediction of student success but did outline the procedures for remedial course-work. Hadley, et al[62] at Southern Illinois University and Brasted[63] at the University of Minnesota studied the relationship of high-school preparation to college chemistry grades. Both papers recognized the wide diversity of high-school courses offered in their states, but found that high-school preparation in physics, chemistry and mathematics to be of great importance to success in the college chemistry course. Brasted, in particular, was strongly against offering remedial-level courses to those students who came unprepared for the college-level course in chemistry.

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[62]Hadley, E., Scott R., & Van Lente, K., "The Relation of High-School Preparation to College Chemistry Grades," Journal of Chemical Education, 30 (June 1953), 311.

[63]Brasted, R., "Achievement in First Year College Chemistry Related to High School Preparation," Journal of Chemical Education, 34 (November 1957), 562.

Hovey and Krohn[64] reported on their efforts to develop a screening examination to be administered to entering freshmen at the University of Toledo to preclude the registration of underprepared students in beginning chemistry courses. This examination later became known as the Toledo Chemistry Achievement Test and is available to institutions of higher education from the Division of Chemical Education of the American Chemical Society. The particular importance of this paper is that it reports an effort to predict success and failure prior to students actually taking the first course in chemistry. Coley[65] found the Toledo Chemistry Achievement Test scores to be of less value in predicting success in freshman chemistry than the grades obtained in a prerequisite chemistry course. He also found that ACT[66] scores correlated better with freshman GPA's than with specific course grades. This was confirmed by Paul.[67] A conclusion drawn from their work was that each institution must develop its own unique prediction equation and methods.

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[64]Hovey, N., & Krohn, A., "Predicting Failures in General Chemistry," Journal of Chemical Education, 35 (October 1958), 507.

[65]Coley, N., "Prediction of Success in General Chemistry in a Community College," Journal of Chemical Education, 50 (September 1973), 613.

[66]The American College Testing Program, Using the ACT Assessment On Campus, Iowa City, IA 1984.

[67]Paul, A., "Factors Affecting Student Performance in General Chemistry," Journal of College Science Teaching, VII (May 1978), 301.

Pickering,[68] Ozsogomonyan and Loftus,[69] and Andrews and Andrews[70] all reported on the relative usefulness of using SAT Mathematics scores in predicting success in freshman chemistry at their respective institutions.

Critics[71] of standardized tests, such as the SAT Test and the ACT Test have made charges of "racial bias" and "unfairness" but Carmichael, et al[72] reported that SAT scores had the highest correlation with success in freshman chemistry at Xavier University, a predominately black institution of higher education.

A follow-up study[73] indicated that SAT scores continue to be utilized for selection of prospective students by selective colleges and universities.

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[68]Pickering, M., "Helping the High Risk Freshman Chemist," Journal of Chemical Education, 52 (August 1975), 513.

[69]Ozsogomonyan, A., & Loftus, D., "Predictors of General Chemistry Grades," Journal of Chemical Education, 56 (March 1979), 173.

[70]Andrews, M., & Andrews, L., "First-Year Chemistry Grades and SAT Math Scores," Journal of Chemical Education, 56 (April 1979), 231.

[71]__________, "Critics and Defenders of Standardized Tests Weigh 'Truth-in-Testing' Bills in New York," The Chronicle of Higher Education, XXXII (May 28, 1986), 13.

[72]Carmichael, J., Jr., Sr. Bauer, J., Sevenair, J., Hunter, J., & Gambrell, R., "Predictors of First-Year Chemistry Grades for Black Americans," Journal of Chemical Education, 63 (April 1986), 333.

[73]Jacobsen, R., "Selective Colleges Use of SAT is Unshaken by Controversies," The Chronicle of Higher Education, XXXII (July 2, 1986), 1.

Summary

The review of the literature concerning the first two years of undergraduate chemistry instruction reflects, to a great extent, the same concerns that colleges and universities have expressed for the undergraduate experience in general: a meaningful curricula; increased opportunities for allowing undergraduate students to become involved in their own education; a new emphasis upon literacy; opportunities for undergraduate research; and an unbiased means of course-placement that will optimize successful completion of their chosen course of study.

An interview survey instrument to evaluate chemistry curricula was developed which integrated elements of the reviewed literature with the particular requirements set forth by the American Chemical Society for the curriculum of the first two years of professional chemistry offered in Michigan state-supported two-year colleges and state-supported universities.

CHAPTER III

METHODOLOGY

Purpose of the Study

The purpose of this study was to analyze the similarities and the differences of the curriculum in chemistry in state-supported two-year colleges and state-supported universities in Michigan that offer a minimum of two years of courses in chemistry which lead to a baccalaureate degree in chemistry as approved by the American Chemical Society.

Procedure

This study was developed in several distinct phases: a) survey instrument item development in which the universe of information that would be useful in a comparision of the instructional programs was reduced to a manageable subset of that universe; b) survey instrument item response phase in which the range of expected responses to the survey items were identified and placed into five levels of absence/ presence, non-compliance/compliance or least-desireable/ most-desireable conditions; c) a perceptions instrument development phase in which possible questions concerning perceptions were reduced to a single question addressing the perception regarding the details of the chemistry curriculum at other institutions; d) a surveys content-validation phase during which the completed surveys were submitted to a panel of five practicing professors of chemistry who was asked to determine whether the questions and responses provided were sufficiently diverse to discern similarities as well as differences in instructional programs; e) the survey instruments improvement phase during which responses to survey questions were modified to include a greater range of responses and additional questions were added to the survey instruments; f) the identification of the population of state-supported two-year colleges and state-supported universities that offered two years of chemistry leading to an approved baccalaureate degree with an emphasis of study in chemistry; g) selection of appropriate statistical tests to analyze the data; and h) determination of the reliability of the paper-and-pencil informational survey instrument.

This chapter is organized into the following sections: 1) survey instrument item development; 2) survey instrument item responses; 3) survey item content-validation; 4) survey instrument item response improvement; 5) determination of the population; 6) selection of appropriate tests of significance; 7) sampling phase; and 8) determination of the reliability of the survey instrument.

Survey Item Development

The general approach taken in developing the survey instrument questions was to make a comprehensive list of aspects of instruction deemed important by a) this researcher's experience as a classroom instructor, and b) the aspects identified by the Committee on Professional Training of The American Chemical Society and those aspects deemed important by recent studies of undergraduate education. From the list of aspects of instruction identified, those aspects that might make useful or interesting comparisons but might be difficult to substantiate were eliminated from further consideration. Thus, salaries and line-item analysis of departmental (or other unit of organization) budgets were eliminated from those aspects of college and university organization that would be studied.

A decision was made to develop a 1 to 5 degree scale of nonconformity/conformity, absence/presence or non-desirable/desirable conditions. The 1 to 5 degrees on the scale could be constructed to represent doubling quantities. With a 1 score as an absence (zero) and 2 as a one score, a 5 score could represent 2^4, that is sixteen times the 2 score. It was expected that this ordering, or similar ordering, would satisfy the expected responses to the survey instrument items.

Survey Item Response Development

The development of the range of anticipated item responses followed the pattern that whenever there were multiple combinations of possible survey item responses, the first step taken was a ranking of the item responses from non-compliance to full compliance or absence to multiple levels of presence. The second step taken was an evaluation of inclusive responses of the 1 to 5 ranking scale. Recognizing that the grouping of responses might be biased and might not permit the detection of the differences or similarities that might occur between or within levels of institutional instructional programs, the responses were regrouped into a checklist form. The sum of the checklist responses was transformed into a 1 to 5 ranking scale. This process was repeated as necessary to permit maximum diversity of item responses.

The survey items were then collected into five catagories: 1) organization of the instructional unit; 2) instruction of first year chemistry; 3) instruction of second year (organic) chemistry; 4) faculty; and 5) facilities and instructional resources.

Such items of interest as the identification of the textbooks used did not lend itself readily to ranking or ordering. For that survey item, an identification of the textbook(s), author(s) and publisher(s) was assumed to be adequate by this researcher. From the outset of the study, the survey instruments were intended to be essentially interview survey instruments so as to preclude possible misunderstandings of individual survey item questions or of the survey item responses.

The Perceptions Instrument was intended to identify the interviewee's overall perception of the program of instruction of the first two years of chemistry at state-supported two-year colleges and state-supported universities in Michigan. The same perceptions question was directed at each of the stratified groupings of small-size two-year colleges, medium-size two-year colleges, large-size two-year colleges, small-size universities, medium-size universities and large-size universities. Examples of institutions were provided for each stratification and five levels of response were provided for each perception question. These responses ranged from "somewhat lesser quality" at the lower end of the scale to a "somewhat better quality" at the higher end of the scale.

Interviewees were not asked to differentiate between the instructional programs in chemistry at institutions of the same stratification size-level as the interviewee's institution.

Survey Item Content-Validation

The Interview Survey Instrument and the Interview Perceptions Instrument were submitted to a panel of five practicing professors of chemistry to determine the content validity. The panel members were specifically requested to respond to two questions: 1) Is the breadth of questions adequate to discern similarities and differences in instructional programs of the target population? and 2) Are the possible responses to the questions sufficiently diverse so as to adequately discern absence/presence of instructional features and also to discern similarities/differences in the instructional programs? Each member of the panel was provided with the survey instruments and a set of definitions of content validity, and construct validity.[1] The specific comments of the Validation Panel may be found in Appendix A.

The scale chosen for use on the Interview Perceptions Instrument was intentionally designed to force a response choice. There was some concern on the part of the validation panel in not including an optional "no opinion" or similar response. This researcher chose not to include such an option as that would defeat the forced response design. This researcher made the assumption that every interviewee possessed a perception about the program of instruction in chemistry at the other institutions whether the perception was based upon some evidence, an assumption, or alternatively upon an institution's reputation. Therefore, every interviewee was expected to reveal his/her perceptions about the other institutions but was not expected to reveal the particular basis for the perception.

Survey Item Response Improvement

Responding to the comments made by the panel of experts who commented upon the validity of the survey items and the item responses provided, modifications incorporating those suggestions were made to the survey instruments.

Improper nomenclature of the laboratory equipment

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[1] L. J. Cronbach, "Test Validation," in Educational Measurement, Robert L. Thorndike, Ed., Washington, DC: American Council on Education, 1971, 446.

was remedied and additional survey items were added that clarified the original survey items. Item responses were refined to reflect the concerns of the validation panel members.

A state-supported two-year college and a state-supported university were randomly selected for a preliminary use of the survey instruments to determine the suitability of the survey items and item responses, to obtain an estimate of the actual on-site time requirements, and the feasibility of administering Part IV Facilities & Resources, by mail. After the preliminary tests, the principal change in the administration of the Interview Survey Instrument was to decide to send the entire Interview Survey Instrument to the interviewees. Early reception of the Interview Survey Instrument permitted the interviewees ample time to examine the questions and responses prior to the actual on-site interview. In each case, the interviewee made preliminary responses to the survey questions along with their own questions about the intent of the survey questions and responses.

The Population

The total population of state-supported two-year colleges and state-supported universities that offered two years of chemistry leading to the baccalaureate degree with an emphasis in chemistry was determined by obtaining an institutional catalog and schedule of classes from each of the state-supported two-year colleges and state-supported universities in Michigan. By examination of the catalogs and class schedules, it was determined which of the state-supported two-year colleges and state-supported universities in Michigan offered two years of instruction in professional chemistry, and to thereby identify those institutions and their instructional programs as the target population of this study. (See Appendix B.)

The institutions identified as offering instruction of two years of professional chemistry were then stratified into small-size, medium-size, and large-size two-year colleges and small-size, medium-size and large-size universities as defined in Chapter I of this study.

The baccalaureate-degree-granting programs at the University of Michigan at Flint and the University of Michigan at Dearborn were considered in this study to be independent of the instructional program at the University of Michigan at Ann Arbor. Therefore, the former institutions and their instructional programs were classified as medium-size state-supported universities for sample selection and analysis purposes. The resulting total population of institutions of interest to this study included five small-size state-supported two-year colleges, seven medium-size state-supported two-year colleges, ten large-size two-year colleges, two small-size state-supported universities, seven medium-size state-supported universities and six large-size state-supported universities.

Additional examination of the catalogs and class schedules of the colleges and universities permitted a close scrutiny of the course credits, as well as examination of the tuition and fees structures utilized to fund instruction by all of the institutions in the target population.

The American Chemical Society[2] has recommended that a total of 180 contact hours be devoted to lecture and recitation, and 240 contact hours be devoted to laboratory instruction in the first two years of instruction in professional chemistry. Examination of the college and university catalogs permitted a scrutiny of the credit and contact hours allotted to lecture, recitation and laboratory instruction. With an examination of the entire target population of state-supported two-year and state-supported universities offering instruction in professional chemistry, a more detailed comparision was made possible than that offered by examination of only a selected sample of the institutions. Those institutions whose instruction in chemistry differed greatly from the recommendations made by the American Chemical Society for lecture and contact hours were readily determined.

Fee and tuition structures differ somewhat from institution to institution, and so a generic sixty-two semester hour curriculum was created for full-time chemistry

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[2]ACS Society Committee on Education, Task Force on ACS Involvement in the Two-Year College, Guidelines for Chemistry & Chemical Technology Programs in Two-Year Colleges: Experimental Version. American Chemical Society, 1987.

students to permit easier comparisons. If only the costs of part-time instruction in chemistry was examined, the unequal weights of registration fees and other fees collected at the institutions might create a seriously flawed evaluation of the actual costs incurred by more probable full-time students at these institutions.

Estimated costs for sixty-two semester hours of instruction (the first two years of study leading to the baccalaureate degree) were determined based solely upon tutition and fees for resident students as determined by the respective institutional guidelines. The estimated costs do not include the expenses a full-time student would incur for books, supplies, room and board, nor for any of the many other costs incurred by students. The estimated costs should not therefore be used for any comparisons that would require a more comprehensive estimation of total costs.

Selection of An Appropriate Test of Significance

The Interview Survey Instrument was divided into five sections. Each section of the Interview Survey Instrument yielded a score that was used to determine a mean score for the six state-supported two-year colleges and a mean score for the six state-supported universities surveyed in the sample of institutional instructional programs in chemistry.

A t-test for independent samples was used as the method employed for tests of significance based on the following: 1) the sample was small and included only six programs of instruction in chemistry at state-supported two-year colleges (as well as an equal number of programs of instruction at state-supported universities); 2) the standard deviations of the scores were readily calculated; and 3) the population of the instructional programs of chemistry as measured by the survey instrument questions were assumed to be normally distributed. In each case, the t-test was used to determine whether there was a significant difference between the mean of the scores obtained from the sample of state-supported two-year colleges and the mean of the scores obtained from the sample of state-supported universities.

Reliability of the Interview Survey Instrument

An internal-consistency reliability coefficient[3] (alpha) of the Interview Survey Instrument was determined to be 0.897 from the scores obtained from the one hundred nineteen interview survey questions responded to by the twelve institutions that participated in the study.

The Sample

A random selection of two institutions from each of the stratified groups of state-supported two-year colleges and state-supported universities was made. This resulted in a total sample size of six state-supported two-year

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[3]Robert L. Ebel, Essentials of Educational Measurement, Englewood Cliffs, NJ: Prentice-Hall, Inc., 1972, 420.

colleges and six state-supported universities. These institutions were then contacted to arrange for a visitation that would not be hurried, but equally would not intrude upon the patience nor valuable time of the representatives of the surveyed institutions. Upon receipt of an oral acceptance to participate in the interview, a statement of participant rights was mailed to the interviewees, as well as the Interview Survey Instrument, which was expected to be examined prior to the actual interview.

Upon receipt of written consent, the Interview Survey Instrument was then administered to the participants. Upon completion of the Interview Survey Instrument, the Interview Perceptions Instrument was administered to the participants. A decision was made to administer the Interview Perceptions Instrument AFTER the administration of the Interview Survey Instrument so that the participants of the survey would have a clear sense of the instructional aspects they were being asked to compare.

Summary

An Interview Survey Instrument was developed to evaluate selected aspects of the educational program of instruction of the first two years of professional chemistry in Michigan state-supported two-year colleges and state-supported universities. A second instrument, an Interview Perceptions Instrument was developed to identify the interviewee's perceptions concerning the instructional program in chemistry at their own institution as compared to the instructional program in chemistry at other institutions. The survey items and item responses for both survey instruments were improved and validated by an expert panel of practicing professors of chemistry who were knowledgable of instruction in chemistry. Two institutions were randomly selected from each of the three stratfied-by-student-enrollment groups of state-supported two-year colleges and state-supported universities. A total of twelve institutions were surveyed from the total number of twenty-two state-supported junior/community colleges and fifteen state-supported universities offering two years of instruction in professional chemistry that leads to the baccalaureate degree with a major emphasis in chemistry.

Raw data were recorded for the survey questions, and the 1-to-5 scores were modified to be inclusive of the data collected after the survey was completed. T-tests were used as tests of significance to compare the programs of instruction in chemistry at the state-supported two-year colleges and state-supported universities in Michigan.

A coefficient of reliability for the Interview Survey Instrument was determined to be 0.897. The Revised Interview Survey Instrument and the Interview Perceptions Instrument may be found in Appendices D and E. The data collected by the two instruments may be found in Appendices F, G and H.

CHAPTER IV

ANALYSIS AND INTERPRETATIONS OF THE STUDY

This chapter is organized into the following sections: 1) Analysis of the Interview Survey Instrument Responses; 2) Analysis of the Interview Perceptions Instrument Responses; 3) Analysis of Tutition and Fees; 4) Analysis of Credit Hours and Contact Hours; and 5) Analysis of Institutional Use of Course Placement Tests.

Analysis of the Interview Survey Instrument Responses.

The Interview Survey Instrument responses were analyzed and interpreted by addressing the five categories of the Interview Survey Instrument: a) Organization of the Instructional Unit; b) Instruction in First Year Chemistry; c) Instruction in Second Year (Organic) Chemistry; d) Faculty; and e) Facilities and Instructional Resources. In addition, the total scores obtained from the Interview Survey Instrument were analyzed to compare overall similarities and differences of the instructional programs of the state-supported two-year colleges and the state-supported universities.

Organization of the Instructional Unit

Eight survey questions addressed aspects of The Organization of the Instructional Unit (OIU) and the potential OIU scores ranged from a low of 8 to a high of 40.

The derived OIU scores for the state-supported two-year colleges in the sample ranged from 12 to 24 with a mean of 17.5. The derived OIU scores for the state-supported universities in the sample ranged from 12 to 37 with a mean of 30.2. (See Table IV-1.)

Ho_1: There is no significant difference between the mean scores that measure aspects of the Organization of the Instructional Unit at the 0.05 level of confidence.

TABLE IV-1

ORGANIZATION OF THE INSTRUCTIONAL UNIT (OIU)

	State-Supported Two-Year Colleges	State-Supported Universities
Scores	12,24,17,17,15,20	31,18,30,37,35,30
Mean Score	17.5	30.2
Standard Deviation	+/- 4.1	+/- 6.6
Sample Size	n = 6	n = 6
Critical Value:	$_{.975}t_{10}$ = 2.23	

A two-tailed t-test[1] of independent samples was used to determine whether the mean of the OIU scores obtained from the state-supported two-year colleges and the

[1] Glass, Gene V., and Julian C. Stanley., Statistical Methods in Education and Psychology, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970.

mean of the OIU scores obtained from the state-supported universities were significantly different. $t_{calc.} = 4.02$. The null hypothesis was rejected. A significant difference was found between the mean of the OIU scores obtained from the state-supported two-year colleges and the mean of the OIU scores obtained from the state-supported universities at the 0.05 level of confidence. (Refer to Appendix D for the survey questions and to Appendix F for the the institutional responses.)

Upon examination of the responses to Questions 1 and 2 (Q1, Q2), the responses indicated that state-supported universities were more likely than the state-supported two-year colleges to have independent departments of chemistry and to have clearly definable financial support addressable through budgetary line items. Additionally, because the administrative organization in the state-supported two-year colleges typically merged the chemistry discipline with a wide range of other related, or seemingly unrelated instructional disciplines, funding for equipment capital outlay equipment, repair and maintenance of equipment, as well as routine acquisition of expendable laboratory and lecture supplies, was uncertain.

Course Placement (Q3) was addressed by four of the six state-supported universities by use of a chemistry pretest, but not at all by any of the six state-supported two-year colleges surveyed. Course placement, as a pre-requisite for entry into the courses comprising the first year of chemistry, was found to be a function of the counseling staff in these state-supported two-year colleges. The extent to which the institution's provided student personnel services, or administrative assistance in determining proper course placements was not studied in this survey.

Tutoring (Q4) was not given a high priority in any of the twelve institutions in the sample. Not disclosed by the responses to Q4 was the observation that one of the state-supported two-year college chemistry departments actively discouraged the use of tutors primarily because the selection and control of the tutors was effectively out of the administrative control of the instructional department.

Student Opportunities for Professional Activities (Q5) was found totally lacking in five of the six state-supported two-year colleges, while the state-supported universities reported a variety of student opportunities such as attendance and participation in departmental seminars, college seminars, and American Chemical Society Student Affiliate Chapters. This great difference in student opportunities between the two types of institutions was assumed to be from a perceived lack of "sense of control" of the "department's life" by members of departments in state-supported two-year colleges.

Professional/Career Counseling (Q6) comparisons fared somewhat better than the Student Opportunities comparisons, with all institutions providing at some level opportunities for career counseling. Additionally, five of the six state-supported universities sponsored an American Chemical Society Student Affiliate Chapter on their respective campuses, while none of the six state-supported two-year colleges had such provision.

The responses to the question on Student Opportunities for Research (Q7) was revealing. It might have been expected that student opportunities for chemical research would have been the domain of the state-supported universities, but two of the six state-supported universities in the survey of institutions had no provision for student chemical research in the first two years of chemistry, while one of the six state-supported two-year colleges did provide such an opportunity. This particular state-supported two-year college was also the only institution of the twelve institutions included in this study that was participating in the American Chemical Society's Project Seed, a funded project designed to provide summer research opportunities for minority students.

Two of the six state-supported two-year colleges and two of the six state-supported universities did not provide any student recognition awards (Q8). The Chemical Rubber Publishing Company has for many years made available a free copy of the CRC Handbook of Chemistry and Physics (along with a small certificate) to award to the Outstanding Student in Freshman Chemistry in each participating institution. Most of the institutions made CRC student recognition awards with the awareness that such awards could be an incentive to student performance as well as a recognition of student performance.

Instruction in First Year Chemistry

Twenty-five questions (Q9-Q33) in the survey address aspects of Instruction of the First Year of Chemistry (IFYC) with potential scores ranging from a low of 25 to a high of 125. The IFYC scores obtained by the state-supported two-year colleges ranged from 66 to 77 with a mean of 70.7 while the IFYC scores obtained by the state-supported universities in the sample ranged from 55 to 77 with a mean of 63.2. (See Table IV-2.)

Ho_2: there is no significant difference between the mean scores that measure aspects of Instruction of the First Year of Chemistry at the 0.05 level of confidence.

TABLE IV-2

INSTRUCTION IN FIRST YEAR CHEMISTRY (IFYC)

	State-Supported Two-Year Colleges	State-Supported Universities
Scores	66,77,77,70,66,68	57,63,59,68,55,77
Mean Score	70.7	63.2
Standard Deviation	+/- 5.1	+/- 8.2
Sample Size	n = 6	n = 6

Critical Value: $_{.975}t_{10} = 2.23$

A two-tailed t-test of independent samples was used to determine whether the mean of the IFYC scores obtained from the state-supported two-year colleges and the mean of IFYC scores obtained from the state-supported universities were significantly different. $t_{calc} = 1.90$. The null hypothesis was not rejected. No significant difference was found between the IFYC mean scores at the 0.05 level of confidence.

Examination of the survey question responses revealed striking similarities between the two- and four-year institutions: two of the six state-supported two-year colleges and two of the six state-supported universities surveyed reported that (Q9) the first-year chemistry course had prerequisites that were published in institutional publications, but that the institutions did not adher to the prerequisites in course placement of students. All of these institutions reported that the course prerequisites were routinely waived by non-departmental personnel. An additional four institutions reported that the course prerequisites were published and firmly enforced. Yet, an additional four institutions reported that the course prerequisites were published in institutional publications, but only the course instructor could waive the prerequisites to the course. The first-year chemistry course pre-requisites generally require the successful completion of two years of algebra and one year of chemistry in high school.

In the scheduling (Q10) of the first-year chemistry course, three of the twelve institutions had morning-only schedules, and an additional four institutions had morning- and/or evening schedules. The remaining five institutions had schedules that included morning, afternoon and evening instruction. Instructional methods (Q11) were quite consistent. Seven of twelve institutions used a lecture-recitation instructional format, and five of twelve institutions used a lecture-without-recitation instructional format. The selection of the course textbook (Q12) for the first-year of chemistry instruction was made by the course instructor or a team of instructors in eleven of twelve institutions. In only one institution was the course textbook selected by a coordinator. A variety of textbooks were found to be used in the sample of institutions surveyed: General Chemistry by Ebbing (Houghton-Mifflin) (three); Chemistry and Chemical Reactivity by Katz and Purcell (Saunders) (three); Chemistry by Zumdahl (Heath)(two); General Chemistry by Brady & Humiston (Wiley) (one); General Chemistry by Whitten and Gailey (Saunders) (one); Chemistry by Sienko and Plane (McGraw-Hill) (one); and General Chemistry by Petrucci (Macmillan) (one).

Pertaining to the course description (Q13) of First-Year Chemistry in the college catalog, ten of the twelve institutions in the sample reported that the course descriptions were brief and had but few to some details. It might be assumed that evaluation of transfer credits includes a somewhat more detailed and critical evaluation than a perusal of the course descriptions found in the institutional catalog of courses. The basis for recognition of, or acceptance of, course credits presented for transfer to other institutions was not a part of this study.

Lecture Behavioral Objectives (Q14) were utilized by two of the six state-supported two-year colleges, while not used at all by any of the six state-supported universities. A common, often-heard report, was that everyone seemed to be willing to use someone else's behavioral objectives or to use the textbook's behavioral objectives, but no one seemed willing to write their own. Most of the participants reported that they expected the students to become aware of the behavioral objectives found in their course textbook.

The first-year chemistry lecture class sizes (Q15-Q16) ranged from thirty to one-hundred-twenty students in state-supported two-year colleges with a mean class size greater than sixty students. State-supported universities generally had classes just twice as large in number of students as the state-supported two-year colleges. There appeared to be very little difference in the total number of tests/quizzes/finals (Q17) administered in the first-year chemistry classes. State-supported two-year colleges and state-supported universities alike utilized between five and eight measurements of lecture material comprehension each semester.

Three of the seven institutions that administered a comprehensive final examination for the first year of chemistry used the American Chemical Society's Cooperative Examination for General Chemistry, and the other four institutions used an institutionaly adopted 'in-house' authored examination. The remaining five institutions did not utilize a comprehensive final examination at the end of the year's work in chemistry. The reasons for utilizing or not utilizing a standardized comprehensive examination was not examined in this survey, but was assumed to be related to the presence or absence of an examinations week in the college/university academic calendar. The question concerning Required Use of Chemical Literature (Q18) revealed that only four of twelve institutions in the sample expected first-year chemistry students to utilize a chemistry handbook for reference use, while none of the institutions made use of any chemical journal references in their instruction.

There was no observed difference in the use of the chemical literature between the state-supported two-year colleges and the state-supported universities in the institutions surveyed. Published Laboratory Behavioral Objectives for laboratory instruction (Q19) were utilized by only one institution of the twelve institutions surveyed, but there was little difference in the intended laboratory experiences (Q20) as described by the participants in the survey. (See Question 20 in Appendix D for the detailed desired laboratory experiences.) Maximum capacity of student numbers in the laboratory (Q21) ranged from twenty to thirty-one students with no differences reported by the state-supported two-year colleges and the state-supported universities. The mean numbers of students in the laboratories (Q22) were slightly smaller but ranged between sixteen and thirty-one students in both state-supported two-year colleges and state-supported universities. This students-per-lab information conforms closely with the data collected in a recent nation-wide study[2] of large graduate-degree-granting universities.

The Student/Faculty Ratio in the laboratory (Q23) was similar in both state-supported two-year colleges and state-supported universities with reported ratios in the range of sixteen to thirty-one students/faculty instructor. The large state-supported universities which utilized teaching assistants (under some supervision) reported a ratio greater than thirty-one students/faculty member. At the beginning of the first-year chemistry laboratory instruction, almost equal numbers (five of twelve) of the institutions used fill-in laboratory reports (Q24) as required written laboratory reports or laboratory journals (six of twelve). Only one institution reported the use of computerized fill-in laboratory reports.

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[2]Rund, J. V., P. C. Keller and S. L. Brown, "Who Does What in Freshman Lab? A Survey," Journal of Chemical Education, 66 (February 1989), 161.

Laboratory Report Requirements (Q25) were non-existent at five institutions, but three institutions required that the laboratory reports conform to a particular format. The most common requirement of the seven remaining institutions was for an analysis of the errors in the experiment performed. Spelling errors and use of significant figures were important aspects of laboratory report writing as reported by five institutions. Only one institution required the use of statistical methods in the writing of the laboratory reports at the beginning of the year. Most interviewees that complained about the lack of ability of students to express themselves reported that they did identify misspelled words and awkward sentence structures on the laboratory reports but, uniformly the interviewees indicated that they did not consider these breaches of writing ability in the final determination of the laboratory report grade. Instructor expectations for laboratory reports at the end of the year (Q26-Q27) differed little from the instructor expectations at the beginning of the year. Despite the experience gained in report-writing by the students over a period of two semesters, the survey of the institutions revealed that the skills gained in report writing by the students were not treated as developmental in nature by the institutions surveyed. This survey did not examine the means used in grading the laboratory reports, nor whether instructors, teaching assistants or graders were involved in the grading of the laboratory reports. Writing (Q28) is not an expectation in the first-year of chemistry in either the state-supported two-year colleges or the state-supported universities in the sample of institutions surveyed. Only one institution (a state-supported two-year college) made one or more writing assignments in addition to the required laboratory reports. It was observed, however, that the state-supported universities began to address this expectation in the student's junior year at the university.

Evaluation of the Laboratory Experience (Q29) was found to be primarily determined by the scores obtained on laboratory reports or the journal scores uniformly across all institutions surveyed. But nine of twelve institutions surveyed used at least two additional methods of evaluation in determining the laboratory grades. These methods included unknowns identification, and observation by instructor, or by the use of a laboratory-practical test. Two institutions (both state-supported universities) used a composite of laboratory report scores, observation by instructor, unknowns indentification and a laboratory practical test score in determining the laboratory grades.

The question on Structured Laboratory Instruction (Q30) permitted the determination of a quasi-consensus of the relative importance of particular laboratory experiences. Eleven of the twelve institutions in the study considered descriptive chemistry, acid-base titrations, qualitative analysis and thermodynamic experiments to be of prime importance. Nine of the institutions considered synthesis, separation and analysis to be of next importance. A third grouping found seven institutions that included determination of constants, periodic properties, theoretical models and experiments in kinetics in their list of important laboratory experiences. Of lesser importance in the first year chemistry laboratory experience was statistical treatment of data, redox titrations, EDTA titrations and structural determinations. These latter experiments were used by only four of the institutions surveyed in the study. There was little difference in these experiments selected for first-year chemistry students to perform as reported by the state-supported two-year colleges and the state-supported universities. The survey did not include questions concerning the authorship or publishers of the experiments selected for use in the first year chemistry laboratory.

Computer Usage (Q31) as part of the instruction in first year chemistry was completely lacking in two institutions. Seven institutions allowed students to use computers for tutorial purposes, and five institutions permitted students to use computers for computational purposes. Two institutions encouraged students to use computers for data collection, and three institutions used computers for experimental simulations. Only two institutions had provision for student-use of spreadsheet software on computers. Despite this seemingly wide-spread use of computers in chemistry, of the institutions surveyed, the state-supported two-year colleges were more likely to include the use of computers in instruction of chemistry than were the state-supported universities.

Assigned student research (Q32) in first-year chemistry leading to a paper or a bibliography was completely lacking in all of the institutions surveyed in the sample.

Required Use of Safety References (Q33) was completely lacking in seven of the twelve institutions in the sample. Three institutions used one safety reference and the remaining two institutions made use of two sources of safety information. Safety data references used by the institutions as reported by the interviewees included the Merck Index[3], and Material Safety Data Sheets that are provided by manufacturers and suppliers of chemical products. The Michigan Right-To-Know Law[4] does not directly address a requirement that students be made aware of the sources of information that describe the hazards of the chemicals they may encounter in the chemical laboratory. However, instructors and student employees of instructional institutions are covered by this law.

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[3]The Merck Index, 10th Edition, Rahway, NJ: Merck & Company, 1983.

[4] Act No. 154 of the Public Acts of 1974, with sections 5, 11, 31, and 63 ammended by Act No. 51 of the Public Acts of 1980.

Instruction in Second-Year (Organic) Chemistry

Twenty-five survey questions (Q34-Q58) address the aspects of instruction in second-year (organic) chemistry (ISYC). The survey questions are similar, though not identical, to the questions that address the instruction of the first-year of chemistry. The potential scores for this section ranged from a low of 25 to a high of 125. The scores obtained by the state-supported two-year colleges ranged from 73 to 89 with a mean score of 79.2. The scores obtained by the state-supported universities ranged from 65 to 90 with a mean score of 73.3. (See Table IV-3.)

Ho_3: there is no significant difference between the mean scores that measure aspects of Instruction in Second-Year (Organic) Chemistry at the 0.05 level of confidence.

Table IV-3

INSTRUCTION IN SECOND-YEAR (ORGANIC) CHEMISTRY (ISYC)

	State-Supported Two-Year Colleges	State-Supported Universities
Scores	80,81,75,89,77,73	73,66,78,90,65,68
Mean Score	79.2	73.3
Standard Deviation	+/- 5.7	+/- 9.5
Sample Size	n = 6	n = 6
Critical Value:	${}_{.975}t_{10} = 2.23$	

A two-tailed t-test of independent samples was used to determine whether the mean of the ISYC scores obtained from the state-supported two-year colleges and the mean of the ISYC scores obtained from the state-supported universities were significantly different. $t_{calc.} = 1.31$. The null hypothesis was not rejected. No significant difference was found between the mean of the ISYC scores obtained from state-supported two-year colleges and the mean of the ISYC scores obtained from the state-supported universities at the 0.05 level of confidence.

Adhering to the prerequisites for the second-year of chemistry (Q34) was found to be much less of a problem for all institutions than was experienced for the first-year course in chemistry. This prerequisite for the second-year (organic) chemistry generally included the successful completion of the first-year chemistry course. The second-year (organic) chemistry courses had limited scheduling variations (Q35) in seven of the twelve institutions surveyed. The second-year chemistry course was generally scheduled either in the morning or in the afternoon, but at least three institutions had both morning and afternoon/ evening schedules for the course.

The lecture method without a separate recitation class was the instructional method (Q36) of choice in the second-year (organic) chemistry course as reported by nine of the twelve institutions surveyed. The remaining three institutions used a lecture-recitation format of instruction.

Eleven of the twelve institutions reported that the course instructor or team of instructors selected the textbook (Q37) to be used in the instruction of the second-year (organic) chemistry course. The textbooks favored by the institutions surveyed include: Organic Chemistry by Morrison and Boyd (Allyn & Bacon) (five); Organic Chemistry by Solomons (Wiley) (four); Organic Chemistry by Wade (Prentice-Hall) (one); Introduction to Organic Chemistry by Streitweyer and Heathcock (Macmillan) (one); and Organic Chemistry by Carey (McGraw-Hill) (one). The second-year organic chemistry course descriptions (Q38) described in the institutional publications were found to be consistent with the first-year chemistry course descriptions, and were brief descriptions with but few details.

Lecture Behavioral Objectives (Q39) were not any more popular in the second-year chemistry courses than in the first-year chemistry courses. But four of six state-supported two-year colleges used extensive behavioral objectives in their lectures as compared to only one of the state-supported universities surveyed. Maximum lecture-class capacities (Q40) ranged from thirty to greater than two-hundred-forty or more students. The mean class capacity reported for the state-supported two-year colleges was in the one to thirty students range while the mean class capacity for state-supported universities was in the sixty to one hundred twenty students range.

These numbers reflect the classroom facilities at these institutions, as well as the method(s), whereby the institutions schedule multiple class sections. Actual Mean Lecture Class Sizes (Q41) were approximately fifteen students in the state-supported two-year colleges and about ninety students in state-supported university lecture classes.

There was little difference in the number of tests/quizzes/final examinations administered (Q42) in the second-year chemistry course, and all institutions used between six and eight measurements each semester to determine student achievement. There was an even split of six of the twelve institutions surveyed that administered a comprehensive final examination. Every institution that administered such a final examination reported the use of the American Chemical Society's Cooperative Examination in Organic Chemistry. The state-supported two-year colleges were, however, less likely to administer a comprehensive examination in the second-year chemistry course.

Although the students in the second-year chemistry course now had a year of experience in chemistry, students in the second-year chemistry course had few requirements for the Use of the Chemical Literature (Q43) much beyond the extent to which the literature was used during the first-year chemistry course. There was little difference in this expectation as reported by the state-supported two-year colleges and the state-supported universities. Without any substantial change from the instruction in the first-year chemistry course, nine of twelve institutions surveyed reported that they did not publish laboratory behavioral objectives (Q44). Of the remainder of the institutions surveyed, two of the state-supported two-year colleges and one of the state-supported universities used behavioral objectives in their laboratory instruction. There was little difference in the reported goals of the student's laboratory experience in chemistry (Q45) among the twelve institutions surveyed. The laboratory goals in order of importance as reported by the survey participants were: (1) Recognize the hazards and unique problems of chemical safety and carefully observe modern safety practices; (2) Keep accurate and complete experimental records; (3) Use effectively and with understanding a good selection of modern instruments, including IR, UV and NMR spectrometers and gas chromatographs; (4) Perform quantitative manipulations; (5) Assess the reliability of the results; (6) Write good reports; and (7) Plan experiments through use of literature.

Maximum Laboratory Class Capacities (Q46) did not vary greatly between the state-supported two-year colleges and the state-supported universities. But there was a collective concern, on the part of most of the laboratory class instructors, to keep the organic chemistry laboratory class-size somewhat smaller than the first-year chemistry class-size. The primary reasons for reducing the organic laboratory class-size by the institutions were reportedly the increased possibilities of explosion and exposure to hazardous chemicals encountered by students in the organic chemistry laboratory.

Eleven of twelve institutions reported having mean organic laboratory class-sizes (Q47) of between one and twenty-three students. The state-supported two-year colleges had mean laboratory class-sizes at the lower end of that range while state-supported universities reported mean class-sizes near the capacity of the laboratory. The Student/Full-Time-Faculty Ratio (Q48) in the organic chemistry laboratory was reportedly eight to fifteen students in the state-supported two-year colleges and about twice that number in the state-supported university laboratories. An exception were the large universities that used teaching assistants (TAs) extensively in the laboratories. These TAs were supervised by full-time faculty but the student/full-time-faculty ratio in these institutions was at least twice as large as the ratio in the universities not using teaching assistants in the laboratory.

Nine of the twelve institutions reported that students wrote laboratory journals or wrote reports at the beginning of the year (Q49). Of the nine institutions, three had zero or only one requirement for the reports written. The remaining six institutions reported having between two and four journal/written report requirements (Q50) at the beginning of the year. These laboratory report requirements included, in order of importance reported, spelling, use of significant figures, and proper report form. The state-supported universities were more likely to require the inclusion of error analysis and statistical analysis in the laboratory reports. At the end of the year, (Q51) ten of the twelve institutions reported having students writing journals or formal reports, but there had been no increase in the expectations concerning the quality, nor the number of details to be included in the reports written (Q52). Only three institutions made additional formal writing assignments (Q53) to the students. Ten of the twelve institutions in the survey of institutions reported that the laboratory experiences in organic chemistry were evaluated (Q54) by a combination of three or more methods which included laboratory report grades, identification of laboratory unknowns, and general observations of the laboratory instructnr. The question on Structured Laboratory Instruction (Q55) found complete agreement by all of the institutions surveyed on the importance of including elements of synthesis, separation and analysis in the laboratory experience. A consensus of most of the institutions also included structure determination and product ratio determination in the laboratory schedule. Less commonly found were experiments regarding kinetics or determinations of thermodynamic properties. Just one institution (a state-supported university) reported the teaching of micro-techniques in the laboratory.

Computers used in teaching organic chemistry (Q56) were limited to tutorial use in four institutions, data collection and tutorials in one institution, and zero usage was reported by six institutions. One of the institutions (a state-supported university) reported the use of computers for tutorials, computations, data collection, and for spreadsheet analysis. There was no discernible difference in computer use in organic chemistry between the state-supported two-year colleges and the state-supported universities surveyed.

Eight of the twelve institutions in the study gave no Assigned Student Research (Q57) to their organic chemistry class students. Of the remaining four institutions, two state-supported two-year colleges and two state-supported universities gave assigned student research that included library research for a bibliography. The majority of institutions were not requiring the use of their library resources in their second-year chemistry courses.

At the end of two years of instruction in chemistry, two institutions did not have required student use of safety references (Q58), while six (one-half the total of institutions surveyed) had a required use of only one source of safety information concerning the use of chemicals. The survey participants indicated that the student's primary source of safety information was the laboratory manual.

Faculty

Eight questions (Q59-Q66) address aspects of the Faculty and potential response scores ranged from a low of 8 to a high of 40. The derived Faculty scores for the state-supported two-year colleges ranged from 14 to 24 with a mean of 19.8. The derived Faculty scores for the state-supported universities in the sample ranged from 23 to 36 with a mean of 32.2. (See Table IV-4.)

Table IV-4

FACULTY

	State-Supported Two-Year Colleges	State-Supported Universities
Scores	19,21,21,14,24,21	33,23,35,36,33,33
Mean Score	19.8	32.2
Standard Deviation	+/- 3.3	+/- 4.7
Sample Size	n = 6	n = 6
Critical Value: $_{.975}t_{10}$ = 2.23		

Ho_4: there is no significant difference between the mean scores that measure aspects of Faculty at the 0.05 level of confidence.

A two-tailed t-test of independent samples was used to determine whether the mean of the Faculty scores obtained from the state-supported two-year colleges and the mean of the Faculty scores obtained from the state-supported universities were significantly different. $t_{calc} = 5.39$. The null hypothesis was rejected. A significant difference was found between the mean of the Faculty scores obtained from the state-supported two-year colleges and the mean of the Faculty scores obtained from the state-supported universities was at the 0.05 level of confidence.

Chemistry faculty numbers (Q59) in state-supported two-year colleges ranged from one to six persons while the state-supported universities reported that faculty numbers ranged from six persons to several times that number. With faculty numbers at the lower end of the scale, state-supported two-year colleges reported having difficulties in providing the variety of chemistry courses they would like to offer, and also, in scheduling of those courses. Four of the institutions (three of the four were state-supported two-year colleges) surveyed did not utilize part-time instructors (Q60) for their professional sequence chemistry courses, while the state-supported universities were quite likely to employee from two to more than seven part-time instructors. The part-time instructor numbers do not include teaching assistants or graduate students. All of the state-supported universities had minimum requirements of the Ph.D degree for their full-time chemistry faculty (Q61). But the state-supported two-year college faculty in the survey tended to possess MS degrees or MS degrees with additional coursework completed. One state-supported two-year college had employeed a BS degreed faculty person who was working on a part-time basis toward the MS degree. Few state-supported two-year college faculty possess the Ph.D degree. On the basis of the survey, it appears that the two-year college faculty generally do, with few exceptions, have the appropriate degrees as recommended by the American Chemical Society and regional accreditation agencies.

The degrees possessed by part-time faculty lecturers (Q62) paralleled the degrees held by the full-time faculty lecturers in both the state-supported two-year colleges, as well as the state-supported universities. There was no difference between the academic credentials of the full-time laboratory faculty (Q63-Q64) and the academic credentials of the part-time laboratory faculty, either in the state-supported universities or the state-supported two-year colleges. Ph.D degrees were held by part-time laboratory instructors in the state-supported universities while MS degrees, or MS degrees with additional coursework completed, were held by the part-time laboratory instructors in the state-supported two-year colleges. In some cases, the part-time instructors in the state-supported two-year colleges had higher academic degrees than were possessed by the full-time faculty at those same institutions.

Faculty loads (Q65) varied considerably from institution to institution and ranged from fifteen to more than twenty contact-hours in the state-supported two-year colleges. The state-supported university chemistry faculties reported faculty loads with a range from ten to more than twenty contact-hours. Institutions had varied formulas in use to determine the faculty loads. Some of the institutions had a per-semester faculty-contact-load expectation, and other institutions expected the faculty load to be averaged over the college academic year. One state-supported university reported a formula that was used to determine the chemistry faculty load that included factors for large student numbers in the lecture courses. There appeared to be no provision for a zero contact hour faculty load at any of the institutions surveyed but there were provisions for reducing the faculty load on the basis of temporary administrative assignments.

Membership in the American Chemical Society (ACS) for the full-time faculty (Q66) was one hundred percent for the state-supported university chemistry faculties, but ranged from zero to one hundred percent with the full-time chemistry faculties of the state-supported two-year colleges. From this study, it can be seen that the state-supported universities consistently have Ph.D requirements for their faculty; the state-supported university chemistry faculty have lower average faculty teaching loads; and the state-supported university faculty are more likely to be members of the American Chemical Society. In addition, the state-supported university faculty were more likely to be teaching only courses in chemistry. Several two-year chemistry faculty reported that the low numbers of chemistry faculty with membership in the ACS was due to the high cost of ACS membership. There were a considerable number of state-supported two-year college faculty members who were teaching "other than chemistry" courses as part of their faculty teaching load. Neither faculty rank nor institutional tenure provisions were examined in this survey to determine whether these two aspects of academic life were factors that affected faculty teaching loads.

<u>Facilities and Instructional Resources.</u>

Fifty-three questions (Q67-Q119) addressed aspects of Facilities and Instructional Resources (FIR), and the potential FIR scores ranged from a low of 53 to a high of 265. The derived FIR scores for the state-supported two-year colleges ranged from 90 to 135 with a mean of 112.7. The derived FIR scores for the state-supported universities in the survey sample ranged from 100 to 159 with a mean of 131.5. (See Table IV-5.)

Ho_5: there is no significant difference between the mean scores that measure aspects of Facilities and Instructional Resources at the 0.05 level of confidence.

A two-tailed t-test of independent samples was used to determine whether the mean of the FIR scores obtained from the state-supported two-year colleges and the mean of the FIR scores obtained from the state-supported universities were significantly different. $t_{calc} = 1.72$. The null hypothesis was not rejected. No significant difference was found between the mean of the FIR scores obtained from state-supported two-year colleges and the mean

Table IV-5

FACILITIES AND INSTRUCTIONAL RESOURCES (FIR)

	State-Supported Two-Year Colleges	State-Supported Universities
Scores	109,105,109,128,135,90	141,100,127,159,116,146
Mean Score	112.7	131.5
Standard Deviation	+/- 16.3	+/- 21.5
Sample Size	n = 6	n = 6
Critical Value:	$_{.975}t_{10} = 2.23$	

of the FIR scores obtained from the state-supported universities at the 0.05 level of confidence.

An examination of the survey questions and the data obtained for Facilities and Instructional Resources revealed 1) the laboratory equipment available at an institution, 2) whether the students at that institution had access to the equipment during the first two years of chemistry, as well as 3) the relative numbers of students (student/equipment ratio) that utilized each piece of equipment in the laboratory setting. Generally, the state-supported universities had a wealth of equipment, but the equipment was not always available for use by the students during the first two years of instruction in chemistry. State-supported two-year colleges reported difficulties in funding some of the recommended organic chemistry instrumentation, such as a NMR spectrometer that the state-supported universities generally possess. On balance, however, whatever equipment that was possessed by a state-supported two-year college was used in a lower student/equipment ratio than used in the state-supported university laboratory. The chemical literature collections possessed by the state-supported universities were found to be greatly superior, in diversity as well as in actual volume numbers, to the chemical literature collections possessed by the state-supported two-year colleges as reported in the survey. The American Chemical Society (ACS) has recommended that a university will possess an extensive chemical literature collection as part of an ACS accreditation of the baccalaureate degree program.

An ACS accreditation for two-year colleges[5] has been proposed and is presently being studied. The recommended chemical literature collection for the proposed two-year college ACS accreditation is much less extensive than the recommendation made to the university/baccalaureate-degree-granting institution. In either case, however, the ACS recommendation for the institutional chemical literature collection greatly exceeds the actual use of the chemical literature in the first two years of chemistry as reported by the state-supported two-year colleges and the

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[5]ACS Accreditation of Two-Year Chemistry Programs, Two-Year College Chemistry Conference, Newsletter, Division of Chemical Education, American Chemical Society, 1989.

state-supported universities surveyed in this study.

Overall Evaluation of the Instructional Program.

In two sections of the survey, the mean score obtained from the scores of the state-supported university chemistry programs was found to be significantly different than the mean score obtained from the scores of the state-supported two-year college chemistry programs at the 0.05 level of confidence. Those sections were: The Organization of the Instructional Unit; and Faculty. The overall scores from the institutions surveyed were then examined to determine whether the total scores obtained from these institutions resulted in mean scores that were significantly different. The one hundred nineteen questions addressing The Overall Evaluation of the Instructional Program (OEIP) resulted in a potential score with a low of 119 and a maximum possible score of 595. The total derived OEIP scores for the state-supported two-year colleges ranged from a low of 282 to a high of 327 with a mean of 306.7. The total derived OEIP scores for the state-supported universities ranged from a low of 280 to a high of 410 with a mean of 342.0. (See Table IV-6.)

Ho_6: there is no significant difference between the mean scores that measure aspects of the entire two years of professional chemisty at the 0.05 level of confidence.

A two-tailed t-test of independent samples was used to determine whether the mean of the OEIP scores obtained from the state-supported two-year colleges and the mean of the OEIP scores obtained from the state-supported universities were significantly different. $t_{calc} = 1.83$. The null hypothesis was not rejected. No significant difference was found between the mean of the OEIP scores obtained from the state-supported two-year colleges and the mean of the OEIP scores obtained from the state-supported universities at the 0.05 level of confidence.

Table IV-6

OVERALL EVALUATION OF THE INSTRUCTIONAL PROGRAM (OEIP)

	State-Supported Two-Year Colleges	State-Supported Universities
Scores	296,318,299,318,327,282	345,280,339,410,314,364
Mean Score	306.7	342.0
Standard Deviation	+/- 17.0	+/- 44.2
Sample Size	n = 6	n = 6
Critical Value: $_{.975}t_{10} = 2.23$		

On the basis of the scores that measure the overall evaluation of the instructional programs in the first two years of chemistry, it may be concluded that the chemistry instuctional programs varied as much <u>within</u> the types of institutions as the instructional progams varied <u>between</u> the types of institutions, to the extent of the measures selected in this survey instrument.

Analysis of the Perceptions Instrument Responses.

The data collected with the Perceptions Instrument resulted in a total of sixty (12 x 5) individual perceptions about the program of instruction in chemistry at the interviewee's institution as compared to other institutions.

This data was collected in the form of ranking the local program as compared to the other institutions on the basis of facilities, faculty, equipment and student opportunities. (See Appendix E for the Interview Perceptions Instrument and Appendix G for the raw data.) The data was then revised to reflect the ranking of the other institutions as compared to the local program of instruction. An example may clarify: if institution A ranked their program as of "slightly less quality" (a 2 grade) as compared to institutional type B, the data was revised to read that institutional type B was of "slightly better quality" (a 4 grade) than the program at institution A. (See Revised Perceptions Data in Appendix H.)

The analysis of the total survey scores in the previous section has indicated that there was no significant difference in the mean scores that measure the Overall Evaluation of the Instructional Program obtained by the state-supported two-year colleges and the state-supported universities at the 0.05 level of confidence. The analysis of the perception ratings proceeded by ignoring the rankings of (2) "slightly lesser quality," (3) "essentially the same quality" and (4) "slightly better quality." These forty-seven perceptions, from the total of sixty, agree with the general conclusions drawn from the t-test of significance. That is, that there is no significant difference in the mean scores that measure the overall evaluation of the instructional programs. Next examined were the perceptions made by institutions that perceived the quality of instruction in chemistry at the "other" institutions to be of (1) "somewhat lesser quality" or (5) "somewhat better quality."

By comparing an institution's total survey score to the mean of the total survey scores of the "other" institutional-type, the perceptions and the total survey scores for each institutional-types were compared to determine whether the scores were different at the 0.05 level of confidence. (See Table IV-7.)

There are thirteen perceptions and accompanying total score comparisons to examine in Table IV-7, and all of the listed perceptions differ from the conclusions that must be drawn from the t-test of significance. The Perceptions Instrument was not designed to identify any differentiation in the basis for the perceptions held by the individuals and institutions surveyed. Because forty-seven of sixty perceptions agreed with the t-test of significance, one might conclude that adequate sources of information were available for use in forming perceptions about the quality of instruction in chemistry that students receive at the state-supported two-year colleges and state-supported universities in Michigan.

Table IV-7

COMPARISON OF PERCEPTIONS AND TOTAL SURVEY SCORES

INSTITUTIONS PERCEIVED OF	BY	INSTITUTIONAL MEAN SCORE	TOTAL SCORE	t_{calc}	SIGNIFICANTLY DIFFERENT?
SSTYC <	LSTYC	307 <	327	1.77	NO
SSTYC <	SSSU	307 <	345	3.36	NO
MSTYC <	SSSU	309 <	345	3.80	NO
LSTYC <	SSSU	305 <	345	1.77	NO
MSSU <	SSSU	375 <	345	0.86	NO
LSSU >	SSSU	339 >	345	0.24	NO
LSSU <	MSSU	339 <	410	2.87	NO
SSTYC <	LSSU	307 <	314	0.62	NO
SSTYC <	LSSU	307 <	364	5.04	NO
MSTYC <	LSSU	309 <	364	5.98	NO
LSTYC <	LSSU	305 <	364	2.61	NO
SSSU <	LSSU	313 <	364	1.57	NO
MSSU <	LSSU	375 <	364	0.32	NO

Critical Value $_{.975}t_1 = 12.71$

Analysis of Tuition and Fees

The academic catalogs and schedules of classes were obtained from all of the state-supported two-year colleges and state-supported universities in Michigan that offered two years of professional chemistry. These documents were then analyzed to identify the manner in which the institutions levied tuition and fees at student registration to partially meet the costs of the institution's operation.

During the 1988-1989 academic year, there was a range from $20.50 to $196.00 per semester hour in tuition charged in Michigan state-supported two-year colleges and universities. Furthermore, there were a battery of fees identified that students encountered as they pursued their goal of a college education: registration fees, high-cost-contact-hour fees, laboratory fees, glassware-breakage fees, user-fees, parking fees, health fees and general fees.

Registration fees each semester/term were as high as $100 without regard to the number of courses enrolled, or alternatively, registration fees were levied on a per credit hour basis.

To make reasonable comparisons of tuition and fees data, it was necessary to convert all quarter-hour tuition and fee rates to a semester-hour basis. Generally, the costs charged to students are on a registration plus tuition plus high-cost-contact-hour fee plus other fee(s) basis. But at least one state-supported two-year college charged students on a contact-hour charge plus fees/semester hour plus other fees basis.

The relative tuition institutions charged the students was difficult to compare directly because of the wide-spread practice of raising fees, or by the addition of new fees in an effort to postpone the raising of the tuition rates. (A summation of the institutional tuition and fees may be found in Appendix I.) In Table IV-8, the state-supported two-year colleges and state-supported universities are ranked by the nominal tuition charged to students as well as by estimated costs of two years (sixty-two semester hours) of tuition and fees. Students attending the

Table IV-8

INSTITUTIONS OFFERING TWO YEARS OF CHEMISTRY

RANKED BY TUITION[1] AND ESTIMATED TUITION AND FEES.

Institution	Tuition	Tuition Rank	Tuition & Fees For 62 Sem. Hrs	Tuition & Fees Rank
UM-Ann Arbor	$193.00[2]	1	$7800	1
Ferris State U	84.00	2	3900	7
Michigan Tech U	82.50	3	5400	2
UM-Dearborn	80.00	4	4200	5
Grand Valley State U	76.00	5	4800	4
Michigan State U	73.88	6	5300	3
UM-Flint	73.00	7	3400	13 -T
Wayne State U	60.50	8	4000	6
Saginaw Valley State	54.50	9	3800	8.5-T
Grand Rapids JC	54.00	10.5-T[3]	3400	13 -T
Western Michigan U	54.00	10.5-T	3800	8.5-T
Central Michigan U	52.00	12	3600	10.5-T
Lake Superior State	51.88	13	3300	15
Oakland U	51.00	14	3600	10.5-T
Eastern Michigan U	50.75	15	3400	13 -T
Oakland CC	49.00	16	3200	16
Northern Michigan U	44.25	17	3100	17
St. Clair Co. CC	35.00	18.5-T	2600	18
Macomb Co. CC	35.00	18.5-T	2400	21.5-T
Northwestern Michigan C	34.50	20	2400	21.5-T
Delta College	34.25	21	2200	24.5-T
Mott CC	34.00	22	2300	23
Jackson CC	33.00	23	2500	19.5-T
North Central Michigan	30.50	24	2200	24.5-T
Schoolcraft CC	30.25	25	2000	28 -T
Wayne Co CC	30.00	27 -T	2000	28 -T
Mid-Michigan CC	30.00	27 -T	2000	28 -T
Muskegon Co CC	30.00	27 -T	1900	30
Lake Michigan College	29.00	30 -T	2100	26
Bay De Noc CC	29.00	30 -T	1800	33 -T
Washtenaw Co CC	29.00	30 -T	1800	33 -T
Alpena CC	27.00	33 -T	2500	19.5-T
Southwestern Michigan C	27.00	33 -T	1800	33 -T
Lansing CC	27.00	33 -T	1800	33 -T
Kellogg CC	24.50	35	1800	33 -T
Kalamazoo Valley CC	23.00	36	1500	37
Gogebic Co CC	22.00	37	1600	36
Monroe Co CC	20.50	38	1400	38

[1]Nominal Tuition per <u>Semester Hour</u> 1988-1989.
[2]Additional credits at $119.00 per Semester Hour.
[3]Tied Ranks.

institutions that charge the higher tuition rates generally pay relatively few additional fees. And students attending the state-supported two-year colleges that charge tuition between twenty-seven and thirty-five dollars per-semester-hour may pay, in addition, two to four fees.

The practice of levying fees, in addition to tuition, permits institutions to collect monies comparable to levying higher tuition rates. The practice also allows institutions to publicize a lesser tuition rate when comparisons are made between institutions.

Analysis of Credit-Hours and Contact-Hours

The state-supported two-year college and state-supported university catalogs and schedules of classes were examined to determine the course-credits and contact-hours students would be expected to encounter as a fulltime student pursuing the first two years of professional chemistry. The descriptions of courses in state-supported two-year colleges and state-supported universities, though meagre, were found to be somewhat more stable than the tuition and fees rates that change annually. However, at least one institution, the state-supported University of Michigan at Ann Arbor, is redesigning the curriculum of the first two years of chemistry at that campus. And Michigan State University may well redesign their chemistry curriculum if the institution changes from a quarter-hour basis to a semester-hour basis. Not withstanding, these pending changes in curriculum, Appendix J contains a description of the credit-hours and contact-hours students encounter when studying the first two years of professional chemistry in Michigan's state-supported two-year colleges and universities. In Table IV-9 may be found a summary of

Table IV-9

SUMMARY TABLE

MEAN CONTACT HOURS IN LECTURE AND LABORATORY
IN TWO YEARS OF INSTRUCTION IN CHEMISTRY OFFERED BY
MICHIGAN STATE-SUPPORTED TWO-YEAR COLLEGES AND UNIVERSITIES

Type of Institution	Number of Institutions	Mean Total Lecture Hours	Mean Total Laboratory Hours
Small-size Two-Year College	5	202.8	176.4
Medium-size Two-Year College	8	231.9	193.9
Large-size Two-Year College	10	222.5	203.3
Small Size University	2	217.5	172.5
Medium Size University	7	226.6	171.1
Large Size University	6	243.8	222.2
Grand Mean Hours	38	220.7 +/- 45.9	193.2 +/- 44.0

all of the Michigan state-supported two-year colleges and universities that offer two full years of the professional chemistry sequence. Excluded from the IV-9 Summary Table are those institutions that do not offer the entire sequence of chemistry courses, or do not regularly schedule those courses. In the examination of the courses, it was found that a student could enroll in four chemistry courses in one institution and in as many as twelve chemistry courses in another institution while receiving essentially the same education. In the first institution, the lecture, recitation and laboratory were combined into a single course, while at the latter institution, the lecture, recitation and laboratory were offered as separate courses with different identifying numbers. Those institutions operating on a quarter-hour basis have at least one and one-half times the number of courses that semester-hour based institutions schedule in two years of study. Taken as a group of institutions, the data indicates that the American Chemical Society Recommendation[6] of 180 contact hours in lecture and recitation, and 240 contact hours in the laboratory for the first two years of chemistry, remains a recommendation, and institutions do not adhere to the guidelines closely.

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[6] ACS Society Committee on Education, Task Force on ACS Involvement in the Two-Year College, Guidelines for Chemistry & Chemical Technology Programs in Two-Year Colleges, American Chemical Society, Washington, DC, 1988, p8. This document superceded the Experimental Version of 1987 but is not substantially different from the latter document.

Examination of Table IV-9 reveals that the Grand Mean Hours in lecture/lecture-recitation exceeds the ACS recommendation, while the Grand Mean Hours in laboratory are less than the ACS recommendation. Many of the institutions provide fewer hours of instruction, and this may reflect the student-institutional transfer patterns. Problems arise when students begin their undergraduate studies at one institution and then transfer after a year or so to another institution. The total credit hours earned may not be lost in the transfer process, but credit for individual courses may not be granted by the other institution.

Analysis of Institutional Use of Course Placement Tests

Course placement in first-year chemistry and second-year (organic) chemistry was examined by questions included in the Interview Survey Instrument in this study of Michigan state-supported two-year colleges and universities. (See Q3, Q9 and Q34 in Appendix D.) In addition, the institutional catalogs and schedules of classes were examined to identify the screening test(s) used by the institutions to place students in courses other than first-year or second-year chemistry. (See Appendix K for Course Placement Tests used in Michigan state-supported two-year colleges and universities.) ASSET[7] is widely used in the state-supported two-year colleges for general course

[7]ASSET, The American College Testing Program, Iowa City, IA.

placement of entering first-year students. The ASSET test, after a few years of use, becomes standardized to the student population served by that state-supported two-year college by correlating a student's ASSET test scores to the grades received by the student in specific first-year entry courses. The ASSET Test was not designed for use as a course placement screening test for the first-year of chemistry.

The Toledo Test[8] is used by only a few institutions in Michigan but was once widely used as a screening test in universities to determine whether students were academically prepared to enroll in the first year of professional chemistry. The California Test[9] was released in 1989 for use in first year chemistry course placement and may replace the Toledo Test but national norms for the California Test are not yet available. Many institutions use locally-authored departmental screening tests for chemistry placement. Other institutions use high-school grade-point-average and high-school chemistry course completion as an individual-by-individual basis for course placement without the use of any particular screening test. The ACT score continues to be the most wide-spread test score used for course-placement in Michigan's state-supported universities.

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[8]Toledo Chemistry Placement Examination, Division of Chemical Education, American Chemical Society.

[9]California Chemistry Diagnostic Test, Division of Chemical Education, American Chemical Society, 1989.

CHAPTER V

SUMMARY AND CONCLUSIONS

Development of the Survey Instruments

One major purpose of this study was to construct a reliable and valid Interview Survey Instrument with the capability to measure selected indices of quality instruction of the first two years of undergraduate instruction in chemistry.

A second purpose of the study was to construct an Interview Perceptions Instrument for use in identifying the perceptions held by professors of chemistry about the first two years of undergraduate instruction in chemistry at "other" universities as compared to their own program of instruction in chemistry.

The third purpose of the study was to use the Interview Survey Instrument and the Interview Perceptions Instrument to gather data that permitted the analysis of and identification of the similarities and the differences of the curriculum in chemistry in Michigan state-supported two-year colleges and universities. The analyses included a study of the perceptions held by the instructional staff at participating institutions about the programs of instruction at "other" institutions.

Questions were written, and responses to the questions were quantified, to examine a) organization of the instructional unit, b) instruction in first-year chemistry, c) instruction in second-year (organic) chemistry, d) faculty, and e) facilities and instructional resources.

Validation of the survey instruments was obtained by submission of the survey instruments to a panel of practicing professors of chemistry. The Interview Survey Instrument questions and responses were improved by a trial use of the instrument. Additional modifications to the Interview Survey Instrument were made after all of the data from the survey became available. The internal-consistency reliability of the Interview Survey Instrument was determined to be 0.897.

The Study

The entire population of state-supported two-year colleges and state-supported universities in Michigan was examined to identify the smaller population of institutions that offered two full years of professional chemistry that led to the baccalaureate degree with a major emphasis of study in chemistry. This sub-population of the state-supported two-year colleges and state-supported universities was then stratified, on the basis of student population, into five small-size state-supported two-year colleges, seven medium-size state-supported two-year colleges, ten large-size state-supported two-year colleges, two small-size state-supported universities, seven medium-size state-supported universities and six large-size state-supported universities.

The validated and improved Interview Survey Instrument was used to identify the variety of instructional practices of a randomly-selected sample of two state-supported two-year colleges and a randomly selected sample of two state-supported universities from each of the stratified-by-size institutional groups. The sample of institutions examined in this study comprised a total of twelve institutions with six state-supported two-year colleges and six state-supported universities participating.

The population of institutions, from which the sample was randomly selected, totaled twenty-two state-supported two-year colleges and fifteen state-supported universities that offered two years of instruction in professional chemistry leading to the baccalaureate degree with a major emphasis in the study of chemistry. While the sample size of twelve institutions is not large, the sample does comprise thirty-two percent of the instructional programs in the population of state-supported two-year colleges and universities studied. The statistical necessity of having equal-sized groups for the analysis precluded any increase in the sample size.

The Interview Perceptions Instrument was administered to the interviewees, after completion of the Interview Survey, to determine how instructional programs at other state-supported two-year colleges and universities in Michigan were perceived by the participants of the study.

Limitations

The following limitations to the study were recognized: 1) the conclusions drawn from the study may directly apply only to the population of state-supported two-year colleges and universities in Michigan that offer a minimum of two years of instruction in professional chemistry leading to the baccalaureate degree with a major emphasis in chemistry; 2) the study may be limited by the particular choice of indices of instructional quality which have been selected to measure the curriculum, facilities and the chemistry faculty that are utilized in providing the desired lecture, library and laboratory experiences that are the minimum requirements for a quality professional training in chemistry as determined by the Committee on Professional Training of the American Chemical Society.

Findings and Conclusions

The following null hypotheses were tested:

Ho_1: there is no significant difference between state-supported two-year colleges and state-supported universities in Michigan in the organization of the instructional units. When the mean of the scores for the state-supported two-year colleges and the mean of the scores for the state-supported universities were compared, a significant difference was found at the 0.05 level of confidence. The state-supported universities were generally found to have independent departments of chemistry with a department chair from within the department, and a departmental budget that had specified line items designed to provide necessary financial support to the instructional program. In contrast, the state-supported two-year colleges were found to have multi-disciplinary departments whose department chairs often were not chemists, and the departmental/divisional budgets often did not have line item support specified for use in the chemistry discipline.

Ho_2: there is no significant difference between the state-supported two-year colleges and the state-supported universities in Michigan in instruction in first-year chemistry. When the mean of the scores for the state-supported two-year colleges and the mean of the scores for the state-supported universities were compared, no significant difference was found at the 0.05 level of confidence. Many areas of commonality between the state-supported two-year colleges and the state-supported universities were found in the examination of the details of the instruction in first-year chemistry: 1) both types of institutions had similar prerequisites for the first-year course in chemistry that included completion of high-school chemistry and two years of high-school mathematics; 2) both types of institutions experienced the similar practice of the waiving of the prerequisites for the first-year of chemistry by counseling staff; 3) both types of institutions reported the similar pattern of course textbook selection by committee; 4) both types of institutions used the same textbooks titles; 5) institutional catalog course descriptions were equally minimal and lacking of detail as reported by the two types of institutions; 6) there was little difference in the number of tests, quizzes and examinations administered and both types of institutions reported the use of between five and eight evaluations each semester; 7) there was no difference in the required use of the chemical literature between the two types of institutions; 8) the intended laboratory experiences did not differ between the two types of institutions; 9) no difference was found in the maximum number of laboratory student stations reported by the two types of institutions; 10) there was a similar lack of an expectancy about the development of student writing skills in both types of institutions; 11) both types of institutions had relatively similar methods of evaluation of a student's laboratory experience that relied primarily upon evaluation of student reports; 12) both types of institutions used computers for tutorial use in first-year chemistry instruction; and 13) both types of institutions reported a similar lack of required use of safety chemical references by students in the laboratory. The list is long but does indicate the great extent to which instruction in first-year chemistry is similar in state-supported colleges and state-supported universities in Michigan. The principal differences between the instructional programs in the two types of institutions were identified as the much larger size of the lecture classes in the state-supported universities and the common use of teaching assistants in the laboratories of the state-supported universities. The differences in the instructional programs, however, were found to be small in comparison to the greater number of similarities in the instructional programs as measured by the Interview Survey Instrument.

Ho_3: there is no significant difference between state-supported two-year colleges and state-supported universities in Michigan in instruction in second-year (organic) chemistry. When the mean of the scores for the state-supported two-year colleges and the mean of the scores for the state-supported universities were compared, no significant difference was found at the 0.05 level of confidence. Many areas of commonality between the state-supported two-year colleges and the state-supported universities were found in the examination of the details of the instruction in second-year (organic) chemistry: 1) both types of institutions had similar prerequisites for the second-year course in chemistry that included a successful completion of the first-year course in chemistry; 2) both types of institutions had a similar pattern of course textbook selection by committee; 3) little difference in the use of textbook titles by both types of institutions; 4) institutional catalog course descriptions were equally minimal and lacking of detail; 5) there was little difference in the number of tests, quizzes and examinations administered, and both types of institutions reported using between six and eight evaluations each semester; 6) no difference was found in the required use of the chemical literature between the two types of institutions; 7) intended laboratory experiences did not differ; 8) there was no difference in the maximum laboratory student capacities in the two types of institutions; 9) there was a similar lack of an expectancy for the development of student writing skills in both types of institutions; 10) both types of institutions had relatively similar methods of evaluation of a student's laboratory experience that included an evaluation of laboratory reports, unknown compound identifications, and student skills in the laboratory; and 11) both types of institutions reported a similar lack of required use of safety chemical references by students in the laboratory.

The list is again long but does indicate the great extent to which instruction in second-year chemistry is similar in state-supported colleges and state-supported universities in Michigan. The principal differences between the instructional programs in the two types of institutions were identified by the much larger size of the lecture classes in the state-supported universities, and the common use of teaching assistants in the laboratories of the state-supported universities. The differences in the instructional programs, however, were again found to be small in comparison to the greater number of similarities in the instructional programs, as measured by the Interview

Survey Instrument.

Ho_4: there is no significant difference between state-supported two-year colleges and state-supported universities in Michigan in their respective chemistry faculty. When the mean of the scores for the state-supported two-year colleges and the mean of the scores for the state-supported unversities were compared, a significant difference was found at the 0.05 level of confidence. The state-supported universities in the study were found to require the Ph.D degree as the minimum requirement for employment, while the chemistry faculty in state-supported two-year college chemistry departments often held MS degrees or less. In addition, the state-supported university faculty in the survey had lower faculty-teaching loads and were more likely to be members of the American Chemical Society, the professional society of chemists.

Ho_5: there is no significant difference between state-supported two-year colleges and state-supported universities in Michigan in regard to their respective facilities and instructional resources. When the mean of the scores for state-supported two-year colleges and the mean of the scores for state-supported universities were compared, no significant difference was found at the 0.05 level of confidence.

State-supported universities were more likely to possess a wide variety of laboratory instrumentation, but the first-year and second-year chemistry students at those state-supported universities had limited access to the instruments. The laboratory-students/faculty-members ratios were found to be higher in the state-supported universities than in the state-supported two-year colleges. This was particularly true in those state-supported universities that used teaching assistants in the laboratory. The state-supported universities typically had superior chemical literature collections in volume numbers as well as in the variety of journal/book titles.

Ho_6: there is no significant difference between the state-supported two-year colleges and the state-supported universities in Michigan when all aspects of a quality education in professional chemistry, as measured by the Interview Survey Instrument, are compared. When the mean of the total scores of the survey instrument obtained from the state-supported two-year colleges and the mean of the total scores of the survey instrument obtained from the state-supported universities were compared, no significant difference was found at the 0.05 level of confidence. As the instructional program in the first two years of chemistry at each institution was surveyed, the unique details of the instructional program at each institution were recognized.

In summary, the instructional programs in the first two years of chemistry at the state-supported two-year colleges and state-supported universities in Michigan, as measured by the Interview Survey Instrument, had greater similarities than differences in the instructional programs in chemistry.

Forty-seven of sixty perceptions about other institutions were found to be "about the same quality" or "slightly better quality" or "slightly lesser quality." These summed perceptions (78%) agree with the statistical measures that there is no significant difference in the instructional programs examined at the 0.05 level of confidence. The remaining thirteen perceptions about other institutional programs of chemistry instruction that were of "somewhat lesser quality" or of "somewhat better quality" were examined for significant differences using a t-test. These perceptions exhibited the greatest differences; and in the examination of the scores, the tests of significance would have the greatest likelihood in determining whether significant differences existed. When the mean scores for those institutions were compared for significant differences, none were found at the 0.05 level of confidence. One might conclude, on the basis of the data, that the majority (in a 78:22 ratio) of the faculty who participated in the study were knowledgeable and held informed perceptions about the programs of instruction in chemistry at other institutions.

The tuition levied at the state-supported institutions that offer two years of professional chemistry was found to vary from a low of $20.50 to a high of $193.00 per semester-hour. Since the programs of instruction for the first two years of instruction in the state-supported two-year colleges and the state-supported universities were not found to be significantly different, as measured by the survey instrument, then it may be assumed that students can receive economical instruction in chemistry in their local state-supported two-year college if that institution offers two full years of professional chemistry.

The analysis of contact hours expected of students to spend in lecture and in the laboratory in the first two years of instruction in chemistry revealed a wide range of contact hours. The number of credit-hours and contact-hours required of students in the state-supported two-year colleges may be related to the expected/intended senior institutions to which the students would transfer their course credits. This, however, was not examined in this study. In general, the data revealed that larger state-supported two-year colleges have greater numbers of contact-hours in lecture and laboratory than do the smaller state-supported two-year colleges. Similarly, the larger state-supported universities have greater numbers of contact-hours in lecture and laboratory than do the smaller state-supported universities.

The analysis of the institutional use of course placement test scores revealed that admissions officers of the state-supported universities placed great credence on the grade-point-average earned by students in high-school studies as the basis for acceptance/rejection to the state-supported universities. But these same state-supported university officials used the student ACT scores as the preferred test scores used for course placement.

The state-supported two-year colleges in Michigan have "open access" policies and do not select/reject the students who choose to attend these institutions. The ASSET scores were found to be used extensively by the state-supported two-year colleges in Michigan; but there were individual state-supported two-year colleges that preferred to use student ACT scores for course placement. Course placement of students into the first-year of chemistry was found to vary from institution to institution in this study. While the Toledo Test was previously widely used, current use of the test has revealed a diminished predictive validity of the test scores in predicting success in the first-year of chemistry in both state-supported two-year colleges and state-supported universities.

Discussion

On the basis of the data collected in this study, it could be assumed that some of the differences identified in the section on Organization of the Instruction Unit of the Interview Survey Instrument could be reduced. While the faculty in the instructional units within the state-supported two-year colleges may not be able to effect a change in the departmental/divisional organization, other aspects of the "life" of the department could be addressed. Even if the department is too small to support a seminar program in chemistry, a seminar program in science might very well be feasible and affordable even in the smallest of the state-supported two-year colleges. In addition, the innovation of announcing a chemistry award for the "Outstanding Student in First-Year Chemistry" and perhaps even an "Outstanding Student in Second-Year Chemistry" might go far in encouraging students to excel.

A wide variety of observations were made while administering this study of the instructional programs in chemistry at the state-supported two-year and state-supported universities in Michigan. Not all of the observations made could be made to fit into the structure of the Interview Survey Instrument. Most, though not all, of the interviewees expressed strong sentiments about how they perceived that their respective institutional administrations were not concerned about the need to provide for routine laboratory equipment maintenance funding in the development of the institutional/instructional unit budget. At one state-supported university there were twenty of twenty-two Spectronic-20 Spectrophotometers that were non-functioning. And at a state-supported two-year college, two of three Infrared Spectrophotometers were not functioning. In each case, the instruments had not been repaired because the instructional unit/departmental budget did not include line items designated for such repairs. In some cases the budgetary constraints were reportedly due to the institution's pattern of grouping instructional disciplines into multi-disciplinary divisions, and by not providing discrete departmental budgetary line items for the maintenance of equipment. The interviewees volunteered the observation that the instructional disciplines in those divisions were made to compete with each other for the limited funds that were made available on a non line item basis. Interviewees again volunteered that from this mix of instructional disciplines, the chemistry discipline could only rely upon those designated monies collected, such as laboratory fees.

Question 56 (Q56) of the Interview Survey Instrument examined the use of computers in the teaching of second-year (organic) chemistry. (See Appendix D for questions and Appendix F for the institutional responses to the questions.) There was no discernable difference found in computer-use in the instruction of second-year chemistry between the state-supported two-year colleges and the state-supported universities. But if the uses of computers in organic chemistry, as measured by the institutions surveyed, was representative of the common use of computers state-wide, then questions arise: Was there a shortage of computers on these campuses? Was there a shortage of computer software appropriate for organic chemistry? Were the organic chemistry faculties resistant to the idea of using computers? Do the organic chemistry faculties lack the skills to use and incorporate computers and computer software into their instructional programs? The Interview

Survey Instrument was not designed to provide answers to these un-anticipated questions.

Questions 18, 28 and 32 of the Interview Survey Instrument examined the practice of assigning report and research writing assignments, as well as the use of the chemical literature, in the first-year chemistry courses. And Questions 43, 53 and 57 of the instrument examined the same practices in the second-year (organic) chemistry courses. The survey question responses revealed that neither the state-supported two-year colleges nor the state-supported universities had placed library-type research and writing experiences very high in the priorities of the instructional design(s) of those courses. It may be that the chemistry departments in the state-supported two-year colleges, and the state-supported universities alike, find that most students enrolled in the chemistry courses of interest in this study do not intend to make chemistry their major emphasis in their quest for the baccalaureate degree. Thus, although the instructional designs of these courses were to prepare chemists and other science-oriented professionals, the courses were really general education, in the greater sense, for possibly a majority of the students. Why have the state-supported universities deferred these across-the-curriculum writing experiences until the junior year of the student's studies? And why have the instructional programs in chemistry in the state-supported two-year colleges in this study apparently neglected these writing experiences? A recent study of "goals in teaching" confirms the observation that only a minority of science faculty consider the development of effective reading and writing skills to be an essential teaching goal.[1]

All of the state-supported two-year colleges and the state-supported universities in this study reported that course-placement (Questions 3, 9 and 34) and provisions for student-tutoring (Question 4) existed on their compuses. But in the interviews, all of the participants of the study indicated that both the course-placement into the chemistry courses and the institutional commitment for student-tutoring continued to be variable from year to year, and these instructional support services were not firmly established in the institutional support services organizational structure.

The questions on scheduling of the first-year chemistry course (Q10) and scheduling of the the second-year (organic) chemistry course (Q35) revealed that in the survey of state-supported two-year colleges and state-supported universities, students at those institutions would find it very difficult, if not impossible, to attend the institutions on a part-time basis. These institutions normally scheduled the first-year chemistry and second-year chemistry courses primarily for the larger group of full-time students

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[1]Cross, K. P., & Angelo, T. A., "Faculty Members As Classroom Researchers," AACJC Journal, 59 (April-May 1989), 23-25.

that attend those institutions during the day-time hours.

Undergraduate research was found to be of increasing importance in the design of undergraduate instructional programs nationwide (see Chapter II). The participants surveyed in the state-supported universities reported that undergraduate research was an important aspect of instruction at their institution, but was also limited only to very outstanding first- and second-year students and to upper class students. No provision had been made, nor was planned for the future, for research opportunities for "less than outstanding" undergraduate students in the majority of the state-supported two-year colleges and universities that participated in this study.

Implications for Education

The Interview Survey Instrument is a validated survey instrument designed to measure aspects of instruction in the first two years of professional chemistry in the state-supported two-year colleges and state-supported universities, and the instrument has a calculated reliability of 0.897. A state-supported institution could make use of the instrument to assist in an evaluation of a chemistry instructional program, and would be an aid in identifying those areas of the instructional program in the first two years of professional chemistry that may require improvement. Not only do the Interview Survey Instrument questions incorporate the recommendations made by the American Chemical Society, but the questions also reflect the recommendations and concerns made by the recent national studies of the undergraduate curricula identified in Chapter II of this study. The questions in the survey instrument have not been weighted in terms of importance nor in terms of expense. Each institution would need to determine the priorities as to which areas of concern about the instructional program should be addressed first.

Suggestions for Future Research

In recognition that the questions in the survey instrument have not been weighted; and that not every question bears equal importance, it would be of value to determine a weighting system that might incorporate cost/benefits that would provide the user(s) of the instrument a means of determining the priorities for correcting deficencies that an institution/department might address over a period of time.

Another suggestion for research would be to investigate the variety of underlying instructional designs inherent in the variety of chemistry course sequences found in the state-supported two-year colleges and state-supported universities offering two full years of professional chemistry. Some of the institutions allow concurrent enrollment in the laboratory course while the students are enrolled in the lecture course. Other institutions prefer that the students do not enroll in the laboratory course until after the students complete the lecture sequence of courses.

Lastly, the incomplete incorporation of the use of computers into the instructional program in the second-year (organic) chemistry in the state-supported two-year colleges and universities might be investigated to identify the underlying causes, and further, to suggest remedial action.

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APPENDIX A

STATEMENTS OF VALIDATION FROM THE VALIDATION PANEL FOR THE VALIDATION OF THE SURVEY INSTRUMENTS

MICHIGAN STATE UNIVERSITY

COLLEGE OF NATURAL SCIENCE
DEPARTMENT OF CHEMISTRY
CHEMISTRY BUILDING

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I have reviewed the document written by Albert G. Krieger:
"Survey Instrument for PERCEPTIONS AND PRACTICE: A CHARACTERIZATION OF THE FIRST TWO YEARS OF UNDERGRADUATE INSTRUCTION IN CHEMISTRY IN MICHIGAN STATE-SUPPORTED COLLEGES AND UNIVERSITIES," for the purpose of assisting in its validation. My perspective is primarily from that of a major research institution.

Section I relates to the organization of the instructional unit. This section is excellent. The breadth of questions and the possible responses are adequate to discern both the differences and similarities among the targeted instructional programs.

Section IIa relates to First Year Chemistry and includes a section on Laboratory experience.

The questions and allowed responses in this section, subject to the suggestions and comments outlined separately, permit differences and similarities in instructional programs to be determined provided the target populations are clearly defined. They do not permit appropriate delineation if all first year students in a unit must be treated as a block and responded to in one survey instrument.

Section IIb relates to second year chemistry. We have two levels of second year courses with different emphases. The laboratory of each series is independent and different. As indicated above for the previous section, the survey document should be completed for each series to be meaningful. Within that constraint, questions and responses seem adequate to allow both differentiation and discrimination

Part III addresses faculty. All questions but (57) are excellent and discriminating; responses are adequate. Responses related to contract hours are inadequate for (57).

Section IV relates to facilities.

Various questions relate to instruments available in the unit. A major institution will most likely have every piece of equipment, but in most cases the equipment will not be available on a per lab basis at either the first or second year level. However, the equipment may be demonstrated as appropriate or simulated by computer, and Honors students will have access to the equipment, generally on a hands-on basis. If the survey instrument is completed on the basis of a "program" rather than a "unit", this section of the document may be adequate. If it is only completed on a "unit" basis, I am unsure that it will discriminate.

Harry A. Eick

Harry A. Eick, Ph.D. January 17, 1989
Professor of Chemistry
Michigan State University

Ph.D. in chemistry awarded by State University of Iowa

Spring Arbor College • Spring Arbor, Michigan 49283 • (517) 750-1200

December 2, 1988

Mr. Albert G. Krieger
Chemistry Department
Jackson Community College
2111 Emmons Road
Jackson, MI 49201

Dear Al:

I have examined the survey instrument you have devised for characterizing the first two years of instruction in chemistry. I have organized my comments for each part to answer the questions concerning breadth, discernment, diversity and differences.

I. Organization of Instructional Unit—
The eight questions posed in this section should give information to discern similarities and differences between institutions. I might suggest an additional question dealing with professional activities of the faculty. Suggested examples might be: part-time consulting or research, summer research activities, workshops or seminars.

II. First Year Chemistry—
The questions posed in this section cover a broad range of items from prerequisites to specific details concerning course content. The breadth of topics covered is good. I would add in either #18 or 26 questions concerning qualitative analysis which seems to be making its way back into the curriculum at many institutions.

Second Year Chemistry—
You might add something more specific about qualitative analysis in #39 or 47.

III. Faculty—
You could add something about faculty development activities.

IV. Facilities and Instructional Resources—
A good addition to this section might be the specific use and the number of computers used for data collection, tutoring, word processing, and data analysis.

I am impressed with the breadth of questions you have in the survey. The questions have been worded and the responses phrased in such a way that the similarities and differences between instructional programs will be identifiable. The selection of responses should help you discern differences and similarities.

I believe you have a sound survey instrument and wish you success as you administer it and analyze the results.

Best wishes and success as you come down the stretch.

Sincerely,

David A. Johnson
Professor of Chemistry

Ph.D. in Chemistry, 1966
Louisiana State University

DAJ/sk

JACKSON COMMUNITY COLLEGE
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November 30, 1988

College of Education
Michigan State University

I have reviewed the Survey Instrument prepared by Mr. Albert Krieger. Based on my seventeen years of teaching experience I find that the questions will provide information that are related to those traits that will allow characterization and comparison of the first two years of the chemistry programs at two- and four-year undergraduate institutions.

Particularly, the questions cover the full breadth of factors that contribute to the students' experience in the chemistry program. I am especially pleased to find that questions deal with class organization and scheduling, behavioral objectives, student access to equipment and literature, and methods of assessing student performance in laboratory as well as in lecture. Many hypotheses can be constructed on the relative importance of these factors to a program's excellence and this data will provide the means of validating the hypotheses.

I also find that the possible responses to the questions is sufficiently diverse as to both provide options for all possible instructional program configurations and to reveal differences among those programs.

I look forward to seeing the results of Mr. Krieger's survey and the conclusions he draws from its data.

John Henderson
Professor of Chemistry
PhD, Organic Chemistry
The Johns Hopkins University

LANSING COMMUNITY COLLEGE
SCIENCE DEPARTMENT
MEMO

TO: Albert G. Krieger

FROM: Gary VanKempen

RE: Validation of Research Instrument

DATE: January 3, 1989

I have completed my evaluation of the instrument that you are planning to use in your research project. My overall comments are given below. I also made some notations on the instrument itself to which you should refer.

As I understand it, you are hoping to use this instrument to assess and compare the overall quality of freshman and sophomore Chemistry programs at state-supported two-year vs four-year institutions in Michigan and also to relate this to intructors' perceptions of the quality of their institution compared to others.

The instrument seems to have two parts: one major part which assesses the actual character of a program and one minor part which asks the instructor to describe his or her perceptions.

Regarding the major characterization part, I feel that these questions will provide a broad description of the Chemistry programs in our state. I was unable to think of any additional areas that you could include in this section. I believe that the five-choice items are sufficiently diverse to characterize and compare each institution's program.

One area that I think you should be careful about is the introduction of your own bias about the factors that contribute to a quality program. For most questions, a "five" represents high quality and a "one" low quality. On a few questions you might get some argument about the ordering. For example, is it better for a faculty committee to choose a text book or a specific instructor? Also is the number of faculty a measure of quality or the faculty to student ratio or the full-time to part-time ratio? I don't feel that this is a problem with the instrument but only something to watch for in the evaluation.

Regarding the perceptions part of the instrument, I feel that the scale definitions are adequate except for the inclusion of an "I don't know" choice. I found myself wanting to choose that one in a couple of cases. Regarding the breadth of questions, I wonder if it would be useful to expand this part of the instrument to include questions which deal with specific aspects of the programs as you did in the major part of the instrument. For example, you might ask how the amount of instrumentation in an instructor's institution compares with that in other institutions. This, I think, will give you a better understanding of the perceptions people have about the various institutions.

I hope you will find this validation statement helpful as you pursue this interesting study. I will be anxious to hear about your results.

Gary W. VanKempen, Associate Professor of Chemistry,
Lansing Community College

Ph.D. Chemistry and Education   Michigan State University

Gary VanKempen

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January 12, 1989

The College of Education
Michigan State University

To Whom It May Concern:

The following is intended as a validation statement concerning a survey instrument "Perceptions and Practice: A Characterization of the First Two Years of Undergraduate Instruction in Chemistry in Michigan State - Supported Colleges and Universities" by Albert G. Krieger.

In my opinion, the breadth of questions and the possible responses with respect to chemistry laboratory courses are fully adequate to achieve the stated goals of the survey instrument.

With respect to the lecture portion of chemistry courses, I think some of the following questions should be considered:

1. What portion of the text is actually assigned to the students for reading?
2. What types of examination questions are given (multiple-choice, essay, fill in the blanks, etc.)?
3. What are the primary sources of examination questions (lecture, hand-outs, textbook, etc.)?
4. What out-of-class (homework) problems, if any, are assigned?
5. What is structure of recitation (active student participation, mini-lecture, problem solving by teaching assistant, etc.)?
6. Who teaches recitation (professor, graduate students, undergraduates)?
7. What training do teaching assistants receive?

Sincerely,

Michael Rathke

Michael Rathke
Professor of Chemistry
Michigan State University
(Ph.D. - Chemistry, 1968, Purdue University)

sg

APPENDIX B

IDENTIFICATION OF THE POPULATION OF MICHIGAN STATE-SUPPORTED TWO-YEAR COLLEGES AND UNIVERSITIES OFFERING TWO YEARS OF PROFESSIONAL CHEMISTRY

Population of Michigan State-Supported Two-Year Colleges and Universities Offering Two Years of Professional Chemistry:
Small-Size State-Supported Two-Year Colleges
Less than 2,500 Students

Colleges	Professional Chemistry 1st Year	Professional Chemistry 2nd Year
Alpena CC	Yes	Yes
Bay De Noc CC	Yes	Yes
Glen Oaks CC	None	None
Gogebic CC	Yes	Yes
Highland Park CC	None	None
Kirtland CC	Yes	None
Mid-Michigan CC	Yes	Yes
Montcalm CC	None	None
North Central Mich	Yes	Yes
West Shore CC	Yes	None

Identified Population of small-size state-supported two-year colleges offering two years of professional chemistry leading to the baccalaureate degree with a major emphasis in chemistry:

Alpena Community College, Alpena, MI 49707
Bay De Noc Community College, Escanaba, MI 49829
Gogebic Community College, Ironwood, MI 49938
Mid-Michigan Community College, Harrison, MI 48625
North Central Michigan College, Petosky, MI 49770

Table B-2
Population of Michigan State-Supported Two-Year Colleges and Universities Offering Two Years of Professional Chemistry:
Medium-Size State-Supported Two-Year Colleges
Greater Than 2,500 But Less Than 7,000 Students Enrolled

College	Professional Chemistry 1st Year	2nd Year
Jackson CC	Yes	Yes
Kellogg CC	Yes	Yes
Lake Michigan C	Yes	Yes
Monroe Co CC	Yes	Yes
Muskegon CC	Yes	Yes
Northwestern Mich	Yes	Yes
Southwestern Mich	Yes	Yes
St. Clair Co CC	Yes	Yes

Identified Population of medium-size state-supported two-year colleges offering two years of professional chemistry leading to the baccalaureate degree with a major emphasis in chemistry:

Jackson Community College, Jackson, MI 49201
Kellogg Community College, Battle Creek, MI 49016
Lake Michigan Community College, Benton Harbor, MI 49022
Monroe County Community College, Monroe, MI 48161
Muskegon Community College, Muskegon, MI 49443
Northwestern Michigan College, Traverse City, MI 49684
Southwester Michigan College, Dowagiac, MI 49047
St. Clair County Community College, Port Huron, MI 48060

Table B-3
Population of Michigan State-Supported Two-Year Colleges and Universities Offering Two Years of Professional Chemistry: Large-Size State-Supported Two-Year Colleges Greater Than 7,000 Students Enrolled

College	Professional Chemistry 1st Year	2nd Year
Delta College	Yes	Yes
Grand Rapids JC	Yes	Yes
Henry Ford CC	Yes	Only 1 semester
Kalamazoo V CC	Yes	Yes
Lansing CC	Yes	Yes
Macomb Co CC	Yes	Yes
Mott CC	Yes	Yes
Oakland CC	Yes	Yes
Schoolcraft	Yes	Yes
Washtenaw CC	Yes	Yes
Wayne Co CC	Yes	Yes

Identified Population of large-size state-supported two-year colleges offering two years of professional chemistry leading to the baccalaureate degree with a major emphasis in chemistry:

Delta College, University, Center, MI 48710
Grand Rapids Junior College, Grand Rapids, MI 49502
Kalamazoo Valley Community College, Kalamazoo, MI 49009
Lansing Community College, Lansing, MI 48914
Macomb Community College, Warren, MI 48093
Mott Community College, Flint, MI 48503
Oakland Community College, Farmington, MI 48024
Schoolcraft College, Livonia, MI 48152
Washtenaw Community College, Ann Arbor, MI 48106
Wayne County Community College, Detroit, MI 48201

Table B-4
Population of Michigan State-Supported Two-Year Colleges and Universities Offering Two Years of Professional Chemistry: Small-Size State-Supported Universities Less Than 5,000 Students

University	Professional Chemistry 1st Year	2nd Year
Lake Superior State U	Yes	Yes
Saginaw Valley State U	Yes	Yes

Identified Population of small-size state-supported universities offering two years of professional chemistry leading to the baccalaureate degree with a major emphasis in chemistry:

Lake Superior State University, Sault Ste. Marie, MI 49783
Saginaw Valley State University, University Center, MI 48710

Table B-5
Population of Michigan State-Supported Two-Year Colleges and Universities Offering Two Years of Professional Chemistry:
Medium-Size State-Supported Universities
Greater Than 5,000 And Less Than 10,000 Students Enrolled

University	Professional Chemistry 1st Year	2nd Year
Central Mich U	Yes	Yes
Ferris State U	Yes	Yes
Grand Valley SU	Yes	Yes
Michigan Tech U	Yes	Yes
Northern Mich U	Yes	Yes
U of M-Dearborn	Yes	Yes
U of M-Flint	Yes	Yes

Identified Population of medium-size state-supported universities offering two years of professional chemistry leading to the baccalaureate degree with a major emphasis in chemistry:

Central Michigan University, Mount Pleasant, MI 48858
Ferris State University, Big Rapids, MI 49307
Grand Valley State University, Allendale, MI 49401
Michigan Technological University, Houghton, MI 49931
Northern Michigan University, Marquette, MI 49885
University of Michigan at Dearborn, Dearborn, MI 48128
University of Michigan at Flint, Flint, MI 48503

Table B-6
Population of Michigan State-Supported Two-Year Colleges and Universities Offering Two Years of Professional Chemistry: Large-Size State-Supported Universities Greater Than 10,000 Students Enrolled

University	Professional Chemistry 1st Year	Professional Chemistry 2nd Year
Eastern Mich U	Yes	Yes
U of Michigan	Yes	Yes
Michigan State U	Yes	Yes
Oakland U	Yes	Yes
Wayne State U	Yes	Yes
Western Michigan U	Yes	Yes

Identified Population of large-size state-supported universities offering two years of professional chemistry leading to the baccalaureate degree with a major emphasis in chemistry:

Eastern Michigan University, Ypsilanti, MI 48917
University of Michigan, Ann Arbor, MI 48109
Michigan State University, East Lansing, MI 48824
Oakland University, Rochester, MI 48063
Wayne State University, Detroit, MI 48202
Western Michigan University, Kalamazoo, MI 49001

APPENDIX C

TRANSMITTAL LETTER TO SURVEY STUDY PARTICIPANTS

Perceptions and Practice: A Characterization of the First Two Years of Undergraduate Instruction in Chemistry in Michigan State-Supported Colleges and Universities. A doctoral study conducted by Albert G. Krieger at Michigan State University.

Michigan State University requires written consent of all individuals participating in research to insure that participants in research are aware of their rights of privacy and to insure knowledge of the limits and intent of the research. Your participation in my research will consist of oral, written and evidential responses to a set of interview questions based upon a survey instrument that I have developed in an effort to assess the instructional practices in the first two years of college/university undergraduate instruction in chemistry. The overall intent is to make multiple comparisons/contrasts of the instruction provided in small/medium/large-sized two-year state-supported community /junior colleges and small/medium/large-sized state-supported universities. In addition, I am seeking to assess the perceptions of the overall quality, as you see it, of the program of instruction at your institution as compared to these other types of institutions. It is understood that the interview will take approximately one-and-a-half to two hours, and that a participant may discontinue the interview at any time without recrimination. All responses and data collected will be treated with strict confidence, and neither the interviewee nor the institution will be identified in the study nor in the appendices of data. Your institution will be identified only as a part of an stratified group of institutions, but will not be identified as to whether or not your institution actually participated in the study.

If you wish, within the restrictions identified above, the results of the comparisons made will be made available to participants upon request.

I understand the intent of the study and my rights provided, and do freely consent to participate.

-------------------------------- ---------

(Signature of Interviewee) (Date)

Name of Interviewee ____________________________

Name of Institution ____________________________

APPENDIX D

REVISED SURVEY INSTRUMENT

INTERVIEW SURVEY INSTRUMENT

for

PERCEPTIONS AND PRACTICE:

A CHARACTERIZATION OF THE FIRST

TWO YEARS OF UNDERGRADUATE INSTRUCTION IN CHEMISTRY

IN MICHIGAN STATE-SUPPORTED COLLEGES AND UNIVERSITIES

Revised Version

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Organization of Survey Instrument:

I Organization of Instructional Unit

II Instruction of First Year Chemistry

III Instruction of Second Year (Organic) Chemistry

IV Faculty

V Facilities and Instructional Resources

I ORGANIZATION OF INSTRUCTIONAL UNIT

(1) Organization of department(i.e., biology & chemistry /chemistry /chemistry & physics /other...

Title ______________________________

1	2	3	4	5
part of division	smaller than division but greater than two disciplines	two depts + dept chair is from "other" discipline	two depts + dept chair is from chemistry	chem dept + dept chair is from chem

(2) Financial Support
Separate line items for Chemistry Department?

1	2	3	4	5
combined line items, part of division	combined line items, smaller than division but greater than two disciplines	combined line items, two depts + dept chair is from "other" discipline	combined line items two depts + dept chair is from chemistry	separate line items chem dept + dept chair is from chem

(3) Remedial/Lower level instruction:

1	2	3	4	5
absence of low level course, absence of counseling. or testing.	low level course is available, counseling is available, no screening	low level course is available, counseling is available, no testing	low level course is available, counseling and advising is available, testing and screening	low level course is available, counseling and advising is available, placement based upon chemistry pretest.

Comments:____

____

(4) Provisions for Tutoring:

1	2	3	4	5
no provision for tutoring	tutors volunteer on non-paid basis	"other" unit regulates, "other" unit authorizes, paid basis	"other" unit regulates, dept authorizes, paid basis	dept regulates, dept authorizes, paid basis.

(5) Student Opportunities for Professional Activities:
Checklist:
___ Departmental Seminars
___ College Seminars
___ Community
___ __________

1	2	3	4	5
None	1 of above	2 of above	3 of above	4 of above

(6) Students and Professional/Career Counseling:
Checklist:
___Academic Advisors,
___Counselors,
___Seminars,
___ACS Student Affiliate Chapter

1	2	3	4	5
None of above	1 of above	2 of above	3 of above	4 of above

(7) Provisions for Individual or Group Student Chemical Research with or without college credits. 1ST TWO YEARS ONLY
Student Research/chemistry students _____ students

1	2	3	4	5
0 students	1-3 students	4-6 students	7-9 students	10+ students

all numbers on an annual basis

(8) Student Recognition/Awards
Checklist:
___ First Year Award (CRC?)
___ Second Year Award
___ __________
___ __________

1	2	3	4	5
None	1 Award	2 Awards	3 Awards	4 Awards

II First Year Chemistry

(9) Prerequisites:

1	2	3	4	5
None	published not adhered	published, adhered to	published, adhered to, waiver by Chair	published adhered to waiver by instructor.

10) Lecture schedule:

1	2	3	4	5
AM or PM or EVE	AM or PM	AM + EVE or PM + EVE	AM + PM or AM + EVE	AM + PM + EVE

(11) Instructional Method Options:
Checklist:
___ lecture,
___ lecture-recitation,
___ independent study
___ video
___ Computer (PLATO)

1	2	3	4	5
one option	two options	three options	four options	five options

(12) Selection of textbooks:

1	2	3	4	5
assigned by "outside" authority	selected by Chair	selected by Coordinator	selected by team of instructors	selected by instructor

Textbook Used:
Title ________________ Author ____________ Publisher_______
Edition ________________ Comments:

(13) Catalog description as compared to course description: College/University course transfer comparisons.

1	2	3	4	5
Catalog has no description of iourse	brief description, few details.	brief description, some detail	brief description more detail	Catalog description is complete

(14) Lecture Behavioral Objectives: BO's written in operational terms, published and shared with students.

1	2	3	4	5
None	4 items	8 items	16 items	32 items

(15) Maximum Lecture Class Sizes:

1	2	3	4	5
241-480 students	121-240 students	61-120 students	31-60 students	1-30 students

(16) Mean Lecture Class Sizes:

1	2	3	4	5
241-480 students	121-240 students	61-120 students	31-60 students	1-30 students

(17) Evaluation of Lecture: Number of tests/quizzes/final
Comments:

1	2	3	4	5
1	2	3-4	5-6	7-8

(18) Required Use of Chemical Literature:
Checklist:
___ Handbooks
___ Journals
___ Chemical Abstracts
___ Database (local)
___ Database (electronic, off-campus)

1	2	3	4	5
0 use	1 uses	2-3 uses	4 uses	5 uses

End of Course Evaluation:
Standardized Examination? No Yes ____________________

---------First Year Chemistry Laboratory Experiences--------

(19) Laboratory Behavioral Objectives:
BO's written in operational terms, published and shared with students to include:
___ Perform quantitative manipulations
___ Assess the reliability of the results
___ Plan experiments through use of literature
___ Handle statistical analysis of data
___ Use effectively and with understanding a good selection of modern instruments, including, for example, visible spectrometers, and pH meters.
___ Recognize the hazards and unique problems of chemical safety and carefully observe modern safety practices.
___ Keep accurate and complete experimental records
___ Write good reports (Manuscript Requirements?)
___ Other? ______________________________________

1	2	3	4	5
None	1-2 items	3-4 items	5-6 items	7-8 items

(20) Intended Laboratory Experiences:

___ Perform quantitative manipulations
___ Assess the reliability of the results
___ Plan experiments through use of literature
___ Handle statistical analysis of data
___ Use effectively and with understanding a good selection of modern instruments, including, for example, visible spectrometers, and pH meters.
___ Recognize the hazards and unique problems of chemical safety and carefully observe modern safety practices.
___ Keep accurate and complete experimental records
___ Write good reports (Manuscript Requirements?)
___ Other? ______________________________
___ Other? ______________________________

1	2	3	4	5
None	1-2 items	3-4 items	5-6 items	7-8 items

(21) Maximum Laboratory class sizes:

1	2	3	4	5
36+ students	32-35 students	28-31 students	24-27 students	20-23 students

(22) Mean Laboratory Class Size:

1	2	3	4	5
32+ students	16-31 students	8-15 students	4-7 students	2-3 students

(23) Student/Full-time Faculty Ratio in Laboratory:

1	2	3	4	5
Only TA	32+	16-31	8-15	1-7

----Students/FT Faculty----

Evaluation of Laboratory Experience:

(24) Student Laboratory Reports at BEGINNING of year.

1	2	3	4	5
None	fill-in forms	computerized fill-in report	written reports or	word processor reports Journals

(25) Report Requirements:

___ Manuscript Requirements (any Journal?) ________________
___ Spelling is checked
___ Use of Significant Figures
___ Error Analysis
___ Statistical Analysis
___ Graphs

1	2	3	4	5
None	1	2-3	4	5

-------Requirements--------

(26) Student Laboratory Reports at END of year.
Comments:

1	2	3	4	5
None	fill-in forms	computerized fill-in report	written reports or Journals	word processor reports

(27) Report Requirements:

___ Manuscript Requirements (any Journal?)________________
___ Spelling is checked
___ Use of Significant Figures
___ Error Analysis
___ Statistical Analysis
___ Graphs

1	2	3	4	5
None	1	2-3	4	5

-------Requirements--------

(28) Additional Writing Assignments:

1	2	3	4	5
0	1	2-3	4	5

additional assignments

(29) Methods of evaluating the laboratory experiences:

___ Laboratory reports
___ Unknowns identification
___ Laboratory Practical
___ Observation by Instructor
___ Lab-Practical, paper-and-pencil

1	2	3	4	5
1 method	2 methods	3 methods	4 methods	5 methods

(30) Structured Laboratory Instruction:
Checklist: (Check all that apply)

___Descriptive Chemistry
___Periodic Properties
___Statistical Treatment of Data
___Development of Theoretical Models
___Determination of Constants
___Acid-Base Titrations
___EDTA Titrations
___Redox Titrations
___Synthesis
___Separation
___Quantitative Type Analysis
___Structure Identification and Determination
___Chemical Kinetics
___Determination of Thermodynamic Properties
___Qualitative Analysis
___Other___________________________

1	2	3	4	5
8 items	9 items	10-11 items	12 items	13 items

(31) Computer Usage Options:
Checklist: (Check all that apply)

___Tutorial
___Computational
___Data Collection
___Simulation
___Spreadsheet

1	2	3	4	5
none	1 use	2-3 uses	4 uses	5 uses

(32) Assigned Student Research:

1	2	3	4	5
None	library research for bibl.	library research, bibl, + paper	library research, individual research, bibl. + paper	library research, team research, bibl, + paper

(33) Required Use of Safety References:
Checklist: (Check all used)

___Merck Index
___MSDS
___Safety Database
___Other ______________________________

1	2	3	4	5
0 None	1 use	2 uses	3 uses	4 uses

III SECOND YEAR OF CHEMISTRY - ORGANIC CHEMISTRY

(34) Prerequisites:

1	2	3	4	5
None	published not adhered to	published adhered to	published adhered to waiver by Chair	published adhered to waiver by instructor

(35) Lecture schedule:

1	2	3	4	5
AM or PM	AM or PM or EVE	AM + EVE or PM + EVE	AM + PM or AM + EVE	AM + PM + EVE

(36) Instructional Method Options:
Checklist:

___ lecture,
___ lecture-recitation,
___ independent study
___ video
___ Computer (PLATO?)

1	2	3	4	5
one option	two option	three options	four options	five options

Textbook in Use:
Name ______________________ Author ________________________
Publisher ___________________________

(37) Selection of textbooks:

1	2	3	4	5
assigned by "outside" authority	selected by Chair	selected by Coordinator	selected by team of instructors	selected by instructor

(38) Catalog description as compared to course description: College/University course transfer comparisons.

1	2	3	4	5
Catalog has no description	brief description, few of course	brief description, some details.	brief description more detail	Catalog description is complete detail

(39) Lecture Behavioral Objectives: BO's written in operational terms, published and shared:

1	2	3	4	5
0 items	4 items	8 items	16 items	32 items

(40) Maximum Lecture Class Size:

1	2	3	4	5
241+ students	121-240 students	61-120 students	31-60 students	1-30 students

(41) Mean Lecture Class Size:

1	2	3	4	5
241+ students	121-240 students	61-120 students	31-60 students	1-30 students

(42) Evaluation of Lecture: Number of Tests/Quizzes/Final

1	2	3	4	5
1	2	3-4	5-6	7-8

End of Course Evaluation:
Standardized Examination? No Yes ____________________

(43) Required Use of Chemical Literature:
Checklist:
___ Handbook
___ Journals
___ Chemical Abstracts
___ Database (floppy disk/hard disk)
___ Database (electronic access)

1	2	3	4	5
0 used	1 used	2-3 used	4 used	5 used

Laboratory Experience

(44) Laboratory Behavioral Objectives: BO's written in operational terms, published and shared with students to include:

___ Perform quantitative manipulations
___ Assess the reliability of the results
___ Plan experiments through use of literature
___ Handle statistical analysis of data
___ Use effectively and with understanding a good selection of modern instruments, including, for example, IR, UV, mass and NMR spectrometers, and gas and liquid chromatographs
___ Recognize the hazards and unique problems of chemical safety and carefully observe modern safety practices.
___ Keep accurate and complete experimental records
___ Write good reports (Manuscript Requirements?)
___ Other? ______________________________

1	2	3	4	5
0 items	1-2 items	3-4 items	5-6 items	7-8 items

(45) Intended Laboratory Experiences:

___ Perform quantitative manipulations
___ Assess the reliability of the results
___ Plan experiments through use of literature
___ Handle statistical analysis of data
___ Use effectively and with understanding a good selection of modern instruments, including, for example, IR, UV, mass and NMR spectrometers, and gas and liquid chromatographs
___ Recognize the hazards and unique problems of chemical safety and carefully observe modern safety practices.
___ Keep accurate and complete experimental records
___ Write good reports (Manuscript Requirements?)
___ Other? ______________________________

1	2	3	4	5
0 items	1-2 items	3-4 items	5-6 items	7-8 items

(46) Maximum Laboratory Class Sizes:

1	2	3	4	5
36+ students	32-35 students	28-31 students	24-27 students	10-23 students

(47) Mean Laboratory Class Sizes:

1	2	3	4	5
36+ students	32-35 students	28-31 students	24-27 students	1-23 students

(48) Students/Full-Time Faculty in Laboratory:

1	2	3	4	5
TAs Only	32+	16-31	8-15	1-7

----Students/Full-Time Faculty----

Evaluation of Laboratory Experience:

(49) Student Laboratory Reports at BEGINNING of year.

1	2	3	4	5
None	fill-in forms	computerized fill-in report	written reports or Journals	word processor reports

(50) Report Requirements:

___ Manuscript Requirements (any Journal?) ________________
___ Spelling is checked
___ Use of Significant Figures
___ Error Analysis
___ Statistical Analysis

1	2	3	4	5
None	1	2-3	4	5

-------Requirements--------

(51) Student Laboratory Reports at END of year.
Comments:

1	2	3	4	5
None	fill-in forms	computerized fill-in report	written reports or Journals	word processor reports

(52) Report Requirements:
___ Manuscript Requirements (any Journal?) ________________
___ Spelling is checked
___ Use of Significant Figures
___ Error Analysis
___ Statistical Analysis

1	2	3	4	5
None	1	2-3	4	5

-------Requirements--------

(53) Additional Writing Assignments:

1	2	3	4	5
0	1	2	3	4

----Additional Assignments----

(54) Methods of Evaluation the Laboratory Experience:
Checklist: (Check all that apply)
___ Laboratory Reports
___ Unknowns Identification
___ Laboratory Practical
___ Observation by Instructor
___ Lab-Practical, paper-and-pencil

1	2	3	4	5
1 method	2 methods	3 methods	4 methods	5 methods

(55) Structured Laboratory Instruction:
Checklist: (Check all that apply)
___Synthesis
___Separation
___Analysis
___Structure Identification and Determination
___Chemical Kinetics
___Determination of Thermodynamic Properties
___Determination of product ratios
___Other? ________________

1	2	3	4	5
one item	two items	three items	four items	five items

(56) Computer Usage:
Checklist: (Check all that apply)
___Tutorial
___Computational
___Data Collection
___Spreadsheet Analysis

1	2	3	4	5
none	1 use	2 uses	3 uses	4 uses

(57) Assigned Student Research:

1	2	3	4	5
None	library research for bibl.	library research, bibl, + paper	library research, individual bibl+paper	library research, team bibl+paper

(58) Required Use of Safety References:
Checklist: (Check all used)
___Merck Index
___MSDS
___Safety Database
___Other ________________________

1	2	3	4	5
None	1	2 of the above	3	4

IV Faculty

(59) Fulltime Faculty Numbers in instructional unit:

1	2	3	4	5
1-2	3-4	5-6	7-8	9+

(60) Parttime Faculty Numbers:

1	2	3	4	5
0	1-2	3-4	5-6	7+

(61) Mean Fulltime Faculty (Lecture Instruction) Degrees:

1	2	3	4	5
<MS	MS	MS+30	EdS	PhD

(62) Mean Parttime Faculty (Lecture Instruction) Degrees:

1	2	3	4	5
NA	BS	MS	>MS	PhD

(63) Mean Fulltime Faculty (Laboratory Instruction) Degrees:

1	2	3	4	5
BS	>BS	MS	>MS	PhD

(64) Mean Parttime Faculty (Laboratory Instruction) Degrees:

1	2	3	4	5
NA	BS	MS	>MS	PhD

(65) Fulltime Faculty Teaching loads:

1	2	3	4	5
22-24 contact hours	19-21 contact hours	16-18 contact hours	13-15 contact hours	0-12 contact hours

(66) Fulltime Faculty Membership in the ACS:

1	2	3	4	5
0-20%	40%	60%	80%	100%

V Facilities and Instructional Resources

(67) Electronic/Mechanical Single-Pan (0.0001g) Balances:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(68) Laboratory section of ____ / ____ pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

---Students/0.0001-g Balance---

(69) Electronic/Mechanical Single-Pan (0.001g) Balances:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(70) Laboratory Section of ____ / ____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/0.001-g Balance----

(71) Electronic/Mechanical Single-Pan (0.01g) Balances:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(72) Laboratory Section of ___ / ___ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

---Students/0.01-g Balance----

(73) Electronic/Mechanical Single-Pan (0.1g) Balances:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(74) Laboratory Section of ___ / ___ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

---Students/0.1-g Balance----

(75) pH meters:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(76) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/pH Meter----

(77) Recording IR Spectrophotometers:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(78) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/IR Spectrophotometer----

(79) Recording visible Spectrophotometers:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(80) Laboratory section of ____ / ____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Recording VIS Spectrophotometer----

(81) Recording UV Spectrophotometers:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(82) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/ Recording UV Spectrophotometer----

(83) Bench-type VIS Spectrophotometers: (Spectronic-20 or other) ______________________

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(84) Laboratory Section of ____ / ____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Bench-Type VIS Spectrophotometer----

(85) Bench-type UV Spectrophotometers:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(86) laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Bench-Type UV Spectrophotometer----

(87) Gas-Liquid Chromatographs:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(88) Laboratory Section of ____ / ____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Gas-Liquid Chromatograph----

(89) High Performance Liquid Chromatographs:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(90) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/High Performance Liquid Chromatograph----

(91) NMR Spectrometer:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(92) Laboratory Section of ____ / ____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/NMR Spectrometer----

(93) Atomic Absorption Spectrophotometers:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(94) Laboratory Section of ____ / ____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Atomic Absorption Spectrophotometer----

(95) Flame Emission Photometers:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(96) Laboratory Section of ____ / ____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Flame Emmision Photometer----

(97) Automated Hot Water Bath:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(98) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Hot Water Bath----

(99) Computerized Data Acquisition Equipment:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(100) Laboratory Section of ____ / ____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Computerized Data Acquisition Equipment----

(101) Thermal Analysis (DTA,TGA,etc):

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(102) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Thermal Analysis Setup----

(103) Polarography (DME/DPP/Cyclic):

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(104) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Polarograph Setup----

(105) Hot Plates:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(106) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Hot Plate----

(107) Cold Plates:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(108) Laboratory Section of ____ / ____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Cold Plate----

(109) Magnetic Stirrers:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(110) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Magnetic Stirrer----

(111) Melting Point Apparatus:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(112) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Melting Point Apparatus----

(113) Optical Rotation Apparatus:

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(114) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Optical Rotation Apparatus----

(115) Simulators: NMR or other? ____________________

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(116) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Simulator----

(117) Other: ____________________

1	2	3	4	5
no equipment	have equipment no usage	have equipment used by technician	have equipment used by instructors	have equipment used by students

(118) Laboratory Section of ____ /____ Pieces:

1	2	3	4	5
NA/32+	16-31	8-15	4-7	1-3

----Students/Other Piece(s) of Equipment----

(119) Chemical Journal/Chemical Literature Collection:

1	2	3	4	5
0-5 works	6-10 works	11-15 works	16-20 works	21-25 works

Handbook Checklist:
___ Merck Index
___ CRC Handbook
___ Lange's Handbook

Journal Checklist I
___ Nature
___ Science
___ Scientific American

Journal Checklist II
___ Chemical Abstracts
___ Chemical and Engineering News

Journal Checklist III

___ Accounts of Chemical Research
___ Analytical Chemistry
___ Angewandre Chemie
___ Biochemistry
___ Inorganic Chemistry
___ Journal of Biological Chemistry
___ Journal of Chemical Education
___ Journal of Chemical Information and Computer Science
___ Journal of Chemical Physics
___ Journal of Organic Chemistry
___ Journal of Physical Chemistry
___ Journal of the American Chemical Society
___ Journal of the Chemical Society (London)
    ___ Chemical Communications
    ___ Dalton Transactions
    ___ Faraday Transactions
___ Perkin Transactions
___ Macromolecules
___ Organometallics
___ Tetrahedron
___ Tetrahedron Letters

Journal Checklist IV

___ Canadian Journal of Chemistry
___ Chemical Physical Letters
___ Chemische Berichte
___ Chemistry Letters (Japan)
___ Environmental Science and Technology
___ Helvetica Chimica Acta
___ Industrial and Engineering Chemistry
___ Journal of Catalysis
___ Journal of Chromatography
___ Journal of Coordination Chemistry
___ Journal of Electroanalytical Chemistry
___ Journal of Organometallic Chemistry
___ Journal of Polymer Chemistry
___ Langmuir
___ Magnetic Resonance in Chemistry
___ Nouveau Journal de Chemie
___ PNAS (Proceedings of National Academy of Sciences)
___ Quarterly Reviews
___ Spectrochemica Acta

APPENDIX E

PERCEPTIONS INSTRUMENT

Perceptions of the interviewee's instructional program as compared to other institution's instructional program...

How would you compare the two-year chemistry instructional program at YOUR institution (facilities, faculty, equipment & student opportunities) to the chemistry program at the following type of institutions?

SCALE DEFINITIONS

1	2	3	4	5
somewhat lesser quality	slightly lesser quality	essentially the same quality	slightly better quality	somewhat better quality

(1) Small-sized two-year colleges such as Alpena CC, Bay De Noc CC, Gogebic CC, Kirtland CC...?

1 2 3 4 5

(2) Medium-sized two-year college such as Jackson CC, Kellogg CC, Muskegon CC...?

1 2 3 4 5

(3) Large-sized two-year college such as Delta C, Lansing CC, Macomb CC...?

1 2 3 4 5

(4) Small-size baccalaureate-granting university such as Lake Superior SU, or Saginaw Valley SU...?

1 2 3 4 5

(5) Medium-size baccalaureate-granting university such as Ferris SU, Grand Valley SU, Northern MU...?

1 2 3 4 5

(6) Large-size baccalaureate-granting university such as Michigan State, Wayne State, U of Michigan....?

1 2 3 4 5

APPENDIX F

SURVEY DATA BASED UPON REVISED SURVEY INSTRUMENT

SURVEY DATA BASED UPON REVISED SURVEY INSTRUMENT

PERCEPTIONS AND PRACTICE: A CHARACTERIZATION OF THE FIRST TWO YEARS OF UNDERGRADUATE INSTRUCTION IN CHEMISTRY IN MICHIGAN STATE-SUPPORTED COLLEGES AND UNIVERSITIES.

Abbreviations:

SSTYC	Small-Size Two-Year College
MSTYC	Medium-Size Two-Year College
LSTYC	Large-Size Two-Year College
SSSU	Small-Size State University
MSSU	Medium-Size State University
LSSU	Large-Size State University

Organization of Instructional Unit

Item ----------------------Responses----------------------

Item	SSTYC	MSTYC	LSTYC	SSSU	MSSU	LSSU
01	01 02	02 02	02 02	05 03	05 05	05 03
02	01 02	04 01	02 04	05 03	05 05	05 05
03	03 04	03 04	02 03	05 03	03 05	05 05
04	01 04	03 03	03 04	04 03	04 05	05 02
05	01 04	01 01	01 01	04 02	03 05	05 04
06	03 03	02 02	02 03	04 02	05 05	04 05
07	01 02	01 01	01 01	01 01	03 02	02 05
08	01 03	01 03	02 02	03 01	02 05	04 01
ST	12 24	17 17	15 20	31 18	30 37	35 30

First Year Chemistry

Item ----------------------Responses----------------------

Item	SSTYC	MSTYC	LSTYC	SSSU	MSSU	LSSU
09	03 05	05 03	02 02	02 03	02 05	05 01
10	02 05	02 04	03 03	03 04	02 05	03 05
11	01 01	02 01	01 02	02 02	02 02	01 02
12	05 05	05 05	04 04	03 04	04 04	04 05
13	02 02	03 03	03 04	02 03	02 05	02 03
14	05 01	01 01	05 01	01 01	01 01	01 01
15	03 05	05 04	02 03	03 04	01 02	01 03
16	05 05	05 05	03 04	03 04	02 03	03 03
17	05 03	05 05	04 05	05 05	04 05	05 05
18	01 02	01 02	01 01	02 02	01 01	01 01
19	01 01	01 01	01 01	01 01	01 01	01 05
20	03 05	05 04	05 04	04 03	04 05	04 05
21	03 04	05 04	04 04	05 05	05 03	04 02
22	03 02	02 02	02 02	02 02	02 02	02 02
23	03 03	03 03	03 03	03 03	03 03	01 02
24	02 04	04 04	03 04	02 02	04 02	02 04
25	01 03	04 03	01 03	01 01	03 01	01 03
26	02 04	04 03	04 04	02 02	04 02	02 04
27	01 03	04 01	04 03	01 01	03 01	01 03
28	01 02	01 01	01 01	01 01	01 01	01 01
29	03 03	03 03	03 03	03 04	02 03	03 04
30	04 03	03 04	01 03	01 02	03 05	03 05
31	05 03	01 02	04 03	02 02	01 02	02 04
32	01 01	01 01	01 01	01 01	01 01	01 01
33	01 02	02 01	01 01	02 01	01 03	01 03
ST	66 77	77 70	66 68	57 63	59 68	55 77

Second Year (Organic) Chemistry

Item	SSTYC	MSTYC	LSTYC	SSSU	MSSU	LSSU
	Responses					
34	04 05	05 05	03 05	03 03	03 05	05 05
35	02 01	02 02	01 02	04 04	02 04	02 02
36	01 01	01 02	01 02	01 01	01 02	01 01
37	05 05	05 05	05 05	03 05	04 04	04 05
38	02 02	02 04	03 03	02 03	02 05	02 03
39	05 05	05 01	05 01	01 01	01 02	01 04
40	05 05	05 05	05 05	04 04	04 03	01 01
41	05 05	05 05	05 05	04 04	04 04	03 03
42	05 04	04 05	04 05	04 05	05 04	05 05
43	02 03	03 03	02 02	03 02	03 03	02 01
44	03 01	01 05	01 01	03 01	01 05	01 03
45	03 04	03 05	03 04	03 03	05 05	04 03
46	05 05	05 05	05 05	05 05	05 05	05 02
47	05 05	05 05	05 05	05 05	05 05	05 04
48	05 05	04 04	04 03	03 03	04 03	02 01
49	04 04	02 04	04 01	04 02	04 04	04 04
50	01 02	01 03	04 01	03 01	03 04	01 03
51	04 04	02 04	04 04	04 02	04 04	04 04
52	01 02	01 03	03 03	03 01	03 04	01 03
53	01 02	01 01	01 01	01 02	03 01	01 01
54	03 03	03 03	02 03	04 02	03 04	03 03
55	03 03	03 04	03 03	03 04	04 04	04 03
56	02 01	02 02	02 01	02 01	01 05	01 01
57	01 02	01 01	01 02	01 01	02 02	01 01
58	03 02	04 03	02 01	02 01	02 03	02 02
ST	80 81	75 89	77 73	73 66	78 90	65 68

Faculty

Item	SSTYC	MSTYC	LSTYC	SSSU	MSSU	LSSU
	Responses					
59	01 01	01 01	02 03	03 02	05 04	05 05
60	01 02	01 01	02 02	04 01	03 05	02 03
61	04 02	02 02	03 02	05 05	05 05	05 05
62	01 05	04 01	04 03	05 01	05 05	05 04
63	04 03	03 04	03 04	05 05	05 05	05 03
64	01 05	01 01	03 03	05 01	02 03	01 03
65	02 02	04 03	03 02	01 03	05 04	05 05
66	05 01	05 01	04 02	05 05	05 05	05 05
ST	19 21	21 14	24 21	33 23	35 36	33 33

Facilities and Instructional Resources

Item	SSTYC	MSTYC	LSTYC	SSSU	MSSU	LSSU
			0.0001-g Balances: Usage			
67	05 05	04 05	05 01	02 02	02 02	02 02
			Students/Balance			
68	03 03	01 03	05 01	01 01	01 01	01 01
			0.001-g Balances: Usage			
69	01 01	01 05	05 05	01 05	05 05	05 05
			Students/Balance			
70	01 01	01 03	05 03	01 04	03 05	05 05
			0.01-g Balance Usage			
71	05 05	05 01	01 02	05 02	01 05	05 01
			Students/Balance			
72	04 03	03 01	01 01	05 01	01 03	01 01
			0.1-g Balance Usage			
73	01 01	01 01	01 01	01 01	01 01	01 05
			Students/0.1-g Balance			
74	01 01	01 01	01 01	01 01	01 01	01 04
			pH Meters: Usage			
75	05 05	05 05	05 05	05 05	05 05	05 05
			Students/pH Meter			
76	04 03	04 04	04 04	05 04	05 03	05 05
			IR: Usage			
77	05 05	05 05	05 05	05 05	05 05	02 05
			Students/IR			
78	03 03	03 02	03 02	03 02	03 03	01 02
			Recording VIS: Usage			
79	01 02	01 05	05 01	05 05	04 05	02 05
			Students/VIS			
80	01 01	01 02	03 01	03 02	01 03	01 02
			Recording UV: Usage			
81	01 02	01 05	05 02	05 05	04 05	02 05
			Students/UV			
82	01 01	01 02	03 01	03 02	01 03	01 03
			Spec-20s: Usage			
83	05 05	05 05	02 05	05 05	05 05	05 05
			Students/Spec-20			
84	02 02	03 04	01 04	05 04	05 05	05 05

Item -----------------------Responses-----------------------

Item	SSTYC	MSTYC	LSTYC	SSSU	MSSU	LSSU
			Bench-type UVs: Usage			
85	01 02	01 01	01 01	05 01	02 05	02 01
			Students/UV			
86	01 01	01 01	01 01	03 01	01 03	01 01
			GL Chromatographs: Usage			
87	05 05	05 05	05 02	05 05	05 05	04 05
			Students/Chromatograph			
88	03 03	03 03	04 01	04 02	02 04	01 03
			HPLC: Usage			
89	01 01	01 05	02 01	02 01	04 04	02 05
			Students/HPLC			
90	01 01	01 02	01 01	01 01	01 01	01 02
			NMR: Usage			
91	01 01	01 01	05 02	05 01	04 05	02 05
			Students/NMR			
92	01 01	01 01	02 01	02 01	01 02	01 01
			AA: Usage			
93	01 01	01 05	02 01	02 02	02 04	02 02
			Students/AA			
94	01 01	01 03	01 01	01 01	01 01	01 01
			Flame Photometers: Usage			
95	02 01	01 05	02 01	02 01	01 02	02 02
			Students/Photometer			
96	01 01	01 03	01 01	01 01	01 01	01 01
			Automatic Temp Control Devices (HW-Baths): Usage			
97	02 01	05 01	02 01	02 01	02 05	02 01
			Students/HW-Bath			
98	01 01	05 01	01 01	01 01	01 04	01 01
			Computerized Data Acquisition: Usage			
99	01 01	01 01	01 01	02 01	02 04	02 05
			Students/Setup			
100	01 01	01 01	01 01	01 01	01 01	01 03
			Thermal Analysis: Usage			
101	01 01	01 01	01 01	02 01	02 01	01 02
			Students/Setup			
102	01 01	01 01	01 01	01 01	01 01	01 01
			Polarography: Usage			
103	01 01	01 05	02 01	02 01	02 02	02 02
			Students/Setup			
104	01 01	01 03	01 01	01 01	01 01	01 01

Item	SSTYC		MSTYC		LSTYC		SSSU		MSSU		LSSU	
	Hotplates: Usage											
105	04	05	05	05	05	04	05	03	05	05	05	05
	Students/Hotplate											
106	01	03	05	04	05	01	05	01	05	05	05	05
	Coldplates: Usage											
107	01	01	01	01	01	01	02	01	01	02	01	01
	Students/Coldplate											
108	01	01	01	01	01	01	01	01	01	01	01	01
	Magnetic Stirrers: Usage											
109	04	05	05	05	05	05	05	03	05	05	05	05
	Students/Magnetic Stirrer											
110	01	02	05	04	05	05	05	01	05	05	05	05
	Melting Point Apparatus: Usage											
111	05	05	05	01	05	05	05	05	05	05	05	05
	Students/Apparatus											
112	03	03	03	01	04	03	05	03	05	04	05	03
	Optical Rotation Apparatus: Usage											
113	02	01	02	01	02	02	02	02	02	02	02	02
	Students/Apparatus											
114	01	01	01	01	01	01	01	01	01	01	01	01
	Simulators: Usage											
115	05	01	01	01	02	01	01	01	01	02	01	01
	Students/Simulator											
116	03	01	01	01	01	01	01	01	01	01	01	01
	Other Equipment: Usage											
117	05	05	01	01	05	01	01	01	04	04	02	04
	Students/Other Equipment											
118	04	03	01	01	03	01	01	01	01	01	01	01
	Other Equipment: Notes											
	1	2			3		4		5	6	7	8
	Chemical Literature: Count											
119	02	02	02	02	03	01	05	03	05	05	05	05
ST	109	105	109	128	135	90	141	100	127	159	116	146
T	296	318	299	318	327	282	345	280	339	410	314	364

Notes for Item 118:

1 Digital Multimeters
2 Centrifuges
3 GC-MS, Electrodeposition, Refractphotometer
4 Heating Mantles
5 FT-IR, GC-MS
6 MS
7 GC-MS
8 GC-MS

APPENDIX G

PERCEPTIONS DATA

PERCEPTIONS AND PRACTICE: A CHARACTERIZATION OF THE FIRST TWO YEARS OF UNDERGRADUATE INSTRUCTION IN CHEMISTRY IN MICHIGAN STATE-SUPPORTED COLLEGES AND UNIVERSITIES

Perceptions of Instructional Program as Compared to

Instructional Programs at Other Institutions:

SCALE DEFINITIONS

1	2	3	4	5
somewhat lesser quality	slightly lesser quality	essentially the same quality	slightly better quality	somewhat better quality

PERCEIVED BY		SSTYC	MSTYC	LSTYC	SSSU	MSSU	LSSU
	SSTYC		3 3	3 3	4 3	4 3	3 3
	MSTYC	3 4		2 2	3 3	4 3	4 2
	LSTYC	5 4	4 3		4 4	4 4	4 4
	SSSU	5 4	5 3	5 3		5 2	4 1
	MSSU	4 3	4 3	3 3	3 3		4 5
	LSSU	5 5	4 5	4 5	3 5	3 5	

APPENDIX H

REVISED PERCEPTIONS DATA

PERCEPTIONS AND PRACTICE:
A CHARACTERIZATION
OF
THE FIRST TWO YEARS
OF UNDERGRADUATE INSTRUCTION IN CHEMISTRY
IN MICHIGAN STATE-SUPPORTED COLLEGES AND UNIVERSITIES

Perceptions of Instructional Programs at Other Institutions:

SCALE DEFINITIONS

1	2	3	4	5
somewhat lesser quality	slightly lesser quality	essentially the same quality	slightly better quality	somewhat better quality

REVISED

PERCEPTIONS OF:

PERCEIVED BY		SSTYC	MSTYC	LSTYC	SSSU	MSSU	LSSU
	SSTYC		3 3	3 3	2 3	2 3	3 3
	MSTYC	3 2		4 4	3 3	2 3	2 4
	LSTYC	1 2	2 3		2 2	2 2	2 2
	SSSU	1 2	1 3	1 3		1 4	2 5
	MSSU	2 3	2 3	3 3	3 3		2 1
	LSSU	1 1	2 1	2 1	3 1	3 1	

APPENDIX I

TUITION AND FEES

LEVIED IN MICHIGAN

STATE-SUPPORTED TWO-YEAR COLLEGES AND UNIVERSITIES

Table I-1
Tuition and Total Tuition and Fee Costs
For Two Years of Instruction
Based Upon 1988-1989 Tuition and Fee Rates:

Small-Size State-Supported Two-Year College

College	Total Credit Semester Hours	Nominal Tuition per Semester Hr	Est. Total Costs	Courses taken in two Years
Alpena CC	17	$27.00*	$2500	121,122
a= NA, b= NA, c= $27/hr, d= $2/cr hr				221,222
Bay De Noc CC	18	$29.00	$1800	105,106
a= NA, b= NA, c= NA, d= $8x4				201,202
Gogebic CC	18	$34.00	$1600	151,152
a= NA, b= $18X4, c= NA, d= $2/cr				201,202
Mid-Michigan CC	16	$30.00	$2000	111,112
a= $5, b= $15x4, c= NA				241,242
North Central Mich	18	$3050	$2200	121,122
a= $2/cr, b= $24x4, c= NA, d= $8x4				231,232

a= Registration Fee
b= Laboratory Fee
c= Contact Hour Fee
d= Other Fees
*= No tuition, all fees based upon contact hours.

Table I-2
Tuition and Total Tuition and Fee Costs
For Two Years of Instruction
Based Upon 1988-1989 Tuition and Fee Rates:

Medium-Size State-Supported Two-Year College

College	Total Credit Semester Hours	Nominal Tuition per Semester Hr	Est. Total Costs	Courses taken in two Years
Jackson CC	18	$33.00	$2500	151,152
a= $2x4, b= $5,5,10,10, c= $75,75,125,125				251,252
Kellogg CC	18*	$24.50	$1800	
a= $1.50/Hr, b= $9.20x2,$4.60x2				101A,101A(L),101B,101B(L)
c= $24.20x2,$38.40x2				201A,201B
Lake Michigan C	16	$29.00	$2100	111,112
a= $2/cr, b= $30x4, c= NA				203,204
Monroe Co CC	16	$20.50	$1400	151,152
a= NA, b= $0x2,$10x2, c= $0.50				251,252
Muskegon CC	20	$30.00	$1900	
a= NA, b= $10x4, c= NA				101,101L,102,102L
				201,202
Northwestern Mich	20**	$34.50	$2400	
a= $2.63/cr, b= NA, c= NA, d= $7x6				
				101,101A,101,103,103A,101,105,105A,106
				201,202,203,204,205,206
Southwestern Mich	20	$27.00	$1800	101,102
a= NA, b= $24x2,$36x2, c= NA				201,202
St. Clair Co CC	20*	$35.00	$2600	111,112
a= NA, b= $5,$15,$25x2, c= $56,$84x3				215,216

a= Registration Fee
b= Laboratory Fee
c= Contact Hours Fee
* = 16-Week Semester
** = Based Upon Term Hours

Table I-3
Tuition and Total Tuition and Fee Costs
For Two Years of Instruction
Based Upon 1988-1989 Tuition and Fee Rates:

Large-Size State-Supported Two-Year College

College	Total Credit Semester Hours	Nominal Tuition per Semester Hr	Est. Total Costs	Courses taken in two Years
Mott CC a= $15x4, b= NA, c= $13x8	20	$34.00	$2300	131,132 237,238
Delta College a= $3x4, b= NA, c= NA	18	$34.25	$2200	111,112 211,212
Grand Rapids JC a= $10x4, b= NA, c= NA	18	$54.00	$3400	113,114 266,267
Kalamazoo V CC a= NA, b= NA, c= NA	18	$23.00	$1500	101,111,102,112
Lansing CC a= NA, b= $5x6, c= NA, d= $5x6	18	$27.00	$1800	171,181,172,182,173,183 251,254,252,255,253,256
Macomb Co CC a= $10x4, b= NA, c= $30,36,0,38,0	18	$35.00	$2400	117,118 226,227,228
Oakland CC a= $20x4, b= $15x4, c= NA	20	$49.00	$3200	151,152 261,262,263,264
Schoolcraft a= $5x4, b= $5,$10x3, c= NA	19	$30.25	$2000	111,117 213,214
Washtenaw CC a= NA, b= NA, c= NA	16	$29.00	$1800	111,122 211,222
Wayne Co CC a=$14x4, b= $10x4, c= NA, d=$1/hr	22	$30.00	$2000	130,131 140,141

a= Registration Fee
b= Laboratory Fee
c= Contact Hour Fee
d= Other Fees.

Table I-4
Tuition and Total Tuition and Fee Costs
For Two Years of Instruction
Based Upon 1988-1989 Tuition and Fee Rates:

Small-Size State-Supported University

University	Total Credit Semester Hours	Nominal Tuition per Semester Hr	Est. Total Costs	Courses taken in two Years
Lake Superior S U	17.3*	$51.88	$3300	
a= NA, b= $0x1,$8x2, c= NA				111,112,113,122,123 221,222,223
Saginaw Valley S U	20	$54.50	$3800	
a= $25x4, b= $16x4, c= NA, d=$3/Cr				111,111L,112,112L 230,231,330,331

a= Registration Fee
b= Laboratory Fee
c= Contact Hour Fee
d= Other Fees
*= Based Upon Term Hours

Table I-5
Tuition and Total Tuition and Fee Costs
For Two Years of Instruction
Based Upon 1988-1989 Tuition and Fee Rates:

Medium-Size State-Supported University

University	Total Credit Semester Hours	Nominal Tuition per Semester Hr	Est. Total Costs	Courses taken in two Years
Central Mich U	16	$52.00	$3600	131,132
a= $25x4, b= $75x2,$40x2, c= NA				345,346,347,348
Ferris State U	10	$84.00	$3900	
a= NA, b= yes, c= NA, d=$5x6				121,122,123 221,222,223
Grand Valley SU	18	$76.00	$4800	111,112
a= NA, b= NA, c= NA				241,242
Michigan Tech	18*	$82.50	$5400	
a= $20x6, b= NA, c= $15x6				101,102,103,111,112,113 218,219,220,224,225,226
Northern Mich U	16	$44.25	$3100	111,112
a= NA, b= NA, c= NA, d= $3.75/Cr, 12.25				321,322
U of M-Dearborn	16	$80.00	$4200	114,116
a= $50,x4 b= $25x2,$40, c= NA, d=$9x4				225,226,227
U of M-Flint	22	$73.00	$3400	
a= NA, b= NA, c= NA				160,161,162,163 230,231,232,233

a= Registration Fee
b= Laboratory Fee
c= Contact Hour Fee
d= Other Fees

Table I-6
Tuition and Total Tuition and Fee Costs
For Two Years of Instruction
Based Upon 1988-1989 Tuition and Fee Rates:

Large-Size State-Supported University:

University	Total Credit Semester Hours	Nominal Tuition per Semester Hr	Est. Total Costs	Courses taken in two Years
Eastern Mich U	17	$50.75	$3400	131,132
a= $20x4, b= NA, c= $22x4				371,372,373
U of Michigan	19	$193.00	$7800	123,125,126
a= $60x4, b= NA, c= $7.63x4				225,226,227,228
Michigan State	20.7*	$73.88	$5300	
a= $110x6, b= NA, c= NA, d= $6.50x6				151,152,153,161,162,163
				351,352,353,354,355,356
Oakland U	22	$51.00	$3600	
a= $40x4, b= NA, c= NA, d= $52.75x4				144,145,149
				234,235,237,238
Wayne State	19	$60.50	$4000	107,108
a= $40x4, b= NA, c= NA				224,226,227
Western Michigan	16	$54.00	$3800	103,120
a= NA, b= $10x2,$0x2, c= NA, d= $89x4				360,361

a= Registration Fee
b= Laboratory Fee
c= Contact Hour Fee
d= Other Fees
*= Converted from Term Hours

APPENDIX J

CREDIT HOURS AND CONTACT HOURS
IN TWO YEARS OF PROFESSIONAL CHEMISTRY
IN MICHIGAN
STATE-SUPPORTED TWO-YEAR COLLEGES AND UNIVERSITIES

Table J-1
Credit Hours and Contact Hours
For Two Years of Professional Chemistry:

Small-Size State-Supported Two-Year College

College	1st Year Sem Hrs	Contact Hours Lec Lab	2nd Year Sem Hrs	Contact Hours Lec Lab	Total Sem Hours	Total Contact Hours
Alpena CC	8	120+ 84	9	90+126	17	420
Bay De Noc CC	10	120+ 84	8	90+ 84	18	378
Glen Oaks CC #	8	90+ 84	NONE	----------------		
Gogebic CC	10	120+ 84	8	90+ 84	18	378
Highland CC #	8	120+ 70	NONE	----------------		
Kirtland CC #	8	90+ 90	NONE	----------------		
Mid-Michigan CC	8	90+ 56	8	84+ 84	16	314
Montcalm CC #	NONE	---------	NONE	----------------		
North Central Mich	10	120+ 84	8	90+112	18	406
West Shore CC #	8	90+ 84	NONE	----------------		

Means:
Sem Hrs Credit 9.2
Contact hrs in lecture 114
Contact hours in lab .... 78+
Sem. Hrs credit for organic 8.2
Contact hrs in organic lecture 89
Contact hours in organic lab 98

Total semester hours credit 17.4
Total contact hours in lecture, recitation & laboratory 379

= Not included in determination of Means.

Table J-2
Credit Hours and Contact Hours
For Two Years of Professional Chemistry:

Medium-Size State-Supported Two-Year College

College	1st Year Sem Hrs	Contact Hours Lec Lab	2nd Year Sem Hrs	Contact Hours Lec Lab	Total Sem Hours	Total Contact Hours
Jackson CC	8	120+ 84	10	120+168	18	492
Kellogg CC	8*	96+ 90	10*	128+ 90	18*	404
Lake Michigan C	8	90+ 84	8	90+ 84	16	348
Monroe Co CC	8	90+ 84	8	90+ 84	16	348
Muskegon CC	10	120+ 84	10	150+ 84	20	438
Northwestern Mich	10**	150+ 54	10**	99+180	20**	483
Southwestern Mich	10	120+ 84	10	120+112	20	436
St. Clair Co CC	10*	144+ 95	10*	128+ 90	20*	457

Means:
Sem Hrs Credit 9
Contact hrs in lecture 116
Contact hours in lab 82
Sem. Hrs credit for organic 9.5
Contact hrs in organic lecture 116
Contact hours in organic lab 112

Total semester hours credit 18.5
Total contact hours in lecture, recitation & laboratory 426

* = 16-Week Semester
** = Converted from Term Hours

Table J-3
Credit Hours and Contact Hours
For Two Years of Professional Chemistry:

Large-Size State-Supported Two-Year College

College	1st Year Sem Hrs	Contact Hours Lec Lab	2nd Year Sem Hrs	Contact Hours Lec Lab	Total Sem Hours	Total Contact Hours
Mott CC	10	105+ 98	10	120+ 84	20	407
Delta College	8	120+ 90	10	120+120	18	450
Grand Rapids JC	8	120+ 84	10	120+168	18	492
Henry Ford CC #	10	90+112	NOT OFFERED			
Kalamazoo V CC	8	90+ 84	10	120+ 84	18	378
Lansing CC	10.7*	110+135	10*	90+162	20.6*	497
Macomb Co CC	8	120+ 84	10	120+ 98	18	422
Oakland CC	8	90+ 84	12	120+140	20	434
Schoolcraft	9	120+ 98	10	120+112	19	450
Washtenaw CC	8	90+112	8	90+ 84	16	376
Wayne Co CC	12	120+ 56	12	120+ 56	24	352

Means:
Sem Hrs Credit 9
Contact hrs in lecture 109
Contact hours in lab 101
Sem. Hrs credit for organic 10
Contact hrs in organic lecture 114
Contact hours in organic lab 111

Total semester hours credit .... 19+
Total contact hours in lecture, recitation & laboratory 426

* = Converted from Term Hours.
# = Not included in determination of Means.

Table J-4
Credit Hours and Contact Hours
For Two Years of Professional Chemistry:

Small-Size State-Supported University

University	1st Year Sem Hrs	Contact Hours Lec Lab	2nd Year Sem Hrs	Contact Hours Lec Lab	Total Sem Hours	Total Contact Hours
Lake Superior S U	9.3*	120+ 54	8*	90+ 81	17.3*	345
Saginaw Valley S U	10	120+ 84	10	105+126	20	435

Means:
Sem Hrs Credit 9.7
Contact hrs in lecture 120
Contact hours in lab 69
Sem. Hrs credit for organic 9
Contact hrs in organic lecture 98
Contact hours in organic lab 104

Total semester hours credit 18.7
Total contact hours in lecture, recitation & laboratory 390

* = Converted from Term Hours

Table J-5
Credit Hours and Contact Hours
For Two Years of Professional Chemistry:

Medium-Size State-Supported University

University	1st Year Sem Hrs	Contact Hours Lec Lab	2nd Year Sem Hrs	Contact Hours Lec Lab	Total Sem Hours	Total Contact Hours
Central Mich U	8	90+ 84	8	90+ 84	16	348
Ferris State U	10*	120+ 81	10*	120+ 81	20*	402
Grand Valley SU	8	120+ 56	10	150+ 84	18	410
Michigan Tech	10*	120+ 81	8*	90+ 81	18*	372
Northern Mich U	8	90+ 84	8	90+ 84	16	348
U of M-Dearborn	8	120+ 84	8	120+112	16	436
U of M-Flint	8	118+ 90	8	148+112	16	468

Means:
Sem Hrs Credit 8.6
Contact hrs in lecture .111
Contact hours in lab 80
Sem. Hrs credit for organic 8.6
Contact hrs in organic lecture 115
Contact hours in organic lab 91

Total semester hours credit 17.2
Total contact hours in lecture, recitation & laboratory 398

* = Converted from Term Hours

Table J-6
Credit Hours and Contact Hours
For Two Years of Professional Chemistry:

Large-Size State-Supported University

University	1st Year Sem Hrs	Contact Hours Lec Lab	2nd Year Sem Hrs	Contact Hours Lec Lab	Total Sem Hours	Total Contact Hours
Eastern Mich U	9	105+ 84	8	90+ 84	17	363
U of Michigan	8	138+ 42	11	165+182	19	527
Michigan State U	10.7*	110+135	10*	120+162	20.7*	527
Oakland U	10	120+112	10	90+196	20	518
Wayne State U	9	120+ 98	10	165+ 70	19	453
Western Michigan U	8	120+ 84	8	120+ 84	16	408

Means:
Sem Hrs Credit 9.1
Contact hrs in lecture 119
Contact hours in lab 93
Sem. Hrs credit for organic 9.5
Contact hrs in organic lecture 125
Contact hours in organic lab 130

Total semester hours credit 18.6
Total contact hours in lecture, recitation & laboratory 466

* = Converted from Term Hours.

APPENDIX K

COURSE PLACEMENT TESTS

USED BY MICHIGAN

STATE-SUPPORTED TWO-YEAR COLLEGES AND UNIVERSITIES

Table K-1
Course Placement Tests
Used By
Michigan State-Supported Two-Year Colleges

INSTITUTION	PLACEMENT TEST(S)
Alpena Community College	ACT, ASSET
Bay de Noc Community College	ASSET
Delta Community College	NONE
Glen Oaks Community College	ASSET
Gogebic Community College	ACT
Grand Rapids Junior College	ACT
Henry Ford Community College	ACT
Highland Community College	NONE
Jackson Community College	ASSET
Kalamazoo Valley Community College	ACT, E R & W
Kellogg Community College	R & W
Kirtland Communty College	ACT
Lake Michigan College	E M & W
Lansing Community College	E M & R
Macomb Community College	SCAT, TOLEDO
Mid-Michigan Community College	NONE
Monroe Community College	ASSET
Montcalm Community College	NONE
Mott Community College	ACT
Muskegon Community College	ACT, TOLEDO
North Central Michigan College	ACT
Northwestern Michigan College	ASSET
Oakland Community College	ASSET
Schoolcraft College	NONE
Southwestern Michigan College	ASSET
St Clair County Community College	ACT
Washtenaw Community College	NONE
Wayne County Community College	ASSET
West Shore Community College	ASSET

ASSET: <u>A</u>ssessment of <u>S</u>kills for <u>S</u>uccessful <u>E</u>ntry and <u>T</u>ransfer, American College Testing Program.

E M & R: A local English, Mathematics & Reading Skills evaluation.

E M & W: A local English, Mathematics & Writing Skills evaluation.

E R & W: A local English, Reading & Writing Skills evaluation.

R & W: A local Reading and Writing Skills evaluation.

SCAT: School and College Ability Test.

TOLEDO: Toledo Chemistry Placement Examination, American Chemical Society.

Table K-2
Course Placement Tests
Used By
Michigan State-Supported Universities

INSTITUTION	PLACEMENT TEST
Central Michigan University	ACT
Eastern Michigan University	ACT/SAT
Ferris State University	ACT
Grand Valley State University	ACT
Lake Superior State University	ACT
Michigan State University	ACT/SAT
Michigan Technological University	ACT/SAT
Northern Michigan University	ACT/SAT
Oakland University	ACT
Saginaw Valley State University	ACT/SAT
University of Michigan at Ann Arbor	ACT/SAT
University of Michigan at Dearborn	ACT/SAT
University of Michigan at Flint	ACT/SAT
Wayne State University	ACT/SAT
Western Michigan University	ACT/DEPT

ACT: ACT Assessment Program, American College Testing Program.

DEPT: A local screening test for placement in first-year chemistry.

SAT: Scholastic Aptitude Test, College Entrance Examination Board & Educational Testing Service.