



A survey of freshmen chemistry classes at Montana State University involving class composition, factors affecting student performance, and student sequencing in these classes
by Anita Ann Dawson

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Chemistry
Montana State University
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Abstract:

The work reported in this thesis concerns a study of class composition, factors affecting student performance, and student sequencing in four freshmen chemistry courses conducted at Montana State University during the academic year 1969-1970. Principal factors affecting student performance were found to be previous background in high school chemistry, mathematics, and physics; interest as evidenced by major subject area; and sex. The actual class composition of Chemistry 121 was found to be quite different than that predicted from consideration of the University catalog course description. Curriculum overlap between two courses surveyed resulted in a definite grade advantage for over 100 students pursuing this particular course sequence.

The principal goal of this work was to gather information for further reference in curriculum design and course development work with freshmen chemistry courses at Montana State University.

The procedure and results of the study are included in the thesis. Attached to the thesis as an appendix is the questionnaire used in the study.

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A SURVEY OF FRESHMEN CHEMISTRY CLASSES AT MONTANA STATE
UNIVERSITY INVOLVING CLASS COMPOSITION, FACTORS
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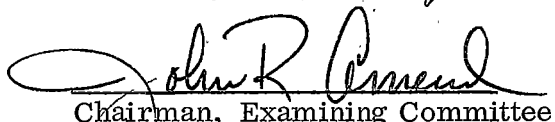
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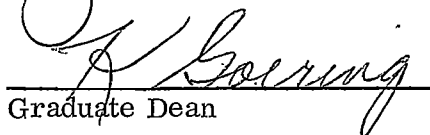
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ABSTRACT

The work reported in this thesis concerns a study of class composition, factors affecting student performance, and student sequencing in four freshmen chemistry courses conducted at Montana State University during the academic year 1969-1970. Principal factors affecting student performance were found to be previous background in high school chemistry, mathematics, and physics; interest as evidenced by major subject area; and sex. The actual class composition of Chemistry 121 was found to be quite different than that predicted from consideration of the University catalog course description. Curriculum overlap between two courses surveyed resulted in a definite grade advantage for over 100 students pursuing this particular course sequence.

The principal goal of this work was to gather information for further reference in curriculum design and course development work with freshmen chemistry courses at Montana State University.

The procedure and results of the study are included in the thesis. Attached to the thesis as an appendix is the questionnaire used in the study.

CHAPTER I

THE PURPOSE AND SCOPE OF THIS STUDY

The freshmen chemistry courses have by far the largest enrollment of the chemistry classes at Montana State University. Of the 18,051 student credit hours taken in chemistry during the academic year 1968-1969, 12,915 of these were taken by students enrolled in Chemistry 121, 122, 131, 132, 133, 134, 135, and 136. These courses are designed for the students with varying interests and background. The Chemistry 131 series, which includes 131, 132, 133, 134, 135, 136, is designed for the student who has had high school chemistry and plans on a career in the science field, such as chemistry, physics, math, microbiology, or the life sciences. The approach to the course is mathematical and requires that the student have an adequate background in mathematics. The Chemistry 121 series, which includes Chemistry 121, Chemistry 122, and perhaps Chemistry 134, is generally considered a terminal course. It is designed for the student who is not science oriented and for those whose subject matter does not require a large amount of science such as home economics, nursing, agriculture, humanities, and education. High school chemistry is not a prerequisite for this course.

Chemistry departments in large universities are faced with a severe problem in sorting out their incoming freshmen students and placing them in appropriate courses for the first year. Montana State also has this problem.

Students are placed in Chemistry 131 or Chemistry 121 according to varying backgrounds and interests. Other universities also have similar systems designed to assign freshmen to those classes which will not be beyond their reach, but yet will offer the inspiration and excitement of new material. Iowa State University has a plan which encompasses four separate courses for the freshmen (1). Each freshman is placed on the basis of his high school record and score on examinations (especially mathematics aptitude). Women who will major in home economics are placed in a separate course, enrolling from 50 to 300 students. Other students who have had no chemistry are placed in a second course, which ranges in size from 200 to 350 students, while those with prior training in chemistry but with low grade records are placed in a third course (900 to 1100 students). These three courses all undertake the study of chemistry from a beginning level, but proceed at somewhat different rates and different levels of sophistication made possible by the past training of the students assigned to them. Students who have had high school chemistry and have a good academic record are assigned to a fourth course (750 to 800 students). Most of the prospective chemistry majors are included in this course, which provides only a very rapid review of the basic principles, and consequently can cover the material of the normal three quarter course in only two quarters.

Here at MSU we do not use such an elaborate plan because our enrollment

is not as high. A simpler plan involving Chemistry 121 and 131 for the freshmen is in use. Even though Chemistry 121 is designed for the student with no previous chemistry background, most of our high schools today offer a relatively modern chemistry course for one year and many students take it. Consequently, over half of the students enrolled in Chemistry 121 have had high school chemistry. Their previous background was definitely to their advantage as will be shown later. Still many people feel the needs of the student with no previous background in chemistry or maybe a specialized field are not being met. Perhaps Montana State should consider a modified version of the Iowa State University plan to help solve this problem.

The purpose of this study was threefold:

(1) To determine the composition of the three large class sequences in freshmen chemistry at Montana State University: Chemistry 121, a course for non-science oriented students with no previous chemistry background required; Chemistry 131, a freshmen course designed for the science oriented student with high school chemistry or the equivalent being a prerequisite; and Chemistry 134, an introductory organic chemistry class with Chemistry 121 or 131 as a prerequisite.

(2) To identify and determine certain factors affecting the performance of these students in their perspective chemistry course. Factors considered

included (a) background previous to the course, (b) interest or subject area, and (c) sex.

(3) To observe maintenance of sequence continuity. Do students continue with the sequence they started? Do they drop out or change to another sequence? And what percent drop the course in which they are already enrolled?

The overall scope of the study included a survey that was done during the fall and winter quarters of the school year 1969-1970. The survey requested answers to questions such as: years out of high school, sex, class standing, amount of high school math, amount of college math, whether or not the student took high school chemistry or physics, present major subject area, and for the Chemistry 121 students if they were planning on taking Chemistry 131. Later the student's grade was added to this information and correlations were sought between these factors and their grade in the course.

CHAPTER II

A REVIEW OF PREVIOUS STUDIES IN THIS AREA

The study conducted was specific for a situation at Montana State University. There were 2033 freshmen students enrolled fall quarter from Montana high schools. 48% of these students were from first class high schools in the state. 31% were from second class high schools, 14% were from third class high schools, and 7% were from private high schools in Montana. Only in a first class high school would the chemistry or physics teacher be teaching only that specific course. In the small rural towns which included the second and third class high schools, the chemistry teacher may also teach a variety of other subjects. Having this unique situation with students from varied environments makes finding related literature difficult. The following studies, each limiting their study to a specific factor, are of interest because their findings are of similar nature to some of the results found in this study.

Charles W. Hendrickson of Shaker Heights High School, Shaker Heights, Ohio, and Al Judge of Euclid Senior High School, Euclid, Ohio, conducted a study of the Form 1967 ACS-NSTA test which was released in March 1967 at the NSTA convention. The results of the study were released in 1968 and appeared in the April 1968 issue of The Science Teacher (2).

10,651 scores representing 145 high schools throughout the country were used for the study. The examination is designed as an end-of-year achievement

for the first year high school chemistry course. There were five sub groups within the total group. These were: Sub Group A which consisted of 275 juniors and seniors with 0 to 2 semesters of mathematics prior to taking the chemistry course. Sub Group B consisted of 666 sophomores with 2 to 4 semesters of mathematics prior to taking the chemistry course. Sub Group C consisted of 1112 juniors having 4 to 6 semesters of mathematics but no physics prior to taking the chemistry course. Sub Group D consisted of 1220 seniors with 6 to 8 semesters of mathematics but no physics prior to taking the chemistry course. Sub Group E consisted of 584 seniors with 6 to 8 semesters of mathematics and two semesters of physics prior to taking the chemistry course.

The test was composed of two equal parts of 40 questions each, giving a total possible score of 80. The following table shows the results of the test with the different sub groups.

Table 1. Percentile ranks for sub groups (abbreviated table)

SUB GROUP AND RELIABILITY COEFFICIENT	SCORES*			Percentile Rank
	Part I	Part II	Total	
Sub group A	28.1	30.8	59.8	99
	14.6	15.9	29.8	75
	7.8	9.4	16.7	50
	3.9	3.9	8.2	25
	0.0	0.0	0.0	1
Reliability coefficient	.924	.928	.959	

Table 1. Percentile ranks for sub groups (abbreviated table). (Continued)

SUB GROUP AND RELIABILITY COEFFICIENT	SCORES*			Percentile Rank
	Part I	Part II	Total	
Sub group B	38.0	38.8	74.4	99
	25.9	28.4	54.1	75
	18.4	20.3	39.6	50
	10.5	12.7	23.5	25
	0.0	0.0	1.8	1
Reliability coefficient	.942	.946	.971	
Sub group C	35.8	36.2	71.9	99
	19.1	21.3	39.8	75
	12.4	14.0	26.9	50
	7.4	8.3	16.1	25
	0.0	0.0	1.4	1
Reliability coefficient	.912	.921	.953	
Sub group D	32.3	33.7	65.0	99
	17.9	20.1	37.9	75
	12.3	13.6	26.1	50
	7.4	8.0	15.9	25
	0.0	0.0	1.4	1
Reliability coefficient	.882	.909	.944	
Sub group E	36.3	36.7	71.1	99
	22.0	24.9	46.4	75
	15.3	17.1	32.6	50
	8.7	9.5	19.0	25
	0.0	0.0	2.2	1
Reliability coefficient	.924	.943	.964	

*Maximum possible score, Part I: 40; Part II: 40; Total: 80.

The group with no previous math background, Sub Group A, had the lowest grades. The sophomores, Sub Group B, received the best grades on the test

even though they had only 2 to 4 semesters of math and no physics. The group of juniors, Sub Group C, with 4 to 6 semesters of math but no physics had approximately the same scores as the seniors. Sub Group E, with 6 to 8 semesters of math and two semesters of physics.

Hendrickson and Judge concluded from the study that a good math background helped to some degree on these tests, but physics did not seem to have any apparent positive effect.

At the University of Colorado during the academic year 1967. Beverly Loeffler Meier conducted an investigation to determine the value of studying high school physics prior to taking college physics and its effect on the college physics performance (3). The freshmen students of Physics 111 were the students surveyed. It was a comparative study of no high school physics, conventional high school physics, and PSSC high school physics and the relation these had on performance. The criteria that were established were: 1) course grade, 2) final exam score and four hourly test scores. The following conclusions were drawn:

- (1) High school physics was of benefit for those taking the freshmen physics course at the University of Colorado. Those students, on the whole, performed better than students with no high school physics.
- (2) For students who had taken PSSC physics, this course was more helpful than conventional high school physics.
- (3) Conventional physics was more helpful than no high school physics.
- (4) As

the college course progressed the benefit of high school physics became more apparent.

CHAPTER III

CLASS COMPOSITION

The composition of a class should determine what will be the direction and level of teaching and the content of the course. In a small class this is relatively easy to do since the students are generally from the same curriculum and communication with each student is easy and often a part of the course. Deciding the direction and level of teaching in a large class is not quite as easy. Most large classes consist of freshmen and sophomores from a variety of backgrounds and subject areas. Communication between the student and instructor is difficult and often times impossible except for individual conferences with the instructor in his office. The instructor is many times at a loss when he faces that vast sea of faces not knowing the preparation the students have had or what they expect to get out of the course because of their varying backgrounds. If the instructor had information as to the composition of his class, he could determine what and how to teach the subject matter with an attempt to meet the needs of all the students. The following presents a brief description of the class composition of Chemistry 121, 122, 131, and 134.

CHEMISTRY 121

There were 861 students enrolled in Chemistry 121 during the fall and winter quarters of 1969-70. Of these a sample of 652 (76% of the class) was used for this study. The majority of the students came from the majors listed on the following graph with the category "other" added to include students not represented by these curriculums. The largest percentage of the class (72%) were freshmen, but in a few curricula the students were mostly sophomores, as in home economics and education. Approximately two thirds of the class were men and one third were women.

The backgrounds of the students varied from a little high school math for some to those with excellent math courses in high school for others. Some students had taken no college math while others had courses higher than Math 121 (calculus). Almost two thirds of the class had taken chemistry in high school, but only one third had taken high school physics.

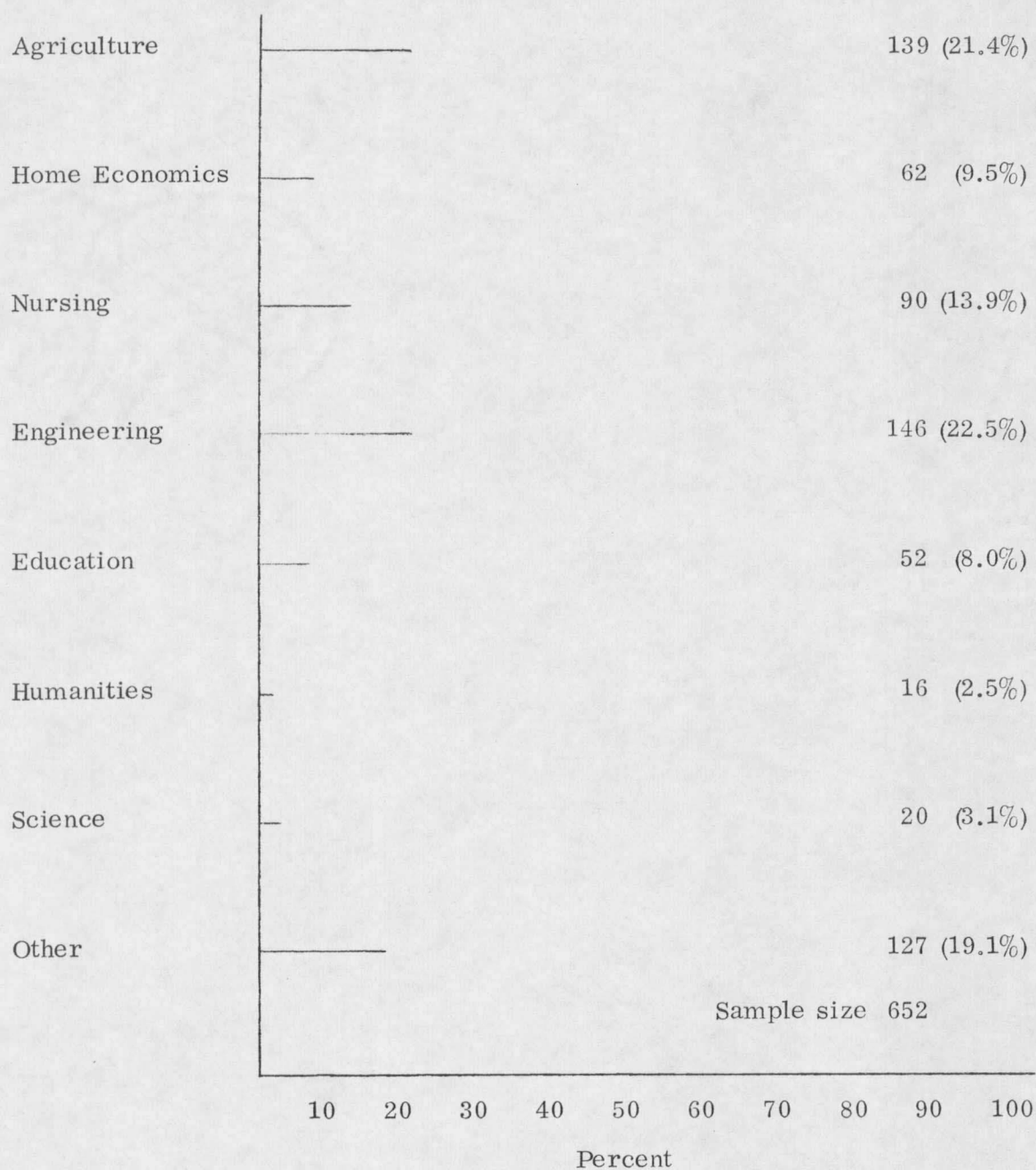


Figure 1

Class Composition in Chemistry 121

-By Subject Area-

CHEMISTRY 122

Chemistry 122 is the second quarter of the Chemistry 121 series. The course material is different for the two classes. Chemistry 121 is a general inorganic chemistry course and Chemistry 122 is an introduction to organic and biological chemistry.

A survey similar to that conducted on the Chemistry 121 classes was also conducted on the Chemistry 122 classes of winter and spring quarters, 1970. There were 518 students enrolled in Chemistry 122 during these quarters, a carry over of 60% from the 861 students enrolled in Chemistry 121. A sample of 349 students (67% of students enrolled) from Chemistry 122 was used for the study. 74% of the sample were freshmen, 66% of these first year graduates of high school. More than two thirds of the class had taken high school chemistry, but only one third had taken high school physics. The previous math backgrounds in high school of the students ranged from those who had taken no math course higher than Algebra I to those who had taken the highest math course offered which was usually calculus. The same was true for college math backgrounds.

The Chemistry 122 students came from a wide variety of interests and subject area majors. 50% of the students sampled were agriculture or nursing majors. The other 50% varied from 1% of the students in humanities to 14% of the students in engineering, with the other curricula falling in between.

