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EDUCATIONAL HANDICAPS IN CHEMISTRY STUDENTS

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Introduction

Research has been carried out to determine which characteristics and abilities are the best predictors of success in a college level chemistry course (1). Much of the work has centered on achievement measures such as high school chemistry performance, SAT or ACT scores, and the like (2), (3), (4), (5), (6). Factors other than demonstrated aptitude and ability are also important to success. Some research has looked at the effect of cognitive styles and motivational factors in attempting to predict success (6), (7), (8). Recent studies in our department indicate that most students who do not perform well may be thought of as suffering from an educational handicap, where handicap is taken to mean any disadvantage that renders achievement or success in competition more difficult. Two different types of educational handicaps may be identified: proficiency handicaps and attitudinal handicaps. A proficiency handicap is defined as the inability of a student to perform a requisite skill. Attitudinal handicap is a general term that refers to a handicap which is not proficiency-related.

Method

We have initiated a project to test for the existence of educational handicaps in entering students, in an effort to separately identify proficiency and attitudinal handicaps. The abilities and attitudes of entering students were tested during the first meeting of each lab section. The results of these pretests were analyzed to see if they correlated with performance in the course. The data analysis was performed using Statistical Package for the Social Sciences (SPSS) routines on the Drake University CDC 6400 computer. The measure of performance selected was the final average for the first semester introductory chemistry course.

Most published research is in the area of student proficiency. Examples of deficiencies that could handicap a student are a lack of mathematical skills, such as simple algebra and problem formulation, and poor reading comprehension. Since previous work has indicated that mathematical preparation is a good predictor of success in introductory chemistry, we gave a mathematical pretest to entering students. The instrument used was taken from an older form of the Iowa Placement Examinations (9). It consisted of two scales. The first scale tested commonly used arithmetical and algebraic skills and the second scale

concerned formulation of mathematical statements from verbal information, *i.e.*, "word problems." The first section contained 25 items worth one point apiece and the second contained 10 items worth three points each, for a total possible score of 55. All items were multiple choice. The sections were individually timed for 15 minutes and 7 minutes, respectively.

Testing for attitudinal handicaps is much more difficult than testing for proficiency handicaps. As educators, we are all aware of the importance of attitudinal factors in the learning process. Examples of such factors include interest in course content, perceived applicability of information to future educational or vocational endeavors, personal reaction to the instructor and past history of success or failure in the area. Since it was not practical to determine a complete attitudinal profile of each student, we chose to focus first on anxiety characteristics. The effect of anxiety on science achievement has been previously studied (10). We administered an achievement anxiety instrument developed by Alpert and Haber that has subscales measuring facilitating anxiety and debilitating anxiety (11). These subscales consist of nine and 10 items, respectively, each requiring a response on an agree-disagree scale of 1 to 5. We also administered a test anxiety instrument designed by Sarason. This instrument required 39 true-false responses about feelings concerning the taking of exams (12). There was no time limit imposed for the anxiety pretests. Supplementary data about each student were also collected: sex, major, high school chemistry background and grades earned on lecture exams and in lab.

Results

The students in our first-year chemistry course are mostly preprofessional health science students. About 45% of the students are in the College of Pharmacy. Most of the rest are in the College of Liberal Arts. Many of these are pre-medical, pre-dental, pre-veterinary or medical technology students, or other health science majors. Females outnumber males by 54% to 46%. Due to the composition of the class, it is interesting to examine the results of male-female and pharmacy-nonpharmacy subgroups.

Table 1 shows the mean scores on the math pretest. The mean scores of most of the various subgroups do not differ significantly. The exception to this is that the mean score of the group that completed the course is significantly higher than the score of those who withdrew from the course. This indicates that mathematical ability is one determining factor in success in the course, a point previously established by other studies.

Table 2 lists the values of the correlation coefficient for the math pretest scores with the final course average. The values of the correlation coefficients indicate that there is a significant positive correlation of course performance as measured by final average with the score on the

math pretest for all subgroups. The correlation coefficients are all significant at the .001 level (a significance level of .001 means that there is a .1% chance that the two variables are not correlated).

Table 1: Scores on Math Pretest

Group	Mean Score (total possible = 55)
All	33.5
Men	32.9
Women	33.9
Pharmacy	34.1
Non-pharmacy	33.0
Completed course	34.8
Withdrew from course	26.3

Table 2: Correlation of Math Pretest with Final Average

Group	Correlation Coefficient
All	0.431
Men	0.533
Women	0.429
Pharmacy	0.457
Non-pharmacy	0.433

The correlation coefficients for all three anxiety measures with the final course average are given in Table 3. Although the significance levels for these correlations are higher than for the math pretest, the results are suggestive. Facilitating anxiety, as determined by the Alpert-Haber instrument, seems at most to be weakly related to course performance. Debilitating anxiety is more strongly related and has a negative effect. The same is true of test anxiety. One interesting trend is the larger and more significant correlation of all three anxiety scores with course performance for non-pharmacy students than for pharmacy students. Due to the high significance levels of some of the correlation coefficients, it is best to regard this trend as tentative rather than conclusive.

Table 3: Correlation of Anxiety Measures with Final Course Average

Group	Correlation Coefficients					
	Facil. Anxiety	Sig.	Debil. Anxiety	Sig.	Test Anxiety	Sig.
All	0.114	.075	-0.230	.002	-0.206	.004
Men	0.113	.172	-0.298	.005	-0.359	.131
Women	0.124	.125	-0.204	.028	-0.120	.001
Pharmacy	-0.042	.357	-0.122	.145	-0.128	.137
Non-pharmacy	0.237	.015	-0.319	.001	-0.299	.002

Conclusions

The math pretest results demonstrate that mathematical ability is a requisite skill for students entering introductory chemistry. The lack of this ability constitutes a proficiency handicap. Several alternatives are available to those who suffer from such a handicap:

(1) Withdrawal from the course until their mathematical proficiency can be improved;
(2) Immediate remediation of their deficiencies by personal study, programmed instruction, computer-assisted instruction (CAI), or other means;
(3) Probable difficulty in the course with the real possibility of an undesirable grade.

We plan to use the results of the pretest for advising students who are apprehensive about their prospects in the course. We are also developing a series of CAI programs designed to aid students who are deficient in mathematical skills.

Attitudinal handicaps revealed by pretesting are more difficult to handle since they may indicate an underlying attitude rather than a specific problem with a definite solution. The results obtained on anxiety measures indicate that, while anxiety may be a problem, it is not a large determining factor in most cases. Differences do exist between certain subgroups. The effect of anxiety on course performance is larger for non-pharmacy than for pharmacy students. This may be related to the long-range prospects of the two groups of students. Pharmacy students for the most part have already made a fairly definite career choice. Since the College of Pharmacy placement rate is nearly 100%, students are assured of employment in their chosen field if they complete the course of study. This is in contrast to the large uncertainties facing a pre-medical student as to whether he or she will be accepted for medical school. Another interesting result is that the performance of men seems to be affected by test anxiety to a greater extent than that of women. This is in contrast to the situation that has been found to exist with math anxiety. Once attitudinal handicaps are identified, personal help on a one-to-one basis can be offered to the student. The Counseling Center at Drake has had some success in treating cases of test anxiety. The program involves test desensitization, the teaching of relaxation techniques and, for some, removing the student from the highly anxious classroom environment during the exam (*i.e.*, the exam is taken at the Counseling Center). One student who had scores of 69%, 47%, and 32% on the first three exams obtained 91%on the fourth exam after entering the program and continued to perform at an improved level. Another student rose from mid-C to near-A level work. Such success stories give cause to hope that identification of attitudinal handicaps may lead to the alleviation of the problems causing them.

The efforts made thus far are only a beginning. New and better instruments need to be developed to identify educational handicaps. In the attitudinal area, characteristics other than anxiety should be inves-

tigated. Programs must be developed to remedy the handicaps that are identified. The results of this study indicate, however, that information that is quite valuable in identifying problems and in advising students can be gained from pretesting of this type.

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Short Courses

The University of Northern Iowa has been awarded a grant from the National Science Foundation to improve elementary and secondary teachers' knowledge in the subject matter of science and mathematics.

During the 1980-81 academic year, eighteen different short courses will be offered. Nine will be offered in the Cedar Rapids area in the Grant Wood AEA in the Fall of 1980. The remainder will be offered at a location in Northeast Iowa (to be announced later) in the Spring of 1981. Each course will carry one semester hour of credit. Participants may select up to three courses during a semester. For further information, contact Dr. Timothy Cooney, Project Director, Price Laboratory School, University of Northern Iowa, Cedar Falls, Iowa 50613.

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Five Home Study Courses

Five science-oriented courses will be offered by ISU and/or SUI beginning in September. There are no classes to attend, and no formal university admission is needed. Credit levels vary from introductory level to graduate level. High school students may enroll in introductory level courses. The course topics include Introduction to Human Biology, Beginning German, Computer Technology and Change, and the Living Environment. For further information contact Emilia Nordvet, UMA, Curtiss Hall, ISU, Ames 50011 or phone toll free 1-515-294-4750.