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ABSTRACT

The problem of low graduation rates for diverse students in engineering has many causes. Low retention rates for all students in the first two years of an engineering program is a significant problem which must be addressed if universities are going to increase the number of graduates in engineering programs. Faculty and administrators agree, not all students can, or should, become engineers. But, are the "right" students leaving? Are all the "leavers" the students who are unable to handle to coursework? While many factors influence a university student's decision to remain or leave a particular field of study or the pursuit of higher education entirely, one factor considered to be relevant is their learning style. This study examined an hypothesized six-factor model of interactive learning styles. Interactive learning styles refers to the learning style students use when learning new information by relating to their environment. Do they interact with other students or with their faculty? Do they interact differently during class than after class? The study sample was 515 undergraduate engineering students enrolled in the three engineering colleges in New Mexico. An exploratory factor analysis using SAS and a confirmatory factor analysis using LISREL was performed on the responses to the survey. The analyses of the data did not support the hypothesized model for interactive learning styles. However, the analysis did suggest an alternative model; and, did support the hypotheses that interactive learning styles are different among various respondent subgroups including, male and female, white and minority, and freshman and seniors. While the interactive learning style of students learning by themselves contributed most to the success of five of the seven respondent groups, the two groups which have the lowest retention rate nationwide, minorities and freshman, did not state learning by themselves contributed most highly to their success. Learning with other students contributed most highly to minority students' success, and learning with faculty in an informal environment, outside of class, contributed most to the freshman students' success. While traditional instructional strategies appear to support the students who are traditionally successful in engineering program, they may fail to provide the same opportunities to their more diverse students. By providing the information learned about interactive learning styles, engineering administrators and faculty can become aware of alternative instructional strategies which can encourage the same level of participation and inclusion by these diverse students. (Author)

Faculty and Student Interaction and Learning Styles of Engineering Undergraduates

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Abstract

The problem of low graduation rates for diverse students in engineering has many causes. Low retention rates for all students in the first two years of an engineering program is a significant problem which must be addressed if universities are going to increase the number of graduates in engineering programs. Faculty and administrators agree, not all students can, or should, become engineers. But, are the "right" students leaving? Are all the "leavers" the students who are unable to handle to coursework? While many factors influence a university student's decision to remain or leave a particular field of study or the pursuit of higher education entirely, one factor considered to be relevant is their learning style.

This study examined an hypothesized six-factor model of interactive learning styles. Interactive learning styles refers to the learning style students use when learning new information by relating to their environment. Do they interact with other students or with their faculty? Do they interact differently during class than after class?

The study sample was 515 undergraduate engineering students enrolled in the three engineering colleges in New Mexico. An exploratory factor analysis using SAS and a confirmatory factor analysis using LISREL was performed on the responses to the survey.

The analysis of the data did not support the hypothesized model for interactive learning styles. However, the analysis did suggest an alternative model; and, did support the hypotheses that interactive learning styles are different among various respondent subgroups including, male and female, white and minority, and freshmen and seniors.

While the interactive learning style of students learning by themselves contributed most to the success of five of the seven respondent groups, the two groups which have the lowest retention rate nationwide, minorities and freshmen, did not state learning by themselves contributed most highly to their success. Learning with other students contributed most highly to minority students' success, and learning with faculty in an informal environment, outside of class, contributed most to the freshmen students' success. While traditional instructional strategies appear to support the students who are traditionally successful in engineering program, they may fail to provide the same opportunities to their more diverse students. By providing the information learned about interactive learning styles, engineering administrators and faculty can become aware of alternative instructional strategies which can encourage the same level of participation and inclusion by these diverse students.

Introduction

The success of U.S. engineering education has long been recognized worldwide. There are 311 engineering schools in the U.S. which are open to academically qualified students from any country, class, gender, race, or ethnic group. Top students from around the world compete to study engineering at U.S. colleges and universities. U.S. engineering education is solidly based on an in-depth study of the natural sciences. It is an education that is highly analytical and theoretical in nature [1].

Graduate education is particularly strong in many U.S. engineering schools, in part because its research base is, generally speaking, second to none. This research orientation enriches the undergraduate curriculum and influences its character through lectures and textbook development by faculty. Many schools have programs that also provide undergraduates with direct research experience. This orientation toward research and discovery is a major attraction to students [1].

Despite these strengths, there are areas where engineering education must improve if it is to remain the best in the world and serve the needs of the nation. One area in which change is needed is in the undergraduate engineering program[1]. University administrators and faculty agree, not all students can, or should, become engineers. But, are the "right" students leaving? Are all the "leavers" students who are unable to handle to course work?

Many factors influence a university student's decision to remain or leave a particular field of study or the pursuit of higher education entirely. While faculty often cite lack of student preparation and interest as major factors contributing to student's inability to complete engineering programs, students attribute their decisions to faculty performance [2]. In their study, Seymour and Hewitt observed that students reported poor relationships with faculty and poor teaching as factors contributing to their switching out of engineering programs; in stark contrast to faculty perception.

Another factor considered to be relevant is learning style [3, 4, 5]. Although, definitions of learning styles vary and the concepts examined by various researchers are diverse, Keffe[6] defined learning style as the cognitive, affective, and physiological factors that serve as relatively stable indicators of how learners perceive, interact with, and respond to their learning environment. The interactive learning style is defined as the person or persons with whom each student learns.

The purpose of this study was to examine a model of interactive learning styles and determine if there are differences by gender (male/female), ethnicity (white/minority), and college class (freshmen/senior). For the purpose of this study, interactive learning style is defined as the person or persons whom the student interacts with when learning, such as the faculty, other students, or no one. This study sought to provide information about the interactive learning styles of the undergraduate students currently enrolled in the accredited engineering programs in the state of New Mexico and determine if there are differences among the learning styles of the various demographic groups.

Procedure

The Interactive Learning Styles Inventory was administered in the spring semester of 1998 to students enrolled in selected classes at the University of New Mexico (N=172) , New Mexico State University (N=247), and New Mexico Institute of Mining and Technology (N=96). Fifteen percent of the target population participated in the study. The instrument was administered by the researcher. Students completed the survey during a class they were taking at their various colleges. There were a total of 596 questionnaires collected, 515 questionnaires were used for the analysis due to missing data or permission forms. Respondent information is shown in Table 1.

Table 1
Respondent Information

	Male	Female	White	Minority	Freshman	Senior
Sample Number	386	127	246	257	183	166
Sample Percentage	75%	25%	49%	51%	52%	48%
Population Percentage	76%	24%	59%	41%	43%	57%

Findings

The study examine whether the interactive learning styles for diverse students; men and women, whites and minority, and freshmen and seniors are the same. When running the exploratory factor analyses, observed models resulted from the analysis of each of the subgroups. LISREL analysis was used to examine the similarities or differences between observed models in two ways. First, LISREL analysis compared the female observations to the male observed model, the white observations to the minority observed model, and the freshmen observations to the senior observed model, to determine if there were significant differences. Then to verify this difference, LISREL analysis was run comparing the male observations to the female observed model, the minority observations to the white observed model, and the seniors observations to the freshmen observed model.

Seven measures were considered to determine if the observed models fit the observed data, including; chi square, adjusted chi square, goodness of fit, adjusted goodness of fit, residuals, root mean square residuals, and modification indices. The seven measures relevant to the overall goodness of fit of the observed models for the data collected from the subgroups indicate the interactive learning styles are different. For all subgroups, the adjusted χ^2 is greater than desired value of 2.0, the adjusted goodness-of-fit is less than 0.89 desired, and the root mean residual is greater than the desired value of .05. Analysis of the standardized residuals in the model show many are greater than the desired 2.0 and the Q-Plots of the residuals do not follow the required 45-degree angle. Modification indices for the data indicate several fell above the desired 5.0, with ranges from 5.09 to 68.65. Several measures were unable to be collected due to the lack of fit between the observed data and models. These measures indicate the observed models do not fit the data collected from the subgroups. Therefore, we can state the interactive learning styles of men and women, white and minority, and freshmen and seniors, are different.

Discussion of the Findings

The significant differences between the subgroups, male and female, white and minority, and freshmen and senior is indicated by the order of the factor loadings. For example, the Student-Self learning style (students who learn best by themselves) is in all comparison groups and, while it contributes the most to the models in five of the seven comparison groups, the two groups which have the lowest retention rate nationwide, minorities and freshmen, did not indicate the Student-Self learning styles as contributing the most to their success. The Student-Student learning style (students who learn best by learning with other students) contributes most to the model for the minority group. The Student-Faculty-Informal learning style (students who learn best by interacting with their faculty outside of class) contributes most to the model for the freshmen group. This suggests that faculty could include or increase the use of instructional methods that would foster students working together to study content material, specifically encouraging the participation of minority students. Similarly, freshmen students might benefit from the inclusion of opportunities to work with faculty outside of the classroom setting, in more informal atmospheres.

Each interactive learning styles model observed for the various comparison groups included two of the hypothesized learning styles, the Student-Faculty-Formal (students who learn best by interacting with their faculty during class), and the Student-Faculty-Informal (students who learn best by interacting with their faculty outside of class); although, these two factors contributed to the observed models to varying degrees among the comparison groups. It appears from this finding that when interacting with the faculty, students perceive that the setting, or learning environment, is also important. It appears that all students value formal interaction with faculty similarly. It also appears that, while all students find informal interaction with faculty useful in pursuing their studies, the observed model for freshmen and female students suggest these students find informal interactions with faculty particularly pertinent.

Freshmen and female students may also be similar in their perceptions about learning with other students since the observed models for these two comparison groups suggest less emphasis on the Student-Student learning style than on informal interactions with faculty. While the observed models for all other comparison groups indicate that both learning with students and independent student learning styles were either the factor contributing most strongly or the next contributing factor, both freshmen and female students ranked the Student-Student learning style as less important.

Three additional learning styles; Studying-Alone (students who learn best when studying alone), Studying-With-Students (students who learn best by studying with other students) and Answering-Questions (students who learn best by answering questions, either during class or outside of class), were found. These three learning styles contribute less highly than the other four learning styles for all respondent subgroups.

Discussion of Differences Between Sub-Groups

The observed data suggests faculty could increase certain interactions with students in an effort to meet their learning style, which may improve their retention. Student-Self, Student-Student, and Student-Faculty-Informal learning styles are ranked among the first three most important learning styles

by all comparison groups. This suggests faculty could increase these learning opportunities for all students. The comparison of the observed models supports the conclusion that there are differences between comparison groups that are important, including:

- Student-Faculty-Informal learning style appears to be more important for females than males. Faculty can offer students opportunities to interact with them in an informal environment (outside of class) , in an academically meaningful way.

- The Student-Student learning style appears to be more important for male students than females. Faculty can provide cooperative learning exercises during or between classes for these students.

- The Student-Student and Answering-Questions learning styles appear to be more important to minority students than white students. Faculty can provide cooperative learning opportunities for these students. Faculty can increase these students' opportunities to answer student's questions in class, as part of the class discussions, or as part of their work in cooperative learning teams.

- The Student-Faculty-Informal and the Answering-Questions learning styles appear to be more important to freshmen students than seniors. Faculty can increase student opportunities to interact with them in an informal environment (outside of class) . Faculty may also want to provide opportunities for students to answer questions, either in class as part of the class discussions, or with them, in an informal setting.

- The Student-Self and Student-Student learning styles appear to be more important to seniors than freshmen. Faculty can provide cooperative learning experiences for seniors, as well as opportunities to work alone, either during class, laboratory experiences, or when studying.

Implications for Student Retention

Traditional instructional strategies appear to support the students who are traditionally successful in engineering programs, yet may fail to provide the same opportunities to their more diverse students. By using the information learned about interactive learning styles from this study, faculty can become aware of alternative instructional styles which can encourage the same level of participation and inclusion by these diverse students.

It appears from the findings of this study that the students who are most successful, the seniors and whites, have the learning style which is traditionally used most often in engineering programs, students learning by themselves. While the students who are less likely to be retained in the engineering courses, the freshmen and minority students, have different interactive learning styles. In addition, while both males and females reported their most successful learning style was learning by themselves, the males' second most successful style was learning with other students, while the females' was learning with the faculty in an informal environment (outside of class) . Many engineering programs are including team work and group work as part of their curriculum, while few are incorporating informal faculty interaction. These factors may be contributing to the retention problem in engineering schools. These observed differences in interactive learning styles suggest multiple instructional strategies may be

helpful in creating successful learning opportunities for diverse students. Providing opportunities for diverse students to learn in which they perceive supports their learning may influence their success and foster their retention in the engineering programs; faculty can consider the interactive learning styles of the various student groups when designing engineering programs which will retain diverse populations.

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