Learning Styles and Freshman Attrition: What Are The Links?

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Abstract

One of the most urgent issues in engineering education relates to levels of attrition and retention of undergraduate engineering students. Most institutions track this data at the university level, meaning that university administrators are easily able to identify students who switch majors from engineering to other areas or identify students who leave the university completely, but there is minimal follow-up data provided at the college and department level.

Our research examines the issue of first-semester attrition from the following perspectives: (1) the individual differences perspective: can data from a 10-minute psychological learning-style survey distributed on the first day of class be used as a means of early-identification of first-semester engineering students who may not continue in engineering? (2) the correlational feedback perspective: what correlations exist between learning-style survey scores and end-of-semester qualitative survey data?

Findings in this study will be further examined from a multi-university perspective: one smaller, private university with relatively low levels of attrition, and another large, urban university with a higher average rate of attrition between the first and second semesters of engineering education. Our conclusions will explore the similarities between our students and faculty, the disparities between the two institutions, and look for multiple methods to strengthen both programs by increased levels of understanding and knowledge regarding attrition and retention patterns.

Introduction

A common concern among engineering educators is the consistently high rate of freshman student attrition from engineering programs. Depending on the source of literature cited, the attrition rate in undergraduate science, math, and engineering programs ranges from 40-70%, with a critical period of attrition between the freshman and sophomore years.

There are multiple research questions addressed in this pilot-scale project, all of which focus on the central issues of attrition and retention levels between the first and second semesters of engineering studies. Specific areas of emphasis include these questions:

- Does the use of data obtained from a cognitively-based psychological learning-style survey administered to students enrolled in entry-level engineering courses contribute valuable predictive information regarding which students are most at risk for attrition?
- Does individualized follow-up data contribute insight into these issues for students who make the decision to switch programs during the first semester of the entry-level class?
- Are there any comparisons that can be drawn between a small, liberal-arts university that has a low degree of attrition at the freshman level and a large, urban university with a significantly higher degree of attrition between the first and second introductory engineering courses?

The goal of this research is to develop a mechanism for identifying students who are not likely to be retained in engineering programs, and to eventually customize strategies from the smaller, liberal-arts college into individualized, successful intervention strategies for retaining at-risk students in the large, urban university. Students at Mercer University in Macon, Georgia, and The University of Memphis in Memphis, Tennessee will be evaluated in order to assess strengths and weaknesses in individual programs which may contribute to student success or attrition.

The research questions will be operationalized by the use of multiple measurement instruments including both qualitative and quantitative measures such as the Kolb Learning Style Inventory (LSI), supplemented with survey data to obtain student feedback from students in both populations as well as individualized interviews with students who leave the programs during the first semester of study. This rationale for the methodology of the project was selected based on existing data from the civil engineering program at The University of Memphis where a modified version of the Kolb LSI has been used with first semester students for the past three years. Preliminary data indicates that students leaving the program after the first semester may have a different preference of learning style in one of the four Kolb Areas. Can Kolb's learning style categories be useful as predictors for at-risk students? Do individualized follow-up methods provide additional information regarding specific reasons for students who make the choice to leave engineering during the first semester of study? These questions led to the development of this research project.

Project Rationale

Before introducing the methodology for this study, it is essential to note the implications of these high levels of attrition in engineering. As noted previously, statistical data relating to attrition and retention of students majoring in science, technology, engineering, or math (STEM) fields continues to be alarming, with high-ranking administrators and researchers describing these trends as a "leak in the engineering pipeline."[1,2,3,4] In a time of great technological growth, these losses have serious implications on multiple levels. Data collected in conjunction with a study commissioned by Department of Education Secretary Richard Riley notes that in 1950, 80% of jobs were categorized as "unskilled positions", meaning the potential applicants were not expected to possess a specific skill set in order to obtain the job; the 2004 data shows a significant reversal with 85% of current jobs categorized as "skilled positions". An example cited was that of a machinist. Because machine tooling equipment now uses computer-numerically-controlled (CNC) technology, an operator must have some knowledge of the

principles of calculus and some experience working with computer programming in order to work independently.[5]

Additional conclusions reached by this committee estimate that in order to keep pace with the current annual increase in national productivity (2.6%), and to meet the needs of an anticipated twenty million additional jobs by 2008, universities and colleges will need to teach and train nearly four times the number of students currently enrolled in the field of computer science alone[5]. Where will these students come from?

Clearly, industrial and technological employers have relevant concerns because the STEM students of today will be their employees of tomorrow, and the response of the academic community has been expressed in a typical scientific manner through collection, analysis, and triangulation of data. The most influential of these academic commissions investigating these trends include "The Neal Report," sponsored by The National Science Foundation (NSF) in 1986, "The Report of Disciplinary Workshops on Undergraduate Education," also sponsored by NSF in 1988, and the Sigma Xi National Advisory Group's "Wingspread Conference" (1989).[1,6,7,8] While each study examined different populations and used differing methodological approaches, one conclusion was consistent: solutions to these needs can be provided best by a coordinated, integrated system of educators, students, and employers working together to maximize results. Targeting the areas of attrition in the critical period between the introductory course in engineering and subsequent courses provides a means of coordinated response by educators working in conjunction with students.

Before progressing into the methodology of this particular study, it is important to provide both a brief overview of the Kolb LSI (1985)[9,10] instrument and an explanation of our decision to use the Kolb LSI as opposed to other metrics designed to assess learning styles and behavior, and to note the relative merits and constraints associated with this metric. It is common knowledge in fields of educational psychology and research that different instruments may be used with frequency following the debut of the instrument only to result in re-analysis of the data with different metrics if an issue of validity or reliability is raised in conjunction with the increase in applications. Perry's model relating to ethical and intellectual development of college students served as a seminal model for developmental theorists for many years, yet recently, the model has been criticized and the validity has been questioned due in part to the limited number of subjects and the gender of the subjects[11,12].

A brief description of the 1985 version of the Kolb LSI instrument follows:

- The 1985 version of the Kolb LSI contains 48 short sentences related to learning, and these questions may be completed and self-scored by the learner/participant within a 15-20 minute time period.
- There are four discrete learning stages assessed by the 1985 version of the Kolb LSI. A learner will obtain a separate score in each of these categories: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE).
- The AE and RO scores represent assessment values of the learner's active-reflective preferences, and they may be plotted on the x-axis of a graph included in the Kolb LSI instrument package.

- The AC and CE scores represent assessment values of the learner's (abstract-concrete preference), and these scores may be plotted on the y-axis of a graph included in the Kolb LSI instrument package.
- Where the x-axis and y-axis values converge represents a single point that identifies each learner as a "diverger," an "assimilator," a "converger," or an "accommodator."

For this study, we researched and assessed a variety of learning style metrics including the Jackson Personality Inventory, revised (JPI-R, 1994), and we selected the Kolb LSI for the following reasons:

- Kolb's LSI was designed specifically to examine adults in learning environments;
- Kolb's LSI results can be used by both individual learners and learners working in groups;
- Kolb's LSI is readily and easily generalizable to a wide range of disciplines;
- Kolb's LSI offers benefits for learners, teachers, and researchers interested in breaking; down the barriers that separate many learners from traditional methods of instruction[12].

As engineering educators and researchers, we share two major goals: (1) to identify the learning styles and needs of engineering students, and (2) to disseminate this knowledge in a manner that promotes curricular modification to reflect these findings. The Kolb LSI, therefore, is a natural fit with our purposes.

Previous studies have attempted to assess the validity and reliability of the Kolb LSI (1984 modified version)[13], with varied degrees of success. One of the most extensive and detailed examinations of the Kolb LSI (1984) is reported by Philbin[14]. According to her research findings:

- Curry (1983) documented "an average test-retest reliability of .85 and an internal consistency of .69, and has concluded that the test-retest reliability and internal consistency of the LSI is adequate for its role in cognitive style assessment" ;
- Sims, Veres, Watson, and Bucker (1986) compared the original 1979 version of the Kolb measurement instrument with the modified 1985 version, and reported "that the internal consistency of the revised version had substantially improved although it still remained unstable across time";
- More recently, an assessment of the 1985 Kolb LSI conducted by Schmeck, Torrance, and Rockenstein (1988) comparing the Kolb LSI with other available metrics "indicated that the Kolb instrument, despite some criticisms related to construct validity was the most appropriate for the present study"[14].

These findings offer valuable insight into the applicability of findings based on the Kolb LSI (1985 version), and reinforce our selection to use this metric in our research.

Methodology

The high rate of attrition from engineering programs has been examined from many perspectives, and has included the development of predictive models using attitude assessment and other descriptive variables to identify engineering students at risk of attrition[15-17]. This type of

assessment is particularly important during the freshman year, as nearly half of all students who leave engineering programs do so during the first year. Based on these factors, our study is focused on attrition occurring during the first semester of the freshman year.

Many theories exist as to the reasons why students leave engineering programs, from lack of confidence or preparedness, to loss of interest in subject material. In, *Talking about Leaving: Why Undergraduates Leave the Sciences*, the third most common response by students as to reasons for their decision to leave science, mathematics, and engineering majors is related to faculty instructional styles[18]. A significant body of literature exists that supports this finding, and further links a discontinuity between course design/instruction and learning styles/personality types of students as a considerable factor contributing to student dissatisfaction in engineering majors[19-26]. The use of the Myers-Briggs Type Indicator to identify the most prevalent personality type among engineering majors, to link personality type to academic success, and to improve student performance through curriculum adjustment has been well documented in the literature[27-31]. Additionally, learning style preferences as indicated by the Kolb LSI have been used to redesign courses so that a broader range of students' needs are met. The incorporation of the Kolb cycle within the teaching methodology has been shown to greatly improve students' experience and performance in engineering courses, with a much greater satisfaction as demonstrated by course evaluations[32-35]. Even minor changes to course design based on student preference result in improved student performance. As stated by Larken-Hein and Budny, "The need to identify individual learning styles and/or personality type as a basis for providing responsive instruction has never been more important that it currently is. Instruction responsive to individual learning styles is especially critical as the pool of students who enroll in our classes continue to become more and more diverse."[36] Detailed examinations of these factors and their potentially correlational findings at the beginning of engineering study could help to provide a framework of factors related specifically to our own engineering programs.

In the first semester freshman course CIVL 1101, in the Department of Civil Engineering at The University of Memphis, students have been divided into teams based upon learning style preferences indicated by a modified version of the Kolb LSI for the past three years. The goal is to populate a team with members having a full range of learning style preferences. The existing data was examined, and preliminary results indicate that students leaving the program after the first semester of the freshman year have a significantly different score in one of the four Kolb areas. Because of the existing data suggesting that the Kolb LSI instrument may be a valuable predictive tool for identifying at-risk students at The University of Memphis, the goal of the current research is to expand the student base examined, and to determine whether or not this tool may be more broadly applicable.

In this pilot scale project, the study has been broadened to include all freshman engineering students at The University of Memphis and at Mercer University. The importance of evaluating the predictive capability of the Kolb LSI on a cross-institutional basis is underscored by literature cautioning that institutions need to evaluate attrition on an individual basis, and presenting findings concerning the differences found in engineering students based on the type of institution they choose to attend[37-39]. One study found differences in attitudes toward the engineering profession existed between students attending opposing types of institutions (public vs. private,

teaching vs. research, urban vs. rural, small vs. large)[40]. These attitudes were correlated to student success and retention.

The Kolb Learning Style Inventory (LSI) was used for this project to determine whether or not significant differences exist in scores between freshman who are retained in engineering, and those who are not. An evaluation will be made on the four individual scores comprising the Kolb index, rather than simply an analysis of preferred learning style. Statistical analysis of each of the four Kolb scores will be used in order to identify potential areas of difference between the two student groups (retained/not retained). Additionally, an exit survey was administered to students at the completion of the first semester, in order to attain data concerning reasons for students remaining or not remaining in the program. One-on-one interviews will be used with students who are leaving the engineering programs to further examine reasons for their departure. This data will be evaluated qualitatively in concert with LSI data to determine if it provides additional support of the learning style differences as significant contributing factors in attrition. Other researchers have underscored the importance of obtaining both the quantitative and qualitative data in order to develop a more accurate understanding of reasons for attrition[35].

The Kolb LSI identifies four different types of learners, or learning preferences. These distinct styles are labeled divergers, assimilators, convergers, and accommodators by Kolb. The assignation of a preferred learning style arises from a combined score for preferred modes of perception (concrete experience vs. abstract conceptualization) and preferred methods of processing (reflective observation vs. active experimentation). It is the score for each of these four perception and processing modes that is of interest in the current study. While an evaluation of assigned learning style will be made, it is considered to be of greater interest to evaluate the processing and perception modes individually, because of the possibility that a student may fall into a particular learning classification under a wide range of values. The theory for this project is that such an assessment would not adequately identify differences in students, as a student classified as a particular style learner could have either a “strong” or “weak” preference for that style. Students at opposite ends of this range would likely have significant differences in learning preferences in one or more of the perception/processing modes.

Preliminary analysis of data from the 2002 and 2003 civil engineering freshman classes at The University of Memphis indicates that a difference may exist in the preferred processing modes of the retained/not retained student groups. Students who continued in the program tended to have a more balanced use of the active experimentation and reflective observation (AE-RO) processing modes, while those who left the program tended to more strongly prefer the reflective observation mode. It is interesting to consider the design of the introductory freshman course in analyzing this trend, in that the course requires a considerable amount of active involvement/experimentation due to the nature of the three design projects that define the course. The preference for the abstract conceptualization versus concrete experience (AC-CE) modes appeared very similar between the two groups. This research will extend to the analysis of all four individual scores using a broader student data set, to determine whether or not there is truly a significant difference in preferred perception/processing modes between retained/not retained student groups, and to the correlation of qualitative data obtained from student surveys/interviews to the quantitative LSI data.

At this point in the project, the Fall 2004 civil engineering freshman class at The University of Memphis is the only group for which all data values for the Kolb LSI have been reported. Analysis of this group failed to determine a significant difference in means between the retained/not retained groups for the combined AC-CE or AE-RO processing modes, due to the large standard deviations. However, some differences can be identified in the individual perception/processing scores, although not at high levels of significance. The students in the retained group had a higher mean score for concrete experience, indicating a stronger preference for this mode ($p = 0.12$). Students in the not retained group had a slightly higher preference for reflective observation than did those in the retained group ($p = 0.16$). The results from the evaluation of the Fall 2004 civil engineering class are shown in Tables 1 and 2.

Table 1. Kolb LSI Results for Fall 2004 Freshman Civil Engineering, The University of Memphis.

Retained Group (n=27)		
	Mean Score	Standard Deviation
AC-CE	7.59	9.70
AE-RO	5.37	10.61
AC	31.52	6.76
CE	23.93	5.25
AE	34.96	6.69
RO	29.59	6.15

Table 2. Kolb LSI Results for Fall 2005 Freshman Civil Engineering, The University of Memphis.

Not Retained Group (n=18)		
	Mean Score	Standard Deviation
AC-CE	9.67	8.99
AE-RO	3.33	8.90
AC	31.39	6.27
CE	21.72	4.35
AE	35.22	5.58
RO	31.89	5.15

These results are not conclusive at this point due to the small number of students involved. The entire population of students being considered still needs to be evaluated. In addition, the students in the not retained groups will also be further subdivided into pass/fail groups to determine if any statistically significant differences can be determined from this subdivision of

the data. Once all of this data is available, it can then be evaluated with the qualitative data collected from exit surveys and personal interviews.

As stated previously, this project is a work-in-progress, and much of the data is currently in the analysis stage because the Spring 2005 semester did not begin until January 24, 2005, and it was impossible to track retention data before this point. Results from other departments (Mechanical Engineering and Electrical Engineering) along with results from Mercer will be analyzed, evaluated, and compared with existing results, and it is expected that the final results will be available in late May 2005. Ultimately, due to the deadline associated with this paper for inclusion in the 2005 ASEE National Conference Proceedings in conjunction with the vast amount of data in the process-stage, only these preliminary findings are reportable at this point. Full results will be included with the conference presentation, and while it is not possible to add these results retroactively to this particular paper, the authors will make this information readily available to anyone upon inquiry.

Conclusions

The high levels of attrition from engineering programs are of great concern to institutions and educators because of the declining number of engineers available to the workforce. It is of extreme importance to identify causes for attrition, and to develop intervention strategies so that students with unique abilities will not select out of programs due to the failure of the program to meet student needs. The goal of this research is to preliminarily determine the usefulness of the Kolb LSI instrument as a predictor of freshman attrition from engineering programs. If a significant link can be identified, the Kolb data could then be used in combination with other variables to develop a predictive model for determining at-risk students at an individual university. It is then anticipated that with these results, an assessment of teaching styles and curricular changes could be determined and/or suggested to draw closer links between the integral components of teaching and learning. It is also hoped through this study to establish whether or not institutional differences may be a deciding factor in the utility of the Kolb LSI as a predictive variable. This study is being performed at a pilot-scale level, and will need to be broadened significantly in order to more adequately assess the technique's value, and to eventually develop successful intervention strategies for at-risk students.

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