When They Stay and When They Don't: Examples of First Semester Retention Rates and Relationships to Learning Styles

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Abstract

Our research presents initial findings of a pilot-scale project performed at The Herff College of Engineering, The University of Memphis, in the 2004-2005 academic year. This project investigates the persistent issues surrounding difficulties in retention of first-semester engineering students and examines the possibilities of variances in student learning style differences as potential contributors to students leaving engineering programs. While the researchers acknowledge the limitations associated with a small sample due to research constraints in both time and funding, attempts to mitigate these issues were undertaken by the comparison of data from three separate programs of study: Civil Engineering, Electrical Engineering and Computer Science Engineering, and Mechanical Engineering. A mixed-methods approach was used consisting of pre/post semester surveys, distribution and analysis of Kolb's Learning Styles Inventory, and qualitative individual interviews with a sample of students who made the decision to leave engineering. Differences between retained and not retained student scores in one of the combined scores from the Kolb Learning Style Inventory were statistically significant for students majoring in Mechanical Engineering at The University of Memphis. Retained students had a stronger preference for abstract conceptualization, while students that were not retained preferred concrete experience. Future plans seek further examination of these findings through refinement of the study instruments combined with repeat data collection and expansion of the methodology to include data from three other engineering institutions in the 2005-2006 academic year.

Introduction

As engineering educators attempt to respond to the ever-changing technological and global issues associated with 21st century advances, statistical data relating to retention levels for 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] Multiple confirmations of these trends are verified by veritable sources including "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). Most recent is a report issued from the National Academy of Engineering Commission, "The Engineer of 2020: Visions of Engineering in the New Century-Part 1," (2004) and this report both confirms the previously mentioned studies and extends the focus to specific characteristics common to engineering students who choose to stay in engineering. [1, 5,6,7,8] 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 strategies for increasing student retention levels in the critical period between the introductory course in engineering and subsequent courses provides a means of coordinated response and accountability for engineering educators working in conjunction with students of the 21st century.

The issues associated with retaining engineering students have been examined from many perspectives, and have resulted in the development of quasi-experimental predictive models using attitude assessment and other descriptive variables to identify engineering students at risk of attrition[9-11]. In addition, multiple theories exist as to the reasons why students leave engineering programs including lack of confidence or preparedness and 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[12]. A significant body of literature supports this finding and notes a discontinuity between course design/instruction and learning styles/personality types of students as a contributing factor cited frequently that may result in student dissatisfaction in engineering majors.[13-20]

Another discrete issue associated with retention of first-semester engineering students is based on the point in the academic program where students most frequently make the decision to leave engineering. Research studies indicate that it is particularly important to provide any available interventional actions during the freshman year of engineering study, 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.

Project Summary

There are multiple research questions addressed in this pilot-scale project, all of which focus on the central issues of promoting and increasing 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 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?
- Can any comparisons be drawn between specific disciplines within engineering programs?

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 apply this model to a larger population in order to obtain more reliable data. The rationale for this research is a result of existing longitudinal data from an ongoing project in the Civil Engineering Department at The University of Memphis where a modified version of the Kolb Learning Style Inventory (LSI)[21] has been distributed to all first semester students beginning in 2001. 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. This study examines core findings from available data in conjunction with

new data obtained from a multi-disciplinary sample in order to determine if Kolb's learning style categories could be useful as predictors for at-risk students.

Kolb LSI Background

After review of relevant metrics and measurement instruments the Jackson Personality Inventory, revised (JPI-R, 1994), Myers-Briggs, and a new hybrid metric from Felder representing a combination of previous metrics weighted against an individual's previous academic background, and the Kolb LSI was selected based on 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 generalized 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[22].

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.

A brief review of the Kolb LSI is important in the distribution/interpretation processes of this metric. The Kolb LSI identifies four different types of learners, or learning preferences. To do this, Kolb suggests that there are four distinct styles, and they are labeled as "divergers", "assimilators", "convergers," and "accommodators". The designation of a preferred learning style results 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.

Previous studies have attempted to assess the validity and reliability of the Kolb LSI (1984 modified version)[23] with varied degrees of success. One of the most extensive and detailed examinations of the Kolb LSI (1984) is reported by Philbin[24]. 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"[24].

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

Methodology

Beginning with the Fall 2001 semester, all students enrolled in the introductory course in Civil Engineering (CIVL 1101: Measurements) at The University of Memphis completed individual slightly-modified versions of the Kolb LSI surveys during the first lab period. Based on the results, students were divided into semester-long project-based teams according to learning style preferences. Instructors of the course used the results to populate a team with members having a full range of learning style preferences. Analysis of compiled data from the 2001-2003 courses indicated possible differences between 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 this particular course (CIVL 1101) in analyzing this trend in that the course requires a considerable amount of active involvement/experimentation to complete three design projects within assigned groups limited by a 14-week semester period. Further analysis indicated that the preference for the abstract conceptualization versus concrete experience (AC-CE) modes appeared very similar between the two groups.

This research project extended the analysis to include all four individual scores using a broader student data set in order to determine whether or not there is an indication of a significant difference in preferred perception/processing modes between retained/not retained student groups. To do this, the project expanded the student base to incorporate all first-semester freshmen enrolled in introductory courses in Civil Engineering, Mechanical Engineering, and Electrical/Computer Engineering. In addition, with a goal to provide greater insight from students' perspectives, the methodology of the project also expanded to include pre/post survey instruments distributed on the first day of class and follow-up individual interviews with a sub-set of students who were not retained following the first semester. This mixed-method approach allowed the opportunity to use the data obtained as a result of the Kolb LSI findings and increase the reliability and validity of the findings through correlation and comparison from both quantitative and qualitative data.

Discipline-Specific Results

Kolb LSI surveys were administered to the all freshmen enrolled in introductory engineering courses during the Fall 2004 in Civil Engineering, Electrical and Computer Engineering, and Mechanical Engineering at The University of Memphis. Analysis of the Mechanical Engineering freshman scores revealed the most striking differences in scores between the retained and not retained groups. Table 1 presents a summary of the findings for each discipline, and discipline-specific interpretations follow.

Table 1. Kolb Learning Style Preference for Freshman Engineering Students (Spring 2005), University of Memphis.

Kolb LSI Type	*Civil Engineering*		*Mechanical Engineering*		*Electrical and Computer Engineering*	
	Retained	*Not Retained*	*Retained*	*Not Retained*	*Retained*	*Not Retained*
Diverging	18.5%	17%	10%	25%	17%	9%
Coverging	33%	33%	40%	37.5%	28%	9%
Accomodating	22%	11%	5%	25%	22%	27%
Assimilating	26%	39%	45%	12.5%	33%	55%

Quantitative Findings

Mechanical Engineering: Analysis of the Mechanical Engineering freshman scores at The University of Memphis revealed the most striking differences in scores between the retained and not retained groups. A total of 28 freshmen entered this program in the Fall of 2004. Of these 28 students, 20 (71%) were retained in the second semester (Spring 2005). A statistically significant difference in the AC-CE combined score ($p = 0.06$) and the AC individual score ($p = 0.05$) was observed in the data between the retained and not retained groups of mechanical engineering students. The students retained in the program had a higher score on both the AC-CE combined and individual AC score. The students retained also had a lower mean score for the CE value, but at a much lower level of significance ($p = 0.16$). These results suggest Mechanical Engineering students who are retained following the first semester of engineering education rely more on abstract conceptualization (thinking) than on concrete experience (experiencing). They also prefer reflective observation versus active experimentation.

Students not retained in this program tended to have a slightly stronger preference for concrete experience than for abstract conceptualization. The scores for this group also reflect a balanced preference for active experimentation versus reflective observation. These results are demonstrated in the kite diagram shown in Figure 1. Large standard deviations and the small sample size precluded the determination of any additional scores with a significant difference evident between the groups. The mean and standard deviations of each of the evaluated scores for the two groups of Mechanical students are shown in Figure 1.

Retained Group (n=20)		
	Mean Score	Std. Dev.
AC-CE	11.9	9.8
AE-RO	2.8	10.9
AC	33.5	7.5
CE	21.6	5.4
AE	33.9	6.6
RO	31.1	7.1

Not Retained Group (n=8)		
	Mean Score	Std. Dev.
AC-CE	2.9	11.6
AE-RO	6.9	12.5
AC	28.1	6.3
CE	25.3	6.4
AE	36.8	5.1
RO	29.9	8.1

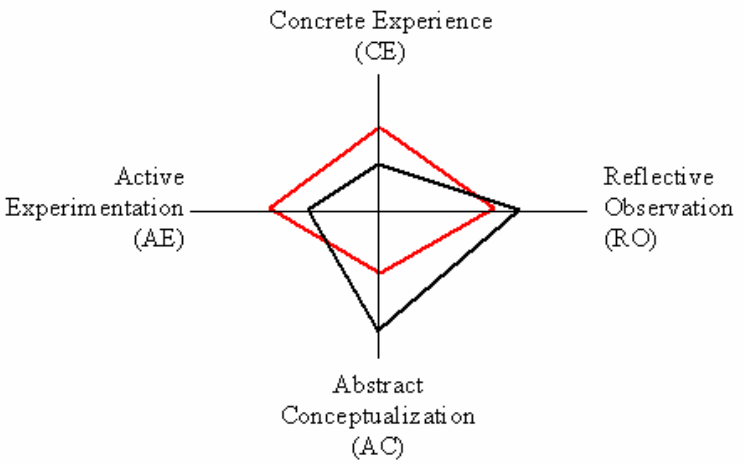

Figure 1. Kite Diagram of Learning Mode Preferences for Retained and Not-Retained Groups of Mechanical Engineering Freshman at The University of Memphis.

Civil Engineering: Analysis of the Civil Engineering group data failed to show a significant difference in means between the retained/not retained groups for the combined AC-CE or AE-RO processing modes, likely due to the large standard deviations and small sample sizes. A total of 45 freshmen entered this program in the Fall of 2004, and 27 (60%) were retained in the second semester (Spring 2005). 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 (CE), indicating a stronger preference for this mode ($p = 0.12$). Students in the not-retained group had a slightly higher preference for reflective observation (RO) than those in the retained group ($p = 0.16$). Thus, no similar trends from those observed in the Mechanical Engineering students were identified in this group.

Additional information was available for the Civil Engineering students that were not retained related to whether or not they passed the course. Of the 18 Civil students that left the program, 9 left due to failure of the first course, while the other 9 passed the course and elected to continue in another major area of study. It is interesting to note that the mean scores of the students that passed the course nearly mirrored that of the retained students, while those that failed the course showed slight trends similar to the not-retained group from Mechanical Engineering.

Electrical Engineering: Analysis of the Electrical and Computer Engineering student scores, like that for the Civil Engineering students, failed to determine a significant difference in means between the retained/not retained groups for the combined AC-CE or AE-RO processing. A total of 29 freshmen entered this program in the Fall of 2004, and 18 (62%) were retained in the second semester (Spring 2005).

Qualitative Instruments

As noted previously, all students enrolled in the introductory course in Civil Engineering at The University of Memphis have completed an Exit Survey at the completion of the first semester since 1999 for the purpose of obtaining narrative information regarding students' perceptions of the course and to provide information regarding students' future academic intentions. Data from the Fall 2004 Introductory Civil Engineering course was reviewed in concert with the LSI data to examine/provide additional information from individual students and with hopes of correlating this information to certain trends in the Kolb LSI findings for the same group. Unfortunately, only 55% of the surveys were returned for analysis and many surveys were incomplete, making correlational assumptions impossible.

However, some potentially useful narrative information was obtained from the surveys in unexpected areas. For example, of the 18 Civil Engineering students who were not retained for the Spring 2005 semester, 9 left due to failure of the first course, while the other 9 passed the course and elected to continue in another major area of study. Sample narrative excerpts from non-retained student respondents include the following comments in response to the question "How has CIVL 1101 influenced your decision to major in Civil Engineering?":

- "At this time, I have decided not to major in Civil Engineering. The class gave me an idea of what I would do as a civil engineer. I liked most parts of the class and may come back to in the future."
- "CE 1101 made me question whether I want to remain in Civil Engineering or not."
- "I no longer want to be a Civil Engineer."

Excerpts from students retained in Civil Engineering:

- "This course has reassured me that this is what I want to do with my life."
- "CIVL 1101 has shown me a few of the different areas of engineering. I now understand more about the field. My decision to major in civil engineering is not 100% final; however, I have enjoyed what we have done so far."

These excerpts may also yield potentially valuable information if engineering instructors are aware of possible cues or traits of students who may be unsatisfied or uncomfortable with engineering. Clearly, it is not possible to draw any substantive findings from narrative comments such as these, but they may serve as a red flag for further investigation.

Based on the premise that students cite varied reasons for making the decision to remain in engineering at the critical junction following completion of the first course, this study was proposed with the concept of personal interviews with all non-retained students to further explore reasons behind decisions to leave engineering. Unfortunately, due to the combination of the large number of non-retained engineering students at The University of Memphis and the complex organization required for two faculty members to locate former students and persuade

them to be interviewed, we were only able to conduct personal interviews with 6 of the 18 students who were not retained in the Civil Engineering program. This discipline was targeted due to the efficient organization of the course data and student records compared with other disciplines that were unable to collect Spring 2005 retention data until mid-semester.

The interviews provided critical information and more detailed explanations of reasons some students leave engineering. Of the 6 students interviewed, 4 cited poor preparation in math skills as a key factor in leaving the program, and 3 students cited poor preparation in both math skills and science skills including chemistry and physics preparation. Two students performed well in all of their first-semester courses yet reported that Civil Engineering was not what they had thought it would be; one had expected more emphasis on computer programming skills, and the other was interested more in the architectural aspects of engineering as opposed to the broad survey of major sub-disciplines covered in the existing course content.

Conclusions

As stated initially, high levels of attrition from engineering programs are of great concern to institutions and educators as we move into the 21st century. It is of extreme importance to identify causes for attrition, and to develop intervention strategies so that students with unique abilities will not choose to leave engineering programs due to misunderstandings and misconceptions related to both teaching and learning styles for students and educators. The goal of this research was to preliminarily determine the usefulness of the Kolb LSI instrument as a predictor of freshman attrition from engineering programs. It appears that the combined AC-CE score, and possibly the individual AC score may be a valuable predictor for Mechanical Engineering students at The University of Memphis. Several additional years of data must be collected, however, in order to determine if this is truly a trend for Mechanical Engineering students at this institution.

It is also important to continue to evaluate the other departments on a long-term basis so that any possible trends might be identified. 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. In addition, expansion of this study is essential in determination of if/how institutional differences may be involved.

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