Active Learning and Engineering Student Retention

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Abstract

This study investigates institutional student retention for engineering majors in a 4-year university setting. Student participant retention was tracked for engineering majors within the institution following enrollment in an introductory to engineering design graphics course that employed active learning sequences. Student retention data was compared to an institution baseline of engineering majors following enrollment in the engineering design graphics course where differences were examined. Notable student retention differences were identified through analysis of the institutional baseline data for participating students.

Introduction

Retention has been a standing issue among university engineering students for some time now. A three-year study of student interviews and enrollment patterns by Correll, Seymour and Hewitt (2003) reported that about 40 percent of those who enroll in engineering change their programs to non-science and non-technical majors. Ohland et al. (2008) reported that 57% of entering first-year students with engineering as their stated major persisted through their eighth semester, but 43% migrate to other disciplines or leave the institution. Numerous research studies have focused on factors that predict retention in engineering (Burtner, 2005; French, Immekus, & Oakes, 2005; Lackey, Lackey, Grady, & Davis, 2003. Takahira et al. (1998) found that the primary factors associated with retention in in engineering are academic success and grade point average.

Researchers have long been interested in understanding the reasons behind students' decisions to persist in college and to help institutions improve student retention and graduation rates (Hayden, 2017). Institutions can replicate best practices, such as building applied and meaningful experiences, that may be helpful in the recruitment and retention of students in engineering fields (Starobin, Jackson, & Laanan, 2013).

Methodology

As part of a curricula enhancement process within introductory engineering design graphics, ten active learning modules were created for the purposes of deepening understandings of technical graphic concepts that include, but are not limited to, the following: visual theory, annotation, and conventional practices. See Table 1 for specific topic areas and access links to individual modules.

Table 1. Active learning modules with access link

#	Module Topic	Access Link
1	Sketching and Text	https://connectingstem.org/alm_eg/index.php?topicNum=1
2	Engineering Geometry	https://connectingstem.org/alm_eg/index.php?topicNum=2
3	Orthographic Projection	https://connectingstem.org/alm_eg/index.php?topicNum=3
4	Pictorial Projection	https://connectingstem.org/alm_eg/index.php?topicNum=4
5	Working Drawings	https://connectingstem.org/alm_eg/index.php?topicNum=5
6	Dimensioning – Standards	https://connectingstem.org/alm_eg/index.php?topicNum=6
7	Dimensioning –Annotation	https://connectingstem.org/alm_eg/index.php?topicNum=7
8	Assemblies	https://connectingstem.org/alm_eg/index.php?topicNum=8
9	Section Views	https://connectingstem.org/alm_eg/index.php?topicNum=9
10	Auxiliary Views	https://connectingstem.org/alm_eg/index.php?topicNum=10

These modules were piloted during the Spring 2017 and Fall 2018 semesters at a major land grant institution in the southeast. The modules were implemented in a total of six sections per semester for a total of 634 undergraduate students participating in the study. Researchers gathered

data on the completion of each module for all participants within the study. Students that completed all modules during the designated semester were then compared to the students in non-participating introductory to engineering design graphics sections where students did not complete the active learning modules. The non-participating sections of students would later form an institutional baseline for retention.

Participating student enrollment and retention data, as well as non-participant student data, were requested and secured from the university's office of institutional research. Information on continued university enrollment and enrollment major were acquired. The institutional research data was secured one full academic year following enrollment in the introductory to engineering design graphics course. Data were analyzed to examine any differences in retention between the pilot participant students and the non-participating student sections. The study team also identified ten random student participants with at-risk indicators (grade point average of 2.9 or less and first-generation college student classification) to gather qualitative feedback on the use of the active learning modules. The ten one-on-one interviews were conducted lasting approximately 15 minutes each. Each interview was conducted by the same graduate assistant in a conference room or office on the university's campus and audio recorded for accuracy.

Findings

A two-sample analysis was conducted to determine the retention of active learning module project participants as compared to an institutional baseline of non-participating students enrolled in an introductory engineering design graphics course at the same institution. Table 2 compares the sample differences of the treatment and baseline groups and determined that the participating treatment group had a significantly higher retention rate than those non-participating student sections.

Table 2. 2017 - 2018 Student Retention

Diff.	Sample Diff.	Std. Err.	DF	T-Stat	P-Value
Treatment-Baseline	0.05	0.02	632	2.52	0.01

Student interviews offered insight into the use and effectiveness of the active learning materials. Analyses of the transcripts led to the formation of three categories of student responses. The ten participants collectively depicted the modules as either a "good supplement" assisting in deeper understanding of engineering graphics concepts, a good "review" to re-establish connections and reference points of real-world practices, or students "just click through" the modules to scan for material to assist in specific modeling applications.

Conclusions

Significant differences in student retention were identified between the sections implementing the active learning modules and the institutional baseline data. Students provided with supplemental active learning support remain enrolled within the university to a greater extent than those not afforded those opportunities. Based on analyses of the qualitative interviews, students see the active learning modules as a good way to review the material they have already learned and would like more quiz checkpoints added to assess their individual learning and increase overall student accountability. As a result, additional self-assessment measures have been incorporated into the software design and content (see Table 1).

Although it is not fully clear why student participants maintain enrollment at higher levels, plausible reasons are relevance of materials, initial support and success within freshman/sophomore level university education, or the chronological sequence of the modules being in alignment and positioning of course content. The active learning materials have now undergone further subject matter expert review and are planned to be field-tested at two institutions this upcoming academic year. The research team also plans to examine any differences in retention impacts on student groups with at-risk indicators. Additionally, introductory engineering design graphics course success will be analyzed to determine its viability as an indicator of engineering retention and persistence within at-risk populations.

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