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Does Student Satisfaction Equal Learning? A Differentiated Design Strategy for Course Improvement: Lessons Learned from Learning Outcomes and Grade Distribution

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Abstract

There has been an increasing need for qualified engineers worldwide, and yet even with expanding engineering programs, positions remain unfilled and projects suffer from lack of qualified engineers. Data suggest most students who began the pursuit of an engineering career failed to complete the required training and earn the credential. Studies have indicated this dropout rate had a high correlation to the students learning experiences, and this was exacerbated in programs designed for adult learners. A graduate program designed for adult learners at a large university in the southwest needed to undergo a program redesign and was chosen for this study. The researchers wanted to identify the key elements of adult student engagement and satisfaction, and develop an instructional design model to address these elements.

The mixed methods study is a Work in Progress (WIP) which utilized the three elements (social, teaching, and cognitive presences) of the Community of Inquiry as the theoretical lens. The study attempted to identify the relationship between satisfaction rates and the performance of students indicated by grades, learning objectives, and dropout rates. Course design components, which were the greatest predictor of student satisfaction in a blended course, were explored as well as the corresponding grade distribution. The satisfaction and grade distribution data of four courses were compared pre and post-treatment considering the inclusion of differentiated improvement elements. Rigorous statistical analysis could not be performed due to the large differences in sample sizes between the untreated and treated courses, but basic course satisfaction and performance data (grades) indicate there was no significant correlation between satisfaction and grades and in fact the overall satisfaction for the courses decreased, but the grade distribution skewed more positive in the treated courses.

Introduction

According to the American Society for Engineering Education, the cumulative median passing rate of engineering degrees was only 47% [1]. In 2018, thousands of students studied engineering courses comprised of technical abstract concepts requiring tangible applications [2]. Chen [3] found many students encountered a course which was poorly designed resulting in feelings of frustration, distress, and disinterest. Due to the poorly designed course, students were forced to focus on technology and navigation skills instead of the content [3, 4]. Student satisfaction was important since the quality and outcomes of a course were linked to these essential considerations [4].

The degree of student satisfaction directly correlated to the quality and effectiveness of learning measured in the outcomes of the course [6, 7]. Additional research demonstrated course design had the greatest impact on student satisfaction [3, 6, 8]. Courses should be structured with clarity, relevance, and student-centered elements [6, 9]. When using formative assessment for higher-level, critical inquiry decisions, such as exercises, navigation menus, and design; students should be part of the course evaluation process [4]. Recognizing Engineering as a field driven by results, finding the optimal solution remains the primary goal [6, 10].

Likewise, the quality and effectiveness of learning were measured in relation to the degree of satisfaction [5]. Given the research and the need for student learning efficiency in the program, efforts were focused on redesigning the course with the specific targets of navigation, content presentation, and chunking. These three points were identified as affecting the student experience in blended courses. Throughout this paper, the main focus was to investigate the effects of course design on student satisfaction and grade distribution through the Community of Inquiry Framework [11]. More specifically, the intention was to compare the effect of differentiated course design on student satisfaction and the achievement of learning outcomes as demonstrated by grade distribution.

While the population of the study was Energy Engineering students enrolled in an accelerated graduate program, the comparative factors between Energy and Biological and Agricultural Engineering were striking. The comparison was enhanced by the interdisciplinary facets of the curriculum and the faculty expertise offered by both degree programs. The two engineering programs were based in physical and biological science, as well as, mathematics. Conservation, environmental quality, clean and efficient energy, economics, multi-scale systems, and societal impact were studied in both programs [12, 13]. Lastly, the focus of this research study was placed upon the engineering curriculum, student satisfaction, and grade distribution; not one specific engineering field.

Course Treatment

The program administrators, working with faculty, identified four courses which were considered prime targets for change. The courses had been taught previously using Mediasite, a known software method for capturing lectures, with some support structure provided by the use of a learning management system. The program was uniquely designed to include a culmination of individual courses divided into 0.5 credit hour units. The units were assembled to create a full 3 credit hour course. The units may be taught by the same faculty member or different faculty members who can then contribute their specific experience to the particular course. While this approach was both student and faculty-centric, reducing faculty teaching load and providing the students with a learning experience which leverages specific faculty expertise was an intended outcome. This dynamic approach also presented design challenges. Course delivery inconsistences and uniformity of engagement represented the primary challenges. Another complicating layer in the process was the diversity of student’s backgrounds in the program. The program enrollment for this interdisciplinary engineering degree program was comprised of both students with engineering and non-engineering undergraduate degrees.

Student feedback surfaced representing the need for the redesign of the program courses. This feedback was used to identify the courses and examine the data under the lens of focused improvement.

Materials and Methods

A total of four courses were analyzed and received treatment. For these cases, the course treatment consisted of creating new course content, improving existing course content by implementing "chunking" of course content, and/or organizing the course content. The structure for course navigation was modified to improve the usability of the course for the current students.

The Energy Engineering survey instrument, a Likert-type instrument consisting of 18 questions spanning the three areas of cognitive, teaching, and social presences; was utilized for this study. Participants took 10 to 30 minutes to complete the survey. Researchers examined the construct validity of the instrument with exploratory and confirmatory factor analyses. The scale contained three factors representing the three presences: teaching (TP), social (SP), and cognitive (CP). The TP consisted of 10 items (Items 1, 4-8, 10, 12-13, 17). The SP consisted of 3 items (Items 3, 11, 16). The CP consisted of 5 items (Items 2, 9, 14-15, 18). The total variance was 67.63%. A confirmatory factor analysis was conducted as well. The fit index was $\chi^2/df=1.74$, RMSEA=0.071, CFI=0.98, NFI=0.96, and NNFI=0.98. The key to the instrument and the associated scoring method are listed below. Mean scores are calculated on a five-point basis: A=5, B=4, C=3, D=2, E=1.

A=Deserves an award in this area; excellent,
B=Very Good,
C=Good,
D=Does not perform well in this area,
E=Has serious deficiencies in this area which are detrimental to students.

Four factors were identified which had the potential to show improvement of satisfaction scores due to the course redesign. The noted factors of the EOC survey instrument were:

Response 12 (TP): the lectures were well organized, stimulating and up to date
Response 13 (TP): the objectives of the course were clearly stated and explained during the lectures
Response 15 (CP): the supplemental material was adequately detailed and positively contributed to the learning experience
Response 18 (CP): the scope of the material covered in the lectures was reasonable in the amount and reflected high standards.

The End of the Course (EOC) satisfaction surveys were administered to the same group of students in the redesigned courses, which were similar to the surveys administered before the course redesign. Individual responses of the satisfaction survey identified above were analyzed for specific efficacy in design. Grades were assumed an appropriate proxy for student learning and analysis of the grade distribution in the courses. The aggregate grade clusters were also examined as part of the work.

In addition to these data, homogeneous focus groups were employed consisting of students from the degree program. All the students and faculty in the program were invited to participate in the focus group. The instrument was created with five semi-structured open-ended questions and two probing prompts for questions four and five. Garrison's Community of Inquiry Theory was utilized as the framework for the associated questions. The questions reflected upon course design and the students' level of satisfaction in terms of the CoI's three presences: teaching, social, and cognitive. The questions were:

1. Considering the online engineering courses, what are the biggest issues, challenges facing students today?
2. How satisfied are you with the course?
3. What strategies do you believe were most effective for you?
4. Focusing on your engineering courses, what is different about them compared to the general classes?
   Prompt: Consider this as unique or different from the way you were learning in other courses. Any surprises?
5. If you had the opportunity to develop an engineering course, what course elements would you recommend be included or enhanced?
   Prompt: Would you recommend your current class? Why?

Results

The cohort of 25 graduate students, enrolled in the Energy Engineering blended master's degree program, were offered an opportunity to voluntarily participate in the study. The homogeneous, purposive sampling typically relied on a sample size related to saturation [14, 15]. The entire cohort population of graduate Energy Engineering students was included.

Table 1 shows the results of the student satisfaction surveys on the treated vs. the untreated courses.

Satisfaction Survey

Course	Condition	Survey Responses																		Satisfaction Survey Overall Mean
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
601-600 (2017)	Untreated	4.4	4.0	4.4	4.7	4.6	4.3	4.7	4.6	4.4	4.5	4.6	4.5	4.3	3.9	4.5	4.4	4.5	4.3	4.4
602-610 (2017)	Untreated	4.5	4.5	5.0	5.0	5.0	5.0	4.5	4.5	4.5	4.5	4.5	5.0	4.5	4.0	4.0	4.5	5.0	4.5	4.6
604-600 (2017)	Untreated	4.8	4.6	4.2	4.6	4.6	4.6	4.6	4.6	4.2	4.6	4.8	4.8	4.4	4.0	4.0	4.6	5.0	4.4	4.5
608-600 (2017)	Untreated	4.3	3.8	4.0	3.8	4.3	4.5	4.0	4.3	4.0	4.0	3.8	3.8	4.0	3.8	3.8	4.0	4.3	4.0	4.0
Community of Inquiry Presence		TP	CP	SP	TP	TP	TP	TP	TP	CP	TP	SP	TP	TP	CP	CP	SP	TP	CP	
Curriculum Component/Instructional Strategy													Lect	Obj	Txt	XM	Dis		Mat	
Mean		4.5	4.2	4.4	4.5	4.6	4.6	4.5	4.5	4.3	4.4	4.4	4.5	4.3	3.9	4.1	4.4	4.7	4.3	4.4
601-600 (2018)	Treated	4.4	4.6	4.1	4.4	4.3	4.4	4.4	4.1	4.4	4.3	4.4	4.0	4.1	3.4	4.1	4.6	4.4	4.4	4.3
602-600 (2018)	Treated	4.5	4.0	4.0	4.5	4.0	4.0	4.0	5.0	4.0	4.0	4.5	4.5	4.0	3.5	3.5	4.0	4.5	3.5	4.1
604-600 (2018)	Treated	4.0	3.5	3.0	4.0	4.0	4.0	3.5	4.0	3.5	4.0	4.0	3.5	3.5	3.0	4.0	4.0	4.5	4.0	3.8
608-600 (2018)	Treated	4.5	4.0	4.5	4.0	3.5	4.0	3.0	4.5	4.5	4.5	4.0	4.5	4.0	3.0	3.5	4.0	4.5	4.5	4.1
Community of Inquiry Presence		TP	CP	SP	TP	TP	TP	TP	TP	CP	TP	SP	TP	TP	CP	CP	SP	TP	CP	
Curriculum Component/Instructional Strategy													Lect	Obj	Txt	XM	Dis		Mat	
Mean		4.4	4.0	3.9	4.2	4.0	4.1	3.7	4.4	4.1	4.2	4.2	4.1	3.9	3.2	3.8	4.2	4.5	4.0	4.1

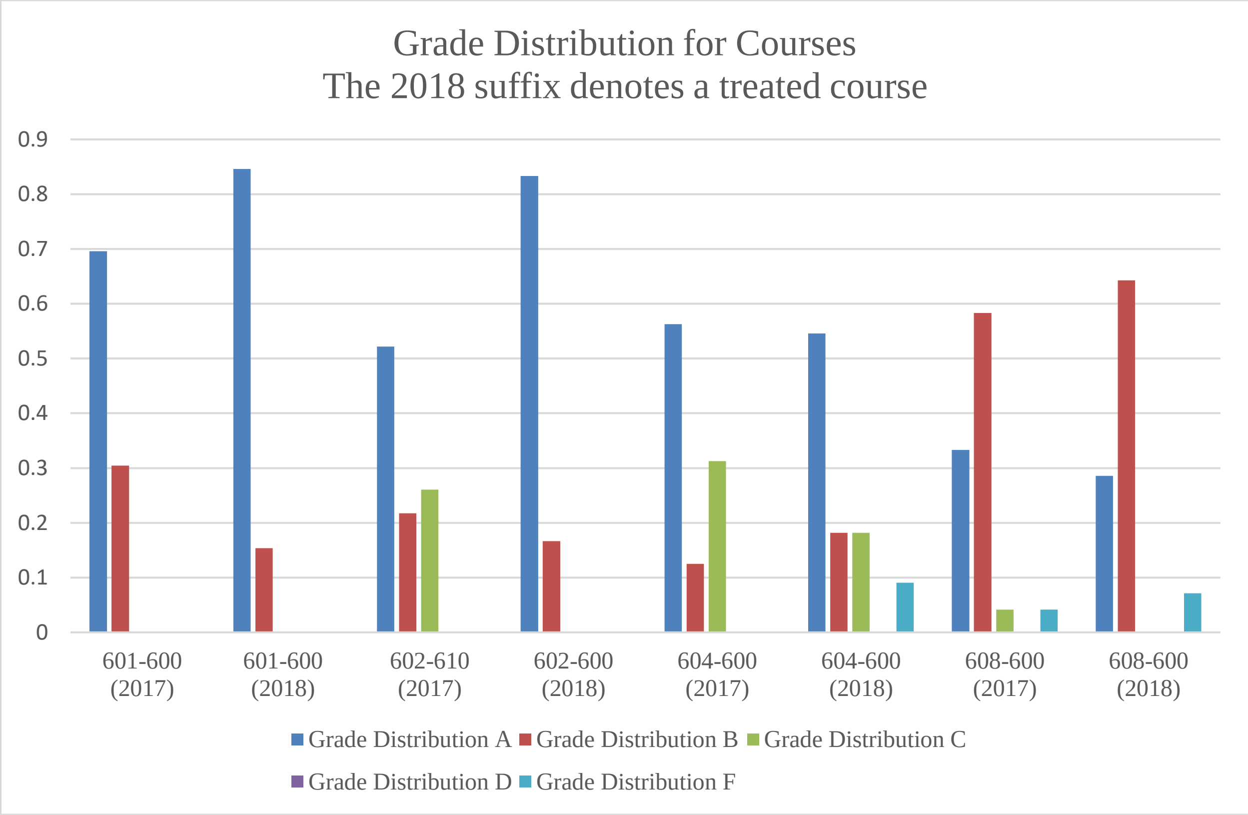
Survey Questions

1. Class Preparation: The class activities are well-prepared and organized.
2. Assignments: The examinations, assignments, projects, etc. aid me in achieving the class objectives.
3. Communications: The instructor clearly explains material so that I can understand it.
4. Responsiveness: The instructor is open to my questions, and effectively answers them.
5. Academic concern: The instructor seems to care that I learn this material.
6. Availability: The instructor willingly makes time to help other students and me.
7. Fairness in Grading: The instructor is fair and consistent in evaluating my performance in the course.
8. Environment: The instructor maintains a good learning environment for me.
9. The class format and learning environment were conducive to learning and maintaining the interest of students.
10. The course instructors were well prepared (presented material on the web, in class).
11. The course instructors were open to questions and effectively answered them.
12. The lectures were well organized, stimulating, and up-to-date.
13. The objectives of the course were clearly stated and explained during the lectures.
14. The textbook made a valuable contribution to the course.
15. The supplemental material was adequately detailed and positively contributed to the learning experience.
16. Students had the opportunity to have classroom discussions and express their opinions.
17. Please rate the extent of experience the instructor had at this course.
18. The scope of the material covered in the lectures was reasonable in amount and reflected high-standards.

Grade distribution across treated and untreated courses

Grade Data Chart

Course	Type	Condition	Grade Distribution					Mean	Median	Mode	Satisfaction Survey Overall Mean
			A	B	C	D	F	A=5, B=4, C=3, D=2, F=1			
601-600 (2017)	Engineering	Untreated	16	7	0	0	0	3.7	4.0	4.0	4.4
601-600 (2018)	Engineering	Treated	11	2	0	0	0	3.8	4.0	4.0	4.3
602-610 (2017)	Engineering	Untreated	12	5	6	0	0	3.3	4.0	4.0	4.6
602-600 (2018)	Engineering	Treated	10	2	0	0	0	3.8	4.0	4.0	4.1
604-600 (2017)	Engineering	Untreated	9	2	5	0	0	3.3	4.0	4.0	4.5
604-600 (2018)	Engineering	Treated	6	2	2	0	1	3.1	4.0	4.0	3.8
608-600 (2017)	Non-engineering	Untreated	8	14	1	0	1	3.2	3.0	3.0	4.0
608-600 (2018)	Non-engineering	Treated	4	9	0	0	1	3.1	4.0	4.0	4.1



Discussion

The Community of Inquiry (CoI) was selected and utilized as a theoretical lens for the research endeavor. Garrison realized a community enhanced the effectiveness of learning [11]. The model is comprised of three elements referenced as presences. The social presence (SP), cognitive presence (CP), and teaching presence (TP) [11] are the foundational components. The overlapping and fluid nature of the presences forms a unique dynamic for the learning environment.

With substantial empirical data in the literature, the CoI maintains a progressive reputation in all modes of learner-centered and active learning environments [8, 9, 11, 16]. The social presence is visible in group discussions, developing relationships, and collaborating in a safe environment [8]. Frequent feedback, open questioning, problem-based learning activities, and reflection form the core of instructional strategies [11, 16]. The cognitive presence builds upon the work of John Dewey. Learners receive stimuli in the form of a triggering event. Exploration follows with integration of learning components. The adult learner constructs meaning from the present learning experience as well as past experiences [8, 11, 16]. The learner then embraces solutions by implementing all factors [8, 11]. The teaching presence is a learner-centered approach [11]. The faculty and student are considered partners with shared responsibilities in the learning endeavor. The presence contains components of instructional design, course facilitation, and direct instruction [11, 16]. The model was selected due to the flexibility, reputation, and constructivist nature of the lens.

The CoI components were noted in the quantitative and qualitative data of this study. Although participants did not always use the same terms, the references were observable. Learners emphasized the importance of engagement found within the teaching presence. This recognition supported the current research literature concerning engagement. Communication with peers was highlighted; however interaction with the faculty member was valued at a higher level than student to student. The real world stories of the professors coupled with a deconstruction of decision-making processes added to the authenticity and value for the learner.

The analysis of the end of the semester satisfaction data does not indicate any improvement in the scores based on the design, nor the key factors which were identified in the focus group data. The data seemed to universally imply the satisfaction scores decreased as a result of the redesign. In an attempt to identify the decrease in potential satisfaction, the faculty and students were surveyed. The responses indicated, in numerous cases, the faculty changed the navigation for the course pathway or made other course changes at the last minute resulting in a sub-optimal experience. This element was supported by student data. Because of the large differences between the enrollment in the treated and untreated courses ranging from 17 to 30 students, any meaningful statistical analysis to examine the correlation among the satisfaction scores and the grades could not be performed. But when reviewing the grade distribution overall as an aggregate, the redesigned courses showed an overall improvement in grade distribution for at least 50% of the courses. The improvement was evidenced by a greater number of A's and B's. However, the failure rate remained static. This situation was reversed in two of the courses. Further investigation of the course data and faculty data were needed to ascertain the cause of the discrepancy.

Overall, given the small number of students in the program, this study provides a nascent look at the relationships between satisfaction and learning. More structured analysis is needed.

Conclusion

Garrison and Archer's Community of Inquiry theoretical framework [11, 16] was utilized as the theoretical lens for this study. The three essential elements for learning, social presence (SP), cognitive presence (CP), and teaching presence (TP), were clearly discernable in the study. The overlap of the three presences created a fluidity, which was well suited to a dynamic learning environment [17]. Student responses reinforced the research by identifying the same elements known to create student satisfaction. At times, the elements were defined into subcategories due to the appearance of the listed elements in the participants' responses and recall. Schedule flexibility, decisive feedback, discussions which build community, layered levels of inquiry assignments, and collaboration through peer-to-peer, as well as, instructor-to-student interaction were identified as course design attributes by the participants [18, 19]. A correlation between student satisfaction and grade distribution resulting from curriculum changes may or may not exist. The positive shift in grade distribution found in this study translated to higher class averages, but did not affect the failure rate. Due to the size of the study, the results cannot be generalized beyond this particular study at this time.

Future Work

In 2020, we look forward to continuing the research of this work in progress (WIP) utilizing differentiated design models for continuous improvement based upon further research and student feedback. Instructional and curriculum components which enhance the engagement and partnering with faculty could be studied further. Identification of particular course elements, the associated benefit to satisfaction, and grade distribution deserve further study with a stratified population. This transformation may reveal various results and trends from the diverse student groups beyond the Biological and Agricultural, as well as, Energy Engineering interdisciplinary fields. Further study of larger populations could increase the generalization factors and the associated applicability. The research and improvement model will provide greater insight for instructional design and enhanced learner-centered teaching strategies, as well as, increased engagement.

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