WIP: Assessment of Student Retention and Satisfaction in Computer Science Service Courses When Using Competency-Based Grading and Assignment Choice

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Abstract

Enrollment in introductory engineering courses, for non-Computer Science majors, often evokes apprehension, particularly when faced with the prospect of learning programming. The presence of peers with prior coding experience can further compound these concerns. This study, applicable to a broad spectrum of engineering service courses, centers on student assignment choice within an undergraduate CS-1 curriculum. Guided by Self Determination Theory, we implement assignment choice as a mechanism for students to chart a tailored path, selecting assignments aligned with course learning objectives. These choices are integrated into Canvas, the Learning Management System, and augmented with a course grade calculator, offering students a personalized course roadmap. This approach leverages students' internal motivation, be it intrinsic or extrinsic, by affording them the agency to customize their path through assignments, fostering a sense of ownership in their learning journey. By incorporating choice, the assignment set becomes more attuned to the diverse interests of the student body.

Building upon preliminary observations, this Work in Progress paper presents results from semesters where assignment choice was integrated, contrasting them with a new study using two courses, one being a control group. One group of 100 students will be taught using the traditional method, while a second group of 100 students will be instructed by the same professor utilizing the Assignment Choice method. We aim to demonstrate that the student populations in both control and experimental groups are statistically similar. Subsequently, we will assess whether there is a statistically significant difference, if any, between the control group and the experimental group. We have witnessed a notable reduction in the DFQ (earn a D, F, or withdraw from the course) rate in recent semesters, with a sample size of 200 students in the traditional course delivery compared to 300 students in the Assignment Choice delivery. This study paves the way for future investigations and enhancements. Our Research-to-Practice endeavor strives to develop a framework that enables instructors to ensure comprehensive coverage of course learning objectives, while still affording students a degree of assignment selection.

Anticipated outcomes from this research aim to furnish instructors with a robust framework that supports the dual objectives of student mastery of course content and successful course completion, thereby enabling them to progress in their chosen fields of study with confidence.

The findings of this study hold promise in revolutionizing pedagogical approaches, ultimately contributing to enhanced student satisfaction, retention, and academic success in computer science service courses.

Introduction

The purpose of this study is to examine the factors influencing success, satisfaction, and retention for students by focusing on assignment choice in a course using competency-based grading in undergraduate first-year Computer Science service courses. The project will build a framework using the Self Determination Theory[1] to provide students the means to expand on their success, autonomy, and belonging, providing a path to greater student success, satisfaction, and retention in Computer Science. The literature analysis[2] revealed several methods to examine that could lead to improved retention in Computer Science and STEM classes. Further, there is also a need to improve other areas of curriculum development to alter or improve retention, and therefore satisfaction and success, for students in service courses.

Students taking introductory Computer Science classes, especially those required to take a "coding class" for their non-Computer Science major, can often be very intimidated[3] by the thought of having to learn to program. Many students are often up against peers who have been coding or otherwise involved with computers before, particularly those underrepresented students in engineering (i.e., Hispanics, African Americans, and women).

Traditionally, for our students, grades are earned as letters ranging from A through F, and are calculated based on weighted averages using a 100-point scale across various categories (e.g., homework, projects, quizzes, exams). Traditional grading practices include point scales that attempt to be objective but do not provide sufficiently meaningful information regarding students' specific deficits associated with course content[4]. In other words, a student could objectively earn an "A," and still be lacking competency in critical skills[5]. Thus, traditional grading conventions of weighted averages across pre-specified criteria may not accurately reflect students' mastery of all core competencies.

Computer Science classes can encompass students from many different majors as more degree plans require a coding class. Coding does not always come easy for some of these students[6]. This project aims to utilize assignment choice and competency-based grading in an undergraduate introductory programming course (CS-1). Guided by the Self Determination Theory the author will conduct an exploratory mixed-methods study on implementing assignment choice as a means of students planning a path to meet the course learning objectives[7,8]. The choices in the curriculum will be fully integrated into Canvas, the Learning Management System, and the course grade calculator available to students. A customized course roadmap will be used for the students to visually plan their path through the assignments and to their individual path to success. This approach applies to students' own motivation, whether intrinsic or extrinsic.

Background

Our study delves into a comprehensive analysis of data spanning from 2012 to the present day. The initial five years of our dataset revealed a persistent trend within our CS-1 courses,

characterized by grade distributions predominantly falling within the mid-C range. Notably, this period witnessed an elevated frequency of students encountering challenges, with a higher-than-normal proportion failing to complete the course. Despite a subsequent change in the instructor, a marginal improvement in grades was observed; however, the outcomes remained below expectations. The previous course structure adheres to a traditional model that necessitates a 90% average for an A and relies predominantly on exams as the primary mode of assessment.

In response to the observed challenges and driven by the commitment to enhance student outcomes, a transformative shift was initiated in 2021. This marked the introduction of assignment choice, an innovative departure from the conventional course template. The assignment choice framework empowered students with the flexibility to select from designated groups of assignments, aligning with the overarching learning objectives of the course. This shift aimed to diversify the assessment approach and address historical concerns related to grade distributions and student success. Our exploration seeks to scrutinize the impact of this paradigm shift on student retention, satisfaction, and overall success in Computer Science service courses.

In response to initial skepticism surrounding the observed improvements following the transition to assignment choice methodology, we looked for empirical validation. Initially, when improvements were presented, attributions surfaced suggesting that the perceived advancement was merely a reflection of instructional prowess. To validate the impact of the new methodology, a refined approach was suggested. This involved the unprecedented step of having two simultaneous classes, one adhering to the traditional teaching methods and the other employing the assignment choice framework, taught by the same instructor. This unique design facilitated a direct comparison within the same semester, the same overall population of students, encompassing identical core assignments, labs, and teaching assistants.

This methodological adjustment will serve as a critical measure to control for potential confounding variables and isolate the influence of the instructional approach. By ensuring a consistent instructional environment, the subsequent data analysis will aim to illuminate the specific impact of the assignment choice methodology on student outcomes. This comparative study will serve to validate our observations and provide insight into the effectiveness of the suggested improvements. The outcomes of this carefully orchestrated dual-class approach should contribute significant depth and reliability to our ongoing exploration of the effects of instructional methods on student success and retention.

Methods

To systematically investigate the impact of instructional methods on student outcomes, two distinct classes were created and are currently being taught within the same semester, each adhering to different teaching methodologies. The first class, designated as the control group, followed the traditional teaching method. For this class, a dedicated syllabus was formulated, with all of the assignments required. All specific assignments were mandated, with the average grade across all components utilized for calculating the final course grade. This traditional class was scheduled at 9:10 am on Monday, Wednesday, and Friday (MWF).

In parallel, the experimental class, designated as the assignment choice group, was structured to incorporate the innovative assignment choice methodology. A separate syllabus was crafted for this class, wherein students were presented with a list of required core assignments. This core group of assignments met the minimum learning objectives for a student. Completing only the core assignments was both necessary and required to earn a C or above in the course. Next, a supplementary list of assignments was created, from which they could choose or skip to accumulate points towards their desired grades. This supplementary list described below, allowed students to focus on those additional subjects they were interested in.

A total of 1500 points worth of assignments were available, with only 1050 points needed for an A. The core set of assignments comprised 750 points, ensuring all students met the minimum learning requirements for a C. Importantly, each assignment category required a minimum of 70% mastery for inclusion in the overall total, preventing the selective completion of only easier components of a category.

This second set of assignments included:

- Weekly discussions, 13 different Computer Science topics spanning the entire semester.
- In-class participation, one to two activities per week in class, showing comprehension of the current topic.
- Technology Scavenger Hunt, looking for everyday items that contained computers.
- Coding Puzzles, a 5-week commitment to solve sets of challenging coding problems.
- JavaScript, adding functionality to one of the core assignments.
- A YouTube Teaching Channel, five teaching videos to teach back some of our core concepts.
- An optional Final Exam to show overall comprehension.

This meticulous design aimed at ensuring not only a comprehensive understanding but also mastery at a passing level. The experimental class, commencing at 10:20 am MWF and following the traditional class, sought to maximize the comparability of the two groups by maintaining identical room settings and similar time slots.

Both classes will undergo pre- and post-course evaluations using a survey, currently being validated[9] with the help of our Center for Teaching Excellence, measuring students' comfort levels and proficiency in Computer Science. Collaborating with faculty members, the survey is going through a validation process to ensure its reliability and effectiveness in capturing the desired outcomes.

Results

As of the current stage of this work-in-progress paper, key milestones in the study's execution have been achieved. The course has been initiated, and both the traditional and assignment choice syllabi have been fully implemented. Furthermore, the initial administration of the survey, a pivotal component of the research, has been completed for both classes. This survey, integral to

the validation process, was distributed not only to the student cohorts but also to a group of 14 Teaching Assistants (TAs) affiliated with the course.

The initial phase of data analysis focused on validating the survey's effectiveness and establishing the comparability of the two student groups[10]. Utilizing a standard statistical test, Multivariate Analysis of Variance (MANOVA), we ascertained that the two classes could be considered drawn from the same population, aligning with the study's methodological objective. Additionally, in comparing the TAs to the students, we observed statistically significant differences, confirming our expectations. The TAs, as anticipated, exhibited higher levels of proficiency and comfort with Computer Science, establishing a baseline for understanding the students' starting points in the course.

At this juncture, the analysis of end-of-course survey data and subsequent comparison between the traditional and assignment choice groups is pending. As the study unfolds, these results will form the cornerstone of our investigation, shedding light on the impact of instructional methodologies on student comfort, proficiency, and overall success in computer science service courses. The ongoing nature of this research underscores its dynamic character, with further insights and conclusive findings to be gleaned in subsequent analyses.

Discussion

As this work-in-progress paper concludes, it is crucial to acknowledge the ongoing nature of this study. The collection and analysis of the remaining data, including end-of-course survey results and other relevant metrics, remain integral to our comprehensive understanding of the impact of instructional methodologies on student outcomes in computer science service courses. This robust methodological approach aims to unveil nuanced insights into the comparative impact of traditional and assignment-choice teaching methods on student learning experiences, satisfaction, and overall success in Computer Science service courses.

The anticipated next steps involve meticulous data analysis to uncover nuanced insights into the comparative effectiveness of the traditional and assignment-choice teaching methods. After this analysis, our goal is to disseminate the results through publication, encompassing not only the empirical findings but also the validated survey and the framework implemented in this experimental approach. The potential for better results in the assignment choice method serves as a catalyst for the creation of a robust framework.

Looking ahead, the overarching objective is to develop a framework that empowers professors to design and implement service courses that are not only effective in imparting essential knowledge but also enhance student satisfaction and retention. The dynamic nature of this research signifies its transformative potential in reshaping pedagogical approaches, particularly in the context of diverse academic backgrounds and majors. By fostering an inclusive and engaging learning environment, we aspire to contribute meaningfully to the broader discourse on optimizing service courses and promoting the success of students across various disciplines. The culmination of this study is not just the culmination of a research project, but a stepping stone towards more effective and inclusive educational practices.

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