


LMC 4702 Research Thesis

The True Cost: An Analysis of Course Registration Patterns in the College of Sciences

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Abstract

In the United States, less than half of college students who enroll in a STEM program will graduate with a STEM degree (Chen 2013). Attrition rates are disproportionately high for marginalized students, leading to a homogenous STEM workforce (Simon et al. 2021). This study, completed at an R1 midsized southeastern university, investigates course registration patterns and student opinions to determine what factors contribute to students leaving STEM majors through the lens of the Deep Teaching model (Dewsbury 2019). Through survey and course enrollment data, we determined that 1) students feel overwhelmingly negative about textbook costs, 2) financially insecure students are significantly more likely to consider course material costs when registering for courses and 3) students add and drop courses for a wide variety of personal, course, and university level reasons. These results indicate that implementing Deep Teaching in the classroom, specifically focused on self-awareness and empathy, can increase retention in STEM and reduce attrition rates.

Introduction

The United States has long been established as a global leader in technological innovation and is currently ranked as the 3rd best country for innovation (WIPO 2021). The United States is also the global driver of life sciences research and home to many of the world's top Science, Technology, Engineering, and Mathematics (hereafter referred to as STEM) university programs (Stewart & Springs 2015, Morse & Castonguay 2021). Despite these statuses, STEM fields in the United States are plagued by a significant lack of diversity. According to the National Science Foundation, white men occupy more than half of scientist and engineering jobs, while underrepresented minorities (Defined as Black/African American, Hispanic/Latino, or Indigenous) occupy under 15 percent of these jobs (National Science Board 2018). The physician workforce is also majority white and male (AAMC 2021). This lack of diversity is the result of and continues to fuel systemic racism and sexism in the United States (Breland 2017, Simon et al. 2021).

Diversity in the STEM workforce is integral for society to progress, but attrition rates among marginalized students in STEM college programs remains high (Chen 2013). We propose an increased focus on professor empathy and self-awareness as one approach to increasing retention. This study, completed at a midsized southeastern R1 university, investigates retention in STEM by analyzing course registration patterns within the university's College of Sciences. Using the Empathy component of the Deep Teaching model (Dewsbury 2019), we developed survey and interview questions to better understand students' thought processes when looking at course material costs as well as registering, dropping and withdrawing from courses. In this study, "dropping" a course refers to un-enrolling in a course within the first week of the semester with no penalty or grade of "W" on the student's transcript. Withdrawing from a course refers to un-enrolling in a course after the first week of courses, resulting in a grade of "W" on the student's transcript. Based on current research, we hypothesize that students drop courses for a multitude of

reasons both personal and related to the course, and predict that marginalized students drop and withdraw from courses at a disproportionately high rate. We also predict that students prefer low-cost course materials, and consider the cost of course materials when registering for a course. Based on student responses, we plan to make recommendations at the classroom and department level to increase retention within the College of Sciences.

Theoretical Framework

The Deep Teaching model, first published by Bryan M. Dewsbury in 2019, is a higher education teaching model based on increasing retention in STEM among underrepresented students. Dewsbury advocates for seeing students as whole individuals, and focusing on “teaching *students* rather than teaching *science*” (Dewsbury 2019). The model contains five components: Self-awareness, Empathy, Classroom Climate, Pedagogy, and Network Leverage. For this study, we are primarily focused on Self-awareness and Empathy, and therefore will not go into detail about the latter three components of the model.

Dewsbury explains that to practice deep teaching, a professor must first start with self-awareness and then work their way through the remaining components. Self-awareness is defined as “the degree to which the instructor has an understanding of him or herself in the context of what they bring to the classroom” (Dewsbury 2019). This includes a professor’s ability to understand their own identities, privileges, and biases in relation to their students. As student populations become more diverse, it’s imperative that professors practice self-awareness to avoid negative interactions with students based on implicit biases or lack of experience with diverse classrooms (Sidelinger et al. 2016). Despite its importance, recognition of biases and privileges among privileged people remains uncommon (Starkey 2017). Dewsbury asserts that while simply having privileges is not problematic, being oblivious or defensive about the benefits of privilege can lead to hostile classroom environments and inhibit a professor’s ability to connect with their students.

Empathy, the next step in the Deep Teaching model, is defined as “the degree to which the instructor commiserates with the social context and authentically listens to the voices of their students” (Dewsbury 2019). Dewsbury describes empathy as occurring on a macro and micro level. At the macro level, professors can practice empathy by understanding the social context of different groups of students. For example, students who commute to class may have different needs than students living on campus. On the micro level, professors can practice empathy by making an effort to engage individually with students and utilize active learning strategies. Current research shows that teacher empathy increases students’ perception of success in the classroom (Bozkurt 2010).

Our study looks at how professor empathy and self-awareness affect students’ decisions when registering, dropping, and withdrawing from courses in order to increase retention in STEM.

Research shows that underrepresented minorities, women, first-generation students, and students coming from a low socio-economic background have higher attrition rates than their respective counterparts (Chen 2013). Marginalized students face systemic barriers that can hinder their sense of belonging in STEM classrooms, especially in non-diverse settings (Strayhorn et al. 2015, Rainey et al. 2018, Dancy et al. 2020). We know that students withdraw from courses for a multitude of reasons, and that deliberate inclusion efforts help increase students' success (Willging & Johnson 2009, van Bragt et al. 2011, Killpack & Melon 2017, Good et al. 2020). Still, the burden of inclusion in the classroom often falls disproportionately on underrepresented faculty (Jimenez et al. 2019). Therefore, it is important to further investigate the link between professor empathy and student withdrawal rates and encourage all professors to implement Deep Teaching in their classrooms.

While not explicitly mentioned in the Deep Teaching model, our study also proposes course affordability as a metric of professor self-awareness and empathy. Textbook costs have skyrocketed over the last several decades, and many students forgo purchasing course materials at the expense of their grades (Donoghue & Senack 2016). Students choose which and how many courses to register for based on textbook costs, and spend extensive time looking for cheaper or free versions of required materials (Donoghue & Senack 2016, Katz 2019). One approach to increasing affordability is the implementation of Open Education Resources (hereafter referred to as OER), which are free or low-cost course materials intended to replace traditional textbooks. Research on OER is fairly new, but evidence to date indicates that they do not hinder student success and are typically on par with the quality of traditional textbooks (Clinton & Khan 2019). Additionally, implementing OER can improve the grades of non-white and low-income students, and students generally perceive OER as useful (Colvard et al. 2018, Brandle et al. 2019, Lin & Tang 2017). While there is literature on the cost benefit and overall efficacy of OER, there is limited research on how course material costs impact the student-professor relationship. Thus, we've chosen to investigate students' perceptions of course material costs as it relates to professors' empathy and self-awareness.

The benefits of incorporating empathy into the classroom are well established, but there is some literature that asserts empathy may have harmful effects (e.g. Sachdev et al. 2020). Sachdev argues that excessive empathy may impede a professor's ability to critically grade students' work, or lead to special treatment for particular groups of students (Sachdev et al. 2020). However, this fear aligns more closely with excessive sympathy than empathy (Meyers et al. 2019). While sympathy may cause a professor to lower their standards, a professor acting with empathy will keep their standards high and instead remove the obstacles hindering student success (Meyers et al. 2019). Outside of the classroom, empathy burnout is a heavily documented phenomena. People experiencing burnout may feel over-extended and unsatisfied if their efforts are not reciprocated, and empathy burnout can lead to high turnover rates in the workforce (Toegel et al. 2013, Wilkinson et al. 2017). It's important to recognize that studies discussing empathy burnout do not

advocate against the effectiveness of empathy, but instead seek to implement boundaries to prevent burnout. This study recognizes the reality of empathy burnout, and does not intend to propose solutions beyond what is reasonable for a professor's wellbeing.

Based on the overall literature regarding STEM retention, our study is integral for several reasons. First, our study utilizes a new framework, the Deep Teaching model, to investigate the impact of student-professor dynamics on retention in STEM. This study will both validate and enhance the Deep Teaching model and increase its popularity in the classroom. Additionally, this study investigates relationships that have not been sufficiently studied yet, such as the impact of course material costs on student-professor relationships and the impact of empathy on course registration patterns.

Methods

Our data collection consisted of two parts: obtaining course enrollment data for core classes within the College of Sciences, and distributing a brief survey to all undergraduates in the College of Sciences.

Through a Request for Student Data application associated with IRB H21259, we obtained course enrollment data for 24 courses taught in the College of Sciences during the Fall 2021 semester. These courses included sections of Intro Physics I, Differential Calculus, Principles of Chemistry I & II, Organic Chemistry, Intro Biology I & II, Genetics, Ecology, Biostatistics, Human Anatomy, Microbiology, Cell and Molecular Biology, and Evolutionary Biology. We obtained the course roster for each class at five timestamps throughout the Fall 2021 semester and its registration period: 1) at the end of Phase I registration, 2) at the beginning of Phase II registration, 3) at the beginning of add/drop week, 4) at the end of add/drop week, and 5) after the withdrawal deadline. Figure 1 shows the timeline of this data collection. After deidentifying the data and exporting to Excel, we compared the rosters within each course to determine the level of churn – how many students dropped or withdrew from the course versus how many students remained enrolled. Additionally, we compared final course grades for students who registered late for a course versus on registering time to determine if there was a disadvantage to registering late.

In addition to collecting course enrollment data, we also distributed a brief survey via Qualtrics to all undergraduates in the College of Sciences during Week 3 of the Fall 2021 semester. The survey utilized 5-option Likert scale questions and free response questions to investigate student registration patterns, opinion of textbook costs, and satisfaction with instructor performance. Question 1 consisted of seven sub-questions, asking students to rank how likely they were to consider certain factors, such as degree requirements or average course GPA, when choosing which courses to register for. Question 2 was used to determine students' financial status and asked students to "check all that apply" to various statements about their financial wellbeing such as "Money is a concern for me" and "I work part-time". Question 3 consisted of six sub-questions,

asking students to rank how often they perform tasks such as looking for textbooks for free online or choosing a course with a free textbook. Question 4 consisted of seven sub-questions, asking students to rank how strongly they agreed with statements about their instructor relationships such as “I tend to build relationships with my professors”. Questions 6 and 7 asked students if they had ever made changes to their schedules after Phase 1 registration, and if they had ever withdrawn from a course. At the end of each question, there was an optional textbox for students to write in any other opinions they had that were not already expressed. The survey also collected demographic data including age, year in school, major, race, gender, and full or part-time status.

The survey, approved under IRB H21259, was distributed to 2110 undergraduate students with a response rate* of 9.3% (n=196). The Likert scale questions were converted to numerical data and analyzed in R using a Kruskal-Wallis test with an alpha value of 0.05 to determine significance. The free response questions were analyzed qualitatively in nVivo 12.0 to determine prevalent opinions among students. We developed a codebook for each free response question focused on common words, ideas, and perceptions in the responses.

*Response rate refers to students who completed 100% of the survey’s required questions and consented to their data being used in this study.

Results

The survey closed on Week 5 of the Fall 2021 semester and the data was de-identified and exported to Excel and R for analysis. We correlated the Likert scale responses to numerical values (i.e. the response “Strongly agree” was converted to “5” and the response “Strongly disagree” was converted to “1”) to run statistical analyses. Figure 2 shows the overall averages for each survey question. Using a nonparametric Kruskal-Wallis test with an alpha value of 0.05, we tested the average Likert scale response for each question against 5 demographics: race, gender, major, year, and financial status. The Kruskal-Wallis test returned significance for questions Q1.1 and Q3.2 (shown in figure 3) when comparing students’ financial status.

We used nVivo 12.0 to qualitatively code the free response questions from the survey. There were five optional free-response questions which yielded a range of 32-87 responses. Using the Select and Code tools, we developed a codebook of 5-7 codes for each free response question. Here, a code refers to a common idea or word seen across multiple student responses. Figure 4 shows the most prevalent themes for each question. Overall, students considered a variety of factors when registering for courses and had overwhelmingly negative feelings about textbook costs.

To analyze the course enrollment data for the introductory College of Science courses, we de-identified the data and imported it into Excel. Using the vLOOKUP function, we assigned each student an enrollment pattern that showed whether or not they were enrolled in the class at each of the 5 recorded timestamps. Figure 5 shows an example student registration pattern. We then grouped the patterns into two categories, Completed Course and Did Not Complete Course to run

a Chi-Square goodness of fit test. For the Chi-Square analysis, we grouped the courses by major to determine if certain majors had a higher rate of noncompletion. The Chi-Square analysis (Figure 6) returned a significant result (p -value = 0.003) and post-hoc tests determined that Biology Courses had a higher rate of churn than Chemistry courses (p value = 0.001).

Discussion

Overall, our findings are consistent with current research in two key ways. First, our study supports the idea that students feel negatively about rising textbook costs, and often resort to looking for free copies or not purchasing the required text. This is more pronounced among students from a lower socioeconomic status. Second, our study found that student registration patterns are determined by a myriad of factors at the personal, course, and institutional level. This supports the idea that there is not a simple solution to high attrition rates in STEM, but rather a need for an expansive restructuring of the system to help students succeed (Good et al. 2020).

In our survey, students of a lower socioeconomic status were significantly more likely (p value = 0.002) to consider the cost of course materials when deciding which courses to register for than their high socioeconomic status counterparts. When asked if textbook prices are fair, students overall disagreed (Likert average = 1.7) and were likely to try to find textbooks for free online (Likert average = 4.35). In the free response questions, some students described textbook costs as “a highway robbery” and “absurd” and expressed gratitude for professors who tried to mitigate these costs. Students also frequently mentioned homework platforms such as Wiley and Pearson as a point of frustration. Required homework access can add extra costs and may force a student to purchase a textbook they otherwise could have found for free. Future studies should deep-dive into student perceptions and outcomes of homework access codes and explore what free replacements currently exist.

Students looked at a variety of factors when choosing what courses to register for, as evidenced by the Likert scale and free response questions. These factors can be broken down into three categories: personal, course, and institution. At the personal level, students may factor in if they have friends in the course, how much they can balance with their extracurriculars, and personal troubles. At a course level, students may look at the course content, GPA, professor etc. At the institutional level, students consider their degree requirements, full-time status requirements for financial aid, and navigating registration holds and permits. Often, students consider multiple factors across the categories, suggesting that a multi-faceted approach is necessary to address high attrition rates.

Our course enrollment data collection showed that Biology courses had significantly higher rates of noncompletion than Chemistry courses. We speculate that many factors could contribute to this. The Biology major is less structured with less prerequisites, allowing students to drop courses while remaining on track to graduate. Future studies should look at the difference between Biology and Chemistry course structures to better understand this outcome.

Our study was limited by a small sample size and data collection limited to one school within the university. While this specificity is useful for identifying school-specific issues, further research needs to be conducted to determine national validity. Additionally, due to time limits not all of the data collected was analyzed and will be studied at a future date.

Conclusion

Our findings support wider implementation of the Deep Teaching model at the college level. With the rise in textbook costs and homework access codes, it's imperative for instructors to view their students as full people and meet them where they are financially. Utilizing Open Education Resources (OER) as an extension of empathy is one solution to help financially insecure students have more autonomy when registering for courses and relieve stress for students overall. Students' variety of reasons for adding, dropping, and withdrawing from courses also indicates a need for empathy in teaching. Because students are individuals and not a monolith, there is not one solution or policy that will help all students. Instead, approaching teaching with flexibility and empathy to address individual concerns can make students more confident and successful in their course. Finally, our research also indicates that registration changes are not necessarily negative and can reflect positive attributes of a program. For example, giving students the choice to drop a course and come back to it later without the threat of prerequisite registration holds or textbook costs is a positive. Further research needs to be conducted about the potential positives of the freedom to drop and add courses, and if this freedom reduces withdrawal and drop-out rates down the line. Overall, this study supports the idea that further implementation of the Deep Teaching model, specifically focused on empathy and reducing textbook costs, will help students succeed in STEM and reduce attrition rates.

Figures

Timestamp	(1)End of Phase 1 Registration	(2)Beginning of Phase II Registration	(3)Beginning of add/drop week	(4)End of add/drop week	(5)Withdrawal deadline
Date	05/21/2021	08/14/2021	08/23/2021	08/27/2021	10/30/2021
Definition	Registration phase that occurs towards the end of the Spring semester.	Registration phase that starts one week before the start of the Fall semester.	First week of classes, students can freely add and drop courses without receiving a W.	Last day that students can freely add and drop courses.	Last day to withdraw from a course and receive a W on transcript.

Figure 1: Explanation of Course Enrollment Data Collection Timeline. We obtained class roster data at each of the five timestamps to determine the level of “churn” - how many students add and drop courses throughout the registration period.

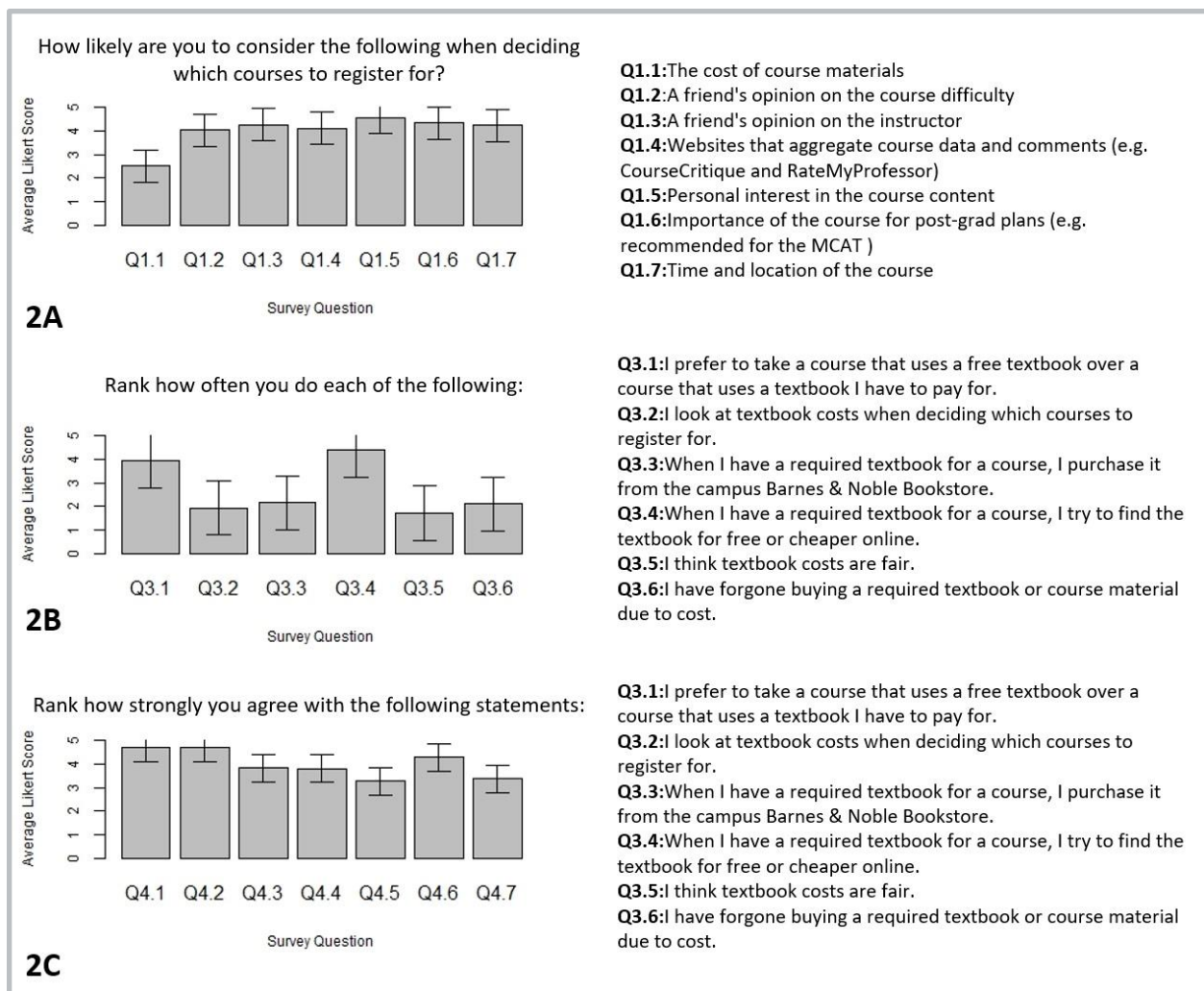


Figure 2: Average Scores for Likert Scale Survey Questions. 2A shows the average response (n=196) to questions Q1.1-Q1.7 where a “5” corresponds to “Very likely” and a “1” corresponds to “Very unlikely”. 2B shows the average response (n=196) to questions Q3.1-Q3.6 where a “5” corresponds to “Always” and a “1” corresponds to “Never”. 2C shows the average response (n=196) to questions Q4.1-4.7 where a “5” corresponds to “Strongly agree” and a “1” corresponds to “Strongly disagree”.

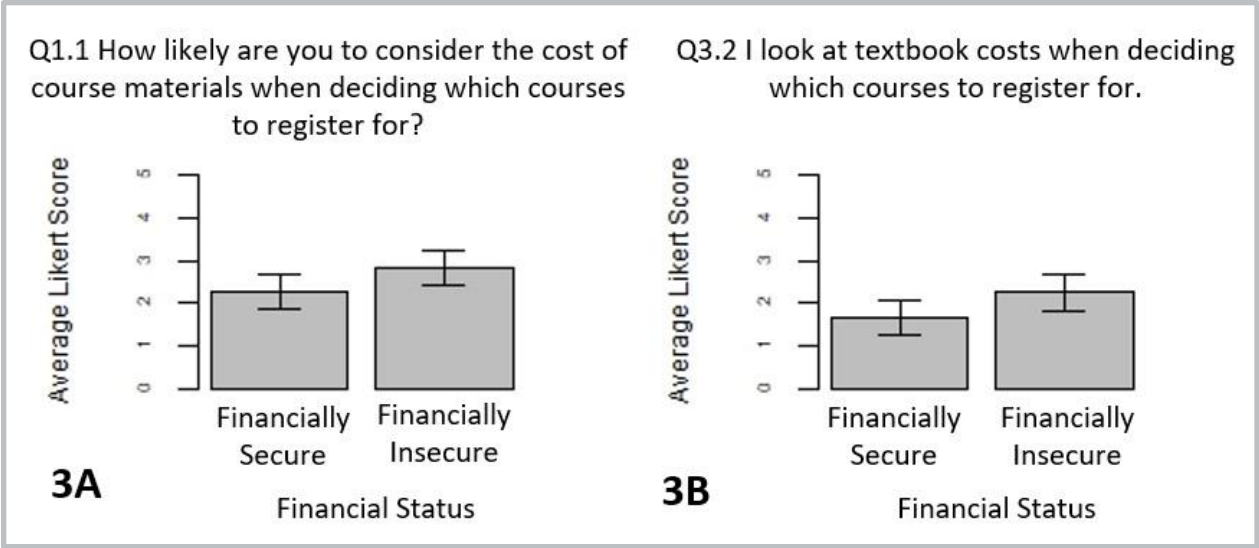


Figure 3: Survey Significance When Comparing Financial Security. When comparing Likert scale averages across Race, Gender, Year, Major, and Financial Status, only the last category returned significance. For questions Q1.1 ($\alpha = 0.003$, $p = 0.002$) and Q3.2 ($\alpha = 0.003$, $p = 0.0005$), financially insecure students were significantly more likely to look at course material costs when deciding which courses to register for. For Figure 3A, a “5” corresponds to “Very likely” and a “1” corresponds to “Very Unlikely”. For Figure 3B, a “5” corresponds to “Always” and a “1” corresponds to “Never”.

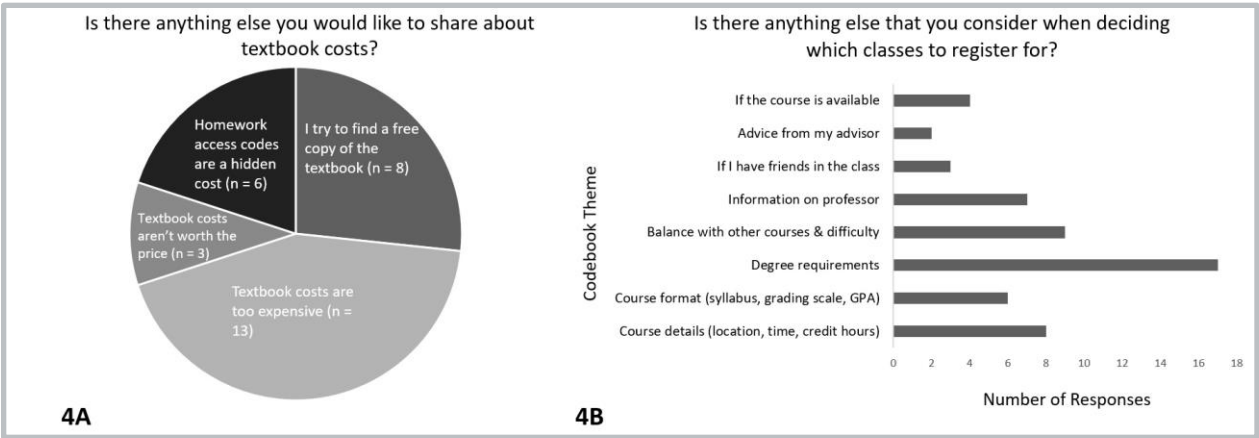


Figure 4: Free Response Major Themes. Using nVivo 12.0, free response questions were coded based on common themes and phrasing among responses. Here, the number of responses is not equal to the number of codes because some responses contained more than one major theme.

Timestamp	5/21/2021	8/14/2021	8/23/2021	8/27/2021	10/30/2021	Enrollment Pattern
Enrollment	0	0	1	1	1	00111, Complete

Figure 5: Example of a student registration pattern. This example pattern shows that the student registered for the course during Timestamp 3 (beginning of add/drop week) and remained in the course past the withdrawal deadline. The pattern for this student is 00111, Completed Course.

Post-Hoc Comparison	p-value
BIOS vs CHEM	*0.0012244323
BIOS vs MATH	0.017351655
BIOS vs PHYS	0.016845509
CHEM vs MATH	*0.0037186400
CHEM vs PHYS	*0.0036139201
MATH vs PHYS	0.055213446

Figure 6: Chi-Square Analysis for Course Enrollment Data. We grouped each course by its major affiliation (Biology, Chemistry, Math, or Physics) and performed a Chi-Square goodness of fit test based on the expected and observed rates of completion. The test returned a significant result ($\alpha = 0.05$, $p = 0.0027$) and post-hoc tests returned significantly different rates of completion between Biology and Chemistry ($\alpha = 0.008$, $p = 0.001$), Chemistry and Math ($\alpha = 0.008$, $p = 0.004$), and Chemistry and Physics ($\alpha = 0.008$, $p = 0.004$).

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