STUDYING AND HELP-SEEKING BEHAVIORS:

PREPARATION FOR CALCULUS

STUDENTS

By

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Title of Study: STUDYING AND HELP-SEEKING BEHAVIORS: PREPARATION FOR CALCULUS STUDENTS

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Abstract: Historically, there have been differences in mathematics students' overall course performance based on their placement information, particularly in Preparation for Calculus. This study explores differences in studying and help-seeking behaviors of students from fall 2019 sections of Preparation for Calculus. Special attention is given to students' placement information and whether or not they were a member of a corequisite section of this course. The results of this study show that having effective learning strategies, visiting the university's walk-in math tutoring center, and attending class are positively correlated with increases in overall course grade.

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CHAPTER I

INTRODUCTION

I.1 Motivation

For the 2018-2019 academic year at Oklahoma State University (OSU), 25.1% of students who took College Algebra at OSU before Preparation for Calculus received a final grade of D or F or withdrew (DFW rate) from the course (Francisco, 2019). In contrast, transfer students who had taken College Algebra elsewhere had a DFW rate of 60.2% (Francisco, 2019). This raises concerns of transfer students being less prepared than continuing students, despite having successfully completed a prerequisite course which has been deemed as holding equivalent credit. This disparity prompted me to consider differences between transfer students, students who had taken College Algebra at OSU, and students who qualified for Preparation for Calculus through a placement exam.

The readiness of transfer students going into Preparation for Calculus at Oklahoma State University depends largely on the institution where students took College Algebra, what material was covered and emphasized in the course, and to what extend that coverage is comparable to College Algebra at OSU. However, some transfer students still perform well in Preparation for Calculus despite potential deficits resulting from their College Algebra experiences. Oklahoma has made efforts to align the content of College Algebra courses across the state through the Course Equivalency Project (Oklahoma State Regents for Higher Education). While this project has contributed to solutions, differences between institutions will always exist. This study does not investigate the details of transfer students' College Algebra experiences, because the OSU mathematics department has little control over this variable. Rather, I will focus on commonalities among transfer students who were successful in Preparation for Calculus in order to inform how to better support future transfer students in being successful.

It is possible that successful mathematics students are studying or interacting with resources differently than unsuccessful students. There are many free university-based resources available to mathematics students to help them be successful in their math courses. At OSU, these include instructor office hours, the Mathematics Learning Success Center (MLSC) for walk-in mathematics help, and the tutoring center. For Preparation for Calculus, as well as all lower-division mathematics courses at OSU, instructors are required to hold at least one of their weekly office hours in the MLSC. Additionally, it may be possible that successful students are practicing more effective studying strategies than unsuccessful students. Possible differences may be present in students' notetaking habits, time management, and dedication to understanding material rather than memorizing procedures. An objective of this study was to investigate which behaviors more successful students implemented.

I.2 Overview and Research Questions

There were multiple overall goals which informed the structure of my study. First, I aimed to identify which help-seeking and studying behaviors students enact. Additionally, I wanted to model the impact that these behaviors have on class performance. Looking at which studying and help-seeking behaviors are positively correlated with overall course performance could provide evidence for what may make specific groups of student more successful in Preparation for Calculus. Instructors or course coordinators could make students aware of these strategies that could raise their overall grades, especially if they are in a group which historically does not do as well in the course. Hence, the following research questions guided this study:

1. What are the help-seeking and studying behaviors of Preparation for Calculus students?
    a. What are the similarities and differences in behaviors of continuing students, placed students, and transfer students?
    b. What are the similarities and differences in behaviors of students in corequisite sections and students in traditional sections?
    c. How do students' help-seeking and studying behaviors impact their success in Preparation for Calculus?

CHAPTER II

REVIEW OF LITERATURE

In the following sections, I describe findings from current literature on help-seeking, studying strategies, and learning strategies. I also describe findings concerning corequisite instruction and transfer students.

II.1 Help-seeking

The process of seeking help involves a student deciding that they need help, deciding where to seek help and how, and acting on this decision. Studies have been conducted looking at students' help-seeking based on various factors. Thus, various factors are present at each of these stages that may either encourage or discourage students from seeking the help they need if they are able to identify that the need it. Zusho, Karabenick, Bonney, and Sims (2007) point out that seeking help is not only a matter of students self-regulating their learning, but also involves social interactions and thus pressures from external social influences.

First, students' decision that they need help is more complex than a student not knowing how to solve a math problem. Metacognition, the "conscious control over one's *cognitive* processes" (Nilsen, 2013, p. 5), impacts students' ability to recognize when they do not actually understand something. Multiple studies have found that students who are not metacognitively self-aware are less likely to seek help because they do not recognize their own deficiencies (Zusho & Barnett, 2011; Tricot & Boubée, 2013). Tricot and Boubée (2013) claim that these students “they think they are more skilled than they really are, and they tend to estimate their performance as above average (when asked to compare themselves with peers)” (p. 25). Moreover, facing failure may be more devastating to these students, as they were not expecting to fail. At OSU in particular, students’ GPAs after their first semester at OSU tend to be lower than their unweighted high school GPAs. For example, a student with a 3.5 GPA in high school has an average GPA of 2.89 after their first semester at OSU (Martindale, 2020). This decrease in performance may be surprising to students, and even demotivating. This may be discouraging to both traditional freshmen and freshman transfer students who completed college-level math via concurrent enrollment.

Zusho et al. (2007) identify four types of goals relating to student achievement; they characterize performance-approach goals as being motivated by wanting to appear superior to others, performance-avoidance goals as being motivated by not wanting to appear inferior to others, mastery-approach goals as being motivated by wanting to understand material, and mastery-avoidance goals as being motivated by avoiding misunderstanding material. These goals can influence students’ actions as well as their success. Zusho et al. found that mastery-approach goals were the type of goals students most identified with among the four, and that “students who adopt ‘approach’ goals generally do better than students who adopt ‘avoidance’ goals” (p. 626). Moreover, they found that “college students who report a focus on not looking incompetent relative to others have higher levels of anxiety, and lower levels of both interest and achievement” (Zusho et al., 2007, p. 624).

Students’ goals and motivation influence the type of help they aim to receive, and the goals of the student must match the help provided in order for the help to be perceived as useful. Makara and Karabenick (2013) claim that “[s]tudents may judge the quality of a source by factors such as whether the source provides help at a level easily understood, how quickly help is given … or whether help is sufficiently scaffolded” (p. 12).

Zusho and Barnett (2011) conducted a study predicting students' help-seeking in English and mathematics classes based on their responses to survey questions measuring their beliefs about learning and learning strategies. Their overall conclusions were that students who both used strategies to acknowledge their metacognition and did not procrastination were more likely to seek help when they needed it; moreover, performance-avoidance goals most strongly predicted help-seeking avoidance (Zusho & Barnett, 2011). One interpretation of this result is that students need to be able to both recognize that they need help and do so soon enough that they have time to seek help. Moreover, students who have negative perceptions of seeking help or believe that others will think negatively of them for seeking help will not seek help because of these social pressures.

Makara and Karabenick (2013) developed a framework for categorizing different help-seeking sources. This divides sources into categories of formal versus informal, personal versus impersonal, mediated versus face-to-face, and dynamic versus static. Although types of help-seeking sources have changed slightly since then, this is still a decent starting point for distinguishing between types of help sources. Makara and Karabenick (2013) point out that "[p]ersonal informal academic sources were generally considered to be more accessible in the past than formal sources, and college learners in particular were especially likely to solicit help from informal sources" (p. 14), and also that "impersonal sources may be perceived as more available and accessible than are personal sources, but the expected type and value of the help may differ" (p. 15). Thus, distinguishing between help-seeking sources and assessing students motivations for where they choose to seek help is a bit complicated.

One roadblock to seeking help identified by several studies is students' perceived help-seeking cost-to-benefit ratio (Tricot & Boubée, 2013; Zusho et al., 2007; Maraka & Karabenick, 2013). Simply stated, if students perceive seeking help as having little reward (e.g. information received) but high social cost (e.g. embarrassment), then they will not seek help. However, if students perceive the results of seeking help as outweighing the social cost of seeking help, they are more likely to seek help. If students are metacognitively self-aware enough to recognize that they need help, the stigma around seeking help may still prevent them from asking for the help that they need. Along with concerns of their peers' perceptions, students may also fear that their instructor will have a negative perception of them for seeking help.

Makara and Karabenick (2013) assessed the cost-to-benefit ratio of seeking help specifically in the context of students' goals and motivation for seeking help. This takes into account expectations about the availability and accessibility of the help, as well as the quality of the help and whether or not it matches up with the student's goal for seeking help (Makara & Karabenick, 2013). For example, a student who only wishes to get answers may consult a solution bank or someone who has already completed the work and will share answers, whereas a student who desires to learn to do the work on their own may consult a tutor or instructor to learn solution strategies.

II.2 Studying and Learning Strategies

Researchers have examined improving students' study skills and metacognition. Cook, Kennedy, and McGuire (2013) implemented an intervention in which they taught college chemistry students about Bloom's taxonomy and the study cycle to improve students' metacognition. The students in the study showed improvement as a result of this intervention, and the conclusion was that "college students who do not have the requisite learning strategies to succeed in general chemistry can be taught these strategies in as little as 50 min," the time taken to complete the intervention (p. 965). Although this study specifically focused on chemistry students, the results may extend to students in mathematics as well. Finally, Cook et al. (2013) claim their results support that "when students are provided with concrete strategies, such as using the Study Cycle and working homework problems without using an example as a guide, they find it easy to begin implementing new behaviors to reach the higher levels of learning required to do well in general chemistry" (p. 966). Zhao, Wardeska, McGuire, and Cook (2014) found similar results in that teaching chemistry students about levels of thinking, the study cycle, and effective learning strategies improved class performance. Both studies reported students' recognition that they needed higher-order thinking skills, reflected by higher levels in Bloom's taxonomy, than they needed in high school in order to be successful in college (Cook et al., 2013; Zhao et al., 2014).

I emphasize that although these studies were conducted with chemistry students as their populations, the results can still be meaningful for improving the learning of mathematics students. Whatever is determined to help students be more successful needs to be presented to students in such a way that they have concrete strategies to follow. Moreover, metacognition is an essential component in a student recognizing that they are in need of help, so improving students' metacognition in the form of studying and learning strategies may have an influence on students' help-seeking as well.

II.3 Corequisite Instruction

Corequisite instruction is a relatively new model of supplemental instruction. For the mathematics courses at OSU for which corequisite instruction is an option, classes typically meet three times a week (Monday, Wednesday, and Friday) for a lecture with their instructor, with two additional days (Tuesday and Thursday) being led by an undergraduate peer learning assistant. Students are typically placed in a corequisite section of a mathematics course if they score slightly below the required placement exam score to get into a traditional section of the course; these range from five to ten points below the required score depending on the course. The activities of students in corequisite sections differ across courses, but typically involve extra exposure to course material and collaboration opportunities. This allows students to be exposed to their mathematics material every day while also providing them additional support and review of prerequisite material as need rather than requiring students to take part in remediation prior to the course. Traditional remediation, to be completed before students complete their credit-bearing required courses, both prolongs the amount of time to graduation and decreases retention to graduation rates (Logue et al., 2019; Pennamon, 2019). However, corequisite instruction provides additional assistance for specific topics as they come up in the curriculum and does not delay students' ability to enroll in credit-bearing courses.

Because corequisite instruction is such a new model, literature on it is sparse. However, benefits from corequisite instruction are already being documented. For example, students who take corequisite courses for their required credits have higher overall grades than students who participated in traditional remediation before their required credits (Kashyap & Mathew, 2017; Pennamon, 2019). Moreover, Logue et al. (2019) followed corequisite students in the years after their corequisite instruction and found that they were more likely to graduate than students who had had traditional remediation. Although these positive effects of corequisite instruction have been acknowledged, they provide little insight into why this model is more successful than traditional remediation.

II.4 Transfer Students

Cook, Kennedy, and McGuire (2013) underline the concern about the success of transfer students because these students "tend to do less well academically than those who are not transfer students" (p. 965). Studies by Lopez and Jones (2016) and Jackson and Laanan (2014) emphasize the importance of STEM curriculum at community colleges lining up with the curriculum at the university level it terms of both content and rigor. Both studies looked at factors that influence transfer students' academic adjustment to a university environment when transferring from community college to university, particularly in STEM subject areas. Lopez and Jones (2016) concluded that “the more that students visit and approach instructors after class, discuss career plans, and ask advice about class projects at both the community college and university, the more likely they are to adjust better academically in a university” (p. 176). In contrast, Jackson and Laanan (2014) found that transfer students having a negative academic adjustment period at university will revert to contacting the faculty at their former community college, and “community college transfer students who visited with university faculty to discuss their career plans and visit with them informally and briefly after class were more likely to experience challenges adjusting academically,” (p. 142) but they attribute this finding to the possibility of students only reaching out to faculty when they are struggling academically.

Lopez and Jones (2016) also found that the “negative perception held by the university of transfer students was a positive predictor of a poor academic adjustment” (p. 176). Similarly, Jackson and Laanan (2014) claim that “the more community college transfer students view faculty at the university as easy to approach, accessible, and interested in their academic development, the more likely they are to have a positive academic adjustment to the university” (p. 142). Additionally, Zusho et al. (2007) found that “college students in classes that, collectively, perceived their teachers as more supportive were more likely to have questions, less inhibited to ask them, and thus more likely to ask questions when necessary” (p. 647). This highlights the importance of instructors encouraging positive communication about class performance and universities projecting positive views about assimilating transfer students into the university, as this may positively influence transfer students’ academic adjustment and help them to be more successful at the university.

Although instructors should be mindful of positively interacting with all students, it is also important to foster a supportive community with students within the classroom. In interviews with transfer students, Townsend (1993) found that “some students were reluctant to ask questions in class, not because they feared the *faculty* would find their questions ‘dumb’ or inappropriate but because they were afraid *fellow students* would view them in this way" (p. 4, my emphasis). Townsend (1993) also had several students report that "the competitive nature of the university made students reluctant to help one another academically" (p. 4). The course serving as the focus of my study, Preparation for Calculus, had many collaborative opportunities built into the curricular materials. For example, once per week students had a group work assignment on which they collaborated with one other classmate. Additionally, lecture notes often included questions labeled as 'Your Turn' problems, where the intention was for student to briefly collaborate during the lecture to test their understanding of the material that had just been presented to them. Although these aspects of the course foster collaboration, it is up to individual instructors to encourage positive interactions among students, and to build a classroom environment in which the students are comfortable with asking questions, expressing confusion, or openly making mistakes. This is beneficial to not only transfer students, but all students.

CHAPTER III

METHODOLOGY

III.1 Overview

To address the questions of what specific studying and help-seeking behaviors different groups of student implement and gain insight into why students enacted those behaviors, I used an *explanatory* mixed-methods research design under a postpositivist paradigm. Creswell and Plano Clark (2007) (citing Slife and Williams, 1995) describe the role of researchers operating under a postpositivist paradigm as making "claims for knowledge based on (a) determinism or cause-and-effect thinking; (b) reductionism, by narrowing and focusing on select variables to interrelate; (c) detailed observations and measures of variables; and (d) 1" (p. 22). They also describe the purpose of explanatory designs as those in which "the results of the first method (qualitative) can help develop or inform the second method (quantitative)" (p. 75). The first phase of the study consisted of collection of quantitative data, the analysis of which informed my selection of participants for interviews and the questions that the students were asked during the interviews. In particular, I used what these authors describe as the *Explanatory Design–participant selection model* because I used the results from the first, qualitative phase of the experiment "to purposefully select participants to best address the quantitative research question[s]" (Creswell & Plano Clark, 2007, p. 86). The purpose of these interviews was to gain insight into why students might make certain decision in seeking or avoiding seeking help in Preparation for Calculus, but not to make generalizations to larger groups of students, as there is not enough data to support such a generalization.

III.2 Participants

Study participants were students enrolled in MATH 1813: "Preparation for Calculus" at Oklahoma State University in fall 2019. Preparation for Calculus is a highly coordinated course, with the course coordinator providing lecture notes for instructors to use and all students were assigned the same group work, written homework, and online homework assignments.

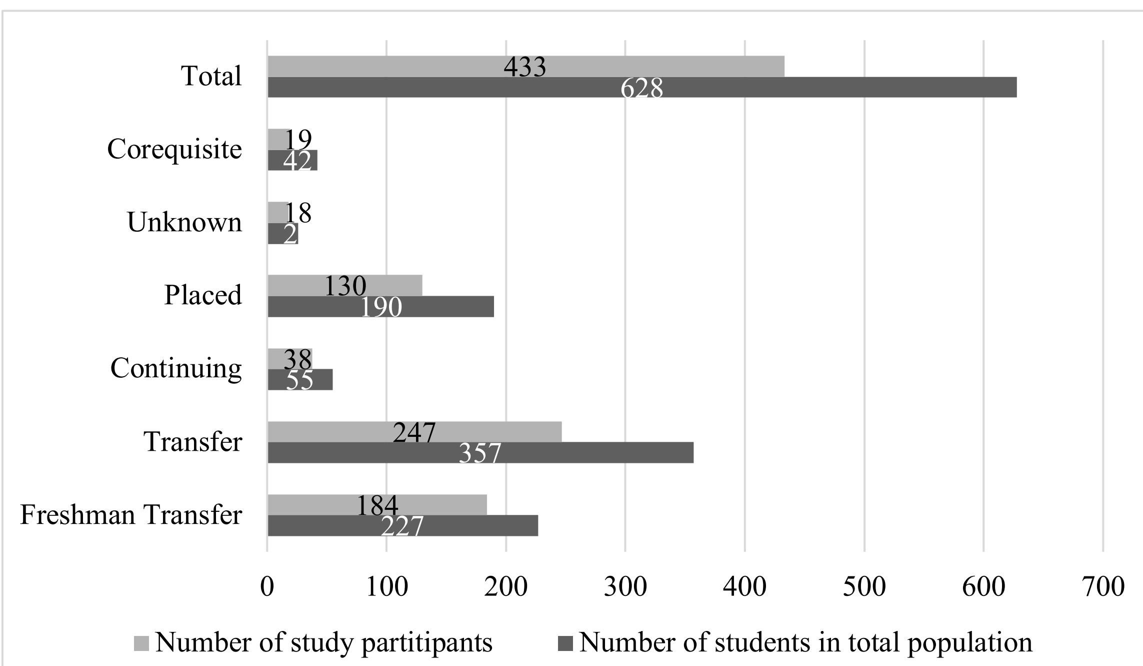
The total population of Preparation for Calculus students included 628 students. There were two corequisite sections, one online section, and 16 traditional sections of the course. Of these students, 357 (56.85%) had transfer credit for College Algebra from another institution, 55 (8.76%) had taken College Algebra at OSU, 6 (0.96%) had test-based College Algebra credit, 184 (29.30%) were placed in the course through the ALEKS placement exam, and 26 (4.14%) students did not have data pertaining to how they were placed in Preparation for Calculus. With students from multiple placement categories, 42 (6.69%) were enrolled in the corequisite sections. Because students who had received test-based College Algebra credit had to take an exam to place into Preparation for Calculus, I considered these students to be in the same category as those who took a placement exam and will henceforth refer to those 190 students as being *placed* in Preparation for Calculus.

Of the 42 corequisite students, 8 had transfer College Algebra credit, 25 were placed in the course, and 9 had unknown placement information; moreover, 39 of these students were freshmen and 3 were sophomores. Notably, there were 227 transfer students who were classified as freshmen. Given the possibility that these students may have received College Algebra credit through a high school concurrent enrollment program, and thus may be more motivated students, I decided to look at freshman transfer students as well as the total population of transfer students in my analysis.

Of the 628 students enrolled in Preparation for Calculus, 466 students (74.2%) completed the survey component of this study and 433 of those students (68.5% of the total population) consented for their data to be used in this study. These participants included 38 (8.78%) continuing students, 247 (57.04%) transfer students, 130 (30.02%) students who were placed in Preparation for Calculus, and 18 (4.16%) students with unknown placement information. Moreover, 19 (4.39%) corequisite students participated in the study; these students had a slightly different composition than the total population of corequisite students, with no continuing students, 12 placed students, 2 transfer students, and 5 students with unknown placement information. The survey participants had a slightly higher, but comparable, final average grade compared the total population of students; the average final grade for students who did not withdraw was 75.71% for all students, 77.53% for study participants, and 70.78% for nonparticipants. The comparison of the survey participants and all students enrolled in Preparation for Calculus in fall 2019 are given in Figure 1.

Figure 1

Categories of Preparation for Calculus Students and Study Participants



III.3 Procedure

Students were sent a link to complete an online survey during the week of their second exam, and the survey was available for eight days. An incentive of extra credit equivalent to one group work score (an addition of 1.25% to the overall course grade) was offered for fully completing the survey. The receipt of extra credit was contingent on answering every survey item, while it was emphasized to students that they need not consent for their data to be used in this study, nor did they need to consent to be contacted for a follow-up interview. As a result, I did not have much missing data to account for in survey responses, as all but 8 students (98.15%) who consented for me to use their data answered every item on the survey.

I received general demographic data for survey participants from the university's Institutional Research and Information Management department. This consists of gender, ethnicity, classification, age, high school math GPA, ACT math subscore, ALEKS placement exam score, final letter grade for College Algebra, midterm letter grade for Preparation for Calculus, how students were placed into Preparation for Calculus, and (for transfer students) the institution most recently attended prior to OSU. The Preparation for Calculus course coordinator provided me with records for class attendance, office hour attendance, final letter grades, and numerical final grades. The director of the MLSC provided records for students' walk-in tutoring at the MLSC and tutoring by appointment at the tutoring center.

During this semester, the grading scale was curved so that 88.5% and higher was an A, 78.5-88.49 was a B, 68.5-78.49 was a C, 58.5-68.49 was a D, and Below 58.5 was an F. For this study, office hour data includes students' visits to instructors' set office hours as well as appointments set up between students and their instructor. The data for tutoring by appointments came from the university's tutoring center and does not include appointments students may have made with independent tutors outside of the tutoring center. Students' visits to the MLSC were documented by them signing in and out of the MLSC at every visit using their student ID cards, which is required of all students visiting the MLSC. Instructors were in charge of recording students' class attendance and office hour attendance, and at the end of the semester I was provided numbers for how many classes students were absent from and how many visits they had to office hours.

Some sections of Preparation for Calculus met three days per week, while other sections met two days per week. As such, the students who attended class twice a week had a lower number of total class visits, despite having the same face-to-face time with their instructors. To remedy this inconsistency, I converted numbers for number of absences into the percentage of total classes attended based on the sections that students were enrolled in. There was one online section of the course which had 24 participants in the study, making up 5.54% of the total population. Since online students do not physically attend class, I replaced their missing data for class attendance with 88.17%, which was the average attendance across all sections for students who participated in the study and did not withdraw from the course (attendance data for withdrawn students was not kept consistently across sections, with some instructors halting attendance data after students withdrew and others counting them as absent for the remainder of the semester after they withdrew).

For most students, I was able to determine whether students were placed in Preparation for Calculus from one of the following options: a placement exam or test-based College Algebra (placed), passed College Algebra at another institution (transfer), or received College Algebra credit at OSU (continuing). For those students who had both transfer College Algebra credit and placed into Preparation for Calculus by taking the ALEKS placement exam, I considered those to be transfer students as they had had exposure to college mathematics outside of OSU before taking Preparation for Calculus at OSU.

To measure prior math ability, I obtained ACT math subscores, ALEKS placement exam scores, high school math GPAs, and/or College Algebra letter grades for every student. I had ACT math subscores for 375 of the students, which was a majority, so I took this to be the baseline for measuring prior math ability. For those students who did not have ACT math subscores, I converted one of the other measures into ACT math subscores using the scale in Appendix A. The parenthesized numbers in the table indicate how many students had scores that used that conversion, and these are ordered by the precedence that these scores took in the conversions.

For converting ALEKS placement exam scores to ACT math subscores, I used a conversion scale developed by Dr. R. Adam Molnar, which is shown in the first two columns of the table in Appendix A. This scale incorporated data from Des Moines Area Community College (2016), Purdue University Department of Mathematics (2014), UNLV Department of Mathematical Sciences (2018), and The College Board (2018). For letter grade conversions, I calculated the average ACT math subscore for each letter grade based on those students for whom I had both pieces of data. I used the same process for converting GPAs to ACT math subscores.

III.4 Survey

The purpose of the component survey was to gain insight into how students seek help, where they prefer to seek help, their learning and studying strategies, and their motivations for seeking help or not. First, students were asked to rank various help-seeking sources in the order of most preferred to least preferred (Appendix B). The categories this question was inspired by the framework for distinguishing among help-seeking sources by Makara and Karabenick (2013). Students had the following to choose from in the ranking: contact your instructor (online or in person), work with a classmate outside of class (online or in person), reference the textbook, watch online help videos (such as Khan Academy or YouTube), use online homework solution banks (such as Chegg), ask a tutor for help, ask someone who is not your instructor, classmate, or a tutor for help. I decided to condense online communication and in-person communication, as well as not distinguishing between different types of non-face-to-face communication, because I was more concerned with who or where students sought help from and less concerned with the specific form that that help took.

The ranking question was used to compare/contrast individual students' preferred sources of seeking help with their actual sources of seeking help and was included in the survey primarily for selecting interviewees. For the help sources from the ranking question for which I did not have documented numerical data, students self-reported how many times per week they usually sought help from those sources; additionally, students gave the average number of hours they thought they spent studying and doing homework per week (Appendix B).

The survey had 14 questions over effective learning strategies using the scales by Zhao, Wardeska, McGuire, and Cook (2014), with permission from the third author (Appendix C). The first 9 items were not altered from the original scales, but the last 5 items were originally one question. This adaptation of including only one studying resource per question was made to investigate at the different ways students study, specifically for exams, in the context of the resources provided to them by instructors. Specific resources available to this group of students to study for exams included exam study guides, answers to study guide questions, videos posted on the MLSC website working through the study guides, and exams from the previous semester. During the entire semester, students had access to an online textbook, lecture videos by the course coordinator for every lesson, and solutions posted for every written assignment after their due dates. Additionally, responses were changed from being on a 4-point Likert scale – 'almost never,' 'sometimes,' 'usually,' 'always' – to a 3-point Likert scale: 'most of the time,' 'about half the time,' 'rarely.' I saw the initial language used for the scale as potentially being viewed as vague by students, and thought that the adaptation provided a clearer linear transition between the choices.

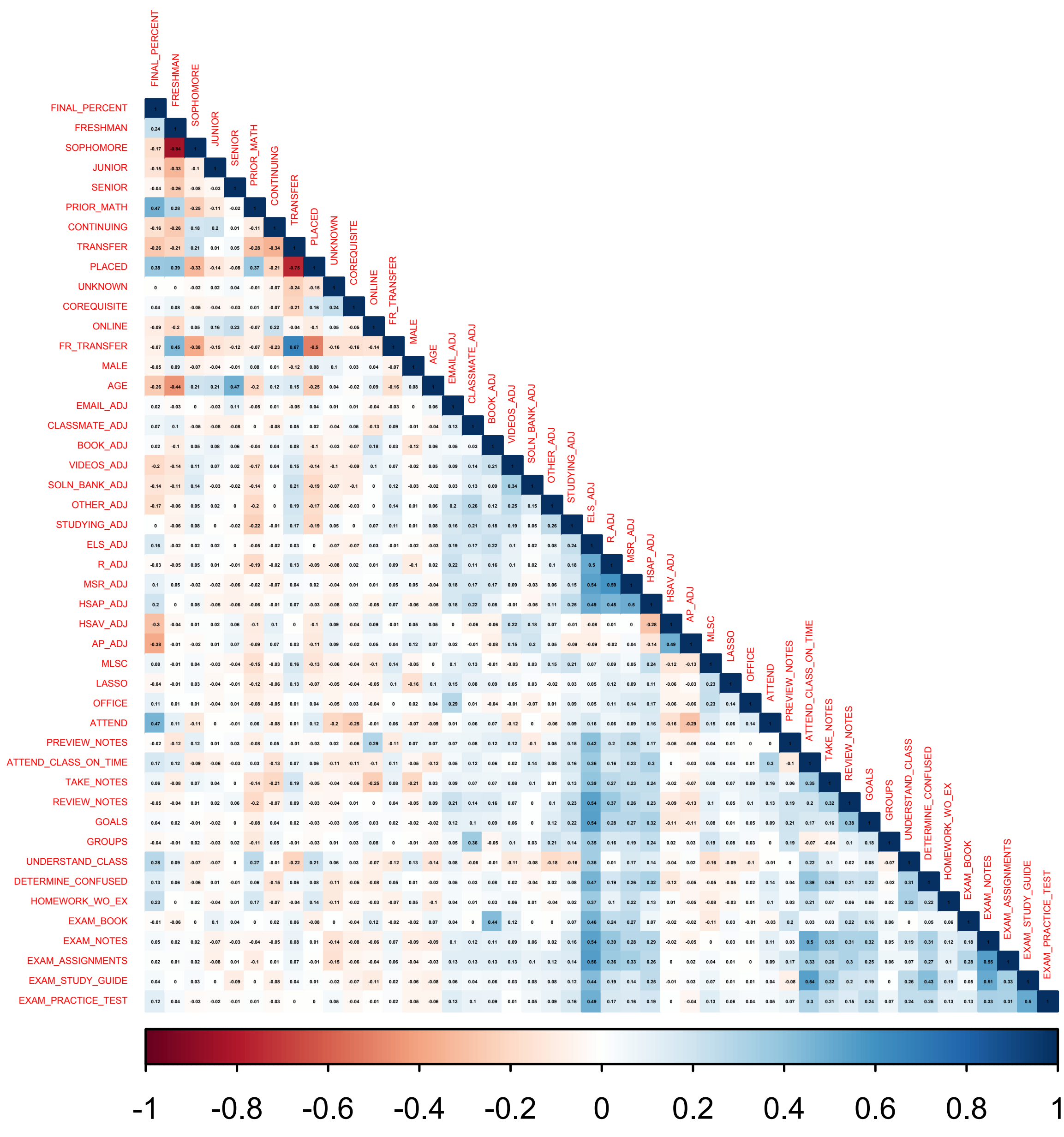
Students were given 16 questions about their beliefs on their own studying and help-seeking, selected from the scales used by Zusho and Barnett (2011) and used with permission of the authors (Appendix D). The original questions were on a 7-point Likert scale from 'strongly disagree' to 'strongly agree,' but I adapted these to only be on a 4-point Likert scale. I removed the ‘neutral’ option from the Likert scale in the hope that participants who had conflicting feelings on their agreeance would consider their responses more deeply as a result of being required to choose a side. I also eliminated the intermediate options of ‘agree’ and ‘disagree’ because I felt that only offering students the options of ‘somewhat’ and ‘strongly dis/agreeing was enough to capture students’ attachment to a particular view. The questions each fell into one of five categories: rehearsal, metacognitive self-regulation, help-seeking approach, help-seeking avoidance, and academic procrastination. I am using help-seeking approach and avoidance to mean students’ affinity for actively seeking help and actively avoiding seeking help, respectively. Metacognitive self-regulation is a combination of two different, though not mutually exclusive, constructs. Nilson (2013) asserts “metacognition involves self-feedback on one’s learning” (p. 5), whereas “self-regulation encompasses the monitoring and managing of one’s cognitive processes as well as the awareness and control over one’s emotions, motivation, behavior, and environment as related to learning” (p. 5). As such, metacognitive self-regulation is the process of both recognizing and monitoring one’s own cognitive processes.

Answers to the multiple-choice questions were converted into numbers, with higher values indicating that students strongly agreed or engaged in that behavior most of the time, and lower values indicating that students strongly disagreed or rarely engaged in that behavior. I ran a multiple regression analysis on the data for all students except those with a grade of W. This predicted final course grade based on various factors.

The variables initially considered in the regression were classification; placement; corequisite status; online status; gender; age; students’ self-reported numerical data from Appendix B; students overall percentage scores for the different question categories in Appendix D; all of the effective learning strategies questions form Appendix C; and MLSC, tutoring center, office hour, and class attendance. I first checked that the variables were not too strongly correlated with one another. The correlation matrix in Figure 2 shows the correlation coefficients between all variables. All of the coefficients were lower than 0.8, meaning they were not strongly correlated enough for me to be concerned with this skewing my results.

Figure 2

Correlation Matrix of Variables



III.5 Interviews

Students were given an option to provide their email address in the survey if they consented to be contacted for a follow-up interview. In the first few weeks of the spring 2020 semester, I emailed the four of these corequisite students who passed Preparation for Calculus, and five transfer students who ended the class with an A but had a midterm grade of B or C. Two students agreed to be interviewed, making the response rate about 22%. Interviews with the two former Preparation for Calculus students, one placed corequisite student and one freshman transfer student, were conducted during week three of the spring 2020 semester. These interviews each lasted approximately 15 minutes, with students being compensated with 20 dollars for their involvement in the interview portion of the study. I downloaded each student's responses to the survey questions, as well as their data for final grade, midterm grade, class attendance, office hour attendance, and MLSC attendance. Students examined their responses and data with me as I asked questions to clarify their motivation for their help-seeking behaviors and preferences, how they interpreted specific questions, and who they went to for help outside of the sources listed in the survey.

Questions were specifically tailored to each student because of their differing backgrounds and help-seeking/studying behaviors. One goal of these interviews was to examine students' actual behaviors according to collected records compared to their preferences based on the data students self-reported, the data I collected, and students' responses to ranking their preferred order of help-seeking sources. Analyzing discrepancies between students' preferences and their actual behaviors has the potential to provide insight into what prevents students from utilizing specific sources of help. Since both of these students ended the semester with higher final grades than midterm grades, I also asked the students questions pertaining to what they felt like contributed the most to their improvement and success in the course, as well as advice they would give to future mathematics students, specifically in Preparation for Calculus.

CHAPTER IV

FINDINGS

IV.1 Descriptive Statistics

For different placement categories, freshman transfer students, and corequisite students, I looked at final grade DFW rates, shown in Table 1. Continuing students had the highest DFW rate among all Preparation for Calculus students. However, there were more transfer students than continuing students this semester, so even though the DFW rate for transfer students was lower, most of the students who fell into the DFW category were transfer students.

Table 1

DFW Rates by Placement

	Continuing	Transfer	Placed	Unknown	Freshman Transfer	Corequisite	All
DFW Rate Within Category	44.74%	35.22%	6.15%	16.67%	32.70%	21.05%	
DFW Rate out of All Students	3.93%	20.09%	1.85%	0.69%	12.01%	0.92%	26.56%

Freshman transfer students had a slightly lower DFW rate than transfer students from every classification. A possible explanation for this finding is that these students may have completed their College Algebra credit as a high school student, and thus may be more motivated than non-freshman transfer students. Another possible explanation is that freshman transfer students may have taken a mathematics course more recently than non-freshman transfer students. Additionally, corequisite students had a below average DFW rate. The placement of students with the lowest DFW rate, falling more than 10% behind every other category, was placed students. I examined overall percentage grades among students who did not withdraw from Preparation for Calculus, as shown in Table 2. Both corequisite students and placed students had above average final grades, with placed students having the highest average grade. Corequisite students also had the highest minimum final grade among all the categories. Continuing students had the lowest average final grade, falling 0.1 points below what would be considered a passing grade. Freshman transfer students had slightly higher average grades than all transfer students.

Table 2

Overall Grades by Placement

	Continuing	Transfer	Placed	Unknown	Freshman Transfer	Corequisite	All
Average final grade	69.4	73.84	86.09	77.47	75.99	80.18	77.53
Minimum final grade	29.41	23.78	43.01	47.71	23.92	54.38	23.78
Maximum final grade	94.26	98.23	98.71	94.69	98.23	97.92	98.71

For students' use of help seeking sources, I looked at the average visits among all students within the different categories, as well as average visits among students who utilized particular resources at least once, shown in Table 3. Both continuing and transfer students had high percentages of students who visited the MLSC at least once, with half of continuing students and nearly half of transfer students having at least one visit. Overall, almost half of the students who participated in this study visited the MLSC at least once during the semester.

Among students with at least one visit, transfer students had the highest average number of visits, with freshman transfer students having a slightly higher average number of visits. Corequisite students had the lowest average number of visits among student with at least one visit.

Table 3

MLSC Visits by Placement

	Continuing	Transfer	Placed	Unknown	Freshman Transfer	Corequisite	All
Number of students with at least one MLSC visit	19	123	51	6	83	9	199
Percent of students with at least one MLSC visit	50%	49.8%	39.23%	33.33%	52.2%	47.37%	45.96%
Average MLSC visits among students with at least one visit	9.11	13.24	9.22	7.50	13.46	7.11	11.64

Similar to the data for MLSC visits, I also looked at average office hour visits among all students and student who visited office hours at least once, shown in Table 4. Overall, only 27.02% of students visited their instructor's office hours at least once. Transfer student had the highest percentage of students visiting office hours, but placed students with at least one visit had the highest average number of visits among the placement categories. Corequisite students with at least one office hour visit had an average of 4.17 visits, which was above the average of 2.96 among all students with at least one visit.

Table 4

Office Hour Visits by Placement

	Continuing	Transfer	Placed	Unknown	Freshman Transfer	Corequisite	All
Number of students with at least one office hour visit	7	76	31	3	47	6	117
Percent of students with at least one office hour visit	18.42 %	30.77%	23.85%	16.67%	29.56%	31.58%	27.02%
Average office hour visits among students with at least one visit	2.29	2.68	3.90	1.67	2.72	4.17	2.96

Table 5

Tutoring Center Visits by Placement

	Continuing	Transfer	Placed	Unknown	Freshman Transfer	Corequisite	All
Number of Students with at Least One Tutoring Center Visit	2	30	8	0	19	1	40
Percent of Students with at Least One Tutoring Center Visit	5.26%	12.15%	6.15%	0%	11.95%	5.26%	9.24%
Average tutoring center visits among students with at least one visit	1	2.83	2.50	NA	3	1	2.68

Finally, I looked at the average number of tutoring center visits among all students and students who went to tutoring at least once, shown in Table 5. Transfer students had the highest percentage of students visiting the tutoring center, with 12.15% of transfer students having visited the tutoring center at least once. Only 9.24% of all the students in the study had an appointment at the tutoring center, and the average number of visits among all categories for students who had appointments three or less for the entire semester.

IV.2 Survey Results

For one component of the survey, students were asked to report, on average, how many times per month they used each of the sources in Table 6. When looking at how often students reported working with a classmate, continuing students reported doing this an average of 5.66 times per month, whereas both transfer and placed students reported higher numbers at 7.52 and 7.35 times per month, respectively. Also, freshman transfer students reported a slightly higher number of times working with a classmate per month, 8.18, compared to transfer students' 7.52 times per month. An explanation for the corequisite number being above average is that these students do group activities twice per week in their corequisite meeting times, and since the question did not specify if working with a classmate comprised of situations inside or outside of class, students could have been including this group work when interpreting the question.

Analyzing at how often students watched videos, transfer students reported the highest instances of watching videos online, whereas corequisite students has almost the lowest reporting of this. The videos students had accessible to them from the university were created by the course coordinator and the director of the MLSC, both of whom taught sections of Preparation for Calculus this semester, but online help videos were not limited to just those. Also, corequisite students were taught by the course coordinator, which may have influenced how often they watched the videos she provided.

Table 6

Self-reported Use of Help Sources per Month

	Continuing	Transfer	Placed	Unknown	Freshman Transfer	Corequisite	All
Email your instructor	1.26	1.22	1.39	1.33	1.23	1.37	1.28
Work with a classmate	5.66	7.52	7.35	5.94	8.18	8.79	7.24
Reference the textbook	7.32	7.20	5.59	5.61	6.69	4.47	6.66
Watch online help videos	8.66	9.17	7.11	5.72	8.75	6.21	8.36
Use online homework solution banks	4.08	5.04	2.57	2.28	4.71	1.63	4.10
Ask a tutor for help	5.50	6.83	3.98	3.78	7.13	4.47	5.73
Ask someone who is not your instructor, classmate, or a tutor for help	1.26	1.22	1.39	1.33	1.23	1.37	1.28

Another aspect of this data to consider is how often students reported using online homework solution banks, such as Chegg. While transfer students had the highest reporting, saying they use solution banks an average of 5 times per month, corequisite students reported far less usage at an average of 1.63 times per month. Students who were placed into Preparation for Calculus also reported relatively low usage of solution banks. This calls into question students' goals pertaining to mastery-approach and mastery-avoidance, and if different values emphasized in the learning context influenced students' decision for or against using solution banks.

Another value that students were asked to self-report was the average number of hours per week they spent studying or doing homework outside of class, show in Table 7. Given that the survey was given to students during the week of an exam, one might expect that the number of hours studying may be higher than during a typical week of the semester, but students did not have as many homework assignments due on weeks when they had an exam which would have decreased the time spent on homework that week, so I was not concerned with this possibility.

Table 7

Self-reported Hours Spent Studying and Doing Homework per Week

	Continuing	Transfer	Placed	Unknown	Freshman Transfer	Corequisite	All
Average hours spent studying/doing homework	6.11	6.92	5.27	7.06	6.94	6.42	6.36

Although placed students outperformed students in all other placement categories with respect to DFW rates and average final grades, these students reported spending less time studying and doing homework per week. One explanation is that these students were more prepared from the course from the beginning, and thus did not need to dedicate as much time to their coursework. Another explanation is that students from the other placement categories may have not been using their time as productively as placed students.

As discussed in the methods, I built a model for predicting students' final grades based on various categories, including collected data, students' self-reported data, and students' survey responses. Table 8 shows the results of my multiple regression analysis. The variables that were found to be significant (having p-value less than 0.05) were students' ACT math subscore (after conversions); if students were continuing; if students were transfer; age; their score on the effective learning strategies scales, help-seeking avoidance scales, and academic procrastination scales; MLSC visits; class attendance; reviewing notes after each class; and understanding lectures during class.

Table 8

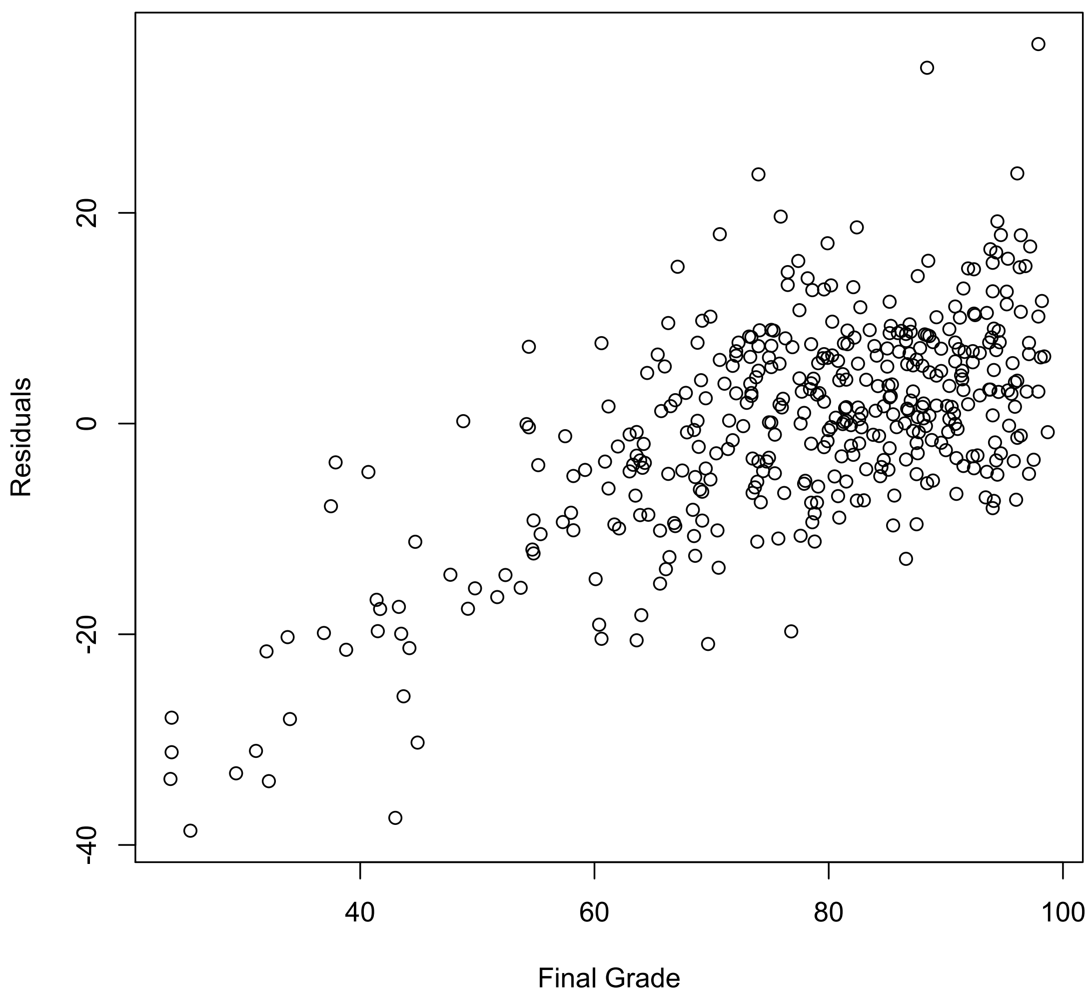
Predicting Final Grade Based on Help-Seeking/Studying Behaviors and Goals

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	20.76464	9.62295	2.158	0.031545
ACT math subscore	1.29057	0.16083	8.024	1.18e-14
Continuing	-7.57088	2.03958	-3.712	0.000235
Transfer	-6.00004	1.21880	-4.923	1.26e-06
Age	-0.63863	0.31058	-2.056	0.040416
Effective learning strategies	0.18617	0.06782	2.745	0.006327
Help-seeking avoidance	-0.08568	0.03528	-2.429	0.015588
Academic procrastination	-0.13736	0.03089	-4.446	1.14e-05
Total MLSC visits	0.12595	0.04928	2.556	0.010974
Percentage of classes attended	0.41249	0.04169	9.894	< 2e-16
Review notes after class	-0.08303	0.02602	-3.191	0.001532
Understand class	0.08033	0.02593	3.098	0.002088

The analysis yielded the following formula for predicting final overall course grades based on the variables above: final percent = 20.76464 + 1.29057(ACT math subscore) - 7.57088(continuing) - 6.00004(transfer) - 0.63863(age) + 0.18617(effective learning strategies) - 0.08568(help-seeking avoidance) - 0.13736(academic procrastination) + 0.12595(total MLSC visits) + 0.41249(percentage of classes attended) - 0.08303(review notes) + 0.08033(understand class). For ‘Continuing’ and ‘Transfer,’ a 1 would be entered if the student fell into that category and a 0 if they did not. For ‘effective learning strategies,’ this number would be the student’s raw score from the survey items multiplied by 100/42. For ‘help-seeking avoidance,’ and ‘academic procrastination,' these numbers would be their raw score from the survey items multiplied by 100/16. For 'review notes' and 'understand class,' answers from the survey would be entered, with 1 indicating strongly disagree, 2 somewhat disagree, 3 somewhat agree, and 4 strongly agree. For percentage of classes attended, this value would be the decimal representation of the percentage multiplied by 100.

Figure 3

Plot of Residuals versus Actual Final Grades

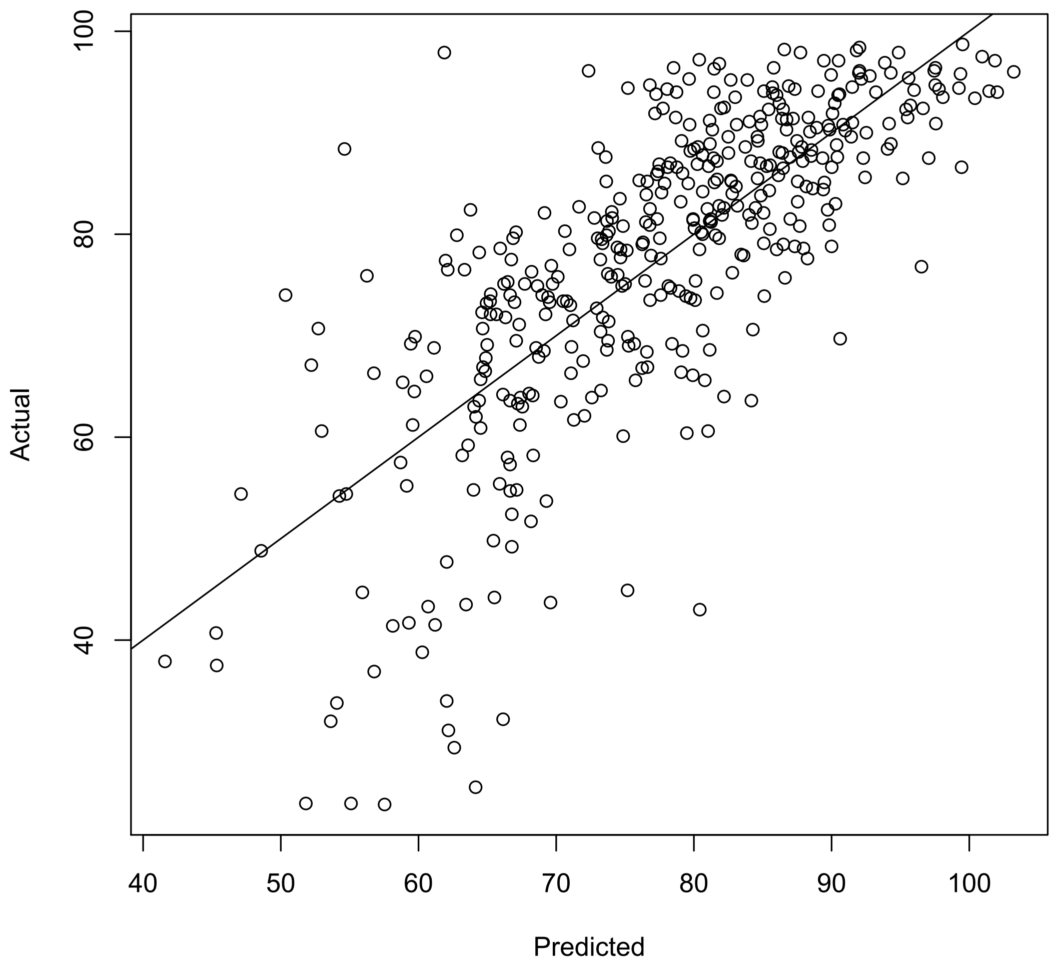


I plotted the residuals from the model (residual = predicted final grade - actual final grade) against the actual final grades from the data, shown in Figure 3. The ideal shape for a plot of this form is random or symmetrically dispersed points. However, since there was not a clear non-linear trend in the residuals, I did not make any adjustments to my model.

I also plotted the actual final grades of the students against the final grades predicted by the model. Figure 4 shows a somewhat strong linear trend among the data. This also shows that the model is more accurate for grades above about 70 percent.

Figure 4

Plot of Actual Final Grades versus Predicted Final Grades



The formula for my model can be interpreted in multiple ways. First, being a continuing student, being a transfer student, age, procrastination, help-seeking avoidance goals, and academic procrastination are all negatively correlated with overall course grade. The correlation with continuing and transfer statuses was to be expected, as those had the highest DFW rates among all the students, with continuing status having a higher effect. Reviewing notes after every class is also negatively correlated with course grade, however, this could be an indication that this is not an effective studying strategy for those students. Another explanation for this finding is that students reviewing notes after class happened so infrequently that the negative correlation is meaningless, given that the most effect this variable has on course grade is about -0.33%. Moreover, procrastination being negatively correlated with grades is also not surprising. Students who procrastinate may be less likely to seek help when they need it because they do not have time to do so. These students may also not dedicate as much time to completing their coursework as their peers who do not procrastinate, and thus may miss assignments or have lower quality work because they spent less time on it.

The factors that are positively correlated with course grade are ACT math subscore, having effective learning strategies, MLSC attendance, class attendance, and understanding lectures during class. This is consistent with Cook, Kennedy, and McGuire's finding that "Students with higher [ACT math subscores] tend to score better than those with lower scores" (Cook, Kennedy, & McGuire, 2013, p. 965). Looking at the coefficient for MLSC visits, this indicates that about every 8 MLSC visits correlates to 1% raise in final grade. This means that if a student would visit the MLSC three times per week for an entire semester, that would correlate to an increase overall grade by 6%. Considering the attendance variable, perfect attendance correlates to an increase in overall grade by 41.25%. The total number of classes for a section that meets three times a week was 44, which was the case for a majority of the sections. We can rewrite the coefficient for the class attendance part of the formula as 0.41249(100/44)(Number of classes attended) or 0.93748(Number of classes attended), meaning every class attended correlates to an almost 1% raise in final grade.

IV.3 Interview Results

I conducted separate interviews with two former Preparation for Calculus students in the semester following their completion of the course. The first student, Jim (a pseudonym), was placed in Preparation for Calculus after completing College Algebra at a community college as concurrent enrollment during his senior year of high school. As such, he is in the nontraditional freshman transfer category of placement. The second student, Dwight (a pseudonym), was placed in a corequisite section of Preparation for Calculus as a result of his score on the ALEKS placement exam.

Both students were selected because they showed improvement over the semester, ending with final letter grades higher than their midterm letter grades. I am not claiming that these students are representative of their respective categories, nor am I making any generalizations about the students in these categories. The purpose of including these interviews is simply to provide examples of two students' motivations for their help-seeking behaviors and how those behaviors may have resulted in their improvement in the course.

IV.3.1 Case 1: Transfer Student

Jim's main struggles in Preparation for Calculus seemed to stem from inadequate study habits, and his ultimate success in the course was the result of changing those habits to productive ones. Jim was a freshman transfer student, so even though he had had exposure to college mathematics, he did not have the experience of being a full-time student at a community college before transferring to university. This, his social adjustment included not only adjusting from community college to university, but also adjusting from high school to university.

Jim had 6 MLSC visits, 5 office hour visits, and attended 96.7% of classes throughout the semester. I asked him if there were any instances where he visited his instructor at the MLSC for office hours, and he said there was not; every MLSC visit was a true MLSC visit, separate from office hour visits. Compared to all freshman transfer students and the entire population of students, he had a below average number of MLSC visits, above average office hour visits, and above average class attendance percentage. On the survey question where students ranked the order in which they preferred to seek help, Jim's ordering, from most-preferred to least-preferred, was: watch online help videos; work with a classmate; ask someone who is not his instructor, a classmate, or a tutor for help; reference the textbook; ask a tutor for help; use online homework solution banks; and contact instructor.

Jim's preference ranking seemed to align with his self-reporting of how many times in a month he engaged in certain help-seeking behaviors. In the survey, he responded that per month (approximately) he emails his instructor once, works with a classmate five times, references the textbook 3 times, watches videos 10 times, never uses online homework solution banks, and asks someone other than an instructor, classmate, or tutor for help 4 times. In the analysis of these results, I was curious to find out why Jim ranked his instructor as his least-preferred source of help, who or where he sought help from that was not listed on the survey, and how he changed his study habits to raise his course grade from C to A. Moreover, since he ranked his instructor last, I wanted to find out why he went to office hours so often despite not preferring this method of seeking help.

When asked about why he ranked videos as the first thing he would want to do in getting help for mathematics, Jim initiated a broader conversation about his change in study habits:

> Jim: Uh, videos are actually, what actually started my increase towards higher grades. So I started learning a lot about how I study, things I've done wrong like, it's a concept called active learning. Have you heard about that?
>
> Interviewer: Yeah.

> Jim: Yeah, so I started employing that a lot more. About maybe like three fourths the end of the semester, so I was- it's number one for me 'cause that's what actually helped me. And Khan Academy I can just practice problems, it's easy, it's free. So that's why it's number one.

I asked Jim if Khan Academy was also where he watched videos from, and he clarified that that is where he finds videos now for Calculus, not during Preparation for Calculus the previous semester. He clarified that he did watch the course coordinator's videos on canvas, and said, "I just kind of just found practice problems anywhere, but whatever is free, I just looked on that."

I questioned Jim further about his ranking question, particularly about why going to his instructor for help was last on his list:

> Interviewer: … working with a classmate, so you ranked that higher than going to your instructor. Why would you - at this point [referring to when Jim took the survey] - why would you have preferred to work with a classmate instead of your instructor?
>
> Jim: What I do, I actually teach. So I try to hold study sessions with like one or two other people. And so, my instructor's usually like a last case scenario, but if I can teach the topic then that means I can understand it a lot more. So that's why I try to work with other people.

This response was indicative of Jim's active learning strategies. When my intention of asking this question was to hear about how Jim sought help, he instead told me how he provided help to his classmates. In that, he was strengthening his own understanding, and thus using working with peers as something different than purely seeking help.

I was also curious as to where Jim sought help that was not from his instructor, a classmate, or a tutor. Survey participants answered that they sought help of this time an average of 5.73 times per month, and Jim answered that he did this 9 times per month. Since that was such a high number, I wanted to find out what those alternate sources of help might be:

> Interviewer: And then, asking someone who's not your instructor, classmate, or a tutor, who would that be in your case? So like, who would you ask for help that wouldn't be an instructor, a classmate or a tutor?
>
> Jim: It would either probably be the smartest kid in the class or it would probably be somebody taken the class before and scored a high grade… You know, being an

> engineer, I know a lot of people who've already taken my classes before. And just since it's precalc. I have friends who are in Calc 3 so, you know, I get to ask them problems and they're more than happy to help.
>
> Interviewer: So asking, like, people who have been successful in the class before.
>
> Jim: Right. 'Cause, you know, they could probably break it in a way down that the professor doesn't, you know?... 'Cause, when we were in class, we learned from the professor, and that doesn't make sense to me, I can try to talk to somebody else and they can re-explain it to me. And if that doesn't work, all else fails, I can go to the professor and tell him why I'm not getting the problem and then he'll break it down for me, which he has.

This shows that Jim valued the expertise of those who had been in the class before him, or those who were performing better than him in the course and reached out to those more experienced peers for help. This discussion also emphasized how going to his instructor was the last resort of help for him, although he did not elaborate specifically on why working with his peers was more favorable that working with an instructor. Based on his statement that peers "could probably break it in a way down that the professor doesn't" and that his instructor's methods sometimes didn't make sense to him, one could infer that Jim was not confident he could get these multiple types of different explanation from his professor, or that he did not feel particularly responsive to his instructor's teaching methods.

Since Jim was a transfer student, I asked him if he felt like his experience taking College Algebra as concurrent enrollment during high school had prepared him for taking Preparation for Calculus at OSU. He responded that he did not, and when I asked him to elaborate on why, he responded:

> Uh, just, it's kind of, teacher was, professor was pretty good. It's just kind of like my mindset back then. Back in my school, you know, the gym teachers taught your AP physics, so every class was easy, you didn't have to study for anything. So I was like, alright I'm gonna just blow through all this like I did in high school. But, that wasn't the case. And so you see by the midterm grade that was definitely not the case. So I just had to, I really realized, you know, I had to change a lot of things. My mindset in college now is different than it was in high school.

Based on this response, it seems like Jim felt more like the structure of the course, specifically having taken it in high school, did not prepare him for college mathematics. However, he did not elaborate on whether or not he felt the mathematical content of his College Algebra course adequately prepared him for Preparation for Calculus. Jim did score high enough on his placement exam to be placed into Preparation for Calculus instead of College Algebra or a corequisite section, so one could infer that he was prepared mathematically, but not prepared for adjusting to university.

Finally, I asked Jim what he thought contributed the most to the improvement in his overall grade in the course:

> Interviewer: Alright and then, midterm grade was a C, you ended the class with an A … what do you feel like contributed the most to the improvement in your grade? Like what would you say was the top thing that helped you?
>
> Jim: Uh, realizing what I was doing wrong in terms of studying and how I went about my studies. 'Cause I would just do the work however way to solve it just to get an A and then go home and, that's it. That was my day. But now I actually go back, uh, I even, even today I still follow the same habits from last semester. I'll read notes, I'll make my own notes, you know, straight from memory. I'll try to teach people, explain concepts to them in class. I started sitting in the front of the class, too, so I could start voicing to the professor whenever he asks a question, even if I get the question wrong in class I could still learn from it, you know? … So I try to be active with my learning, too. … So, kind of like the mindset shift, I would definitely say helped that a lot. And I learned that through YouTube. Some students, too, you know I picked that up from a couple students. So YouTube, students, and even just going to office hours and seeing that was actually like starting to work. It just kind of motivated me to just do more, just continue with it.

Jim showed strong metacognition in that he was able to identify not only that he was not understanding the material, but that his old study habits were not working. In this interview he emphasized not being afraid to ask question, learning from mistakes, and shifting his mindset about learning. This is an example of a student who was able to make positive changes in his learning in order to be more successful in the course.

IV.3.2 Case 2: Corequisite Student

Students may be placed in the corequisite section of Preparation for Calculus in one of two ways. First, if a student's score on the ALEKS placement exam is from 53 to 55, then they may only take Preparation for Calculus under the corequisite model. The minimum ALEKS score to be placed in a traditional section of Preparation for Calculus is 56. Second, students may be invited to opt-in for the corequisite sections of the course. During the second day of class, students took a 10-item, multiple choice readiness assessment quiz to gauge their preparedness for the course. Students with a score of 30% or lower on this assessment were invited to join a corequisite section of the course, but they were not required to join. Dwight fell under the first category of being placed in a corequisite section with an ALEKS score of 55.

Dwight was selected to be interviewed for this study because he had a midterm grade of B, but ended the semester with a final grade of A. Additionally, he had no visits to the MLSC, his instructor's office hours, or the tutoring center. I was curious to hear him discuss if he sought help from anywhere; if so, where he sought help from and why he made those decisions. My hypothesis was that the supplemental instruction provided by the twice weekly corequisite class meetings may have provided enough support that the student may not have needed to seek help. However, the fact that students are receiving help from an undergraduate peer learning assistant, who may be more approachable than an instructor, may make asking for help less intimidating for some students. This could result in those students reaching out for help more than they might have had they not been placed in a corequisite section.

I started the interview asking Dwight about his response to the ranking question from the survey. Dwight's preferred order of seeking help, from most-preferred to least-preferred, was working with a classmate; watching online help videos, asking someone other than his instructor, classmate, or a tutor for help; referencing the textbook; contacting his instructor; asking a tutor for help; and using online homework solution banks. I first asked Dwight who he sought help from other than his instructor, a classmate, or a tutor. Dwight responded that this category included two roommates of his who were also in Preparation for Calculus, but not in the same section as him, and one friend who was in Calculus I at that time. I also asked the student where the videos he watched came from, and he responded that he mainly watched the course coordinator's lecture videos and the exam review videos posted on the MLSC website. Dwight's professor was the course coordinator, so most of the videos he was watching were done by the same person he was receiving lectures from.

One reason Dwight was selected for an interview was because in contrast to Jim, he had not used the MLSC or been to his instructor's office hours. I asked Dwight to confirm this information, and when he did I asked him why he chose not to take advantage of these resources. He responded with, "Honestly, I just didn't really feel like I needed it for this class. Nothing really challenged me too heavily. So yeah, that's why I didn't. … I really didn't feel the need to come to office hours, and I never really had any questions." My initial hypotheses about corequisite students were that they 1) may not need to seek help because of the supplemental instruction they receive twice a week and 2) may be more open to seeking help because they work with a peer learning assistant twice a week. Dwight said he did not feel like he needed help, but I still asked questions to gain insight into my second hypothesis:

> Interviewer: So did you feel comfortable asking your learning assistant for help?
>
> Dwight: Yeah. It wasn't hard to ask for help.
>
> Interviewer: Okay. Did you ever reach out to your learning assistant outside of class for help? Or only in class during the-
>
> Dwight: Nah, just in class.

Reacting to Dwight's response of it not being hard to his learning assistant for help, I asked if he was more willing to has his learning assistant for help than his professor. He responded with "Probably, just 'cause he was younger. He was just, like we (inaudible) he wasn't very much older than us. And he's just easier to talk to. … And he's just really approachable, 'cause it's a smaller room, just like you're all there trying to figure stuff out, so…" Dwight's response made it seem as if he had not given much thought to whether or not he preferred reaching out to his learning assistant over his professor, probably because he identified that he did not feel like he needed help in the course, and thus did not need to ask questions. However, it did seem as if the fact that the learning assistant was closer to the students in age was a positive feature of the corequisite model for this student.

Finally, I asked Dwight specifically about his study habits. Dwight reported that he spent about four hours outside of class studying and doing homework per week. I asked him what studying meant to him besides doing homework and he responded:

> So what I would do is I would print off the review. Then I would watch the review- or I would work through as much as I could, and then watch the videos and fill in the rest, teach myself how to do it with the videos. And then I would print off the old exams that they gave us … and then I would work that one as far as I could and then watch the videos and fill in the rest. So that's- and that's all really all I would do for studying. And then I would look over my notes while I was doing the [practice] exam.

Because of this response, I asked Dwight if he only did what he considered as *studying* in preparation for exams, and he said yes. Compared to Jim, Dwight seemed like he did not need to put in as much active effort into learning for this class. Both students reported working with peers, but whereas for Dwight this was often enough to get him through his coursework, Jim still felt the need to use more formal outside sources such as the MLSC and his instructor's office hours. In summary, Dwight credited more independent work for his success in the course, whereas Jim credited active learning and reaching out for help.

IV.4 Final Remarks

My last interview questions for both of my questions was what advice these students would give to current or future students in Preparation for Calculus in order to be successful in the course. I asked this question of both students because they had ended the course with a higher grade than their midterm grade, and they both had a final grade of A, so they might have ideas of what made them particularly successful in this course. The students' responses are as follows:

> Jim: Seek help. Definitely try to evaluate yourself. If you're not doing good in the class, ask yourself why you're not doing well in the class. And talk to professor, I mean they're there, they're not gonna say no they're not gonna help you, you know. Go to office hours, it's free, that's what it's there for. Even if it's not during your times available, they will-

> you can schedule a time with them just to talk. Say you're like, "hey, I need help in this, this, and this," and talk to your classmates, too. Or talk to past classmates who've been in the class. Just seek help. That's- that's what I say. Especially if you're not doing well, ask yourself "why?" and "how can I make it better?" That's what I did and that's how I changed everything.

> Dwight: Um, show up to class. Do the notes, like print off the notes before you get there, 'cause it's really, they make it really easy to have the notes with you. And then make sure you do those reviews, watch the videos, and if you don't know how to do it then watch it, and kind of, you know, learn from there. And definitely use the old tests 'cause, I mean sometimes there's harder questions on the review and the old tests that aren't even on the test.

In these final remarks, both students reiterated what they did to seek help or study, so it seems as if they saw these behaviors as influencing their success in the course. Although both students were successful in the course, they had very different behaviors and advice. For instance, Jim's advice was to mainly to seek help from others and be reflective about what is or is not working with certain studying behaviors. In contrast, Dwight's advice did not focus on reaching out to others, and instead focused on encouraging students to utilize impersonal resources provided by the instructor, even though he did work with roommates and friends on coursework. It makes sense that Dwight did not comment on seeking help from others given that he only utilized informal sources of help, however, I was surprised that there was no suggestion from him of forming a community of classmates to work with when struggling in the course.

CHAPTER V

CONCLUSION

V.1 Summary of Findings

Overall my study did find some differences in students' behaviors based on their placement information and corequisite status. One finding that was consistent for all students was that more students went to the MLSC than attended office hours, where the MLSC had help available from undergraduate tutors and instructors, whereas office hours only had instructors available for help. Corequisite students did visit the MLSC, but had a lower number of average visits per semester than students in traditional sections, which could support the hypothesis that students receiving corequisite instruction did not need to seek outside help as much as students in traditional sections. Additionally, although office hours were not found to have an effect on final grade, both corequisite and placed students had the highest number of average office hours visits, and these were the most successful groups of students. This could support the hypothesis that since corequisite students are accustomed to receiving extra help twice per week from their learning assistant, they may be more likely to reach out for help when they need it. Some factors found to be positively correlated with course performance that we can make students aware of were MLSC visits, class attendance, and having effective learning strategies.

One limitation is that this sample was take from just the Fall 2019 population of students, not the students for the entire 2019-2020 academic year. As a result, the number of continuing students may be underrepresented, and the number of transfer students may be overrepresented compared to what the total population of these students would look like for the full academic year. Another limitation of the methods for collecting office hour attendance and MLSC attendance comes from the fact that instructors are required to hold at least one of their weekly office hours in the MLSC. Students must sign in to the MLSC regardless of whether or not they were only attending office hours. Instructors did not distinguish between whether students attended their office hours in or out of the MLSC, and instructors also did not track whether students used the MLSC before or after attending office hours. Thus, we cannot make the assumption that a student went to the MLSC to receive walk-in tutoring for all of their visits, we can only conclude that they visited the MLSC for either walk-in tutoring, help from their instructor, both, or simply for a place to work and not to receive help.

V.2 Implications

Although there are some factors that students cannot change once arrive at university, such as their incoming prior math ability (ACT math subscore) or their placement status, this study shows concrete strategies students can implement that have the potential to positively influence their grade. Among these strategies are attending class, visiting the MLSC, not procrastinating, and adopting some of the effective learning strategies listed in Appendix B. Although visiting instructor office hours was not found to be significant, instructors of Preparation for Calculus are required to hold at least one hour of office hours in the MLSC every week, and since we did not distinguish between whether or not students went to the MLSC to see their instructor or not, we cannot rule out the possibility that visiting office hours may also have the potential to positively influence grades.

Students in this study showed a higher preference for working with peers and a lower preference for contacting their instructor. This could align with findings from Makara and Karabenick (2013), in that “learners who placed greater importance on companionate peer relations were more likely to prefer peers as sources of help as well as to prefer, on average, in-person over online sources" (p. 29). Zusho et al. (2007) make the claim that "[o]ne important reason why students approach each other for help rather than instructors or advisors involves reduced evaluation-based threat" (p. 634), the belief that instructors' or advisors' negative views of students will affect their class performance. Instructors should be aware of reasons students may be reluctant to reach out to them for help and make extra efforts to be approachable and reach out to students.

Future research would likely need to be done to explore students' motivations for their studying and help-seeking behaviors in a more comprehensive way in order to provide insight into their decisions. In particular, more interviews could be conducted with students from multiple placement routes, especially transfer students, and corequisite mathematics students. Interviews could be conducted with transfer and non-transfer mathematics students to compare and contrast their perceptions of math faculty in particular. Interviews with corequisite students could focus on their perceptions of their instructor compared to their learning assistant. Another possible area of research worth exploring would be the effectiveness of instructor office hours in mathematics, and the factors that either influence students toward or against attending office hours. A possible direction would be to look at influences from students' peers on attending office hours, and if students are more likely to attend office hours with a classmate than alone.

In the words of Cook, Kennedy, and McGuire (2013), "when students start using the strategies and experience greater understanding and success, they are motivated to continue, and their performance continues to improve" (p. 966). Possible interventions that would benefit all Preparation for Calculus students would be (1) promoting effective learning strategies (as in Cook, Kennedy, & McGuire, 2013 and Zhao, Wardeska, McGuire, & Cook, 2014); (2) encouraging students to visit the MLSC, even if they do not feel like they need help, but just so they have a quiet place to work where help is available if they need it; (3) encouraging students to attend class regularly; (4) teaching students how to be more metacognitively self-aware; (5) helping transfer students with both academic and social adjustment to the university; and (6) having past successful students, with stories like Jim's, talk to students about how they employed these behaviors and they actually led to their success in the course. Providing students with strategies for success, and students recognizing that these actually work for improving their performance, promotes sustainability of this improvement. Moreover, students hearing stories from others who did engage in these behaviors and benefit from them may motivate them to engage in these behaviors themselves.

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APPENDICES

Appendix A

Prior Math Ability Conversion Scale

ACT Math Subscore	ALEKS score (31)	Letter Grade (22)	GPA (5)
10	0-10		
11	11		
12	12		
13	13		
14	14		
15	15-18		≤ 1.5
16	19-22		
17	23-26		
18	27-29		
19	30-34		
20	35-39		2-2.49
21	40-44		2.5-2.99
22	45-49	B, C, D	3-3.49
23	50-54		3.5-3.99
24	55-59	A	
25	60-64		

26	65-69	≥ 4
27	70-74	
28	75-79	
29	80-84	
30	85-89	
31	90-94	
32	95-99	
33		
34		
35		
36		

Appendix B

Different Help Sources

Opening statement of survey: All of the following questions are specifically about your Preparation for Calculus class. Please note that this is not a test, and there are no right or wrong answers. Please answer each question as honestly and accurately as possible about your experiences in Preparation for Calculus.

If you were having trouble understanding a concept or solving a problem, drag and drop the items in this list to organize how you would prefer to use the following resources. Organize items with the most preferred at the top and least preferred at the bottom:

Contact your instructor (online or in person)

Work with a classmate outside of class (online or in person)

Reference the textbook

Watch online help videos (such as Khan Academy or Youtube)

Use online homework solution banks (such as Chegg)

Ask a tutor for help

Ask someone who is not your instructor, classmate, or a tutor for help

For your Prep for Calc class, how many times IN A MONTH do you:

Email your instructor

Work with a classmate

Reference the textbook

Watch online help videos (such as Khan Academy or Youtube)

Use online homework solution banks (such as Chegg)

Ask a tutor for help

Ask someone who is not your instructor, classmate, or a tutor for help

For your Prep for Calc class, how many hours do you study/do homework outside of class PER WEEK?

Appendix C

Effective Learning Strategies

(The following questions and are verbatim from the Effective Learning Strategies Survey in Zhao et al. (2014).)

Select how often you do the following activities:

1. I preview the lecture material before I go to class.
2. I attend class on time.
3. I take notes in class by hand.
4. I review my notes and textbook after each class.
5. I study with concentrated time and specific goals.
6. I join study groups.
7. I understand the lecture and classroom discussions while I am taking notes.
8. I try to determine what confuses me.
9. I try to work out the homework problems without looking at the example problems or my notes from class.

(The following questions were adapted from Zhao et al. (2014).)

Select how often you do the following activities:

1. I review the textbook before an exam.
2. I review my lecture notes before an exam.
3. I review past assignments before an exam.
4. I review the study guide before an exam.
5. I do the practice test before an exam.

Appendix D

Mixed Survey Questions

(The following questions and their categories are from Zusho and Barnett (2011), adapted to mention the Preparation for Calculus class.)

Rehearsal

1. When I study for Prep for Calculus, I make lists of important terms and memorize the lists.

12. When I study for Prep for Calculus, I memorize key words or formulas to remind me of important concepts.

18. When I study for Prep for Calculus, I read my class notes over and over again.

Metacognitive Self-Regulation

2. When I become confused about something in Prep for Calculus, I go back and try to figure it out.

8. When reading for Prep for Calculus, I make up questions to help focus my reading.

11. I ask myself questions to make sure I understand the material that I have been studying for Prep for Calculus.

15. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.

Help-Seeking Approach

3. Getting help would be one of the first things I would do if I were having trouble in Prep for Calculus.

7. I would ask for help in Prep for Calculus to learn to solve problems and find answers by myself.

13. If I were having trouble understanding the material in Prep for Calculus I would ask someone who could help me understand the general ideas.

Help-Seeking Avoidance

4. If I didn't understand something in Prep for Calculus I would guess rather than ask someone for assistance.

9. Getting help in Prep for Calculus would be an admission that I am just not smart enough to do the work on my own.

10. I would not want anyone to find out that I needed help in Prep for Calculus.

17. I would rather do worse on an assignment I couldn't finish than ask for help.

Academic Procrastination

5. I am too lazy to work on assignments ahead of the deadlines.

6. I generally postpone working on assignments for school.

14. I have problems prioritizing tasks.

16. My procrastination prevents me from asking for help when I need it.

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