Evaluating Pedagogical Methods that Influence Homework Assignment Completion

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by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Education
in the Department of Learning Sciences and Educational Research
in the College of Community Innovation and Education
at the University of Central Florida
Orlando, Florida

Fall Term
2019

Major Professor: Richard Hartshorne

ABSTRACT

College students enrolled in an online introductory engineering course are not completing their homework assignments at an acceptable rate which impacts them, the instructor, and the college. This research study employed a quasi-experimental evaluation model to assess the effectiveness of two pedagogical methods designed to positively influence student homework completion rates and student attitudes toward homework. Despite evidence that grading penalties encourage students to submit their homework assignments, such strategies have historically been unsuccessful for the course used in this study. The researcher designed two pedagogical interventions, along with a survey instrument, to measure the impact of the interventions on completion rates and student attitudes toward homework, using a combination of inferential and descriptive statistics. Ideally, the findings of this study would be generalizable to subsequent offerings of the course used in this study, as well as other courses taught by the investigator, and potentially other faculty at the college. Although both interventions did not produce statistically significant results on impacting student homework completion rates, or improve student attitudes toward homework, the results of the study did indicate a positive correlation between student self-assessed knowledge gains attributed to the course and its homework. One intervention did improve homework completion rates, but the results only marginally improved final course grades, which does not fully align with prior research studies. In addition, this study provided the researcher an opportunity to study their own practice and the importance of homework and its effectiveness for student learning.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Richard Hartshorne, for the guidance, feedback, and support he provided for the past 18 months. I would also like to thank all members of my committee, Dr. David Boote, Dr. Sarah Bush, and Dr. Enrique Ortiz, who pointed me in the right direction at the very beginning of this research study. I would also like to thank my wife Lin, and my sons Cael and Colin, for their ongoing support, interest, encouragement, and flexibility. Finally, I would like to thank the faculty at the University of Central Florida whose coursework provided an excellent foundation for this research project and numerous strategies for my classroom.

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CHAPTER ONE: INTRODUCTION

History of Homework in the United States

Since the 19th century, opponents of homework have exaggerated its drawbacks, and supporters have often overstated its benefits (Gill & Schlossman, 2004; Marzano, 2007; Vatterott, 2018). During this period, the role of homework changed considerably, with its perceived importance to education cycling back and forth. Thus, it is critical that current homework practices use the best evidence available consistent with educational research to help students receive the optimum benefit from homework (Cooper, Robinson, & Patall, 2006). The purpose of this study was to evaluate pedagogical methods designed to positively influence college students to complete homework assignments in an introductory engineering course.

Prior to the twentieth century, homework was considered a means of exercising the brain as it was generally believed mental exercise strengthened our brain, similar to physical exercise strengthening our muscles (Cooper, 1989b). In particular, the mindset was mental discipline should emphasize drills, memorization, and recitation. These activities were intended to be practiced at home, hence they became known as homework (Corno, 1996; Gill & Schlossman, 1996). Although most families supported setting time aside for such activities, homework created a conflict for some families because younger children were expected to help around the home, and older children were expected to work to provide financial support for their family. During this time period, education was compulsory only to age 14; after this, few children attended high school, and even fewer attended college (Gill & Schlossman, 2004; Vatterott, 2018). Given the pressure placed on children over the age of 14 to provide financial support for their family, many educators reasoned that those who wanted to continue with school must also

be willing to study, otherwise they were free to drop out and enter the workforce full-time (Gill & Schlossman, 2004).

Near the turn of the century, and continuing into the 1940's, the progressive education movement regarded homework as inconsistent with pedagogical best practices established by educational experts (Gill & Schlossman, 1996; Vatterott, 2018). Consequently, homework was de-emphasized in favor of other activities such as family time, work, sports, clubs, and social activities (Marzano, 2007). However, this changed once again in 1957, with Russia's launch of Sputnik, the world's first satellite, as public opinion became rooted in the firm belief that America had lost its competitive edge. If American students were ill-prepared for the rigors of complex technologies in the workplace, then the American education system needed to quickly improve (Marzano, 2007). Homework was considered one way to correct this deficiency, while simultaneously serving as a tool for improving learning outcomes (Cooper, 1989a).

The emphasis on the importance of homework continued for another 15 years, until the early 1970's, when many learning theorists considered homework harmful to the mental health of students (Marzano, 2007). Furthermore, it was believed most students were neglecting other aspects of their personal lives, such as outdoor recreation, personal fulfillment, and even sleep (Wildman, 1968). In the 1980's, the perception of the role of homework changed once again, with the release of the National Commission on Excellence in Education's report, *A Nation at Risk*. This report stated that the educational system of the United States was failing to meet the country's need for a competitive workforce. Since the release of this report, there have been numerous studies on homework, particularly for kindergarten through high school (Cooper, 1989b; Cooper, Lindsay, Nye, & Greathouse, 1998; Cooper et al., 2006; Cooper & Valentine, 2001; Núñez, Suárez, Rosário, Vallejo, Cerezo & Valle, 2015). Unfortunately, there is

considerably less research on homework in post-secondary education, and even less on the role of homework in the community college (Cohen, Brawer, & Kisker, 2014; Fan, Xu, Cai, He, & Fan, 2017). In general, except for college-based institutional research teams focused on funding, job placement rates, and completion rates, nearly all researchers studying community colleges are affiliated with universities, federal agencies, or state agencies focused on the role of the community college in the American education system (Cohen et al., 2014).

Today, many learning theorists believe students need opportunities to practice new skills that will deepen their understanding of new information (Mayer, 2011). One way for students to practice new skills learned in the classroom, is by spending time studying, or more commonly referred to as homework (Marzano, 2007; Mayer, 2011). Cooper (1989a) defined homework as a task assigned to students, by their instructors, intended to be completed outside of the classroom. This definition is widely accepted and cited in research studies ranging from early childhood, to post-secondary education (Cooper et al., 2006; Fan et al., 2017).

Although attitudes toward homework and its role in the American education system have changed over the past century, today most educators agree homework is a means of extending learning opportunities beyond the school day and the classroom (Marzano, 2007). This is more compelling as students transition from high school to college due to the reduction in contact hours and increased expectations for work outside the classroom. Although research suggests too much homework may diminish its effectiveness, up to 12 hours per week for college-bound seniors is considered reasonable (Cooper et al., 2006), and two to three hours per credit hour is not uncommon for many college students (Cerrito & Levi, 1999). In particular, many college freshmen have difficulty adjusting to the amount of time they should be spending on homework, reading course materials, and course preparation (Cerrito & Levi, 1999).

Completing Homework in College Introductory STEM Courses

College students do not regularly complete their homework assignments and this problem is not unique to the college, nor the course used in this study. For example, in a comprehensive study of several thousand students at over 10 universities, the homework completion rate was 75%, despite the instructors' goal of 80 to 90% (Edgcomb, Vahid, Lysecky, & Lysecky, 2017). Some college instructors proposed offering students a grade incentive for submitting their completed homework assignments as a means of improving the homework completion rate (Kontur & Terry, 2014; Radhakrishnan, Lam, & Ho, 2009; Ryan & Hemmes, 2005). Prior research studies found that providing college students credit for completing their homework was a powerful, motivating factor (Ryan & Hemmes, 2005), plus there was a strong, positive relationship between awarding credit for homework, and the number of homework assignments students completed (Kontur & Terry, 2014). Just as with prior research, the course used in this study offered an incentive by counting homework as part of the final course grade. However, this prior research used introductory college courses taught in the traditional face-to-face modality, not the online modality, which will be discussed in greater detail later in this study.

Significance of Completing Homework

The significance of completing homework assignments is critical for students and the instructor. For students, homework provides practice with new material, one of the broad areas for assigning homework identified by Epstein and Van Voorhis (2001). Homework assignments also prepare students for formal assessments, such as exams, since homework assignments should be designed to help students demonstrate their understanding of course material (Cooper, 1989b). For the instructor, homework serves as a formative assessment providing personal

reflection, a chance to share best practices with students, and an opportunity to improve instructional tools or enhance the curriculum (Yorke, 2003). Homework assignments also provide instructors an opportunity to dispense feedback to students that can be incorporated into subsequent coursework (Hattie & Timperley, 2007).

According to Cooper's (1989b) highly cited synthesis of research on homework and its effectiveness, there are numerous reasons for assigning homework to students, including achievement and learning, an improved attitude toward school, willingness to learn during leisure time, better time organization, greater self-direction, and greater parental involvement in schooling. However, the primary reason for assigning homework should be for instructional purposes, such as diagnosing individual learning problems, providing feedback to students, and creating an opportunity for students to practice, or review, new material (Cooper et al., 2006). This is particularly true at the post-secondary level, since it is highly unlikely instructors would assign homework for non-instructional purposes, such as parent and child interactions, administrative requirements, or punishment (Cooper et al., 2006).

In an online course, similar to the course in this study, homework assignments provide instructors opportunities to diagnose potential misunderstandings with course material, and to provide feedback to students on an individual basis. Students who do not complete their homework miss critical content tied to measurable course objectives and they are not practicing skills they should be developing (Cooper, 1989b). Students are expected to transfer these new skills to subsequent coursework in their degree programs, and ultimately to industry.

Statement of the Problem

College students enrolled in an online introductory engineering course are not completing their homework assignments at an acceptable rate. In the course, students are required to submit one homework assignment each week throughout the course, with each homework assignment being graded and returned to students with individual instructor feedback. Homework assignments that are not submitted earn zero points, and students miss an opportunity to receive instructor feedback. As the grading system for this course, which has been in place since fall 2016, weighs homework as one-half of the final course grade, there is a considerable penalty for not submitting homework assignments.

Contrary to prior STEM higher education research (Kontur & Terry, 2014; Radhakrishnan, Lam, & Ho, 2009; Ryan & Hemmes, 2005), penalizing students who do not complete and submit their homework assignments has been ineffective for improving homework submission rates for the course used in this study. One challenge with prior research has been the course modality, as most studies used courses taught in a physical classroom (face-to-face modality). For example, although Edgcomb et al. (2017) used students enrolled in numerous introductory engineering courses, they were taught face-to-face, not online, which may partially explain why results from prior studies do not align with historical data from the course used in this study. This is problematic, as online education is increasing in popularity; as of 2016, one in seven students at all higher education institutions was taking some of their courses online, and this number is expected to grow for the foreseeable future (Allen, Seaman, Poulin, & Straut, 2016). Another difference between prior research and the course used in this study is content complexity. The rigor of the conceptual and mathematical concepts addressed in this course are considerably more complex than typical introductory college courses. Given the additional

challenges with this course, the purpose of this study was to evaluate the integration of additional pedagogical strategies in an effort to improve student homework assignment completion rates.

Purpose of this Study

The purpose of this study was to evaluate pedagogical methods designed to positively influence college students to complete homework assignments in an introductory engineering course. Although the course has been taught by the same instructor for several years using both modalities, this study was devoted to the online modality. Based on historical data, the online modality for this course has a higher withdrawal rate than the face-to-face modality, consistent with data from other colleges (Aragon & Johnson, 2008). One potential cause for a higher withdrawal rate could be attributed to students failing to submit their homework assignments, leading to low initial grades in the course, as these are the first assessments students receive in the course. Also, the online modality of this course typically has a greater number of students who complete the course with grades of D, F or W, which also may be attributable to missed homework assignments, since they account for one-half of the final course grade. Existing research does not suggest that either modality is superior for students completing and submitting their homework assignments (Allen et al., 2016); in fact, the findings are varied due to measuring different outcomes and using different research methodologies (Bowen, Chingos, Lack, & Nygren, 2014).

Due to a variety of advantages and benefits, demand for online learning at the community college level continues to rise (Allen et al., 2016; Capra, 2011), especially for older students who have employment requirements or family obligations. This national trend is also true at Live Oak State College, as is evident by more than 40 degree and certificate programs offered by the

college. Unfortunately, online education, especially at the community college level, is typically accompanied by higher student withdrawal rates and higher student failure rates (Aragon & Johnson, 2008). Therefore, it is important to identify strategies and support mechanisms to help students succeed, especially in online courses.

The Course Used in This Study

The course used in this study, *Engineering Concepts and Methods*, is a required course in several engineering degree programs offered by Live Oak State College. The course is taught by the engineering faculty and introduces students to two powerful industry-standard tools: Microsoft® Excel (Excel), a spreadsheet application featuring an extensive library of built-in functions, graphing tools, and analysis packages; and MathWorks MATLAB® (MATLAB), a computing environment and programming language that supports matrix manipulations, plotting of functions and data, and algorithm development. The course is taught using both modalities to accommodate a wide range of student needs and schedules. Students enrolled in the face-to-face sections typically complete assignments in the classroom which may be a more effective strategy for facilitating homework completion and submission (Cooper, 1989b). Unfortunately, this is not viable for the online modality, as the course is conducted asynchronously with students working at their own pace, on their own time, and in an environment of their choice, although they must adhere to the overall course schedule. An additional barrier, as highlighted by prior research on computer-based learning environments (Lee, Lim, & Grabowski, 2010), is that some students are unsuccessful at controlling their own learning. *Engineering Concepts and Methods* relies entirely on computer-based instruction which may also contribute to students not completing and submitting homework assignments.

The Course and its Problem-Solving Methodology

Both software tools used in the course were intended to help the instructor teach students a methodology relevant to solving engineering-related problems encountered in subsequent courses and industry. Introducing students to this problem-solving methodology early in their academic sequence helps them develop skills that can be extended to larger and more complex problems. The five steps of the problem-solving methodology taught in the course are summarized below (Moore, 2015).

1. <u>State the problem</u>. Students learn to develop a sketch, or a brief written summary of the scenario, to ensure they have a clear understanding of the problem.
2. <u>Describe inputs and outputs</u>. Students learn to identify inputs and outputs, plus the necessary constants to properly compute the required unit conversions. In general, inputs are typically known values, and outputs are typically unknown values.
3. <u>Develop an algorithm</u>. Students learn to develop a handwritten example or sample calculation. The objective is for students to identify the equations relating constants, unit conversions, inputs, and outputs.
4. <u>Solve the problem</u>. Students learn to use the software tools to create a solution using the algorithm developed in the third step.
5. <u>Test the solution</u>. This last step is critical, but often overlooked. Students should use the example created in the third step to validate their solution works as intended.

This methodology, or some variation of it, is used throughout the engineering curriculum at the college, and it is commonly used in industry.

The Course and its Relevance to Industry

Part of Live Oak's vision is to advance student learning and development with programs that cultivate their success in the workplace. For these engineering students, familiarity with industry-standard tools, such as Excel and MATLAB, gives them a competitive advantage for securing a job upon graduation. Graduates of the college's Engineering Technology program find rewarding careers throughout construction, manufacturing, plant management, product testing, and quality assurance. According to the Live Oak's institutional research team, the college's job placement rates are greater than the state-wide average, plus starting wages are considerably above service-area average starting wages. Successfully completing *Engineering Concepts and Methods* is an early step in helping these college students prepare for subsequent course work, degree completion, and to find rewarding jobs in industry.

Student Challenges with the Course

As discussed earlier, the instructor used two software tools to teach students skills they would need for solving challenging STEM-related problems. In the course, students learn to use the software and how to apply them to a typical engineering problem-solving methodology. Although some students have prior experience using Excel, the course exposes students to numerous functions and capabilities they may not have used before such as graphing, regression analysis, statistics, and matrix algebra. Based on feedback from students over the past several years, a common comment to the instructor was, "I did not know Excel could do that."

Similarly, based on discussions with prior students, most students have not used MATLAB prior to *Engineering Concepts and Methods*, and they are unfamiliar with software development tools using multiple windows. For example, MATLAB uses a program editor window, a variable definitions window, a graphical window for charts and graphs, and an output

data window, which initially appear unnecessary and confusing. First-time users often find MATLAB daunting, frustrating, and challenging due to the windows, pull-down menus, and extensive options. To help these students, the first MATLAB homework assignment focuses on an initial orientation of the software tool. Although this homework assignment has a firm due date, the instructor works with students one-on-one until they can submit a legitimate file in the correct format (script .m file). For some students, this takes multiple iterations spanning several days. However, once students successfully master the first MATLAB homework assignment, homework submission rates were similar to Excel homework submission rates.

Homework Assignments and the Course

Homework assignments played a critical role in *Engineering Concepts and Methods* because students were able to confirm their understanding of course material via practice. Homework assignments also prepared students for the course's projects and exams, provided an opportunity for instructor feedback, and presented an opportunity for the analysis of potential misconceptions (Cooper, 1989b; Cooper et al., 2006). Instructor feedback is important, as it affords students an opportunity to learn from their mistakes, examine alternative solutions, and incorporate feedback into subsequent homework assignments. Earlier studies have found feedback alone did not motivate college students to turn in their homework assignments (Kontur & Terry, 2014; Ryan & Hemmes, 2005). However, these earlier studies did find counting homework as part of a student's overall grade as a punitive measure was necessary to ensure students completed it. Unfortunately, based on historical data (Table 1), this strategy was unsuccessful for the course used in this study. Since fall 2016, 278 (20.4%) homework

assignments were not submitted, and 143 (10.5%) were submitted late, representing numerous lost opportunities to receive feedback, improve grades, and prepare for the exams and projects.

Table 1: Historical Homework Assignment Completion Data

	Term					
HW Status	F 16	S 17	F 17	S 18	Total	Percent
Late	36	48	39	20	143	10.5
Missed	66	69	88	55	278	20.4
On-Time	194	221	348	178	941	69.1
Total	296	338	475	253	1,362	100.0

Note. HW = homework; F = fall semester; S = spring semester.

Students enrolled in *Engineering Concepts and Methods* were expected to demonstrate their knowledge of course content covered by the homework assignments on the summative assessments. In addition to traditional exams, the course also included a project for each software tool providing students an opportunity to demonstrate their ability to solve an open-ended problem, using what they learned regarding the functionality of Excel or MATLAB. Completing homework assignments afforded students an opportunity to practice new skills addressed in the course, and provided a foundation for using new skills and knowledge on the exams and projects (Cooper, 1989b; Cooper et al., 2006; Cooper & Valentine, 2001; Epstein & Van Voorhis, 2001).

Not only were homework assignments intended for students to practice and prepare for assessments, but they were also intended to manage student expectations, particularly for exams. Exam problems were similar in complexity to those used on homework assignments to ensure students were adequately prepared. Also, since students resent surprises on exams, providing

relevant homework assignments, combined with instructor feedback to students who submitted their homework, was an excellent way to eliminate them (Felder, Woods, Stice, & Rugarcia, 2000). Properly designed tests should provide students an opportunity to demonstrate they learned what instructors had intended, and met the course learning objectives (Felder et al., 2000). Ideally, tests based on homework assignments would encourage students to complete them throughout the course (Jensen, McDaniel, Woodard, & Kummer, 2014).

The Course and Historical Homework Completion Data

To evaluate the impact of the pedagogical methods used in this study, historical data was collected to establish a baseline (Table 1). These data pertain to the online delivery modality, the same modality as the course used in this study. The values for *Total Homework Assignments* represent students enrolled in the course when a homework assignment was both assigned and due. Data from students who withdrew from the course were excluded after their withdrawal date, one reason why the total number of homework assignments fluctuates, despite using the same number of homework assignments each semester. Other reasons for the fluctuations were due to student enrollment and the number of course sections offered each semester.

The data in Table 1 clearly demonstrate numerous homework assignments were not submitted, or submitted late. These missed, or late homework assignments, impacted a student's final course grade since homework assignments accounted for half of the final course grade. For each homework assignment missed by a student, their final course grade dropped by three and one-half percentage points. Clearly, students who missed several homework assignments significantly impacted their final course grade. In addition, despite access to the solution key,

students who did not complete homework assignments were more likely to perform poorly on exams as they had less practice with that course topic.

Impact of Homework Completion on Final Course Grade

Although some instructors do not collect and grade homework, homework assignments for the course used in this study accounted for 50% of the final grade. As discussed earlier, this was intended to ensure students completed their homework assignments, while also conveying the importance of completing all homework. The remainder of the course grade was split equally between course exams and projects. Consequently, not regularly completing homework assignments would negatively impact a final course grade, the extent varying dependent upon the amount of homework completed. This was consistent with Bembenutty's (2009) findings that students who completed course homework earned higher course grades.

The course was designed to release a new homework assignment each week for 14 weeks. By doing so, half of a student's final course grade was spread evenly throughout the semester. Each homework assignment had a two-week window from the day it was assigned to when it was accepted for full credit. After this, students could turn in a homework assignment one day late, but only for half-credit. This timeline provided the instructor an opportunity to publish a solution key immediately after the homework assignment due date so students could check their work, examine problem-solving methodologies, and learn how to present technical results. Although the homework grading policy was punitive, it was intended to indicate the importance of homework and to encourage homework completion. Typically, students who did not submit their homework did not perform as well as other students on the exams and projects, consistent with prior research (Bembenutty, 2009).

Impact of Homework Completion to the College

Students who did not complete their homework assignments also negatively impacted the college. As one of Florida's 28 state colleges, the college is part of the Performance-Based Funding Program instituted by the Florida Legislature in 2016 (Florida College System, 2018b), in which member institutions are competing for their share of $60 million in annual funding. One of the state's metrics to determine performance funding levels is "completion rate," which measures a cohort of students who graduate within two, three, or four years (Florida College System Completion Rate Measure, 2018). Students who repeat courses increase the length of time it takes to graduate, detrimentally impact the college's completion rate, and reduce the college's performance funding.

Each semester, several students who did not complete their homework assignments, withdrew from the course to avoid a poor grade reported on their transcripts. Similarly, students who did not complete their homework assignments, but remained in the course, finished with a grade of an F. Both cases contributed to a lower completions rate, which detrimentally impacted performance funding at the college. Although the college has been at gold-level performance-funding for the past two years, there is a great deal of scrutiny with courses that have low completion rates. The online modality of *Engineering Concepts and Methods* has the lowest completion rate in the engineering department, making it an excellent candidate for this study.

Impact of Homework Completion to the Student

In addition to impacting the college, there was also a financial impact to students who performed poorly in the course. The college has two course withdrawal deadlines each semester: an early withdrawal allowing students to drop a course and receive a full tuition refund, and a late withdrawal which does not provide any refund to students. Students who did not take

advantage of the early withdrawal can repeat the course, but they must pay for it a second time. As shown in Table 2, 25 (21.6%) students withdrew from the course who would need to repeat and pay for it a second time.

Table 2: Historical Final Course Grades

	Term					
Grade	F 16	S 17	F 17	S 18	Total	Percent
A, B or C	15	16	25	12	68	58.6
D or F	6	6	3	4	19	16.4
EW	4	0	0	0	4	3.4
LW	4	7	10	4	25	21.6
Total	29	29	38	20	116	100.0

Note. F = fall semester; S = spring semester; EW = early withdrawal; LW = late withdrawal.

All students who completed the course with a grade of a D or F were eligible for the college's grade forgiveness policy providing students an opportunity to repeat a course, but only the last grade earned is computed into the student's GPA. According to Table 2, 19 (16.4%) students were eligible to take the course a second time, although they would have to pay for the course again. Unfortunately, students who repeat a course often encounter problems with financial aid due to credit hour limitations on their financial aid packages. Combining the 25 (21.6%) late withdrawal students with the 19 (16.4%) students who finished with a grade of D or F, corresponds to 44 (38.0%) students required to repeat, and pay for, the course a second time.

Impact of Homework Completion to the Instructor

Instructors can also be negatively impacted by students who do not perform well in a course due to their feedback provided to the college. The college administers a student survey at

the end of each semester, the Student Perception of Instruction (SPOI), which directly, and anonymously, solicits student feedback. The survey includes 12 questions covering student self-evaluation and faculty evaluation. The survey responses are measured using a 5-point Likert scale ranging from *Strongly Agree*, to *Strongly Disagree*. If 70% of student responses for any question, in any course, are not *Strongly Agree* or *Agree*, then the instructor must discuss the results with their Dean and develop an improvement plan. Two student self-evaluation questions are: *I have dedicated a sufficient number of hours to this course to be successful*, and *I have completed all of my assignments*. For either of these questions, students who did not complete their homework assignments might not select *Strongly Agree* or *Agree*. If enough students select these options (i.e., less than 70%), then the instructor must address it with their Dean.

Similarly, one faculty evaluation question is: *Overall, the instructor was effective in helping me achieve the objectives*. If a student did not regularly complete and submit their homework, they might select *Strongly Disagree* or *Disagree*. Unfortunately, the SPOI is anonymous, so there is no link between a student's final grade and their SPOI feedback. Therefore, a student who did not dedicate sufficient time to the course, or did not complete all of their homework, might complete the SPOI indicating the instructor was ineffective, which may not be entirely true. The college's instructors, Deans, and Academic Affairs personnel consider the SPOI a valuable source of feedback, plus it is used as part of an instructor's annual evaluation. Encouraging students to complete their homework assignments, so they perform better on the assessments and earn a higher grade in the course, is one means of improving SPOI feedback. Therefore, it is important to identify strategies and support mechanisms to help students succeed, similar to the interventions evaluated in this study.

Organizational Context

Live Oak State College, a pseudonym to maintain the confidentiality of the participants of this research study, is located in Florida and supports more than 20,000 students across several campuses pursuing a degree, a certificate, or a program (Florida College System, 2018a). The college has more than 1,200 employees with approximately 225 full-time and 500 part-time faculty. According to Live Oak's institutional research team, the most recent student demographics are: 55% female, 62% part-time, 54% between 18-24 years old, and 69% pursuing a two-year degree. These demographics closely align with national averages for state and community colleges (Cohen et al., 2014).

The college has four schools: Academic Foundations, which provides educational opportunities for adults seeking basic academic skills, a high school diploma, or skill building; Arts and Sciences, which provides core academic courses for students pursuing an associate's or bachelor's degree; Career and Professional Programs, which provides courses for students pursuing business, legal and entrepreneurship degree programs; and Engineering, Design, and Construction, which provides comprehensive technical programs for students interested in professional careers in local industry. The School of Engineering, Design, and Construction offers degree programs grounded in academic course work, and practical applications of industry principles via its two centers: Construction, Design, and Apprenticeship; and Engineering and Computer Technology. The course used for this study, *Engineering Concepts and Methods*, falls under the Center for Engineering and Computer Technology.

The Center for Engineering and Computer Technology offers two and four-year degrees, on several campuses, with both full and part-time faculty members. The Engineering and Computer Technology faculty have at least one graduate technical degree, in addition to

extensive industry experience. The Center for Engineering and Computer Technology is further divided into a Computer Technology department, and an Engineering Technology department. Courses managed by the Engineering Technology department support several programs including the AA in Pre-Engineering, AS in Chemical Technology, AS in Engineering Technology, and BS in Engineering Technology. *Engineering Concepts and Methods* is taught by the faculty in this department. As discussed earlier, the course is taught using both face-to-face and online modalities, although during the summer, it is only offered in the face-to-face modality due to the shorter semester.

Positionality of the Researcher

The researcher has been a part of the organization's faculty since 2013. In 2016, the researcher became the organization's program manager for the AS and BS degree programs in Engineering Technology. In this capacity, the researcher played a key role in curriculum development, student and faculty recruitment, and community involvement. The researcher is also responsible for the organization's Sustainability Technical Certificate, a multi-disciplinary 18 credit-hour program providing students with hands-on projects in "green" and emerging technologies, research opportunities, and curricula to create a better-informed global citizen. Using the continuum presented by Herr and Anderson (2015), this places the researcher as an "insider" studying their own practice.

In fall 2017, as part of UCF's Ed.D. Curriculum and Instruction degree program, the researcher conducted an informal intervention to investigate similar concerns with students completing their homework assignments. The research question was, "Does student behavior change if students are offered a modest incentive to submit homework assignments early?" To

investigate this, the researcher offered a small grade incentive to students for turning in homework assignments early; the results were promising and aligned to earlier studies (Hill, Palladino, & Eison, 1993; Norcross, Horrocks, & Stevenson, 1989). Unfortunately, there were two challenges: a hurricane impacted the course schedule and the ability for some students to submit their homework due to extensive power outages, and student awareness of the incentive despite it being announced to the class several times.

Conceptual Framework

Knowlton (2000) suggested courses should be student-centered, but one challenge with an online course is students ultimately determine their engagement with course materials, and the order to use them (Lim, 2016). In a face-to-face classroom, the teaching-learning process between the instructor and students is interactive, and instructors can provide guidance on important aspects of new content as it is being introduced (Cobb, Yackel, & Wood, 1992; Marzano, 2007). For the asynchronous online classroom used in *Engineering Concepts and Methods*, students were expected to use course materials provided by the instructor to gain familiarity with new content prior to attempting homework. For example, students should have read the textbook which provided step-by-step examples for solving problems similar to homework, and reviewed supplemental information which provided background material on underlying mathematics principles and programming structures. After submitting their homework, students should have examined solution keys for tips and suggestions, plus reviewed instructor feedback. Based on historical student performance, some students were not using course materials and skipped directly to the homework assignments.

Under the prior course structure, the only aspect measured by the instructor was if students submitted their homework assignments. There was not any measurable evidence if students read the textbook, prepared sample exercises, developed a study plan, or reviewed supplemental information. As discussed earlier, some students did not submit homework assignments, which impacted them, the college, and the instructor. Encouraging students to complete their homework assignments was the focus of this study; it was also the foundation for developing the research questions and methods for evaluating them. The following sections provide an overview of the conceptual framework used for this study.

Self-Regulated Learning

An important aspect of higher education is preparing students to be life-long learners (Pintrich, McKeachie, & Lin, 1987). One way of helping students meet this objective, is to provide learning strategies for studying, planning, and time management that could extend past a current single course. Helping students improve their self-regulated learning skills is particularly important in *Engineering Concepts and Methods* because the course is conceptually rich, computer-based, delivered online, and asynchronous. Zimmerman (1990) characterized self-regulated learners as more highly motivated because they readily engage in, provide effort for, and persist longer with learning tasks than those students who do not self-regulate.

Zimmerman (2002) broke down self-regulated learning into three phases, with the first phase being the forethought phase, where students focus on task analysis and self-motivation beliefs. In this phase, students proactively set goals, identify strategies to achieve their goals, and assess their self-efficacy and interests of their self-regulated learning strategies (Zimmerman 2002). Part of this phase entails students conducting an informal strategic plan whereby they

select the proper strategy to meet the demands of the task (Bembenutty, White, & Vélez, 2015; Bol, Campbell, Perez, & Yen, 2016).

The second phase is performance, where students focus on self-control and self-observation (Zimmerman 2002). Students engage in self-monitoring, self-evaluation, and self-oriented feedback about the effectiveness of their learning (Zimmerman 2002). Students identify if they need help, and seek appropriate resources such as self-instruction, time monitoring, environmental control, tutoring, support from the instructor, or outside resources (Bembenutty, White, & Vélez, 2015; Bol, Campbell, Perez, & Yen, 2016).

The third phase is self-reflection, where students focus on self-judgment and self-reaction (Zimmerman 2002). Students engage in self-evaluation of completed tasks, self-satisfaction, and determine whether tasks should be repeated, or if they are ready to move on to a new task. Ideally, students identify strengths and weaknesses to attribute successful task completion (Zimmerman 2002). These three phases, followed in sequence, provide students an opportunity to continually improve their learning strategies as they move from one task to the next.

Instructional Pathway

In traditional face-to-face classrooms, instructors regulate and monitor sequential movement, or the instructional pathway, as course content is introduced. Some instructors are concerned students may not complete learning activities as designed, hence these instructors leverage measures to force students to proceed following a prescribed path (Lim, 2016b). Lower ability students perform better with a logical sequence, especially with mathematics instruction, whereas higher ability students typically remain unaffected (Lim, 2016b). This is relevant to *Engineering Concepts and Methods* because the college has an open enrollment policy, which

means lower ability students may be enrolled in this course who would perform better with a prescribed pathway.

ABC Model of Attitude

Attitude has been defined as a psychological tendency expressed by evaluating a particular item or entity, such as homework, with some degree of being favorable or unfavorable (Eagly & Chaiken, 2007). Student attitudes toward homework (entity) could impact their willingness to complete (behavior) their homework assignments (Ajzen & Fishbein, 2005). Rosenberg and Hovland (as cited in Breckler, 1984) developed a three-part classification of attitude, the ABC Model, breaking down attitude into affect, referring to an individual's emotional response such as their feelings or mood; behavior, referring to an individual's actions or intentions; and cognition, referring to an individual's beliefs or thoughts. In the context of *Engineering Concepts and Methods*, students with better attitudes toward homework may be more likely to complete their homework assignments.

Research Questions

Research Question One

The first part of the conceptual framework was self-regulated learning, because this strategy is intended to help students become better life-long learners (Pintrich et al., 1987). Empowering students is part of the college's vision, plus it is important to the researcher conducting this study. Helping students enrolled in the course used in this study may provide a near-term impact to homework completion, but it may also help these students adopt better study habits that will extend into subsequent courses.

Research Question One: *To what extent do self-regulation strategies, such as planning and reflecting, influence student completion of homework assignments?*

Research Question Two

The second part of the conceptual framework was the instructional pathway, because some students may miss critical resources when they circumvent the course's intended pathway. The term used was *sequencing*: students were required to perform small tasks, in order, before gaining access to homework assignments which was a modification of the instructional pathway from prior semesters. The term "sequencing" is similar to Mayer's (2011) principle of segmenting whereby complex lessons are presented in manageable parts, but for this study, students were also required to follow a prescribed order (i.e., sequence) using course materials prior to gaining access to homework assignments.

Research Question Two: *To what extent do sequencing strategies, such as a content quiz and a practice problem, influence student completion of homework assignments?*

Research Question Three

The third part of the conceptual framework was the ABC model of attitude, because student attitudes toward homework can influence their behavior to complete it. Also, prior behavior has been shown to be a predictor of future behavior (Ajzen, 2002a, 2002b; Conner & Armitage, 1998). Ideally, measuring student attitudes toward homework before taking this course, and again after taking this course, would be beneficial to determine if student attitudes changed as a result of the interventions used in this study.

Research Question Three: *To what extent do self-regulation strategies, such as planning and reflecting, or sequencing strategies, such as a content quiz and a practice problem, influence student attitudes toward homework?*

Summary

Today, most educators agree homework is a means of extending learning opportunities outside the classroom (Marzano, 2007), whether that classroom be face-to-face, or virtual. Unfortunately, college students do not regularly complete their homework, a problem with students enrolled in the course used in this study, and colleges across the United States (Edgcomb et al., 2017). Based on the information presented in this chapter, there is sufficient evidence students were not performing well due to missed homework assignments, and it impacted the students, the instructor, and the college. Consequently, this problem warrants further investigation to address the research questions, develop appropriate interventions, design a methodology to evaluate the interventions, examine the results of the evaluation, and consider future work. The next chapter is devoted to a literature review of pertinent areas of homework research as it pertains to post-secondary STEM education before proceeding to the methodology used in this study.

CHAPTER TWO: LITERATURE REVIEW

Introduction

The purpose of this study was to evaluate pedagogical methods designed to positively influence students to complete homework assignments. This study examined college students enrolled in an online introductory engineering course, *Engineering Concepts and Methods*, taught asynchronously using the online delivery modality. Although the course had prescribed due dates, students set the schedule at their own discretion and worked at their own pace to meet course requirements.

The rationale for this study, as discussed in Chapter One, is briefly summarized here before proceeding with the literature review. First, despite evidence that including homework assignments as part of the final course grade encouraged students to complete and submit them, it was not historically successful as evidenced by the number of missing homework assignments (Table 1). Second, students missed opportunities to practice course concepts when they did not complete their homework. Third, the instructor missed opportunities to provide feedback to students because they did not submit their homework. Fourth, there was a financial impact to the college due to lower completion rates, plus there was a financial impact to students who repeated the course. Finally, the instructor was concerned SPOI data was negatively impacted by students who were not performing well. All of these issues were created because students did not submit their homework assignments.

The conceptual framework for this study was discussed in Chapter One, but it is briefly summarized here. Students in *Engineering Concepts and Methods* should have read the textbook, reviewed the supplemental information, submitted homework assignments, and

reviewed solution keys. Historical data (Table 1) provided evidence students were not turning in their homework assignments. The conceptual framework for developing the research questions was self-regulated learning strategies, sequencing strategies, and the ABC model of attitude. The three research questions are restated below:

1. To what extent do self-regulation strategies, such as planning and reflecting, influence student completion of homework assignments?
2. To what extent do sequencing strategies, such as a content quiz and a practice problem, influence student completion of homework assignments?
3. To what extent do self-regulation strategies, such as planning and reflecting, or sequencing strategies, such as a content quiz and a practice problem, influence student attitudes toward homework?

The literature review preceded the research because the investigator sought to understand prior work, its strengths and weaknesses, and its meaning (Boote & Beile, 2005). This literature review is broken down into research topic areas, or perspectives, in lieu of a chronology (Feak & Swales, 2009). Searching for existing literature in support of this study focused on the keywords *homework*, *homework assignment*, and *assignment*. Studies that exclusively examined elementary or middle school were eliminated, as were studies that did not examine STEM-related course work. Although this narrowed down the results considerably, further reductions were made to focus on post-secondary STEM-education, particularly at community colleges. Where possible, the literature searches were further reduced to relevant studies from the past five years using Google Scholar, ERIC, and PsycINFO. The journal articles, their references, plus other pertinent materials (e.g., textbooks) were further reviewed and categorized to determine their relevance to this study, specifically targeting the conceptual framework.

Unfortunately, there are limited studies addressing homework at the community college, particularly in STEM education. However, there is prior research with relevance to this study which was included in this literature review. Before proceeding with existing literature associated with the conceptual framework, several aspects of homework warrant a preliminary discussion such as defining homework, establishing the importance of homework, examining the appropriate amount of homework, and understanding the important role of instructor feedback.

Defining Homework

A simple and concise definition of homework generally accepted in the literature, is an academic task assigned to students by their instructors, which will be completed outside of the classroom (Cooper, 1989a; Cooper, Steenbergen-Hu, & Dent, 2012). The terms *homework*, *homework assignment*, and *assignment* are used interchangeably in this study, and refer to the definition established by Cooper (1989a). Since the course used in this study was taught online, and all work was completed outside of the traditional classroom, a revised definition was needed. Homework assignments, as used in this study, refer to any graded activity except for exams or projects.

Epstein and Van Voorhis (2001) stated instructors not only assign homework, but they also design homework. As such, the homework assignment process begins with instructors selecting topics and material that will help their students meet specific learning goals, which means an important role of the educator is to properly design homework. Therefore, it is critical instructors identify the underlying purpose of each homework assignment. Based on their review of studies, research, workshops, and interviews regarding homework, Epstein and Van Voorhis (2001) identified 10 broad purposes of homework. Of these 10 purposes, one aligns with the

purpose of homework assignments in this study: practice. Practice focuses on giving students an opportunity to gain proficiency with new skills, and ideally, to demonstrate mastery using them (Cooper et al., 1998; Cooper et al., 2006; Cooper & Valentine, 2001; Epstein & Van Voorhis, 2001). Other reasons cited by Epstein and Van Voorhis (2001) included preparation for new material (e.g., a flipped classroom), parent-child relations, parent-teacher communications, peer interactions, policy, public relations, and punishment. However, these other reasons do not pertain to the underlying purpose of homework for the course used in this study.

Beyond the fundamental purpose of homework, it can also be broadly classified as the amount of homework assigned, the skill area being emphasized, the degree of choice students can make, and the degree of individualization (Cooper et al., 2006). These attributes also contribute to the design and development of homework assignments. For *Engineering Concepts and Methods*, the purpose of homework was practice, and it was designed so students could develop the necessary skills to demonstrate mastery with each course topic assessed on the exams and projects.

The Importance of Homework

Multiple studies have examined the relationship between homework and its positive impact on academic performance (Cooper, 1998b; Cooper et al., 1998; Cooper et al., 2006; Cooper & Valentine, 2001; Epstein & Van Voorhis, 2001; Núñez et al., 2015). For example, in the original synthesis of literature conducted by Cooper (1989b), 20 studies compared students who were given homework assignments, with those who were not. Of these studies, 14 produced statistically significant effects favoring homework, providing data suggesting the importance of homework as a contributing factor to academic success (Cooper, 1989b).

Later, Cooper et al. (2006) conducted a subsequent synthesis of homework-related research spanning from 1989 to 2003, and again found evidence supporting a positive influence of homework on academic achievement. In particular, this highly cited synthesis provided data supporting improved academic achievement among older students, when homework was integrated into the curriculum. This notion was supported by a myriad of earlier work, which indicated that within reason, more homework, and more time spent on homework, led to better achievement for high school students (Cooper & Valentine, 2001; Keith, 1982; Keith & Cool, 1992; Paschal, Weinstein, & Walberg, 1984). Further, high school students who were assigned homework outperformed nearly 70% of those students not assigned homework (Cooper, 1989b). While *Engineering Concepts and Methods* is a college-level course, the introductory nature of the course makes the applicability of the results of these studies, which use high school student data, more relevant.

The association between the amount of time spent on homework, and academic performance in science and mathematics, was studied by Maltese, Tai, and Fan (2012). Their study used data from two nationally representative samples of high school students collected in 1990 and 2002. Their results did not show a strong positive correlation between time spent on homework and grades, but there was a consistent and positive relationship between time spent on homework and standardized exam scores, which are typically used for college acceptance. Although this study did not find an improvement in grades, it did align with prior research in showing that homework contributed to improving student academic achievement.

Rayburn and Rayburn (1999) examined a mathematically rigorous, college-level introductory accounting course. The course required problem-solving, critical thinking, and quantitative analysis, hence its relevance to an introductory engineering course. The results of

their study demonstrated that students who completed their homework learned the course material better, as measured by exam scores. The results of this study suggest that encouraging students to complete their homework helps them improve their overall learning of challenging course material, a similar objective for students enrolled in *Engineering Concepts and Methods*.

Bennett, Schleter, Olsen, Guffey, & Li (2013) studied college freshmen engineering students enrolled in a physics for engineering course. The course, taken by all incoming engineering students, combined physics with an introduction to engineering. Similar to *Engineering Concepts and Methods*, homework counted for a considerable portion of the final grade (21%), although students in Bennett et al.'s (2017) study could pass the course without completing any homework. The overall pass rate for students enrolled in the course was 83%, but the pass rate for students who completed at least 80% of the assigned homework, was 97%. These results are compelling: students who completed most of the homework had a substantially higher pass rate in the course, further linking the importance of homework to student achievement.

A more recent meta-analysis by Fan et al. (2017) also examined homework and student achievement, specifically in mathematics and science. The study expanded on earlier work by Cooper et al. (2006) by including studies outside the United States, an expanded time period (1986 to 2015 versus 1987 to 2003), and a narrower subject matter focus. This meta-analysis is especially relevant to this study given its focus on mathematics and science, key components of engineering education. Similar to the synthesis by Cooper et al. (2006), this 30-year meta-analysis also found a strong relationship between homework and achievement, particularly for older students. However, unlike earlier work, this meta-analysis found homework and achievement was stronger for elementary school students than middle-school students. Their

explanation for this contradiction was the narrower subject matter focus and parental involvement with elementary school students and their homework. Fan et al. (2017) also found a stronger positive relationship between homework and achievement for students in the United States.

Instructors generally agree that homework deepens student understanding of new materials via additional practice with concepts and applications tied to student learning outcomes (Arasasingham, Martorell, & McIntire, 2011; Doorn, Janssen, & O'Brien, 2010; Richards-Babb, Drelick, Henry, & Robertson-Honecker, 2011). Despite the lengthy history of homework, its research, and the synthesis of research supporting its positive impact on academic success, there are methodological and theoretical aspects of prior research that suggests there is still a great deal of work to be done (Cooper et al., 1998; Cooper et al., 2006; Trautwein & Köller, 2003). This is particularly true given the limited research available for two-year college students. Exploring pedagogical interventions that encourage students to complete their homework was the focus of this study as there is compelling evidence suggesting this is an important aspect of a student's learning process.

Assigning Homework

A critical factor influencing the effectiveness of homework is determining how much should be assigned to students. In general, and spanning more than three decades, research has shown a positive correlation between time spent on homework, and student performance as measured by academic achievement (Cooper et al., 2006; Cooper & Valentine, 2001; Fan et al., 2017; Paschal et al., 1984). The quantitative synthesis by Paschall et al. (1984) of 15 earlier studies found an overall positive effect of homework as measured by student learning,

particularly with more frequent homework assignments, suggesting students who spend time over several days may perform better academically than those who did not.

Subsequent to the work by Paschall et al. (1984), Cooper (1989b) also found evidence that students who spent more time on homework earned better grades. Of the 50 studies that examined the amount of time students spent on homework and their achievement levels, 43 indicated students who did more homework, had better achievement scores (Cooper, 1989b). The more recent meta-analysis by Fan et al. (2017) also aligns to this earlier work, and is particularly relevant because it focused on mathematics and science, unlike the prior syntheses.

However, one shortcoming of these meta-analyses and syntheses is that they were not exclusive to college students. This is problematic because of the course used in this study, and since the amount of time students devote to homework changes considerably from high school to college. Adjusting to homework demands and instructor expectations can be challenging for new college students, especially since there are other activities on which students may want to spend their time (Calderwood, Ackerman, & Conklin, 2014). Calderwood et al. (2014) emphasized that new college students typically experience little parental or instructor oversight regarding their study habits (e.g., time spent doing homework), which distinguishes college students from high school students.

Grade Level

In general, most existing research on homework focused on K-12 education. For example, the first large-scale synthesis on homework (Cooper et al., 2006) analyzed more than 120 prior studies, although few of these studies were associated with post-secondary education. Despite this shortcoming, the key finding in Cooper et al.'s (2006) synthesis was that homework

has substantial positive effects on high school student achievement. However, for elementary school students, the effect was trivial, and junior high school students were somewhere in between the two age groups (Cooper et al., 2006).

Although the topic of this study focused on a college-level introductory engineering course, some of the literature reviewed and referenced included selected studies from high school education, particularly STEM education. The rationale behind this is that the Florida College System admittance process guarantees admission for high school graduates with standard diplomas, General Education Development (GED) graduates, or high school graduates with an approved home education in accordance with Florida Statutes. The college's open enrollment acceptance process means classes have students with a broad range of study habits; varying degrees of preparedness, knowledge, and skills; varying levels of motivation; and different levels of maturity. Beyond the challenges of open enrollment, Live Oak students also have a wide range of ages, from under 18 to over 45 years old. All of these student characteristics should be considered when assigning homework, not just its underlying purpose (Warton, 2001).

Transition from High School to College

The amount of time spent on homework, relative to the amount of time spent in class, changes as a student progresses from high school to college. A typical high-school student, for example, spends approximately 30 hours per week in the classroom, regardless of whether it is their first or last year. However, the time spent on homework increases from an average of 7.5 hours per week, to 10 hours per week, from freshman year to senior year (Cooper et al., 2006). This is a sharp contrast for a typical full-time college freshman, who has approximately15 hours of classroom time and potentially 30 or more additional hours of homework per week

(Calderwood et al., 2014; Cerrito & Levi, 1999). The data from these studies suggests an average high school senior has one hour of homework for every three hours of contact time. Conversely, an average college student has six hours of homework for every three hours of contact time (Cerrito & Levi, 1999). This is a six-fold increase for the typical college freshman, and requires a substantial adjustment as one transitions from high school to college. Ideally, the interventions used in this study should help college students develop better homework management skills as they adjust to this considerable increase in time spent outside of the classroom.

As discussed previously, homework was an important aspect of *Engineering Concepts and Methods*, particularly since the course was online and students were unable to complete assignments in a physical classroom. The instructor expected students to spend four to six hours per week for the course based on two contact hours that would take place in the classroom, plus an additional two hours per contact hour, totaling six hours. This is consistent with time expectations for a typical two-credit hour course (Cerrito & Levi, 1999). Six hours per week is one-half of the total time a typical high school student spends outside the classroom (Cooper et al., 2006), a drastic change for many new college students.

Challenges with college students doing homework is not unique to the college nor the course in this study. Numerous studies on engineering students sought to resolve this same problem (Arora, Rho, & Masson, 2013; Bennett et al., 2013; Edgcomb et al., 2017; Flori, Oglesby, Philpot, & Hubing, 2002; Jones, 2017; Trussel & Dietz, 2003). For example, Arora et al. (2013) found that the best means for students to master concepts covered in statics, a core course in an engineering curriculum, they must spend time solving numerous problems, and they must develop good problem-solving techniques for subsequent engineering course work.

According to the researchers, it was challenging to have engineering students spend the necessary time on homework. Clearly, the problem with engineering students and homework is not unique to the students enrolled in *Engineering Concepts and Methods*.

Adult Learners

Approximately one-half of the students attending Live Oak State College are over the age of 25, consistent with community college demographics nationwide (Cohen et al., 2014). Adult learners, or non-traditional students, typically have other time constraints such as being a single parent, working full-time, or having other dependents in addition to a spouse (NCES 2002). All of these characteristics impact time spent outside the classroom (e.g., homework), and in most cases, these constraints have a higher priority. According to the NCES (2003), adult students typically prioritized school third, with family being their first priority, and work being their second priority. Instructors are competing for a student's time for all work outside the classroom, including homework.

Xu (2013) found two themes applicable to non-traditional students in his synthesis on homework management: they need to learn how to structure, control, and regulate their study environment to make it conducive to completing their homework; and they need to learn how to establish study schedules, set priorities, plan ahead, and balance family, work, and school. *Engineering Concepts and Methods* had a single checkpoint for each topic, submitting a homework assignment, which may not encourage students to plan properly. Xu (2013) suggests encouraging adult students, who comprise 50% of the college's student demographics, to expand their self-regulated learning skills to improve their academic performance.

Engineering Education

Engineering education continues to receive scrutiny from national panels, the Accreditation Board for Engineering and Technology (ABET), and industry, to teach students real-world engineering skills, and to provide students training for critical thinking and problem-solving skills (Felder et al., 2000). Just as with other STEM fields, homework is an important part of the curriculum, and it is crucial to student success, particularly in engineering courses (Li, Bennett, Olsen, & McCord, 2018). Li et al. (2018) found that one-quarter of first-year engineering students were completing less than 80% of their homework assignments. The results of this study indicated low homework completion rates were primarily attributed to poor time management skills. Bennet et al. (2013), also using first-year engineering students, found that students who completed 80% of their homework assignments had a 97% pass rate, whereas students who completed less than 80%, had a 33% pass rate. This same study found a strong correlation between homework grade, and final course grade, indicating the importance of homework, at least for the freshman engineering course used in their study.

The work by Bennet et al. (2013) was compelling because it correlated homework completion to incoming ACT mathematics scores, and found students who did not complete their homework were more likely to have lower ACT scores, further hindering their success in the course. Although this data was not available to the researcher for this study, it would be an interesting topic for further research. Other studies focused on introductory engineering courses also found success when students did more homework, giving them a chance to practice their problem-solving skills, and to prepare them for subsequent courses and industry (Arora et al., 2013; Bennett et al., 2013; Edgcomb et al., 2017; Flori et al., 2002; Trussel & Dietz, 2003).

Online Courses

Hachey, Wladis, and Conway (2015) studied prior online course experience as an indicator of subsequent online STEM course academic outcomes. Their study used students enrolled in a STEM course at a large northeastern community college and found that attrition rates for online STEM courses were higher than non-STEM courses. The most successful students, as measured by GPA, had the most prior experience taking online courses. In a similar study, also at a community college, mathematics, computer science, and physical science courses also had larger gaps with their online course sections versus their face-to-face course sections (Wladis, Conway, & Hachey, 2015). Both studies are relevant because data came from community colleges similar in size to Live Oak State College, they evaluated STEM courses, and they evaluated student performance in online courses.

Hachey et al. (2015) noted two problems with prior online course research. First, most prior research focused on four-year colleges and universities. Although Live Oak does offer four-year degrees, this is a recent change, and most of its degree seeking students are pursuing two-year degrees. Given the difference in student profiles, four-year college and university research may be difficult to generalize at the community college level (Capra, 2011; Cohen et al., 2014). Second, there was a shortage of online STEM course research outside of homework tools (Bowen et al., 2012). Although most prior research overlooked two-year colleges, particularly online STEM courses at two-year colleges, these aspects are important to this study since *Engineering Concepts and Methods* was an online STEM course taught at a predominantly two-year college. Notwithstanding these challenges with a lack of prior research, several studies found successful course completion was lower for online course sections than traditional face-to-

face course sections (Hart, Friedmann, & Hill, 2015; Xu & Jaggars, 2011), consistent with historical data from the course used in this study.

One additional challenge facing students in an online course, especially one that includes self-paced progress, is procrastination (Broadbent & Poon, 2015; Goda, Yamada, Kato, Matsuda, Saito, & Miyagawa, 2015; Koper, 2015). In particular, the asynchronous online learning environment of *Engineering Concepts and Methods* invited procrastination, especially given the additional demands of self-regulation in an online education setting versus traditional face-to-face settings (Klingsieck, Fries, Horz, & Hofer, 2012). Two broad categories to measure and study procrastination are self-reporting surveys and measures of actual recorded delay behavior, such as when students get started on an assignment, how students pace themselves, or how students complete an assignment (Lim, 2016a). Although procrastination was not examined in this study, examining self-regulation was, and it is covered further below.

Online Tools

One proposed solution to encourage students to spend more time on homework has been the advent of online homework tools. Online self-paced courses allow students to start at any time, and work through the course materials at their own pace. Students can complete course materials in any order, despite a recommended sequence for progressing through the course content (Anderson, Annand, & Wark, 2015; Lim, 2016b).

Numerous research studies investigated alternative homework systems in lieu of traditional paper and pencil homework. The primary reason for this comparison was it created an opportunity for students to solve numerous problems, while simultaneously eliminating the burden of grading for instructional staff (Arora et al., 2013; Flori et al., 2002; Jones, 2017; Reece

& Butler, 2017; Taraban, Anderson, Hayes, & Sharma, 2005). Some of these tools offered no assistance and others provided complete solutions (Lindquist & Olsen, 2007). A complete solution has the benefit of illustrating the problem-solving process, but it may encourage some students to examine the solution in lieu of completing the homework on their own, which is an advantage to providing check figures (Lindquist & Olsen, 2007). *Engineering Concepts and Methods* did not provide an online homework tool as part of this study.

Homework as a Formative Assessment Tool

Black and William (2009) broke down formative assessments into five activities typically found in a classroom: sharing success criteria with students; classroom questioning; comment-only marking, or feedback that helps students move forward; peer- and self-assessment; and formative use of summative tests. Although these activities were developed as a basis for unifying classroom practices, they are also relevant for an online classroom environment. This work built on Ramaprasad's (1983) three critical processes in teaching and learning: establishing where students are in their learning, establishing where they are going, and identifying what they need to do to get there. Homework, as a formative assessment tool, fits in well with these activities and processes since the responsibility for learning is mutually shared by the instructor and student (Black & William, 2009), and it empowers students as self-regulated learners (Nicol & Macfarlane-Dick, 2006).

Gikandi, Morrow, and Davis (2011) expanded on the work by Black and William (2009) and defined formative assessment as the process of establishing how much, and how well, students are learning relative to the established learning goals to support further learning. In a classroom, the instructor is able to provide immediate feedback. However, in an asynchronous

online course, this may not be possible, yet timely feedback is critical. Tallent-Runnels et al. (2006) reviewed more than 75 studies examining online courses. Their findings emphasized the importance of ongoing feedback that is clear and quick for sustained student engagement, student satisfaction, and active participation.

Effective feedback should be frequent and meaningful to encourage student interactions, establish a firm understanding of learning goals, and promote expected outcomes (Capra, 2011; Gaytan & McEwen, 2007; Wolsey, 2008; Yorke, 2003). Wolsey (2008) studied graduate students and found it essential to share grading rubrics, and meaningful examples with students in support of the feedback process. Gaytan and McEwen (2007) found meaningful and timely feedback was a critical component of online assessments, and in general, weekly homework assignments worked best. Faculty and students stated discussions, timed tests, quizzes, and projects were important features of an online course (Gaytan & McEwen, 2007). Some of these features were not incorporated into *Engineering Concepts and Methods*, but they should be considered based on these prior studies.

Feedback

Feedback has a powerful influence on learning and achievement, although some types of feedback may be more beneficial than others (Hattie & Timperley, 2007). Students who receive feedback about a specific task, and how to improve it, have the greatest impact on subsequent student performance (Hattie & Timperley, 2007). Although *Engineering Concepts and Methods* students were only required to submit homework assignments at the end of a two-week period, they were graded as they were submitted. Grading consisted of examining each problem and providing suggestions, corrections, and areas for improvement. In grading as assignments were

submitted, students received ongoing, personalized, and timely feedback. If any consistent misconceptions emerged, corrective feedback was shared with the entire class. Yorke (2003) noted that formative assessments should help students understand and appreciate the standards, or work quality, of what is expected of them.

In an earlier synthesis on homework (Paschall et al., 1984), the review of 15 prior studies found an overall positive effect of homework, especially if it was graded and feedback was provided. Trussell and Dietz (2003) found similar results with electrical engineering students. In their experiment, two course sections were assigned the same homework, but only one section was graded. The students whose homework was graded outperformed the control group as determined by exam scores. This was relevant because the graded homework made an impact on student exam scores, plus the instructor's time was well spent grading homework and providing feedback to the students (Trussell & Dietz, 2003).

Sadler (1989) identified three required conditions for students to properly benefit from feedback: a student needs to understand what good performance is, a student should know how their current performance compares to good performance, and a student should understand how to close the gap. Based on Nicol and Macfarlane-Dick's (2007) synthesis, good feedback has several principles critical to this study, especially in an online environment: a) instructors should clarify what good student performance is, b) instructors should facilitate student reflection, c) instructors should encourage positive motivational beliefs and student self-esteem, and d) instructors should provide opportunities for students to close the gap referenced by Sadler (1989).

Increasing Homework Completion

Knowing what motivates students should influence how instructors develop assignments to maximize completion, and ideally, student achievement, particularly since there are numerous reasons students do not complete assignments (Planchard, Daniel, Maroo, Mishra, & McLean 2015). The study by Planchard et al. (2015) was relevant because it used a STEM course, it focused on homework assignments, and it awarded credit to students for submitting homework. These are similar to the course design for *Engineering Concepts and Methods*. Planchard et al.'s (2015) study also found a strong positive relationship between homework assignment completion, and successful academic achievement, confirming results of earlier studies (Cooper, 1998b; Cooper et al., 1998; Cooper et al., 2006; Cooper & Valentine, 2001; Epstein & Van Voorhis, 2001). However, the key difference with Planchard et al.'s study (2015) was that it used college-level data, making it even more relevant to this study. Planchard et al. (2015) also found students were less likely to complete homework assignments if there were external demands on their time, the homework assignments were too complex, or an assignment would take too much time. Unfortunately, some instructors rely solely on a student's intrinsic motivation for completing homework (Kontur & Terry, 2014), hence instructors should carefully evaluate their homework assignment requirements for these attributes.

Course Credit

Ryan and Hemmes (2005) found providing students credit for turning in homework assignments was a powerful motivating factor. Their study examined using homework assignments, with written feedback, as preparation for quizzes, similar to *Engineering Concepts and Methods*. The quiz questions in their study, similar to exam questions used for the course in this study, corresponded to content covered by homework. Their study had two types of

homework assignments: those that were graded, and those that were not, but in both cases, all homework assignments received written instructor feedback. Their findings indicated students were more likely to turn in homework assignments when it counted toward their final grade and, more importantly, students who completed their homework assignments scored higher on quizzes (Ryan & Hemmes, 2005).

Tuckman (1998) found weekly quizzes based on homework provided students motivation, as well as improved learner achievement. In this study, the homework was neither collected nor graded, but it did provide students with practice and preparation for the weekly quizzes. Kontur and Terry (2014) found students were motivated by course credit for homework assignments with an optimal weighting of 15%: less than 15%, and students completed less homework and more than 15% did very little to change student behavior. Their study spanned 16 semesters, used students enrolled in college physics, and experimented with various course weightings for homework assignments.

Kontur and Terry (2014) also found administering quizzes based on homework encouraged students to complete and submit their homework assignments. Associating a grade for homework was important, but so was establishing it as a means for quiz preparation. Further, Fulton and Schweitzer (2011) found giving students a choice on homework assignments improved the number of completed homework assignments submitted by students. Students selected problems that were either more interesting, or that they could work to a solution.

Incentives

Radhakrishnan et al. (2009) found offering students small incentives to do homework assignments increased completion rates and overall student achievement. The incentive in their

study was a small grade incentive added toward the final course grade. Although this was a psychology course, the study used university students and found those students who did their homework did better in the course, as measured by final course grade. The grade incentive, or extra credit, was a catalyst to encourage students to actually do their homework.

Hill et al. (1993) qualified extra credit opportunities as those with the highest educational value. Their study randomly selected faculty to evaluate 39 extra credit opportunities and the likelihood they would use them in their courses. Of the faculty who responded, 82% favored offering extra credit incentives to students. These results align to an earlier study (Norcross et al., 1989) that found extra credit opportunities were worthwhile for instructors, but only if they provided an opportunity to explore specific topics in greater detail. From a student's perspective, extra credit was viewed as a second chance, or a means of improving their final grade (Hill et al., 1993; Norcross, Dooley, & Stevenson, 1993; Norcross et al., 1989).

Other Positive Effects

In an introductory college mathematics course, Bembenutty (2009) found an association between student homework activities and homework completion. Students maintained homework logs and the data revealed some homework behaviors were positively correlated with homework completion; specifically, time management, actual time spent on homework, and studying alone in a quiet environment. Over the course of the semester, these students were also developing better study skills. Similarly, Kitsantas and Zimmerman (2009) also studied college freshmen and found the quality of student homework had a significant impact on grades, as did the positive psychological benefits of homework on college student development as they took more responsibility for their own learning. These studies share common results: encouraging

students to complete their homework improved academic performance. Given the positive impact homework completion has on student development, as suggested by these prior studies, encouraging students to complete their homework was a critical part of this study.

Self-Regulated Learning

As discussed in Chapter One, self-regulated learning was part of the conceptual framework used in this study because it is intended to help students become better life-long learners (Pintrich et al., 1987), and empowering students is part of the college's vision. Helping students complete more homework may provide a near-term impact, but it may also help students adopt better study habits that will extend into subsequent courses. Student self-regulation has been summarized as a cyclical learning process with forethought, performance, and self-reflection phases (Bembenutty et al., 2015; Zimmerman, 1990, 2002, 2008). Each phase has numerous processes taking place concurrently as students assess new tasks from the forethought phase, to the self-reflection phase. An important part of this process is self-feedback, whereby students apply lessons learned from prior task success, or failure, to new tasks. As learning becomes more self-regulated, students become less dependent on their instructor and take more control over their learning (Zimmerman, 2002).

Zimmerman (2002) expanded on his initial work by emphasizing self-regulation does not rely on mental ability or an academic performance skill, but rather it is the student's ability to self-direct their mental abilities into academic skills. These students are aware of their efforts to learn because they are aware of their personal strengths and limitations, and take ownership for their learning. Ideally, students learn to become self-reliant (Zimmerman, 2002). Self-regulated learners can also be characterized as highly motivated because they will more readily engage in

an activity with greater persistence than students lacking self-regulation (Zimmerman, 2002). One such activity is completing homework assignments. However, Zimmerman (2002) also pointed out that it is more than just motivation because these learners must also develop a perceived self-efficacy, and intrinsic interest in the topic. Homework motivation can be further categorized as the drive to perform well on the homework assignment itself, whereas homework self-efficacy is self-reflective and a judgment of one’s abilities to complete an assignment (Calderwood et al., 2014).

Since *Engineering Concepts and Methods* is an introductory course, and nearly one-half of the college’s students are over the age of 25, some students may not have taken a college course previously, or potentially for several years. As such, many students may not have developed self-regulated learning skills, good study habits, or their skills diminished over time. Additionally, prior instructors may not have taught effective study strategies, which makes it difficult for some students to assess their competencies when confronted with new tasks (Zimmerman, 2002). These issues, combined with an asynchronous, online, conceptually complex course, pose a considerable challenge for many students. Students may also have been unable to assess when they needed help, how to seek it, or how to use the college’s tutoring center. Bembenutty and White (2013), in their study of college students, found a positive correlation with students who sought help, and their final course grade, which further espouses the necessity of such skills.

Earlier work by Zimmerman (1990) described self-regulated learning as actions and processes directed at acquiring new information or skills. Broadbent and Poon (2015) focused on how students in an online course could improve their academic achievement. Their review indicated the top three strategies were time management, metacognition, and effort regulation.

Given the complexity of the two software tools used in *Engineering Concepts and Methods*, students may be challenged with processing new information while taking this course. Students need to learn the context of the software tools, set and manage meaningful goals, identify correct problem-solving strategies, and judge their understanding of each course topic (Azevedo, Behnagh, Duffy, Harley, & Trevors, 2000). Helping students with their metacognitive development, and more specifically self-regulation, may help students improve their ability to regularly complete and submit their homework assignments.

Pintrich (2004) classified the different phases of self-regulated learning as planning and goal setting, self-monitoring, self-regulation, and reflection. As Pintrich (2004) noted, these phases are a time-ordered sequence a learner goes through while performing a task, such as a homework assignment, or learning new material. One challenge facing some learners, especially in an online course, is that they may not know how to use appropriate strategies to manage their learning environment, plus these learners lack self-regulation abilities to appraise the task with their learning needs (Kirschner & Merriënboer, 2013). Another challenge facing some students, especially newer students, is the open-door policy found at community colleges like Live Oak State College. Some of these students are less likely to be properly prepared for the academic rigor found in a college environment. Developing self-regulated learning skills could benefit these students, especially as they adjust to the shift in academic responsibility from the instructor, to the student, in post-secondary education (Bol et al., 2016).

Pintrich (2004) proposed a four-phase conceptual framework for self-regulated learning in the college classroom. In the first phase, forethought and planning, students set a target goal to assist with time management, effort planning, and evaluating their prior knowledge. Thibodeaux, Deutsch, Kitsantas, and Winsler (2017) found students who wrote down their goal,

performed better than students who did not. Ideally, this would help students develop an improved understanding of what is required to complete a task, such as a homework assignment. In the second phase, monitoring, students develop a metacognitive awareness, assess their time management, and potential need for help. In the third phase, control, students select and adapt cognitive strategies for learning, and increase or decrease their effort to meet the plans established in the first phase. The last phase, reaction and reflection, students judge their cognitive development and evaluate their task (e.g., homework) performance.

According to Pintrich et al. (1987), students should establish goals during a semester, ranging from semester goals, weekly goals, or even homework goals. This creates a cyclical process whereby students learn how well they met their goals, and potentially improve their goals during the next cycle. Pintrich et al. (1987) also found when self-regulatory processes were integrated into homework assignments, students reported a positive learning experience and increased levels of motivation. Clearly this is a strategy that could benefit students enrolled in *Engineering Concepts and Methods*.

Bol et al. (2016) studied community college students enrolled in a developmental mathematics course. Participants were randomly assigned into a treatment and control group. The treatment group completed four self-regulated learning exercises following Zimmerman's (2002) model. At the end of the course, the researchers found participants in the treatment group significantly outperformed the control group, as measured by mathematics achievement. The treatment group had also developed better metacognitive self-regulation, and time/study environment management skills. Although this prior work focused on mathematics achievement, mathematics skills are an important aspect of a STEM curriculum. Therefore, it is relevant to *Engineering Concepts and Methods* and to this study.

Bembenutty (2009), in his study of first-year mathematics students, found self-regulated learners were more effective in setting goals, but only if they established effective methods for attaining them. The study specifically investigated mathematics homework assignments and found time management played a critical role in student success. These first-time in college students were not accustomed to adequately estimating, and budgeting, ample time for studying. As noted earlier, an average high school senior has one hour of homework for every three hours of contact time, but an average college student has six hours of homework for every three hours of contact time; time management requires an adjustment for a typical college student as they transition from high school to college.

Kitsantas and Zimmerman's (2009) study used college students in an introductory science course and found the quality of student homework was significantly related to their study habit development, suggesting the importance of self-regulated learning. As noted in their study, by encouraging students to complete their homework, their beliefs about learning improved, and ideally, students will take more responsibility for their academic outcome, especially in introductory courses. This research extended their previous work using high school students and found the quality of student homework assignments was significantly related to the development of student study habits (Zimmerman & Kitsantas, 2005). Extending this earlier research, Ramdass and Zimmerman (2011) found a positive relationship when skilled students engaged in self-regulatory behaviors during homework activities, plus the quality of homework improved when there was an improvement in student study habits.

Sebesta and Speth (2017) conducted a study using students enrolled in a first-semester introductory biology course for life science majors. The purpose of their study was to investigate self-regulated learning strategies used most frequently to prepare for exams, as well as strategies

associated with higher learner achievement. The results of the study demonstrated that higher-achieving students reported using metacognitive strategies much more frequently than lower-achieving students. In addition, lower-achieving students more often reported they did not implement their planned study strategies. The most important strategies reported by these participants were goal setting, planning, environmental structuring to create a workable study environment, self-evaluation, seeking help, and reviewing graded work such as exams, quizzes, and homework assignments (Sebasta & Speth, 2017). These prior studies share a common theme: encouraging students to expand their self-regulated learning skills improved their academic performance. Therefore, helping students enrolled in *Engineering Concepts and Methods* develop self-regulated learning skills was an important part of this study. In particular, the intervention associated with self-regulated learning was evaluated for its effectiveness compared to historical data.

Instructional Pathway

In a traditional face-to-face classroom, the instructor regulates and monitors the instructional pathway as course materials are introduced. Unfortunately, this can be more challenging for courses taught using the online modality, like the course used in this study, because students may not complete learning activities in the order prescribed by the instructor. Lim (2016b) found lower ability students performed better with a logically ordered sequence, especially with mathematics instruction, whereas high ability students remain mostly unaffected. Due to the college's open enrollment policy, this is particularly relevant to *Engineering Concepts and Methods*, as some lower ability students may be enrolled in the course.

Step-by-Step Teaching

Historically, the online modality of *Engineering Concepts and Methods* has been taught with the weekly schedule driven by homework assignment due dates. Unfortunately, this did not discourage students from waiting until the last day to begin a homework assignment and foregoing some, or all, of the instructional pathway. Students could attribute the weekly milestone to consist entirely of the homework assignment due for grading, and circumvent all other instructional resources. One method of mitigating this problem is using what McDonald (2013) referred to as Step-By-Step-Teaching (SBST): forcing students to complete one step before proceeding to the next step. This helps the instructor ensure students follow the prescribed instructional pathway, without eliminating or bypassing critical steps. According to McDonald (2013), students also progressively gained self-confidence as they moved from the beginning to the end in a structured and ordered sequence designed by the instructor.

McDonald (2013) noted two other important aspects of the SBST methodology. First, students had a better understanding of the assessment process because each topic was broken down into smaller pieces, and each smaller piece was individually assessed. Students also had more granular data to gauge their incremental progress, as well as more opportunities to seek clarification. Second, students did not receive just one overall score at the end of a topic; rather, they received scoring and feedback incrementally. McDonald (2013) pointed out that students found this to be a considerable contrast from secondary education, where accountability was inconsistently emphasized in terms of assignments, due dates, or consequences for missing them. McDonald (2013) described a sharp contrast to receiving a single assessment at the end of a topic, or unit, as has been the practice for *Engineering Concepts and Methods* via its homework

assignments. Not surprisingly, students in the SBST study considered receiving incremental grades and feedback to be a fair and satisfying process (McDonald, 2013).

Part of the SBST methodology leveraged work by Knowles (1988) on andragogy, which is relevant to this study because nearly one-half of the students enrolled in *Engineering Concepts and Methods* are adult learners. According to Knowles (1988), there are four critical assumptions of adult learners: self-concept, where adult learners move from dependency to self-directness; experience, where adult learners draw on their personal experiences to aid their learning; readiness, where adult learners begin to assume new social roles; and orientation, where adult learners want to begin applying their new knowledge immediately to a problem, as their time perspective changes from delayed application of knowledge to its immediate application. These assumptions should be taken into consideration when working with post-secondary students, particularly with older student demographics, as is the case for the course used in this study.

McDonald (2013) emphasized that the SBST process leveraged Knowles' (1988) fourth assumption: students should have the opportunity, since they have the desire, to immediately begin applying new knowledge via properly constructed instructional sequences. This is particularly relevant to *Engineering Concepts and Methods* because students were typically adult learners. These students should be applying new skills to solve challenging engineering problems presented in homework by using proper instructional tools designed by the instructor.

Cognitive Research and Chunking

Cognitive research highlights three limitations to our ability to process information: the time we can consciously identify and consolidate a visual stimulus into short-term memory, the

number of stimuli that can be stored in short-term memory, and choosing an appropriate response to a new stimulus (Marois & Ivanoff, 2005). Research suggests the human brain is not able to process all information it receives, hence selecting which information gets access to the capacity-limited resources is critical (Marois & Ivanoff, 2005; Mayer, 2011). Another method of presenting new material, whether it is in a face-to-face classroom, or a virtual classroom, is to break down the introduction of new material into small steps, or pieces, so working memory does not become overloaded (Linden et al., 2002; Mayer, 2011; Rosenshine, 2002). This technique is more commonly referred to as chunking, an instructional tool used to organize and group small units, or pieces of information, into larger clusters, because it increases the amount of information students can process (Miller, 1956). Chunking, as a means of introducing new instructional material, was combined with the proper instructional steps (i.e., SBST) to develop the sequencing intervention used in this study.

ABC Model of Attitude

The final part of the conceptual framework used in this study was the ABC (Affective, Behavioral, and Cognitive) model to assess student attitudes, since attitudes can influence subsequent behavior (Ajzen & Fishbein, 1977; Fazio, 1990) such as completing and submitting homework. The ABC model incorporates three components to explain attitudes: the affective component, which refers to an individual's emotional response such as their feelings or mood; the behavioral component, which refers to an individual's actions or intentions; and the cognitive component, which refers to an individual's beliefs or thoughts (Breckler, 1984; Jain, 2014). Furthermore, an individual's actions are linked to their attitudes (Ajzen & Fishbein, 1977) meaning if students have a positive attitude toward homework, it is likely they will complete

more homework assignments and earn a higher grade in the course. Similarly, according to Fazio (1990), attitudes do relate to subsequent behavior: a positive attitude toward homework will likely lead to a student's willingness to complete more of their homework.

Eagly and Chaiken (2007) identified three key features in their definition of attitude: entity, tendency, and evaluation. In their definition, entity was an item, thing, or object being evaluated, and it could be either concrete or abstract. For this study, the entity being evaluated was homework. Tendency reflects how an individual's past experiences establish a positive or negative response to an entity. For example, a student's tendency to view homework positively or negatively is impacted by their prior experience, or lack of experience, with homework. As described earlier, the college has an open enrollment policy, which means lower ability students may be enrolled in this course who may not have positive experiences with homework. Evaluation, according to Eagly and Chaiken (2007), includes the three attitude components of the ABC model: an individual's affective, behavioral, and cognitive responses to an entity, such as homework.

Ajzen and Fishbein (2005) found background factors can shape behavioral beliefs, attitudes toward the behavior, and actual behavior, which aligns with Eagly and Chaiken's (2007) definition of tendency, in that past experiences can impact an individual's current responses to an entity. In addition, behavior, such as students completing their homework, can be predicted from attitudes toward that behavior (Ajzen & Fishbein, 2005; Sutter & Paulson, 2016). Albarracin, Hepler & Tannenbaum (2011) found individuals with a general goal, such as earning a grade of an A in a course, were more likely to pursue additional behaviors, such as doing their homework, in support of that goal. One way to identify student goals would be to survey them at the beginning of the course for their grade expectations.

Anticipating a positive or negative consequence may influence an individual's intentions or behaviors, depending on its potential affective impact (Ajzen, 2011; Wolff et al., 2011). A student who anticipates regret could point to their beliefs about whether feelings of regret would follow from their inaction (Abraham & Sheeran, 2003). For example, a student who does not want to regret (affective impact) they did poorly on an exam (negative consequence) due to inadequate preparation chooses to prepare for the exam by doing their homework (behavior).

Determining whether students believe they are capable of completing their homework assignments may impact their behavior as there is a relationship between self-efficacy and behavioral intention (Conner & Armitage, 1998; Sutter & Paulson, 2016). Ajzen (1991) noted a strong tie to Bandura's (1993) perceived self-efficacy as students regulate their learning, choose their activities, prepare for the activities (e.g., homework), effort used during performance, and academic achievement. According to Ajzen (2002b, p. 108), "It is an undisputed fact that the frequency with which a behavior has been performed in the past can be a good predictor of later action." Prior behavior, such as completing homework assignments, has been shown to be a predictor of future behavior (Ajzen, 2002a, 2002b; Conner & Armitage, 1998; Sutter & Paulson, 2016). Therefore, measuring participants' prior behavior on completing homework assignments was an objective of this study. It was also important to assess the participants' prior attitude on the importance of homework. Ideally, measuring student attitudes toward homework before and after taking the course used in this study, would be beneficial to determine if student attitudes changed, potentially as a result of the interventions used in this study.

Summary

The literature review covered a range of prior research associated with homework, such as examining the significance of homework, investigating how much time should be spent on homework, and the importance of homework as a formative assessment tool. For the course used in this study, some research areas were particularly relevant, such as homework and online courses, homework and engineering education, and potential methods for increasing homework completion. The literature review also included prior studies as they pertained to the conceptual framework of self-regulated learning, the instructional pathway, and the ABC model of attitude. As discussed in Chapter One, the conceptual framework was the basis for forming the three research questions investigated in this study. The next chapter is devoted to the methodology before proceeding to the results of this study.

CHAPTER THREE: METHODOLOGY

Introduction

The first chapter established most educators now agree homework is a means to extend learning opportunities outside the classroom (Marzano, 2007), provide students an opportunity to practice what they learned (Epstein & Van Voorhis, 2001), and give instructors a chance to provide feedback to their students (Cooper, 1989b). The second chapter provided a literature review covering prior research topics associated with homework relevant to this study and formed the basis for the conceptual framework. This chapter focuses on the methodology used to evaluate the interventions and survey instrument developed from the conceptual framework to address the research questions.

Course Information

As described in Chapter One, the course used for this study, *Engineering Concepts and Methods*, is an introductory software applications course that exposes students to two powerful, industry-standard tools. Additionally, because the course is part of numerous degree programs, the concepts presented in the course address a wide range of STEM topics. Further, the course is one of six engineering courses in an articulation agreement between UCF's College of Engineering and Live Oak State College, with the other five being *Introduction to the Engineering Profession*, *Statics*, *Dynamics*, *Probability and Statistics for Engineering*, and *Engineering Economic Analysis*.

Relevant Degree Programs

The course is taught by the college's engineering faculty, and it is a part of four different degree programs offered by the college: the Associate of Science in Engineering Technology (AS ET), the Bachelor of Science in Engineering Technology (BS ET), the Associate of Science in Chemical Technology (AS ChT), and the Associate of Arts in Pre-Engineering (AA Pre-Eng). Students completing the AS ET degree program typically enter the job market as technicians, or continue until they complete their BS degree, or both. Students completing the BS ET degree program typically enter the job market as technologists, although some students attend graduate school on a part-time basis while working full-time. Students completing the AS ChT degree program have several options after graduation depending on their career goals: transferring to UCF to complete their BS degree in biology, biomedical science, biotechnology, chemistry, or forensic science; entering UCF's engineering program; or entering the job market as technicians. Finally, students completing the AA Pre-Eng degree program typically transfer to UCF to complete a BS degree in engineering via UCF's *DirectConnect* Program. The *DirectConnect* program guarantees students who completed their AA degree from one of several partner colleges, including Live Oak State College, admission to UCF (University of Central Florida, 2018).

Historical Course Design

Engineering Concepts and Methods was developed with seven modules for each software tool. The course structure, described below, is built on a four-step sequence, repeated 14 times throughout the course: *Overview and instructional resources => Homework assignment=>Solution key=>Grading and feedback.*

- Overview and instructional resources. An instructor-developed summary of the course topic augmenting the textbook with outside resources such as websites, video content, or tutorials. The textbook has an extensive amount of reading and examples, and tutorials prioritized to focus on the most critical topics along with tips, suggestions, and recommended exercises accompanied by numerical answers.
- Homework assignment. The homework assignment typically consisted of four to six problems. Students were required to complete and submit these problems no later than the cutoff date. In some cases, students could submit bonus problems for additional credit.
- Solution key. The day after the homework assignment due date, the instructor released a detailed solution key for students to compare against their work. Students were encouraged to review the solution key for presentation suggestions, alternative approaches, self-assessment, and revising their work.
- Grading and feedback. Each homework assignment was individually graded and returned. Grading included correcting student mistakes, providing individual feedback, suggestions, and tips on areas for improvement. Many suggestions referred back to the solution key to encourage students to independently examine them throughout the course.

After a module was opened, students had two weeks to complete all assigned activities and submit their homework assignment for grading. *Engineering Concepts and Methods* had two timed exams covering material included in the homework assignments. There were also two projects, one for each software tool, but the projects were not time constrained. Instead, students had two weeks to solve an open-ended problem using techniques covered throughout the course, and in particular, the homework assignments.

Engineering Concepts and Methods was an online, asynchronous course that required students to develop, use, manage, and monitor self-regulated learning skills. The process was heavily reliant on students using course resources as intended, setting up their own schedule, working examples, and submitting their homework assignments per the course schedule. Unfortunately, based on 278 (20.4%) missing assignments (Table 1), some students did not develop the appropriate self-regulated learning skills required to be successful in the course.

Historical Grade Distribution

As discussed in Chapter One, numerous students did not submit their homework assignments. The material on the homework was an opportunity for students to practice skills they would need for exams and projects, plus receive instructor feedback useful for subsequent assignments. Based on historical data (Appendix E), 62 (53.5%) students did not submit 278 (20.4%) homework assignments, and 143 (10.5%) were turned-in one day late, resulting in a significant negative impact on student grades and their concept attainment.

The impact of missed homework assignments on final course grade (Table 3) shows that of the 64 (55.2%) students who missed two or less homework assignments, 58 (50.0%) finished the course with a grade of an A or B. All 14 (12.1%) students who missed five or more homework assignments finished the course with a grade of a D or F. Although the course structure provided a substantial penalty for students who did not submit their homework, students still missed numerous assignments.

Table 3: Historical Homework Completion and Course Grade

	Final Course Grade							
MHA	A	B	C	D	F	W	Total	Percent
0	39	7	2	0	0	6	54	46.6
1	6	5	2	0	0	3	16	13.8
2	1	0	1	1	0	3	6	5.2
3	0	2	1	0	1	3	7	6.0
4	0	0	1	1	2	2	6	5.2
≥ 5	0	0	0	1	13	13	27	23.2
Total	46	14	7	3	16	30	116	100.0

Note. MHA = Number of missed homework assignments during fall 2016, spring 2017, fall 2017, and spring 2018 semesters.

Historical Enrollment Data

Enrollment for the past two academic years indicates 66.4% of the students who completed this course potentially transferred to UCF to complete their STEM education (Table 4). Prior to the fall 2017 semester, online enrollment was reduced from 30 to 20 students due to intensive time commitments required for grading and feedback. In addition, during the same term, two online modality sections were offered based on student demand, resulting in an overall increase in enrollment despite a reduction in course section headcount.

Table 4: Historical Enrollment by Declared Degree

	Student Enrollment					
Degree	F 16	S 17	F 17	S 18	Total	%
AA Pre-Engineering	18	19	13	11	61	52.6
AS Chemical Technology	1	3	7	5	16	13.8
AS Engineering Technology	2	0	1	0	3	2.6
BS Engineering Technology	7	5	13	4	29	25.0
Other/non-degree seeking	1	2	4	0	7	6.0
Total Enrollments	29	29	38	20	116	100.0

Note. F = fall semester; S = spring semester

Importance of This Course

As described earlier, the course used in this study articulates into UCF's Engineering degree program, plus it is part of more than 15 different UCF degree programs. The college's *DirectConnect* transfer students must be equally well-prepared for the academic rigor of UCF's Engineering and Science programs as those students who began their studies at UCF. Therefore, it is critically important the college's AA Pre-Eng and AS ChT transfer students complete the course with the same content knowledge as those students who took the course at UCF. Similarly, students pursuing the college's AS ET and BS ET degree programs are expected to complete the course with the same proficiency as those students transferring to UCF, as Excel and MATLAB are also used in subsequent courses at Live Oak. Beyond the classroom, it is important the college's students graduate with the knowledge of how to use Excel, since many college graduates enter the workforce with limited office software proficiency (Kirschner & van

Merriënboer, 2013). Learning how to use Excel provides Live Oak graduates with capabilities industry requires, and gives them a competitive edge over other applicants.

Participants

During the fall 2018 semester, two sections of *Engineering Concepts and Methods* using the online delivery modality were available to students. Both sections were taught using the same syllabus, instructor, textbook, homework, schedule, exams, and projects, plus both course sections began with an enrollment of 20 students. After the college's enrollment period closed, both sections had 19 students enrolled, totaling 38 students, all of whom were participants in this study. Two sections of the traditional face-to-face modality were also offered; however, only students enrolled in the online modality participated in this study, in order to align with historical data (Tables 1, 2, and 3).

Sampling Method

During the fall enrollment period, students were able to enroll in either online course section, since both sections were available to all students. Students were also able to enroll in the traditional face-to-face modality, which is typically less popular, as illustrated by how quickly the online course sections fill relative to the face-to-face sections. Assignment to specific course sections was self-selected by students, as a student could elect to take either course modality, or to enroll in either of the online course sections. One exception to this enrollment procedure occurred with students that had a temporary administrative hold due to financial aid challenges or academic reasons, prohibiting them from registering as early as other students. Otherwise, enrollment in the course sections was on a first-come, first-serve basis.

There were no additional sampling methods throughout the study period and all 38 students enrolled in the two course sections were invited to participate in the survey regarding attitudes toward homework. Half of the participants were used to evaluate the influence of self-regulated learning strategies on homework completion, and the other half were used to evaluate the impact of sequencing strategies on homework completion (Table 7) The participants, and how they were assigned to the interventions after the beginning of the fall 2018 semester (i.e., the study period) is discussed further below.

Evaluation Model

The study employed a quasi-experimental evaluation model to assess the effectiveness of two pedagogical methods in positively impacting homework completion rates and student attitudes toward homework. Ideally, the findings would be generalizable to subsequent course sections of *Engineering Concepts and Methods* or other engineering courses taught by the investigator of this study or other engineering faculty at the college. There were three research questions included in this study, all developed from the conceptual framework:

1. *To what extent do self-regulation strategies, such as planning and reflecting, influence student completion of homework assignments?* The goal was to examine the effectiveness of self-regulation strategies in impacting homework completion rates.
2. *To what extent do sequencing strategies, such as a content quiz and a practice problem, influence student completion of homework assignments?* The goal was to examine the effectiveness of sequencing strategies on homework completion rates.
3. *To what extent do self-regulation strategies, such as planning and reflecting, or sequencing strategies, such as a content quiz and a practice problem, influence student*

attitudes toward homework? The goal was to investigate student attitudes toward homework, before and after the interventions, via a survey instrument.

The interventions were evaluated using inferential statistics to compare student homework assignment completion rates after the interventions with historical course data. The responses to the survey items were evaluated using a combination of descriptive and inferential statistics. The statistical methods are described in greater detail later in this chapter.

Data Collection Methods

The data collected in this study were intended to support three different statistical analyses. The first two analyses evaluated the interventions associated with the self-regulation and sequencing strategies to determine if homework assignment completion rates improved, potentially due to the interventions (Norman & Streiner, 2003). The third analysis, using survey data, evaluated whether student attitudes toward homework changed, potentially due to the strategies used in this study (Norman & Streiner, 2003). The data collected in support of the two interventions and the survey instrument are described below.

Self-Regulation Strategies Intervention

The self-regulation strategies intervention was developed using the conceptual framework to address the first research question: *To what extent do self-regulation strategies, such as planning and reflecting, influence student completion of homework assignments?* The data used to evaluate the impact of this intervention on homework completion rates were collected from Canvas, which provided for weekly data collection for each participant, as homework assignments were submitted by students participating in this study. This data

provided all information needed for subsequent statistical analyses associated with this intervention (Appendix F).

Sequencing Strategies Intervention

The sequencing strategies intervention was developed using the conceptual framework to address the second research question: *To what extent do sequencing strategies, such as a content quiz and a practice problem, influence student completion of homework assignments?* The data used to evaluate the impact of this intervention on homework completion rates were also collected from Canvas. Once again, Canvas allowed for weekly data collection for each participant, as homework assignments were submitted by the students participating in this study. This data provided all information needed for subsequent statistical analyses associated with this intervention (Appendix G).

Survey Instrument

The survey instrument was developed using the conceptual framework to address the third research question: *To what extent do self-regulation strategies, such as planning and reflecting, or sequencing strategies, such as a content quiz and a practice problem, influence student attitudes toward homework?* Although evaluation components of the ABC model could be measured by physiological responses, verbal statements, or written reports (Breckler, 1984), a survey was the best approach, as the participants were enrolled in an online asynchronous course. In order to create pre-post data regarding the impact of the two pedagogical interventions on student attitudes toward homework, the survey instrument (Appendix B) was sent to all participants both at the beginning of the semester, and to those participants who responded to the initial survey at the end of the semester.

Intervention Procedures

The course has two major areas of focus, Excel and MATLAB, in accordance with its primary learning goal: "An introduction to computer software applications involving spreadsheets (Excel) and symbolic processing (MATLAB) in order to solve a variety of engineering-related problems." For 14-weeks, students were expected to complete and submit a homework assignment for each course module. A solution key was provided to all students once the homework assignment due date had passed, as students have shown to be less frustrated if they have timely solutions to homework assignments (Lindquist & Olsen, 2007). The balance of the course was spent on a course introduction, two projects, and two exams.

Course Design for Collecting Intervention Data

One potential design procedure to examine the effectiveness of the interventions would be to split each course topic in approximately half (Table 5). In a single course section, there would be a three-week block of Excel, and a four-week block of Excel, to cover all seven modules. The first block would not use an intervention, but the second block would. Similarly, MATLAB could also be broken down into two blocks. The second course section would be set up similarly, but reverse the interventions.

For Course Section A (Table 5), students would be evaluated before and after each intervention within the same course section. Participants in Course Section A would not be engaged in either intervention for Excel Modules 1-3, but for Excel Modules 4-7, participants would be engaged in the self-regulation strategies intervention. The same design would be repeated for Course Section B, but reversing the intervention order to eliminate potential problems with the course topic sequence, and its respective complexity. This methodology would provide a comparative analysis of participants for both interventions. Subsequent analysis

would use a paired pretest-posttest (McNemar test) as the same participants would be evaluated before and after each intervention (Norman & Streiner, 2003). The rationale behind using both interventions in each course section, and across topics, was to reduce the effect of a software tool confounding subsequent data. Unfortunately, this design procedure could contaminate the data if the first intervention changed student behavior making it difficult to isolate and evaluate the impact of the second intervention. For these reasons, this potential design procedure was abandoned for this study.

Table 5: Potential Intervention Design Procedure Addressing Research Questions One & Two

		Intervention	
Module	Assignment	Course Section A	Course Section B
Excel 1, 2, 3	1, 2, 3	None	None
Excel 4, 5, 6, 7	4, 5, 6, 7	Self-Regulation	Sequencing
MATLAB 1, 2, 3	8, 9, 10	None	None
MATLAB 4, 5, 6, 7	11, 12, 13, 14	Sequencing	Self-Regulation

A second potential design procedure (Table 6) could set up each course section with one intervention eliminating participant knowledge gained from the first intervention potentially contaminating subsequent data. This design also supported a paired pretest-posttest, but it only addressed one software tool in each course section. In addition, if the intervention was intended to help participants, they would not be able to take advantage of an intervention until the second half of the course, which was troubling for the researcher. Consequently, this potential design procedure was also abandoned for this study.

Table 6: Potential Intervention Design Procedure Addressing Research Questions One & Two

		Intervention	
Module	Assignment	Course Section A	Course Section B
Excel All	1 – 7	None	None
MATLAB All	8 – 14	Self-Regulation	Sequencing

Based on the shortcomings of the first two potential design procedures (Tables 5 and 6), the final strategy used the design procedure identified in Table 7: one intervention per course section, and the intervention applied to all homework assignments. From a participant's perspective, the course followed one procedure for the entire semester, which should be less disruptive. Although this eliminated paired pretest-posttest analysis via the McNemar test, it did allow the researcher to use historical data (Appendix E) and chi-square testing. For the balance of this study, historical data was used as the baseline for statistical analyses.

Table 7: Intervention Design Procedure Addressing Research Questions One & Two

		Intervention	
Module	Assignment	Course Section A	Course Section B
Excel All	1 – 7	Self-Regulation	Sequencing
MATLAB All	8 – 14	Self-Regulation	Sequencing

Self-Regulation Strategies Intervention

The self-regulation strategies intervention was developed from the conceptual framework and Pintrich's (2004) four phases of self-regulated learning: plan, monitor, control, and reflect. Pintrich et al. (1987) suggested students should establish goals during a semester, such as semester goals, weekly goals, or homework goals. Participants in this study were required to

establish weekly goals in support of meeting homework assignment deadlines. Once weekly goals were established, participants were required to reflect on and assess their ability to set and meet goals. This resulted in a cyclical process whereby participants could learn from one week to the next, or one homework assignment to the next, how well they met their established goals and potentially improve their ability to do so during the next cycle. Another reason for additional tasks was to encourage earlier self-identification for the need for additional help in a course module. Students have reported positive learning experiences and increased levels of motivation when self-regulatory processes were integrated into homework assignments (Pintrich et al., 1987). However, for this study, only Pintrich's (2004) first and fourth phases were used as tasks, since this course was online and only two contact hours. Participants were required to spend additional time completing these tasks before proceeding to the next module.

Pintrich's (2004) second and third phases were not formally used in this study to reduce the number of activities required by participants, but they were included as part of the reflection. In Table 7, the plans and reflections were included as part of the *Self-Regulation* intervention. Grading for the plan and reflection was part of each module's homework assignment grade, but they were separately graded. Instead of each homework assignment counting as 40 points, as it did historically, it was counted as 30 points, with the remaining 10 points split equally between the addition of the plan and reflection assignments. However, unlike the homework assignments, plans and reflections were accepted late to encourage students to complete and use them, despite missing a deadline. These additional assignments were excluded when tallying the number of homework assignments submitted by participants during the study period. The specific features of the intervention are described below.

- Plan. Within three days after releasing a new module, students were required to submit a learning plan, "*Please submit a learning plan, in the form of a schedule, that includes a timeline of when you will: read the textbook; review the supplemental information; identify and prepare examples (or applications) from the textbook; turn in your problem set for grading; and review the solution key. This is intended to be a task list with self-imposed due dates of when you will complete the various items associated with this module.*" The participants were free to choose the format of their plan provided it had the task list and a date for each task on the list.
- Reflect. Within three days after the solution key was released, students were required to submit their reflection, "*Please submit a reflection (i.e., a commentary on your ability to meet the schedule you set for yourself) for this module. Specific items to include are how well you did with your timeline for: reading the textbook; reviewing the supplemental information; turning in your homework assignment; and reviewing the solution key. Also, please comment on what materials and/or strategies did/did not help you learn the content in this module*." Participants were free to choose the format of their reflection provided it had the task list, a reflection of how well they adhered to their schedule, and a short reflection on the materials and strategies they used for the content in the module.

The participants were graded for creating the plan and reflection. If participants did not meet the intention of the intervention, the researcher reminded them to do so for future plans and reflections. This also provided the instructor an additional opportunity to provide feedback to students for ongoing improvement. The plans and reflections were important components of the intervention, although a reflection would have limited significance without a meaningful plan. Participants were required to submit their plan and reflection for each module because the built-

in Canvas tools required participants to view the overview first, then submit their plan before gaining access to the homework assignment. The last step for participants was to submit their reflection before proceeding to the next module.

Collecting data for the self-regulated strategies relied upon incorporating content directly into Canvas. For the self-regulated strategies intervention, all 14 course modules were modified to: *Overview & instructional resources=> <u>Plan</u>=> Homework assignment=> Solution key=> Grading & feedback=> <u>Reflect</u>.* The two additional steps are underlined to differentiate them from the prior course structure. Neither of the new components impacted measuring whether a particular homework assignment was submitted by a participant. The mechanics of the self-regulation strategies were implemented during August 2018, prior to the fall semester. Once in place, participant homework assignment completion data was extracted directly from Canvas, similar to the baseline data (Table 1). Historically, the only milestone available was when students submitted their homework assignments, a weakness of the original course design.

Sequencing Strategies Intervention

One challenge with teaching a course like *Engineering Concepts and Methods* is ensuring students do not omit critical parts of the instructional pathway. This is more challenging with a course taught online, as students can skip to a homework assignment without reading the textbook, reviewing supplemental information, or examining sample problems. As students may not be taking advantage of the instructional resources designed to help them (Lim, 2016b), they may struggle with homework assignments and have additional challenges with formal assessments. Evidence of this is based on instructor experience, particularly with this course,

since some students historically submitted incomplete homework assignments just prior to the deadline.

The ability to place elements of a particular topic, lesson, or module in a prescribed sequence is a feature supported by Canvas. For example, students could be required to take a short quiz on an assigned reading, submit a sample problem, or both. These two steps must be performed in advance of accessing a homework assignment, and in the prescribed sequence established by the instructor. By establishing activities in advance of a homework assignment, students could get a better start because they would be spending more time thinking about new course material earlier. The course content could also be broken down into smaller chunks, or steps, to improve student learning and retention (Linden et al., 2002; Mayer, 2011; Miller, 1956; Rosenshine, 2002) and presented in a specific instructor designed sequence. In addition, students would be required to begin the new material earlier in support of homework assignments for each module. The instructor would also have additional activities that could be monitored prior to students submitting a homework assignment, which has not been true, historically.

One highly effective means of helping students learn from reading is a content quiz based on reading material (Pintrich et al., 1987). Ideally, a content quiz aids in recognizing the most important content for assigned readings, as well as requiring students to examine specific material earlier in a module. Another reason for additional steps in each course module is to encourage students to identify the need for help earlier.

The design used to evaluate the sequencing strategies intervention, developed from the conceptual framework to address the instructional pathway, added two preparatory tasks ahead of each homework assignment that required completion, in sequence, before assigned problems would be available to participants. Built-in Canvas tools supporting implementation of a

required sequence for students in accessing course materials were used. By establishing these checkpoints ahead of homework assignments, students would be required to perform certain academic activities in a specific order and in advance of gaining access to homework. This was a means of ensuring students were actually using course resources as designed by the researcher.

The first checkpoint implemented was a 10-question multiple-choice quiz based on reading both the textbook and supplemental information. This was designed as a guided reading quiz, focusing on factual or procedural knowledge. The quizzes were automatically graded as students submitted them in an effort to provide immediate feedback. All answers provided textbook page references so students could review course materials again, if needed. Although students in prior semesters should have read the textbook prior to attempting homework assignments, there was no means to ensure students were doing so. This was the first fundamental change to the course associated with this intervention. Fourteen quizzes were developed for this research study, one for each module (Appendix C).

The second checkpoint was a practice homework problem, selected to introduce participants to a new concept they would need to complete the balance of the homework assignment. Once a participant submitted the practice problem, a solution key was instantly available to them. This provided an opportunity for participants to immediately compare their work against the suggested process for arriving at the answer. Although students in prior semesters should have completed practice exercises before proceeding to homework assignments, there was no means to ensure students were actually doing so. This was the second fundamental change to the course associated with this intervention. Fourteen practice problems were developed for this research study, one for each module (Appendix D).

Similar to the plan and reflection used in developing the self-regulation strategies interventions, grading for these two checkpoints was separately recorded. Instead of each homework assignment counting as 40 points, as it did historically, it counted as 30 points, with the remaining 10 points split equally between the addition of the quiz and practice problem assignments. However, unlike homework assignments, quizzes and practice problems were accepted late to encourage participants to use them, despite missing a deadline. Similar to the data collected to address self-regulated strategies intervention, these additional assignments were excluded when tallying homework assignments submitted by participants during the study period. The specific features of the intervention are described below.

Collecting data relied upon incorporating content directly into Canvas. For the sequencing strategies intervention, all 14 course modules were modified as follows: *Overview & instructional resources => <u>Content quiz</u>=> <u>Practice problem</u>=> Homework assignment=> Solution key=> Grading & feedback.* The two additional steps are underlined to differentiate them from the prior course structure. The mechanics of the sequencing strategies intervention were also implemented during August 2018, prior to the fall semester. Once in place, participant homework assignment completion data was extracted directly from Canvas, similar to the baseline (Table 1). As discussed earlier, the only milestone previously available was when students submitted their homework assignments, a weakness of the original course design.

<u>Analysis of the Intervention Data</u>

Homework assignment completion data collected in support of evaluating the interventions were extracted from Canvas. If a participant submitted a homework assignment on time, it was recorded as an "S," otherwise it was recorded as an "M" (missing, or not submitted)

or “L” (late). These were nominal data (Norman & Streiner, 2003) as they were tallied by counting the number of homework assignments submitted, missed or late by each participant consistent with the baseline (Tables 1 and 3).

The purpose for collecting these data was to determine whether participants completed more homework assignments during the study period than during the baseline period, potentially as a result of the interventions developed in this study. A homework assignment was considered submitted if students made a good faith effort of completing the assigned problems, and if they submitted the homework assignment. As noted previously, additional tasks associated with the interventions were omitted as part of the data collection procedures to properly align study data with the baseline. Participants who dropped the course were retained in the data, but a “W” was recorded once they officially dropped the course. During the study period, a “W” was not counted as a missed homework assignment, consistent with the baseline.

Inferential Statistics used for Intervention Data

Hypothesis testing was used to evaluate the intervention data. The null hypothesis (H_0) and alternative hypothesis (H_a) were:

- H_0: $\theta_{B/L} = \theta_{IV}$ (no difference in the parameter of interest); and
- H_a: $\theta_{B/L} > \theta_{IV}$ (there was a difference and the baseline was greater than the intervention)

  where θ was the proportion of late, missed or on-time homework assignments.

All hypothesis testing in this study used a significance level of $\alpha = .05$, as the probability of a Type I Error was determined to be acceptable at 5%. Results of the test procedures determined if H_0 would be rejected in favor of H_a (Devore, 2016; Montgomery & Runger, 2018). Failing to reject H_0 meant there was not a statistically significant basis for concluding the intervention

produced results different than those of the baseline. Hypothesis tests were one-tailed as the interventions were only considered successful if θ_{IV} was less than $\theta_{B/L}$. As discussed earlier, the nominal data collected during the interventions were analyzed using the non-parametric chi-square test.

Survey Instrument

The survey instrument (Appendix B), developed from the conceptual framework to assess student attitudes toward homework, was sent to all 38 participants via email at the beginning of the study period. Although the email invitations were sent to the participants' college email address, results were anonymous because neither student ID nor course section was tracked. In addition, sampling was not used as all participants in this study were invited. The email invitation included a brief explanation of the research study, reminded participants of the age requirement, and provided the researcher's contact information for questions regarding the survey or its procedures. The first survey item was an informed consent to ensure participants agreed to participate in the survey, and to remind them their participation was voluntary.

Qualtrics, a cloud-based product to capture customer, brand, employee, or product experiences was used to administer the survey (Qualtrics, 2019). Although *Qualtrics* has an extensive set of capabilities, for this study it was only used to capture survey data and facilitate post-collection data summaries and analyses. Several survey items addressed background factors such as major, hours completed, employment, and current course load, to identify potential themes with participant responses. The remaining instrument items leveraged material from Manstead and van Eekelen (1998) focused on academic achievement intentions and behavior, as well as concepts based on the affective, behavioral, and cognitive elements of the ABC model of

attitude. The instrument items were grouped by their intended purpose based on a four-question test outlined by Joshi, Kale, Chandel, and Pal (2015):

1. Are the items arranged in a logical sequence?
2. Are the items closely interrelated yet provide some independent information?
3. Is there an element of coherence between the responses (i.e., the next response in this group is somewhat predictable based on the prior response)?
4. Does each item measure a distinct element of the intended purpose?

If the answer to all four questions was affirmative, these items were combined for subsequent analysis. The instrument items are summarized below by their intended purpose.

- Background Factors (Items 6a, 6b, 8-12). These items examined background factors, including student demographics, because they can shape behavioral beliefs, attitudes, and actual behaviors (Ajzen & Fishbein, 2005).
- Affect (Item 5d). There is evidence of a relationship between anticipating a feeling of regret after performing a behavior, and subsequently repeating the same behavior (Conner & Armitage, 1998). In the case of this study, anticipating regret could affect a participant's feelings, and potentially their intention or behavior, if they did not adequately prepare for an exam due to missed homework assignments (Abraham & Sheeran, 2003; Ajzen, 2011; Wolff et al., 2011).
- Behavior, both prior and current (Items 4a-4d, 5a-5c). Understanding a student's prior behavior, with respect to completing their homework assignments, was critical since past behavior can be used to predict future behavior (Conner & Armitage, 1998).
- Cognitive, or beliefs and self-efficacy (Items 2a-2d, 3a-3d, 7). These items examined aspects of student beliefs since attitude is a function of a person's behavioral beliefs

(Ajzen & Fishbein, 2005; Conner & Armitage, 1998; Sutter & Paulson, 2016). Investigating whether students believed they were capable of completing their homework assignments was important because there is a positive relationship between self-efficacy and behavioral intention (Conner & Armitage, 1998; Sutter & Paulson, 2016).

The survey instrument was also intended to be sent a second time, at the end of the study period, but only to those participants who responded to the initial survey. The rationale was to examine student attitudes, beliefs, and intentions, with respect to homework, before and after taking the course. By doing so, the survey results could be used to assess the impact of the pedagogical methods used in the interventions on student attitudes toward homework in *Engineering Concepts and Methods*. Although the survey was anonymous, students were randomly assigned a temporary ID to track participants who responded to the pre-course survey, so they could be sent the post-course survey, and the two sets of responses could be correlated.

Analysis of the Survey Responses

Statistical procedures to analyze the survey responses used descriptive statistics (average response and dispersion) and inferential statistics (hypothesis testing), due to the different types of data. The survey instrument contained numerous Likert-scale items treated as ordinal data for individual items, or interval data if four or more Likert-scale items were combined into a single composite score (Boone & Boone, 2012; Joshi et al., 2015). Descriptive statistics were used for all items with a nominal scale. The remaining items used inferential statistics to determine if there was a significant difference between participant responses at the beginning of the course, compared to their responses after taking the course.

Descriptive Statistics used for Survey Responses

Survey responses with ordinal scale data used the median (*Mdn*) as the measure of central tendency and the interquartile range (IQR) as the measure of dispersion (Norman & Streiner, 2003; Stevens, 1946). The items analyzed as ordinal scale data were 5a, 5b, 5c, 5d, and 7. Item 5d had a different intended purpose than 5a, 5b, and 5c, thus these items could not be combined into a single composite score treated as interval data.

Survey responses with interval scale data used the mean (*M*) as the measure of central tendency, and the standard deviation (*SD*) as the measure of dispersion (Norman & Streiner, 2003; Stevens, 1946). Four or more Likert-scale items (e.g., 2, 3, 4) combined into a single intended purpose, based on Joshi et al.'s (2015) four-question test, were described by the mean and standard deviation. Items 6a and 6b were also treated as interval scale data as their intervals were reasonably equivalent and equidistant.

Ordinal and interval scale data were converted to quantitative data for calculation purposes. For example, Likert-scaled items with responses of *Strongly Agree*, *Agree*, *Neither Agree nor Disagree*, *Disagree*, and *Strongly Disagree* were converted to 1, 2, 3, 4, and 5, respectively. By doing so, median and range were calculated for ordinal data, and mean and standard deviation were calculated for interval data.

Nominal scale data do not have an implied ordering in their response categories (Norman & Streiner, 2003; Stevens, 1946). To summarize participant responses for these items, the mode (*Mode*) was reported. These items (8, 9, 10, 11, 12) pertained to demographic information included in background factors, such as degree program, and were only collected once at the beginning of the study period.

Inferential Statistics used for Survey Responses

Similar to the analysis procedures for the intervention data, the procedures to evaluate pre-post course data used hypothesis testing for items 2, 3, 4, 6a, and 6b. The null hypothesis and the alternative hypothesis were:

- H_0: $\theta_{\text{PRE}} = \theta_{\text{POST}}$ (no difference in the parameter of interest); and
- H_a: $\theta_{\text{PRE}} > \theta_{\text{POST}}$ (there was a difference and the parameter of interest was greater at the beginning of the semester) where θ_{PRE} was the beginning of course parameter of interest, and θ_{POST} was the end of course parameter of interest.

The survey instrument used a low score (1) for *Strongly Agree* and a high score (5) for *Strongly Disagree*, meaning if student attitudes shifted from *Strongly Disagree* (pre-course) to *Strongly Agree* (post-course), θ_{PRE} would be more than θ_{POST}. Failing to reject H_0 meant there was not a statistically significant basis for concluding the interventions changed student attitudes toward homework after taking the course used in this study. Test procedures used the Wilcoxson signed rank test since responses of the same participants were evaluated before and after the course.

Summary

This chapter summarized the rationale, defined the participants, specified the sampling and collection methods, and outlined the procedures, data analyses, and methodology used to evaluate the interventions and examine the participant responses collected via the survey instrument. Both interventions and the survey instrument were developed from the conceptual framework to address the research questions. The interventions were evaluated using inferential statistics to compare historical data to the intervention data to determine if they positively impacted students to complete more homework assignments.

Part of the methodology determined the appropriate statistical test procedures to evaluate the data. The survey instrument was designed to be sent to all participants in this study at the beginning of the study period, and again at the end of the study period. The instrument's items were grouped into categories associated with the three elements of the ABC Model of attitude plus participant beliefs and intentions toward homework. The survey responses were evaluated using descriptive and inferential statistics to describe participant attitudes, and to determine if participant attitudes potentially improved toward homework as a result of the interventions. The next chapter is devoted to results of the methodology prior to the conclusions of this study, and discussion of implications for practice, as well as a discussion of potential future research.

CHAPTER FOUR: RESULTS

Introduction

The prior chapter provided the rationale, identified the participants, specified the sampling and collection methods, and outlined the methodology used to evaluate the interventions and survey responses. The interventions, developed from the conceptual framework established in Chapter One, were evaluated using inferential statistics to compare historical data to data collected after implementing the interventions to determine if the interventions positively impacted students to complete more homework assignments. The survey instrument, also developed from the conceptual framework, was intended to be sent to all participants in this study at the beginning and end of the study period. The survey responses were evaluated using a combination of descriptive and inferential statistics to describe participants and their attitudes toward homework, and to determine if participant attitudes toward homework potentially changed as a result of the interventions.

Intervention Data

Homework assignment completion data were collected to determine whether students completed more homework assignments, compared to the baseline, potentially as a result of the interventions. Data collected during the study period for the two interventions are in Appendices F and G, and the baseline is in Appendix E. To distinguish participants yet maintain their confidentiality, they were identified as History, IV1 (self-regulation strategies intervention), or IV2 (sequencing strategies intervention), and then numbered.

Two scenarios were evaluated for each intervention to ensure students who withdrew from the course did not impact the results. Although removing withdrawals was not in the

original methodology, it was added to provide more thorough testing. All students in the baseline (N = 116) were used for the first set of testing to examine total enrolled students. Students who withdrew prior to the end of the semester were removed for the second analysis (n = 88). The same reductions were made to the interventions, except for the self-regulation strategies intervention, as two participants withdrew from the course one day after the survey was sent. Since this was prior to collecting data, they were omitted from all analyses.

<u>Self-Regulation Strategies Intervention Analysis</u>

Hypothesis Testing Results

The null hypothesis (H_0) and alternative hypothesis (H_a) using all enrollments:

- H_0: $\theta_{B/L} = \theta_{IV}$ (no difference in the parameter of interest); and
- H_a: $\theta_{B/L} > \theta_{IV}$ (there was a difference and the baseline was greater than the intervention)

  where θ was the proportion of late, missed, or on-time homework assignments.

Results of the chi-square goodness of fit test (using all enrollments) failed to reject H_0 indicating there was not a statistically significant difference between the baseline proportions of homework completion, and the self-regulation strategies intervention proportions of homework completion (χ^2 (2, N = 1577) = 4.29, p = .12).

The null hypothesis (H_0) and alternative hypothesis (H_a) after removing all withdrawals:

- H_0: $\theta_{B/L} = \theta_{IV}$ (no difference in the parameter of interest); and
- H_a: $\theta_{B/L} > \theta_{IV}$ (there was a difference and the baseline was greater than the intervention)

  where θ was the proportion of late, missed, or on-time homework assignments.

Results of the chi-square goodness of fit test (removing all withdrawals) failed to reject H_0 indicating there was not a statistically significant difference between the baseline proportions of

homework completion, and the self-regulation strategies intervention proportions of homework completion (χ^2 (2, n = 1357) = 2.04, p = .36).

Summary of Self-Regulation Strategies Hypothesis Testing

To what extent do self-regulation strategies, such as planning and reflecting, influence student completion of homework assignments? Hypothesis test results indicated the intervention was not statistically significant for either scenario. For all enrollment data (Table 8), participants missed more homework assignments during the intervention (25.1%) than during the baseline period (20.4%). After removing the withdrawals, there was a marginal improvement during the intervention (79.7%) compared to the baseline (75.7%). The results were neither statistically significant, nor practically significant, since participants still missed a considerable proportion of their homework assignments.

Table 8: Baseline and Self-Regulation Strategies Intervention Homework Completion Data

	All Enrollments				No Withdrawals			
	Baseline		Intervention		Baseline		Intervention	
HW Type	Qty	%	Qty	%	Qty	%	Qty	%
Late	143	10.5	15	7.0	122	10.4	13	7.1
Missed	278	20.4	54	25.1	163	13.9	24	13.2
On-time	941	69.1	146	67.9	890	75.7	145	79.7
Total	1,362	100.0	215	100.0	1,175	100.0	182	100.0

Note. HW = homework; Qty = quantity.

Participant Feedback of the Self-Regulation Strategies Intervention

Several participants provided positive comments in Canvas as part of the plans and reflections. For example, "*Overall the schedule I laid out was well planned, and I was able to*

achieve my objectives before the set dates." This indicates the participant developed a schedule for the module, and followed it, suggesting they may have developed self-regulated learning skills by setting a target goal (Pintrich, 2004) potentially as a result of this intervention. Another participant noted, "*Reading the textbook - I read the textbook on time and on schedule and understood the rest of the content in chapter 9. Reviewing the supplemental information - I read and analyzed the key points/information in the textbook and used that knowledge to help me with my work. Turning in your homework assignment - I turned in my homework assignment on time and had no problem doing the problems. Took time to think of ways to simplify the code for grading. Reviewing the answer key - After getting feedback on my homework, I found that I did really well but forgot to put clear, clc with my script and got penalized for it. But I will make sure the same mistake doesn't happen again twice*. This participant provided an itemized reflection of their schedule, and their performance against it (Pintrich, 2004; Thibodeaux et al., 2017), providing evidence of Zimmerman's (2002) third phase, self-reflection, where students focus on self-judgment and self-reaction. This participant engaged in self-evaluation of their completed tasks, self-satisfaction, and identified strengths and weaknesses associated with successful task completion (Zimmerman 2002) with evidence of the importance of integrating self-regulatory processes into homework (Pintrich et al., 1987).

Sequencing Strategies Intervention Analysis

Hypothesis Testing Results

The null hypothesis (H_0) and alternative hypothesis (H_a) using all enrollments:

- H_0: $\theta_{B/L} = \theta_{IV}$ (no difference in the parameter of interest); and

- H_a: $\theta_{B/L} > \theta_{IV}$ (there was a difference and the baseline was greater than the intervention) where θ was the proportion of late, missed, or on-time homework assignments.

Results of the chi-square goodness of fit test (using all enrollments) rejected H_0 indicating there was a statistically significant difference between the baseline proportions of homework completion, and the sequencing strategies intervention proportions of homework completion (χ^2 (2, N = 1606) = 27.18, $p < .001$).

The null hypothesis (H_0) and alternative hypothesis (H_a) after removing all withdrawals:

- H_0: $\theta_{B/L} = \theta_{IV}$ (no difference in the parameter of interest); and
- H_a: $\theta_{B/L} > \theta_{IV}$ (there was a difference and the baseline was greater than the intervention) where θ was the proportion of late, missed, or on-time homework assignments.

Results of the chi-square goodness of fit test (removing all withdrawals) rejected H_0 indicating there was a statistically significant difference between the baseline proportions of homework completion, and the self-regulation strategies intervention proportions of homework completion (χ^2 (2, n = 1399) = 29.21, $p < .001$).

Summary of Sequencing Strategies Hypothesis Testing

To what extent do sequencing strategies, such as a content quiz and a practice problem, influence student completion of homework assignments? Hypothesis test results indicated the intervention was statistically significant as evidenced by the p-value (< .001) for both scenarios. For all enrollments (Table 9), participants missed fewer homework assignments during the intervention (12.3%) than during the baseline (20.4%). After removing the withdrawals, there was a considerable improvement during the intervention (92.0%) compared to the baseline

period (75.7%). Consequently, these results were both statistically significant and practically significant, since participants missed fewer homework assignments than the baseline.

Table 9: Baseline and Sequencing Strategies Intervention Homework Completion Data

	All Enrollment Data				No Withdrawal Data			
	Baseline		Intervention		Baseline		Intervention	
HW Type	Qty	%	Qty	%	Qty	%	Qty	%
Late	143	10.5	7	2.9	122	10.4	7	3.1
Missed	278	20.4	30	12.3	163	13.9	11	4.9
On-time	941	69.1	207	84.8	890	75.7	206	92.0
Total	1,362	100.0	244	100.0	1,175	100.0	224	100.0

Note. HW = homework; Qty = quantity.

Participant Feedback of the Sequencing Strategies Intervention

Although participants did not provide specific feedback on content quizzes or sample problems, they did provide feedback on other course resources. For example, "*I reviewed the solution key and understand my mistakes. I just need to reread the questions to make sure I understand what it is asking for, and if I do not understand, I need to ask the professor*. This illustrates the importance of getting an early start. If a student does not understand a homework problem, an earlier start provides an opportunity to seek appropriate resources such as self-instruction, time monitoring, environmental control, tutoring, or support from the instructor (Bembenutty et al., 2015; Bol et al., 2016). Another participant commented on the solution key, "*The solution key was excellent, as it has showed me what I have done wrong and the way in which to rectify the problem. All the material proved to be very useful during this module. The video and solution key have provided much needed advice*." This participant used the solution

key to independently examine their work, plus they used instructional materials designed by the instructor (e.g., content quiz and sample problem).

Analysis of Final Course Grade

Although analyzing participant final course grades was not in the original methodology, it was established in Chapter One that final course grades impacted the college, the students, and the instructor. Therefore, this analysis was added to the study's evaluation (Table 10). The null hypothesis (H_0) and alternative hypothesis (H_a) were:

- H_0: $\theta_{B/L} = \theta_{IV}$ (no difference in the parameter of interest); and
- H_a: $\theta_{B/L} > \theta_{IV}$ (there was a difference and the baseline was greater than the intervention) where θ was the proportion of participants completing the course with grades of D, F, or W (DFW).

Table 10: Final Course Grade Distribution for Baseline Students and Study Participants

	Baseline		Self-Regulation		Sequencing	
Grade	Qty	Percent	Qty	Percent	Qty	Percent
A	46	39.7	6	35.3	11	57.9
B	15	12.9	2	11.8	2	10.5
C	7	6.0	4	23.5	2	10.5
D	3	2.6	0	0.0	0	0.0
F	16	13.8	1	5.9	1	5.3
W	29	25.0	4	23.5	3	15.8
Total	116	100.0	17	100.0	19	100.0

Note. Qty = quantity.

Results of the chi-square test failed to reject H_0 indicating there was not a statistically significant difference between the baseline DFW final course grade proportion, or either intervention DFW final course grade proportion (χ^2 (2, N = 152) = 27.18, p = .18). Based on these results, there was no evidence supporting either intervention had statistical significance on improving final course grades as measured by the proportion of DFW's. However, a smaller proportion of participants in both interventions completed the course with a grade of DFW than the baseline students which is of practical significance.

Analysis of Survey Responses

The design methodology to address the third research question was the pre-post course survey instrument (Appendix B) sent to all participants (*N* = 38) at the beginning of the study period. Unfortunately, only eight participants responded to the survey (Appendix H) despite two follow-up reminders. The response rate (21.1%) was considerably lower (*SD* = -1.6) than the typical response rate (52.7%, *SD* = 20.4%) for studies utilizing data collected from individuals (Baruch & Holtom, 2008). Consequently, the original pre-post design was abandoned in favor of sending the survey to all participants at the end of the study period to potentially increase participation. The survey instrument was revised to reflect a post-course only survey (Appendix I) and sent to all participants (*N* = 29) at the end of the study period. The number of participants at the end of the study period was lower because nine participants withdrew from the course. The revised survey instrument (Appendix J) response rate (*M* = 31.0%) improved, but there were only nine total responses (*SD* = -1.1), still considerably low for a study using data collected from individuals (Baruch & Holtom, 2008).

Despite the low response rate, the responses were evaluated as if they were representative of all participants in this study. The revised survey instrument items were categorized as background factors (12, 13, 14, 15, 16) plus the three elements of attitude: affective (7d), behavioral (6a-6d, 7a-7c), and cognition (4a-4d, 5a, 5b, 10, 11). Since the survey was originally intended to collect pre- and post-course data by administering it twice, the revised survey collected participant self-assessed knowledge gains for the two software tools (8a, 8b, 9a, 9b), and beliefs about homework before and after taking the course used in this study (2a-2d, 3a-3d).

Background Factors

Participant background data was collected as these factors can shape behavioral beliefs, attitudes, and actual behaviors (Ajzen & Fishbein, 2005). Participants had a GPA over 3.1 (*Mdn* = 3.1-3.5, *IQR* = 3.1-3.5 to 3.6-4.0) and were more than half-way through a two-year degree program (*Mdn* = 49-60 credit hours, *IQR* = 37-48 to 49-60 credit hours). Participants took the course as part of their degree program and more than half planned to transfer to UCF's engineering program based on identifying their degree as AA Pre-Eng (44%) or AS ChT (11%). Most participants were less than 24 years old (*Mdn* = 18-24, *IQR* = 18-24), which aligns to college-wide demographics (54%), and most participants worked more than 20 hours per week (*Mdn* = 21-30, *IQR* = *No plan to work* to *Work more than 40 hours per week*). If participants who worked also attended college on a part-time basis, most participants (67%) attended college on a part-time basis, which aligns to the college-wide average (64%). Based on reported GPA data and how far along participants were with their degree program, some participants may have modest self-regulated learning skills since they balance work, school, and their study schedule.

Ideally, an increase in participant self-assessed knowledge gains with the software tools could be associated with the interventions used in this study.

Affective Element of Attitude

Survey instrument Item 7d was designed to explore the participants' affective reaction with respect to homework assignments. As described in Chapter Three, anticipating regret could affect a participant's feelings, and potentially their behavior (Abraham & Sheeran, 2003; Wolff et al., 2011). For the participants in this study, the feeling of regret would be due to not spending more time on homework assignments as preparation for an assessment. Participants were, in general, in agreement that they regretted not spending more time on homework (*Mdn* = *Agree*, *IQR* = *Strongly Agree* to *Neither Agree nor Disagree*) if they did not do well on an assessment. Only 22% of the participants did not have an emotional reaction to their performance on an assessment, providing support that the affective element has influences participant attitudes toward homework as anticipating a negative consequence may influence their behavior (Ajzen, 2011; Wolff et al., 2011).

Behavioral Element of Attitude

Participants study and prepare homework assignments in a place where they can concentrate, complete homework assignments early, would do homework even if it did not count as part of their grade, and complete almost all of their homework assignments (*M* = 2.13 or *Agree*, *SD* = 0.96). In particular, participants would complete nearly all of their homework assignments (*Mdn* = *Strongly Agree*, *IQR* = *Strongly Agree* to *Agree*), supporting the importance of carefully designed homework assignments, and prior behavior is a strong indicator of future behavior (Ajzen, 2002a, 2002b; Conner & Armitage, 1998; Sutter & Paulson, 2016).

Participants were neutral on their ability to adhere to a study and homework schedule (*Mdn* = *Neither Agree nor Disagree*, *IQR* = *Agree* to *Disagree*), and their intention is to avoid missing important points because they are thinking about other things while doing homework (*Mdn* = *Neither Agree nor Disagree*, *IQR* = *Agree* to *Disagree*). However, participants intend to work hard on a homework assignment, even if they don't like the topic (*Mdn* = *Agree, IQR* = *Strongly Agree* to *Agree*). Since some participants find it difficult to adhere to a study and homework schedule, providing students tasks prior to a homework assignment may help them manage their schedules better, and improve their self-regulated learning skills. Based on participant responses, they were willing to complete their homework, which supports positive attitudes toward homework will likely lead to a willingness to complete more of it as attitudes relate to subsequent behavior (Fazio, 1990).

Cognitive Element of Attitude

Participants believe if they study appropriately, they will be able to successfully meet course objectives, understand homework assignment material, and also that they have the knowledge, skills, and support to complete their homework assignments. Additionally, participants take responsibility if they do not learn the homework assignments (*M* = 1.30 or between *Strongly Agree* and *Agree*, *SD* = 0.58). These results align with prior studies in that self-efficacy and behavioral intention are closely related (Conner & Armitage, 1998; Sutter & Paulson, 2016). Participants also indicated they had studied appropriately throughout the course used in this study (*Mdn* = *Strongly Agree*, *IQR* = *Strongly Agree* to *Agree*), and that by studying appropriately, they would understand the homework assignment materials (*Mdn* = *Strongly Agree*, *IQR* = *Strongly Agree* to *Agree).* The last two items in this category (10 and 11),

addressed participants' self-efficacy via their grade based on the course description, and then on their performance. Based on the course description, respondents believed they would earn a grade of an A (*M* = 1.1, *SD* = 0.33), the same grade they expected based on their actual effort in the course (*M* = 1.2, *SD* = 0.67). Nearly all participants strongly believed in their ability to do well in the course based on their effort, indicating a positive cognition element of attitude (Breckler, 1984; Jain, 2014) toward academic tasks, such as completing homework.

Analysis of Pre-Post Course Survey Response Data

One of the original design goals for the survey instrument was to measure participant attitudes about homework, before and after the course, to investigate whether or not the interventions positively impacted participant attitudes toward homework. Although the pre-post course survey was abandoned, reframing the survey instrument still permitted limited inferential statistical analysis. Analysis of participant responses to item 2 pertained to general beliefs toward homework (pre-course), and participant beliefs toward homework assignments associated with the course used in this study (post-course) were surveyed in item 3. Although this was not a true pre-post design, it could provide an indication of participant beliefs toward homework for *Engineering Concepts and Methods*. Similarly, items 8 and 9 examined participant self-assessed knowledge/e gains with the software tools used in the course. The analyses followed the procedures developed in Chapter Three.

Participant general beliefs toward homework were positive, and illustrated a view that homework helps them meet course objectives and is a productive use of their time (*M* = 1.61 or between *Strongly Agree* and *Agree*, *SD* = 0.69), and participant beliefs toward homework after the course improved, and they felt homework aided in meeting course objectives and preparing

them for assessments better than no homework assignments (M = 1.47 or halfway between *Strongly Agree* and *Agree*, SD = 0.56). Since participant beliefs after taking the course used in this study more strongly agreed with the importance of homework, participant attitudes toward homework may have improved, potentially due to the interventions used in this study.

Hypothesis testing (2 and 3) used the Wilcoxon signed-rank test since beliefs toward homework used the same participants (correlated) for pre- and post-course survey responses:

- H_0: $Mdn_{\text{Item2abcd}} = Mdn_{\text{Item3abcd}}$ (no difference between pre- and post-course medians); and
- H_a: $Mdn_{\text{Item2abcd}} > Mdn_{\text{Item3abcd}}$ (the pre-course median value was greater).

Note that the survey instrument used a low score (1) for *Strongly Agree* and a high score (5) for *Strongly Disagree*, meaning if student attitudes shifted from *Strongly Disagree* (pre-course) to *Strongly Agree* (post-course), $Mdn_{\text{Item2abcd}}$ would be greater than $Mdn_{\text{Item3abcd}}$. The results of the Wilcoxon signed-rank test (N = 11, W = 30, z = 1.33, p = .095) failed to reject H_0, indicating the medians were not statistically different between the pre- and post-course survey responses. Although participant attitudes toward homework improved, it was not statistically significant.

Items 8 and 9 examined participant beliefs with respect to knowledge gains using the two software tools. For Excel, a few participants (11%) believed they were *Very Knowledgeable* prior to taking the course used in this study. After taking the course, most respondents (88%) believed they were *Extremely Knowledgeable* or *Very Knowledgeable*. For MATLAB, the results were more dramatic: all participants (100%) believed they were *Not Knowledgeable* with MATLAB prior to taking the course; afterwards, more than half (67%) believed they were *Extremely Knowledgeable* or *Very Knowledgeable*. The survey responses aligned well in this category in that participant attitudes and beliefs improved as a result of taking this course. Although the survey responses were limited, the responses suggest participants believed their

knowledge of the software tools improved as a result of taking this course, and ideally, due to the homework assignments.

Participant responses regarding Excel (items 8a and 9a) supported hypothesis testing via the Wilcoxon signed-rank test since self-assessed knowledge gains used the same participants (correlated) in the pre- and post-course responses:

- H_0: $Mdn_{\text{Item8a}} = Mdn_{\text{Item9a}}$ (no difference between pre- and post-course medians); and
- H_a: $Mdn_{\text{Item8a}} > Mdn_{\text{Item9a}}$ (the pre-course median value was greater).

The results of the Wilcoxon signed-rank test ($N = 8$, $W = 36$, $p = .005$) rejected $H_{0,}$ indicating the medians were statistically different between the pre- and post-course survey responses. Therefore, the results of participant self-assessed knowledge gains associated with Excel were statistically significant.

Similarly, participant responses regarding MATLAB (items 8b and 9b) also supported hypothesis testing via the Wilcoxon signed-rank test:

- H_0: $Mdn_{\text{Item8b}} = Mdn_{\text{Item9b}}$ (no difference between pre- and post-course medians); and
- H_a: $Mdn_{\text{Item8a}} > Mdn_{\text{Item9a}}$ (the pre-course median value was greater).

The results of the Wilcoxon signed-rank test ($N = 9$, $W = 45$, $p < .005$) rejected $H_{0,}$ indicating the medians were statistically different between the pre- and post-course survey responses. Therefore, the results of participant self-assessed knowledge gains associated with MATLAB were statistically significant. Given that homework assignments were an integral part of the course used in this study, there was evidence to support the interventions positively impacted student self-assessed knowledge gains.

Summary

This chapter summarized the results of the interventions and survey responses developed to address the research questions. The interventions were evaluated using inferential statistics to compare historical data to the data after the interventions. The survey instrument was sent to all participants at the beginning of the study period, as originally planned. Unfortunately, the number of participants that responded was insufficient for statistical analysis and a revised survey was sent to all remaining participants at the end of the study period. The data from the revised instrument were evaluated using a combination of descriptive and inferential statistics, with the results summarized by intended purpose. The next chapter is devoted to the conclusions of this study, and potential future research.

CHAPTER FIVE: CONCLUSIONS, DISCUSSION, AND FUTURE RESEARCH

Introduction

As discussed in Chapter One, most educators now agree homework is a means of extending learning opportunities outside of the classroom (Marzano, 2007). Based on historical data for the online introductory engineering course used in this study, students were not regularly turning in their homework, which impacted the students, the instructor, and the college. Based on information presented in the first chapter, there was sufficient evidence that students were not performing well due to missed homework assignments.

The literature review in Chapter Two covered prior research topics associated with homework. For the course used in this study, *Engineering Concepts and Methods*, several research areas were particularly relevant: homework and online courses, homework as it pertains to engineering education, and potential methods for increasing homework completion. The literature review also included prior research as it pertained to the conceptual framework developed for this study: self-regulated learning, the instructional pathway, and the ABC model of attitude. This framework was the basis for developing the research questions, and designing the interventions and survey instrument used in this study.

The methodology formulated in Chapter Three was created to evaluate the intervention results and the survey responses. The methodology summarized the rationale, defined the participants, specified the sampling and collection methods, and outlined the procedures and data analyses used in the evaluation. The interventions were evaluated using inferential statistics to determine if they positively influenced students to complete more homework assignments. The responses to the survey instrument were evaluated using descriptive and inferential statistics to

evaluate if participant attitudes toward homework changed, potentially as a result of the interventions used in this study.

Chapter Four summarized the results of the methodology to evaluate the interventions and the survey responses. Several adjustments were made to the original methodology developed in Chapter Three, such as performing additional statistical testing because of student withdrawals, and modifying the survey instrument due to limited participant responses at the beginning of the course. This final chapter provides a discussion of the results, implications and limitations of this study, and potential topics for future research.

Discussion of Results

This research study took place during the fall 2018 semester (study period) at Live Oak State College. The course used in this study, *Engineering Concepts and Methods*, is part of several degree programs at the college, plus it articulates into numerous degree programs at UCF. The number of participants in this study was originally 38; however, by the end of the study period, there were 29 because nine participants withdrew from the course. The interventions and survey instrument were developed during the summer of 2018 to address the three research questions developed from the conceptual framework. Each intervention was integrated into one course section during early August 2018, and the survey instrument was sent to all participants in late August, during the first several days of the fall semester.

Two chi-square analyses for each intervention were evaluated to determine whether there was a significant difference between historical homework completion data, and the intervention homework completion data, although the original methodology planned for just one analysis per intervention. This change was made to investigate whether students who withdrew from the

course potentially impacted statistical test results. In addition, due to the limited number of participant responses to the pre-course survey, the methodology to address the third research question was revised to using a single survey administered at the end of the semester in lieu of the original pre-post course survey design. A discussion of the interventions and survey results addressing the three research questions is below.

Research Question One

The self-regulation strategies intervention was developed using the conceptual framework to address the first research question: *To what extent do self-regulation strategies, such as planning and reflecting, influence student completion of homework assignments?* The details of the intervention, statistical testing, and test results were included in Chapters Three and Four. The results indicated there was not a statistically significant difference between the baseline and intervention data for all enrollments (χ^2 (2, N = 1577) = 4.29, p = .12). Similarly, after removing students who withdrew from the course, there was not a statistically significant difference between the baseline and the intervention data (χ^2 (2, n = 1357) = 2.04, p = .36). Therefore, this intervention did not provide sufficient statistical evidence of positively influencing participants to complete their homework assignments.

Using all enrollments, baseline students missed 20.4% of the homework assignments, and study participants missed 25.1% (Table 9). After removing students who withdrew from the course, baseline students missed 13.9%, and study participants missed 13.2%. Using all enrollments, on-time assignments dropped from the baseline (69.1%) to the intervention (67.9%). After removing students who withdrew from the course, on-time assignments marginally improved from the baseline (75.7%) to the intervention (79.7%). Summarizing these

data, the intervention results were statistically insignificant, and the intervention did not provide practical significance as participants still missed a considerable proportion of the homework assignments. Therefore, the intervention addressing Research Question One did not positively influence students to complete more homework assignments. This study also discussed the impact final course grades had on students, the college, and the instructor. Although the evaluation suggests final course grades marginally improved (Table 10), the change was not statistically significant (χ^2 (2, N = 152) = 27.18, p = .18).

This intervention was designed to guide participants through Pintrich's (2004) four-phase conceptual framework for self-regulated learning. Although the participants in this study followed this framework, the results did not align to prior research which found that encouraging students to expand their self-regulated learning skills, improved their academic performance (Bembenutty, 2009; Bol et al., 2016; Ramdass & Zimmerman, 2011; Sebasta & Speth, 2017; Thibodeaux et al., 2017; Zimmerman & Kitsantas, 2005). However, most of these prior studies did not measure final course grades. Instead, they examined other outcomes such as mathematics achievement (Bol et al., 2016; Bembenutty, 2009), improved study habits (Zimmerman & Kitsantas, 2005), the quality of homework (Ramdass & Zimmerman, 2011), time management (Thibodeaux et al., 2017), and exam preparation (Sebasta & Speth, 2017) which could explain the difference in results.

Contrary to prior studies, counting homework as part of the final course grade did not encourage students to complete their homework assignments (Edgcomb et al., 2017; Kontur & Terry, 2014; Radhakrishnan et al., 2009; Ryan & Hemmes, 2005). This was true for the historical course data, and it was true for the intervention data associated with the first research question. This could be attributed to the course used in this study, which is an online,

asynchronous, introductory engineering course taught at a predominantly two-year institution. Unlike many colleges and universities in prior studies, this college has an open enrollment policy, which means lower ability students may be enrolled in the course. Also, as noted in the literature review, there is limited research on the role of homework in the community college (Cohen et al., 2014; Fan et al., 2017), which means the results of this study may not align with prior research.

As discussed in chapter two, helping students complete more homework may provide a near-term impact, such as improving their final course grade, but this intervention was ideally intended to help students with forethought, performance, and self-reflection (Bembenutty et al. 2015; Zimmerman, 1990, 2002, 2008) based on the conceptual framework developed in Chapter One. One implication for the researcher's practice would be to implement plans and reflections into other courses, for both modalities, to continuously help students develop better self-regulated learning strategies. This is particularly important for project-based courses where students must develop scheduling skills in order to meet critical course deadlines.

The extra assignments for this intervention encouraged participants to plan their time more effectively as there were now three graded assessments for each course module, not one (i.e., the homework assignment), a weakness of the course design used during the baseline period. During the intervention's plan and reflect phases, participants had an opportunity to self-evaluate about the effectiveness of their learning (Zimmerman 2002). More importantly, participants were able to identify if they needed help earlier and could seek additional support such as self-instruction, tutoring, discussions with the instructor, or additional outside resources (Bembenutty et al., 2015, Campbell et al., 2016). Another shortcoming with the course design used in the baseline was the number of instructor opportunities to provide students regular

feedback. This intervention provided two additional opportunities for the instructor to provide ongoing task specific feedback to participants, which can have a considerable impact on their academic performance (Hattie & Timperley, 2007).

Although the results of this intervention were not significant, this could also be due to its implementation. For example, potential future research could require students to reflect on why they were unable submit their homework, and help them avoid these challenges on subsequent homework assignments. Broadbent and Poon (2015) found that one of the top three strategies to helping students in an online course was time management. If a similar study using this intervention was repeated, surveying participants to establish why they missed a homework assignment could be relevant to helping students complete more homework.

Research Question Two

The sequencing strategies intervention was developed using the conceptual framework to address the second research question: *To what extent do sequencing strategies, such as a content quiz and a practice problem, influence student completion of homework assignments?* The details of the intervention, statistical testing, and test results were included in Chapters Three and Four. The results indicated there was a statistically significant difference between the baseline and intervention data for all enrollments (χ^2 (2, N = 1606) = 27.18, p < .001). Similarly, after removing data from students who withdrew from the course, there was also a statistically significant difference between the baseline and intervention data (χ^2 (2, n = 1399) = 29.21, p < .001). Therefore, this intervention did provide sufficient statistical evidence of positively influencing participants to complete more homework assignments.

Using all enrollments, baseline students missed 20.4% of the homework assignments, and study participants missed only 12.3% (Table 9). After removing students who withdrew from the course, baseline students missed 13.9%, and study participants missed just 4.9%. Using all enrollments, on-time assignments improved considerably from the baseline (69.1%) to the intervention (84.8%). After removing students who withdrew from the course, on-time assignments also improved from the baseline (75.7%) to the intervention (92.0%). These results were statistically significant, and the intervention provided practical significance as participants missed considerably fewer homework assignments, plus they turned in fewer late assignments.

The results of this intervention align with prior research (McDonald, 2013) in that students performed better with a logically ordered sequence (Lim, 2016b). This ensured participants followed the prescribed instructional pathway, without eliminating, or bypassing, critical steps. Participants in this intervention may have gained self-confidence as they moved through a course module in an ordered sequence designed by the instructor (McDonald, 2013), which could account for the statistically significant fewer missed homework assignments. Also, participants may have had a better understanding of the assessment process because each module was broken down into smaller pieces, and each piece was individually assessed, a key aspect of the SBST methodology McDonald (2013). The results of this intervention also align to Pintrich et al.'s (1987) research in that a highly effective means of helping students learn from reading, is a content quiz based on that reading.

The content quizzes and sample problems developed in this study will be used in subsequent sections of *Engineering Concepts and Methods* because they encouraged students to begin topics earlier, plus they guided students through challenging materials prior to attempting homework assignments. The sequencing strategies intervention was successful because it

required participants to read the textbook to prepare for an assessment (content quiz), plus participants were required to submit a sample problem for each module providing scoring and feedback incrementally. As discussed earlier, this study described the impact final course grades had on students, the college, and the instructor. Although the evaluation suggests final course grades improved (Table 10), the change was not statistically significant (χ^2 (2, N = 152) = 27.18, p = .18).

Although helping students complete more homework may provide a near-term impact, such as improving their final course grade, this intervention was intended to help students follow the instructional pathway (Lim, 2016b), based on the conceptual framework developed in Chapter One. In addition, this intervention provided students an opportunity to immediately apply new knowledge to a problem, a critical aspect of andragogy (Knowles, 1988). One implication for the researcher's practice would be to apply similar sequencing strategies for other courses. For example, in addition to reading course materials prior to a class meeting, students could also be required to take short content quizzes based on the reading material and prepare several sample problems. The short quizzes and sample problems would help students focus on the critical concepts, particularly since the human brain is not able to process all information it receives (Marois & Ivanoff, 2005; Mayer, 2011). Similar to the first research question, if a similar study using this intervention was repeated, surveying participants to establish why they missed a homework assignment could be relevant.

The two extra assignments developed for this intervention required participants to spend more time practicing concepts and applications included in the homework assignments to deepen their understanding of new material (Arasasingham et al., 2011; Doorn et al., 2010; Richard-Babb et al. (2011). Although students should have been performing these tasks (i.e., reading

course materials and working sample problems) in the baseline period, there was no objective evidence they were, a weakness in the prior course design. In addition, participants followed a prescribed logical sequence which helps lower ability students (Lim, 2016b), plus it created an academic environment where participants could progressively gain self-confidence (McDonald, 2013) in advance of preparing the homework assignments. Similar to the intervention associated with the first research question, there were now three graded assignments for each course module, meaning participants spent more time spent on homework, which has a positive effect on academic performance (Cooper, 1989b; Fan et al., 2017; Maltese et al., 2012). Also, as noted previously, participants could identify if they needed help earlier and seek additional support in advance of weekly deadlines. Finally, this intervention also created two additional opportunities to provide timely feedback to participants to help them assess their performance versus what was expected (Nicol & Macfarlane-Dick, 2007; Sadler, 1989).

Unfortunately, despite participants completing more homework assignments, there was not a statistically significant improvement in their final course grades which does not align to prior studies (Bennet et al., 2013; Cooper, 1989b; Cooper et al., 1998, 2006; Fan et al., 2017; Planchard, et al., 2015; Rayburn & Rayburn, 1999; Radhakrishnan et al., 2009; Ryan & Hemmes, 2005; Trussel & Dietz, 2003). However, these prior studies used sample sizes considerably larger than this study which was limited to 20 students per intervention due to the enrollment cap. One way to improve the statistical test procedures examining the proportion of DFW's for final course grades, would be to increase the sample size, thereby increasing the power and decreasing the probability of a type II error (i.e., a false negative, or incorrectly failing to reject H_0) (Norman & Streiner, 2003). Due to the enrollment cap of this course, the revised study period may require more than one semester.

Research Question Three

The survey instrument was developed using the conceptual framework to address the third research question: *To what extent do self-regulation strategies, such as planning and reflecting, or sequencing strategies, such as a content quiz and a practice problem, influence student attitudes toward homework?* The details of the survey instrument and the proposed procedures were included in Chapter Three, and the results and their statistical analyses were provided in Chapter Four. It was established in Chapter Two that behavior (completing homework) can be predicted from attitudes toward that behavior (Ajzen & Fishbein, 2005; Sutter & Paulson, 2016). For this study, the survey was intended to measure participant responses to determine if the homework assignments positively influenced student attitudes toward homework. Although nine survey responses was disappointingly low (*M* = 31%), participant attitudes toward homework were positive. Participant attitudes may be partially shaped by their background factors such as a good GPA (*Mdn* = 3.1-3.5, *IQR* = 3.1-3.5 to 3.6-4.0), near completion of their two-year degree program (*Mdn* = 49-60 credit hours, *IQR* = 37-48 to 49-60 credit hours), and plans to enter UCF's Engineering Program (77%). These items indicate the participants who responded were good students at the end of their degree program planning to enter UCF's rigorous engineering program. It was established in Chapter Two that background factors can shape behavioral beliefs, attitudes toward the behavior, actual behavior, and tendency (Ajzen & Fishbein, 2005; Eagly & Chaiken, 2007).

The survey instrument was also designed to collect participant attitudes toward homework framed around the ABC Model. For the affective element of attitude, participants responded they regretted not spending more time on homework if they did not do well on an assessment (*Mdn* = *Agree, IQR* = *Strongly Agree* to *Neither Agree nor Disagree*). For the

behavioral element, participants responded they would do homework even if it did not count as part of their grade and complete almost all homework assignments (*M* = 2.13 or *Agree*, *SD* = 0.96). For the cognitive element of attitude, participants believed if they studied appropriately, they would successfully meet course objectives, understand homework material, and take responsibility if they do not learn the homework assignments (*M* = 1.30 or between Strongly Agree and Agree, *SD* = 0.58).

Although the survey results indicated participant background factors would positively shape their actual behavior (Ajzen & Fishbein, 2005), they do not align with this study's intervention results associated with the first research question. Similarly, the survey results of participants' feelings (Wolff et al., 2011), prior behavior (Connor & Armitage, 1998), and self-efficacy (Sutter & Paulson, 2016) suggested participants would complete their homework, yet this also does not align with the intervention results associated with the first research question. These positive survey responses indicate homework is important, yet the homework completion data associated with the first research question was not measurably better than historical homework completion data. One implication would be to segregate survey data by intervention for subsequent research studies.

In order to evaluate whether participant positive attitudes were due to the strategies used in this study or participant background factors, participant general beliefs toward homework (*M* = 1.61, *SD* = 0.69) were compared to their beliefs toward homework after taking the course used in this study (*M* = 1.47, *SD* = 0.56). Unfortunately, the results were not statistically significant ($N = 11$, $W = 30$, $z = 1.33$, $p = .095$). However, the course had a statistically significant impact on self-assessed knowledge gains with Excel ($N = 8$, $W = 36$, $p = .005$) and MATLAB ($N = 9$, $W = 45$, $p < .005$). Additionally, participants believed they would earn a grade of an A or B based

on their effort (M = 1.2, SD = 0.67). Despite insufficient evidence of the strategies used in this study influencing student attitudes toward homework, there was sufficient evidence suggesting homework positively impacted self-assessed knowledge gains.

Based on the participation level of the survey responses (M = 31.0%), this was a significant limitation for this study and the results of the survey do not have any practical significance despite some of the promising statistical results. The researcher's emphasis focused on keeping data anonymous, administering the survey electronically, and using *Qualtrics*. Instead, the researcher should have focused on maximizing the number of survey responses. Additionally, during the study period, the college changed email security procedures such that all incoming bulk email, including the survey requests, were sent to a recipient's quarantine folder. If a participant did not release the email from their quarantine folder, they would never receive it, and they would not respond to the survey. Despite two follow-up requests from the researcher, only eight participants responded to the original pre-course survey, and only nine participants responded to the revised end of course survey.

To acquire more participant data, one possible solution for subsequent studies would be to administer the survey using Canvas, instead of *Qualtrics*, thereby making it a part of the course. This would require all students to participate in the survey and increase the response rate. For example, the survey could be administered so students would be unable to access course materials until they had completed the survey. Unfortunately, the results would not be anonymous, but student information could be suppressed for subsequent reporting and analysis. The same procedure could be used for the post-course survey. If these procedures had been used for this research project, there would have been 29 participant responses for the pre-post surveys,

not nine. In addition, the survey responses would have been segregated by intervention providing more insight into survey results versus intervention results.

Limitations

The intervention results and specific implications were discussed earlier. However, there were other limitations associated with this study that warrant further discussion. One limitation was outside circumstances preventing participants from completing and submitting homework assignments, such as family and work priorities (NCES, 2003). If this study was repeated, surveying participants to establish why they missed a homework assignment could be relevant. Based on informal discussions with baseline students, family and work were common reasons students did not submit homework, which aligns to the findings of the NCES (2003). However other reasons might include workloads with other courses, participants may be satisfied with their current grade, or participants did not set aside enough time (i.e., planning and time management).

A second limitation relates to the course in this study as it is a course required for two student profiles: those planning to transfer to UCF's Engineering Program, and those pursuing an AS or BS degree in Engineering Technology. In general, other Live Oak students do not take this course, meaning the results of this study may only be meaningful to other engineering-related courses. The survey results indicated all responses came from participants enrolled in these programs.

A third limitation is the modality of the course used in this study. Although the course is taught using both modalities, this study only examined the online delivery modality. As noted in

Chapter One, students in the face-to-face modality typically complete homework in the classroom, meaning the results of this study may not pertain to both modalities.

A final limitation was the environment as this course was taught at a state college. These results may not transfer to programs offered by larger universities with a more homogeneous student age demographic (i.e., mostly 18-24 years old), or more stringent entrance requirements. Although 77% of the participants were pre-engineering students planning to transfer to UCF's Engineering Program, they may not be representative of typical university students, particularly since 45% of the survey responses came from AS and BS ET students.

Potential Future Research

Throughout this chapter, several areas for future research were discussed such as evaluating plans and reflections for project-based courses, increasing the sample size for statistical test procedures, and examining both course modalities using self-regulation strategies. Another area for future research would be to examine differences between students who plan to transfer to a four-year institution (e.g., UCF), versus those who plan to remain at Live Oak. Specific examples could include whether students planning to transfer to a four-year institution are more likely to complete homework assignments, more likely to complete the course with a higher grade, or less likely to complete the course with a grade of DWF.

One other area for potential future research would be to examine incoming student mathematics scores to determine if there is a correlation with homework completion, final course grade, or attitude toward homework. The findings of this study could compare results to earlier work by Bennet et al. (2013) who found students who did not complete their homework were more likely to have lower incoming ACT scores. This is particularly relevant given the college's

open enrollment policy. This research topic could also be expanded to include other engineering courses such as Statics, Dynamics, Probability and Statistics for Engineering, Engineering Economic Analysis, and Introduction to the Engineering Profession.

These suggested areas for potential future research would provide valuable information to the researcher and the college, particularly since there are relatively few research studies using community college data (Cohen et al, 2014; Fan et al., 2017). In addition, the results of these studies could improve the teaching practices of other Live Oak engineering faculty. Ideally, subsequent research could demonstrate that improving self-regulated learning skills leads to better final course grades, improved course completion, and aligns to prior research studies (Bennet et al., 2013; Cooper, 1989b; Cooper et al., 1998, 2006; Fan et al., 2017; Planchard, et al., 2015; Radhakrishnan et al., 2009; Trussel & Dietz, 2003).

Summary

This chapter discussed the results of the interventions and survey responses developed to address the three research questions. In addition, implications and limitations of this study were addressed plus potential topics for future research. For the researcher, this study demonstrated the practical importance of helping students develop self-regulated learning skills, and creating instructional task sequences to guide them through critical course materials before proceeding to homework. The sequencing strategies have already been incorporated into several other courses taught by the researcher; thus far, the results have been positive. Although the results of the study were not entirely successful, the interventions and survey results provided valuable insight into the researcher's practice and the importance of homework and its effectiveness for student learning.

APPENDIX A: IRB APPROVALS

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Determination of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Kirk Sawyer**

Date: **September 24, 2018**

Dear Researcher:

On 09/24/2018, the IRB reviewed the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Evaluating Pedagogical Methods That Influence Student Homework Assignment Completion
Investigator:	Kirk Sawyer
IRB Number:	SBE-18-14336
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

This letter is signed by:

Signature applied by Gillian Morien on 09/24/2018 11:40:03 AM EDT

Designated Reviewer

Page 1 of 1

[redacted]
Institutional Review Board
Request for Research Review

Title of Research Project	Evaluating Pedagogical Methods That Influence Student Homework Assignment Completion
Name of Principal Investigator	Kirk Sawyer
Phone number	[redacted]
Email address	[redacted]
Please describe the proposed study, including the research question, hypotheses, and methodology.	Description: The purpose of the research study is to evaluate methods that influence student homework assignment completion. The study will compare interventions in two sections of the same course. The collected data will be compared against an existing baseline of data from prior semesters that were also taught by the principal investigator. Students will also be asked to voluntarily participate in an online confidential survey. Research Questions: 1) To what extent do metacognitive strategies influence engineering student homework assignment completion in an introductory software applications course? 2) To what extent do metacognitive strategies influence engineering student attitudes towards homework completion in an introductory software applications course? Methodology: Quasi-experimental and survey. Hypotheses: 1) Metacognitive strategies, such as self-regulated learning, influence engineering student homework assignment completion. 2) Engineering student attitudes towards homework completion may be influenced by metacognitive strategies such as self-regulated learning.
Describe the target audience of participants, including the anticipated number of participants.	The target audience of participants includes AS ET, BS ET, and AA pre-engineering students. The anticipated number of participants is 40.
Describe the location of participants and how you will acquire access.	The students will be enrolled in an online [redacted] course. Access will be via their homework completion as recorded by [redacted] Learning Management System (i.e., Canvas).
Describe if participants are subject to any risk or harm from the study.	The participants will not be subject to any risk or harm from the study.
Projected start date for study.	Fall Semester 2018
Projected end date for study.	December 2018
Targeted audience of participants.	The target audience of participants includes two sections of EGN1007. Each section has a maximum of 20 students.
Provide details on how you will protect the rights of participants, particularly how you will ensure that subjects may elect NOT to participate without consequence.	Homework assignment completion data will be collected at the summary level only. The survey is voluntary and participants may select to opt-out. Survey data is also collected at the summary level only.
Provide details on how you will verify informed consent and that participants are at least 18 years old (or provide attachments of consent forms).	Informed consent for the survey will include the following as the first item in the survey (i.e., students may opt-out). *I am interested in understanding engineering student attitudes regarding homework assignments. You will be asked to answer questions about this topic. Please note that your responses will be*

[redacted]

Institutional Review Board
Request for Research Review

	The survey should take you less than 5 minutes to complete. Your participation is voluntary but greatly appreciated. You have the right to withdraw at any point and for any reason. If you would like to contact me, please e mail me at sawyerk@seminolestate.edu. *Thank you very much.* o *I consent to begin the study and that I am 18 years or older* o *I do not consent, I do not wish to participate*
Provide details on who will have access to research data and how you will protect the data.	Research data will be reported at the summary level only. There will not be any personally identifiable information used in this study.
Provide details on the questions or instruments used in your study (or provide attachments).	Details on the questions and instruments used in the study can be found below. Quizzes (prep quizzes used in Section I of the course): Attached Prep Questions (prep problems used in Section I of the course): these are examples found in the course textbook. Plan & Reflection (student study plans and reflections used in Section II of the course): Attached. Survey (the survey instrument used for both sections of the course): Attached.
Provide information on any other organizations, agencies, or departments involved in the study.	This study is being conducted as part of a graduate degree program at UCF.
Principal Investigator's signature.	*Kirk Sawyer* 12 September, 2018
IRB Review	
Exempt from Review	
Approved without Conditions	
Approved with Conditions	
IRB Chair Signature	[redacted]
Date	9/12/18

RESPONSIBILITIES OF THE PRINCIPAL INVESTIGATOR:

- Any additions or changes in procedures in the protocol will be submitted to the IRB for written approval prior to changes being implemented.
- Any problems connected with the use of human subjects once the project has begun must be communicated to the IRB Chair.
- The principal investigator is responsible for retaining informed consent documents for a period of three years after the project.

APPENDIX B: SURVEY INSTRUMENT

Welcome to the survey.

I am interested in understanding engineering student attitudes regarding homework assignments. You will be asked to answer questions about this topic. Please note that your responses will be kept completely confidential.

The survey should take you less than 5 minutes to complete. Your participation is voluntary but greatly appreciated. You have the right to withdraw at any point and for any reason. If you would like to contact me, please e-mail me at sawyerk@liveoakstate.edu.

Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

Thank you very much.

Q1.
- ❍ I consent to begin the study and that I am 18 years or older
- ❍ I do not consent, I do not wish to participate

Condition: If participant does not wish to participate, skip to, "Thank you for taking the survey."

Q2	**In general, I believe that homework assignments are**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q2a	are an important part of my coursework.					
Q2b	help me meet course objectives better than no homework assignments.					
Q2c	help me prepare for exams and projects better than no homework assignments.					
Q2d	are a productive use of my time.					
Q3	**In general, I believe that**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q3a	if I study appropriately, then I will be able to successfully meet course objectives.					
Q3b	if I study appropriately, then I will understand the homework assignment material.					
Q3c	I have the knowledge, skills, and support to complete homework assignments.					
Q3d	it is my own fault if I don't learn the homework assignment material.					

Q4	**Typically, I**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q4a	study and prepare my homework assignments in a place where I can concentrate.					
Q4b	complete homework assignments early.					
Q4c	would do homework assignments, even if they did not count as part of my grade.					

Q5	**In general, I**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q5a	find it hard to stick to a study and homework schedule.					
Q5b	work hard on homework assignments, even if I don't like what we are doing.					
Q5c	may miss important points because I am thinking of other things while I am doing homework assignments.					
Q5d	regret not spending more time on homework assignments when I don't do well on a quiz, exam, or project.					

Q6	**Prior to this course,**	Extremely knowledgeable	Very knowledgeable	Moderately knowledgeable	Slightly knowledgeable	Not knowledgeable
Q6a	my self-assessment of Excel is					
Q6b	my self-assessment of MATLAB is					

Q7. Based on the course description, I expect the following grade in this class.

❍ A
❍ B
❍ C
❍ D
❍ F

Q8 What is your age as of 8/21/2018?

❍ 18-24
❍ 25-34
❍ 35-44
❍ 45+

Q9. According to MyLiveOak, my current program and plan are
- ❍ Associate in Arts Degree – AA General – General
- ❍ Associate in Science/Applied Science – Chemical Technology
- ❍ Associate in Science/Applied Science – Engineering Technology
- ❍ Other Degree Program (AA or AS)
- ❍ Bachelor of Science – Engineering Technology
- ❍ Other Degree Program (BS)
- ❍ Non-Degree Seeking

Q10. How many credit hours have you have completed at Live Oak *including* this semester?
- ❍ This is my first semester
- ❍ 1-12
- ❍ 13-24
- ❍ 25-36
- ❍ 37-48
- ❍ 49-60
- ❍ More than 60

Q11. What is your approximate overall GPA after this semester?
- ❍ 3.6-4.0
- ❍ 3.1-3.5
- ❍ 2.6-3.0
- ❍ 2.1-2.5
- ❍ 2.0 or less
- ❍ This is my first semester

Q12. This semester, on average, how many hours do you expect to work for an employer?
- ❍ I do not plan to work this semester
- ❍ 1-10
- ❍ 11-20
- ❍ 21-30
- ❍ 31-40
- ❍ More than 40

Thank you for participating in this survey.

APPENDIX C: QUIZZES

Quiz Excel Module 1

1. For absolute cell addressing, which special character is used in the cell formula before copying and pasting? *Multiple Choice*
2. What is the most common purpose for using absolute addressing in calculations that will be copied to additional rows or columns? *Multiple Choice*
3. What is the [F4] key useful for? *Multiple Choice*
4. Where do you type the name for a *named cell*? *Multiple Choice*
5. What is one method for entering the edit mode to change the contents of the active cell? *Multiple Choice*
6. What character must be placed in front of the expression below to tell Excel that you want to use a built-in function called AVERAGE()? *Multiple Choice*
7. What does the following error message mean: #NUM! *Multiple Choice*
8. Cells can contain labels, such as text. *True/False*
9. Cells can contain numbers. *True/False*
10. Cells can contain formulas. *True/False*

Quiz Excel Module 2

1. Table 1 on page 59 lists numerous Paste options. In Example 1, which of the three Paste Methods uses the fewest number of mouse clicks or keystrokes to fill cells C6 through D8? *Multiple Choice*
2. How many total payments were made in the loan amortization table depicted in the Application starting on page 64 and ending with Figure 26? *Multiple Choice*
3. What is the Principal after the final payment depicted in the Application starting on page 64 and ending with Figure 26? *Multiple Choice*
4. The Alignment Group on the Ribbon bar provides horizontal and vertical alignment plus Wrap Text and Merge & Center toggle buttons. *True/False*
5. Microsoft Excel supports Superscript and Subscript font effects. *True/False*
6. By default, the contents of the cells in a worksheet are displayed using this format. *Multiple Choice*
7. Which format does Excel recommend for very large or very small values? *Multiple Choice*
8. What kind formatting is useful if particular format attributes are applied only if a certain condition is met? *Multiple Choice*
9. You can rename a worksheet by doing the following: *Multiple Choice*
10. The only way to insert a row or column is using a mouse right click. *True/False*

Quiz Excel Module 3

1. The CONVERT function uses the following syntax: =CONVERT(value, to_units, from_units). *True/False*
2. When using the SUM() function, the values can be text or numbers in the range that is being added together. *True/False*
3. The SUM() function can only be used for vertically summing numbers, not horizontally summing numbers. *True/False*
4. Excel's trigonometric functions express angles in degrees, not radians. *True/False*

5. Excel's inverse trigonometric functions return an angle in radians, not degrees. *True/False*
6. The AND() function returns a TRUE if any arguments passed to the function are TRUE. *True/False*
7. What will the following expression return: =EVEN(PI()). *Multiple Choice*
8. What will the following expression return: =DATE(1916,12,25)-DATE(1916,8,12). *Multiple Choice*
9. What will the following expression return: =LEFT("EGN1007",3) *Multiple Choice*
10. What will the following expression return: =ROUNDUP(PI(),2). *Multiple Choice*

Quiz Excel Module 4

1. To create a graph, data must be placed in columns like Figure 1. *True/False*
2. According to the textbook, the majority of graphs used by engineers are: *Multiple Choice*
3. A second curve can be added to an existing plot but both plots must share the same set of x values.
4. Excel only supports adding a linear (i.e., straight line) trend line to a graph. *True/False*
5. If the x values are not uniformly spaced, the best type of graph to use would be a line graph. *True/False*
6. Graphs should use chart titles, axis titles, and a legend. *True/False*
7. According to the Materials Testing (Stress-Strain Curve I), the linear portion of the stress-strain curve is: *Multiple Choice*
8. The two types of text files used to store data are most typically *Multiple Choice*
9. Excel allows the user to edit an existing graph. *True/False*
10. Excel will automatically determine the proper trend line for a chart so the user does not need to address this. *True/False*

Quiz Excel Module 5

1. The R^2 value for a perfect fit is *Multiple Choice*
2. The SLOPE function can be used to determine the slope of the best-fit straight line through a set of data. *True/False*
3. What is another name for the coefficient of determination? *Multiple Choice*
4. If the data set contains an x value equal to zero, the logarithmic and power types of trend lines are not available. *True/False*
5. Which type of chart should be used for creating the trend line information? *Multiple Choice*

Quiz Excel Module 6

1. To add two matrices, they do not need to be the same size. *True/False*
2. What is the special character sequence used when entering array formulas? *Multiple Choice*
3. The braces { } indicate that array math has been used and that the result is an array (i.e., a collection). *True/False*
4. In order to multiply two matrices, the number of columns in the first matrix must equal the number of rows in the second matrix. *True/False*
5. The following matrices be multiplied: [3x3] & [1x3]. *True/False*

6. What is the size of the resulting matrix if the following matrices are multiplied: [1x3] & [3x3] *Multiple Choice*
7. The transpose of [6 1 4] is *Multiple Choice*
8. Any matrix, regardless of size, can be inverted. *True/False*
9. The determinant of a matrix is a matrix with the same dimensions. *True/False*
10. To solve a system of linear equations, there must be twice as many equations as unknowns. *True/False*

Quiz Excel Module 7

1. The *mode* of a set of data is the value that appears with the lowest non-zero frequency. *True/False*
2. To calculate the mean of a set of numbers in Excel, you would use the following function: =MEAN(). *True/False*
3. What is the *median* for a set of data? *Multiple Choice*
4. What is a five-number summary? *Multiple Choice*
5. In the following IF statement, which of the two conditions would appear if cell A1 had the letter "M" as its contents? =IF(A1="M", "Condition 1", "Condition 2") *Multiple Choice*

Quiz MATLAB Module 1

1. The *workspace* window keeps track of *Multiple Choice*
2. Which window is similar to a scratchpad? *Multiple Choice*
3. What does a semi-colon do when it is placed at the end of a command? *Multiple Choice*
4. The *edit window* is used for typing and saving a series of commands without executing them. It is how M-files are created. *Multiple Choice*
5. All MATLAB variable names must start with a letter. *True/False*
6. The *isvarname* command is used to set a variable name. *True/False*
7. Variable names are not case sensitive. *True/False*
8. MATLAB allows the user to reassign built-in functions. For example, if you want to create your own function called sin (which is a built-in function for MATLAB, just like it was for Excel), will MATLAB let you? *True/False*
9. What is the basic data type used in MATLAB? *Multiple Choice*
10. When specifying a vector within a set of brackets (i.e., [ ]), what does the semi-colon mean? *Multiple Choice*

Quiz MATLAB Module 2

1. d=**linspace**(3, 5, 3) returns a vector, d, with which values? *Multiple Choice*
2. When using the **logspace**(a, b, c) command, where a, b, c are numbers, what is the base being used for the values a & b? *Multiple Choice*
3. Matrix multiplication is different from element-by-element multiplication. *True/False*
4. What character transposes a matrix? *Multiple Choice*
5. To change the numeric display, use which set of commands? *Multiple Choice*
6. Programs in MATLAB are stored in which type of file? *Multiple Choice*
7. What character is used to signify a comment? *Multiple Choice*

8. MATLAB supports breaking up files into sections or cells. What characters are used for this purpose? *Multiple Choice*
9. What commands are used to clear the workspace and command window? *Multiple Choice*
10. A vector is a 1xn or nx1 matrix. *True/False*

Quiz MATLAB Module 3

1. The argument of a function in MATLAB is *Multiple Choice*
2. The MATLAB function **log** uses what number as its base? *Multiple Choice*
3. The MATLAB syntax to raise e to the third power, or e^3 is **exp**(3). *True/False*
4. MATLAB trigonometric functions assume that angles are specified in: *Multiple Choice*
5. How does the command **sort**(x, 'descend') sort vector x? *Multiple Choice*
6. Which command would determine the size of a matrix if you wanted to know the number of total elements? *Multiple Choice*
7. Let x = [1, 2, 3, 4; 5, 6, 7, 8]. What would the answer be for **size**(x)? *Multiple Choice*
8. Let x = [1, 2, 3, 4; 5, 6, 7, 8]. What would the answer be for **length**(x)? *Multiple Choice*
9. Let x = [1, 2, 3, 4; 5, 6, 7, 8]. What would the answer be for **sort**(x)? *Multiple Choice*
10. What would the answer be for **factor**(24)? *Multiple Choice*

Quiz MATLAB Module 4

1. What is the default spacing when defining a matrix using a colon? *Multiple Choice*
2. Assume Matrix Y has 5 columns and 3 rows. Which command would produce vector X that is the third column of Matrix Y? *Multiple Choice*
3. Referring to Matrix M on textbook page 477, what would the following command result in: M(2, end)? *Multiple Choice*
4. The command **ones**(m) creates an m x m matrix of ones. *True/False*
5. You do not need to use a semi-colon to indicate a new row when specifying a matrix because you can also enter the data on a new row. *True/False*
6. In general, the following is true in Matrix multiplication: **A** * **B** = **B** * **A.** *True/False*
7. If the determinant of a matrix is 0, then the matrix does have an inverse. *True/False*
8. To solve the system of equations **Ax** = **B**, MATLAB does support using the inverse method, or $\mathbf{x} = \mathbf{A}^{-1}\mathbf{B}$. *True/False*
9. To solve the system of equations **Ax = B**, MATLAB does support using left division, or **x = A\B**. *True/False*
10. A matrix times its inverse (i.e., $\mathbf{AA^{-1}}$) is equal to? *Multiple Choice*

Quiz MATLAB Module 5

1. Assume you have created a user-defined function. The first line of your function is: function output = square(x). What is the name of your function? *Multiple Choice*
2. Assume you have created a user-defined function. The first line of your function is: function output = square(x). What is the input argument of your function? *Multiple Choice*
3. Assume you have created a user-defined function. The first line of your function is: function output = square(x). What is the output variable of your function? *Multiple Choice*

4. You can execute a function M-file directly from the M-file itself. *True/False*
5. A function may only have a single input and single output. *True/False*
6. To determine the number of input arguments for a function, you could use the following built-in function: *Multiple Choice*
7. Which command is used to display a string or a matrix in the command window? *Multiple Choice*
8. Which command creates formatted output which can be sent to the command window or to a file? *Multiple Choice*
9. Which character is used as a placeholder in the **fprintf** command? *Multiple Choice*
10. Which character is used to begin and end a string? *Multiple Choice*

Quiz MATLAB Module 6

1. The equals operator (==) and the assignment operator (=) mean the same thing in MATLAB. *True/False*
2. Which symbol is used for the "or" operator? *Multiple Choice*
3. The **find** function returns the index numbers from the matrix that meet the search criterion. *True/False*
4. Assume you had a vector called height defined as follows: height = [63, 67, 65, 72, 69, 78, 75]. You issue the following command: pickme = **find**(height>=76). What would the answer be? *Multiple Choice*
5. The if/else structure allows us to execute a series of statements if a condition is true and to skip those steps if the condition is false. *True/False*
6. Assume you also create the following for loop:

   for k = [1, 3, 5, 2, 4, 6, 8]

           k

   end

   How many times will the loop be executed? *Multiple Choice*
7. The variable used to control the **while** loop must be updated every time through the loop. *True/False*
8. The commands **tic** and **toc** are used to start and stop a timing sequence. *True/False*
9. With a few modifications, it should be possible to use a **while** loop in place of a **for** loop. *True/False*
10. The element numbering sequence for a MATLAB matrix is left-to-right and then top-down. *True/False*

Quiz MATLAB Module 7

1. Adding a grid, a title and labels makes a plot easier to interpret *True/False*
2. A list of characters enclosed by single quotes is called *Multiple Choice*
3. MATLAB does not support plots with more than one line. *True/False*
4. Does MATLAB support lines with different colors on its plots? *True/False*
5. Which MATLAB command is used to create a histogram? *Multiple Choice*

APPENDIX D: PREPARATORY PROBLEMS

Preparatory Problem Excel Module 1
Modify textbook Example 2 to display velocities in feet per second.

Note that the conversion between miles per hour (mph), and feet per second (fps), is 1.467 fps/mph. Include this conversion factor as part a cell on the worksheet plus include the units so your audience knows what the value is used for.

To help keep the presentation organized, place constants and parameter values near the top of the worksheet, where they are easy to find.

Preparatory Problem Excel Module 2
As an example of how a lot of decimal places can be displayed on inaccurate numbers, consider the driving distances between some US cities shown in textbook Figure 56.

The values listed in miles are approximations from values listed at various Internet sites, and they are not that accurate. For example, the reported distance between New York to Los Angeles ranges from 2,400 to 3,000 miles, and probably depends heavily on the route that you take, detours, or road closures.

The values listed in kilometers were calculated from the values in miles by using the conversion factor 0.6214 miles per kilometer (note that one of these calculations is shown in textbook Figure 56). Excel displayed the calculated results with three decimal places, and someone might see those values and think those are highly precise values, but they were actually calculated using some highly imprecise and inaccurate mileage values.

In order to get rid of those extra decimal places to eliminate some of the confusion, do the following:

- Select the cells containing values to be reformatted with fewer decimal places.
- Click the **Decrease Decimal** button three times (once for each decimal place).
- You should match the results shown in textbook Figure 58.

Preparatory Problem Excel Module 3
If we used a pitot tube with a real flowing fluid with a specific gravity of 0.81, and the pressure transducer indicated the pressure difference ($p_a - p_b$) = 0.25 atm, what was the local velocity at point b?

The equation used to address this problem is $u_b = \{(2/\rho)*p_a - p_b)\}^{1/2}$
Note the following:

- the pressure difference in atmospheres should be converted to Pascals
- specific gravity is the ratio of a fluid's density to the density of water
- the density of water is 1,000 kg/m^3

Preparatory Problem Excel Module 4 (Temperature vs. Time Scatter Plot)
Create a Scatter Plot of Temperature vs. Time for the data provided below. Your plot must have a title, a labeled x-axis, a labeled y-axis, and a legend.

Time (seconds)	Temperature (^oC)
0	54.23
1	45.75
2	28.41
3	28.30
4	26.45
5	17.36
6	17.64
7	9.51
8	5.76
9	8.55
10	6.58
11	4.62
12	2.73
13	2.91
14	0.32
15	1.68

Preparatory Problem Excel Module 5 (Linear Regression Line)
Using the data below, create a linear regression line using Excel's SLOPE() and INTERCEPT()

1. Calculate the slope using the SLOPE()
2. Calculate the intercepts INTERCEPT()
3. Using the results from the first two steps, complete the table (i.e., Calculated Temp) using y = mx+b, where x is the time and m & b were calculated in the first two steps
4. Create a Scatter Plot of Temperature vs. Time for your data. Your plot must have a title, a labeled x-axis, a labeled y-axis, and a legend.

Time (seconds)	Temperature (^oC)	Calculated Temp (^oC)
0	54.23	
1	45.75	
2	28.41	
3	28.30	
4	26.45	
5	17.36	
6	17.64	
7	9.51	
8	5.76	
9	8.55	

Preparatory Problem Excel Module 6 (Matrix Multiplication)
Use the following two matrices to answer the questions below.

A = [1 3
  7 2
  8 11]

G = [1 2 3 4
  5 6 7 8]

1. What is the size of the product matrix (i.e., the result of multiplying the two matrices)?
2. Using the built-in functionality of Excel, what is the result of the multiplication?

Note that you are multiplying the following $[A]_{3x2}$ & $[G]_{2x4}$

Preparatory Problem Excel Module 7 (Statistical Data)
Create the table shown in columns B and C. Using Excel's built-in functions and your data in column C, calculate the Mean, Median, Mode, Q1 Cutoff, Q3 Cutoff, Lowest Score, and Highest Score. Display your results similar to the presentation shown below in Columns E and F.

A	B	C	D	E	F
Population Data: All results for Exam #1					
	Student ID	**Test 1**		**Statistic**	**Value**
	1	68		Mean=	
	2	83		Median=	
	3	61		Mode=	
	4	70		Q1 Cutoff =	
	5	75		Q3 Cutoff =	
	6	82		Lowest Score=	
	7	57		Highest Score=	
	8	5			
	9	76			
	10	85			
	11	62			
	12	71			
	13	96			
	14	78			
	15	76			
	16	68			
	17	72			
	18	75			
	19	83			
	20	93			

Preparatory Problem MATLAB Module 1
As you perform the following calculations, recall the difference between the * and the .* operators (i.e., scalar vs. vector), as well as the / and ./ and the ^ and .^ operators.

1. Define the matrix *a* = [2.3 5.8 9] as a MATLAB variable.
2. Find the sine of **a**.

3. Add 3 to every element in **a**.
4. Define the matrix **b** = [5.2 3.14 2] as a MATLAB variable.
5. Add together each element in matrix **a** and in matrix **b**.
6. Multiply each element in **a** by the corresponding element in **b**.
7. Square each element in matrix **a**.

Preparatory Problem MATLAB Module 2

Create a conversion table of pounds force to newtons. The table will start at 0 and go to 1000 lbf at 100 lbf increments. Note that 1 lbf = 4.4482216 newtons (N). This is an excellent opportunity to practice with the five steps for setting up and solving a problem.

1. State the Problem.
   Create a table converting pounds force (lbf) to newtons (N)
2. Describe the Input and Output
   Input:
      Starting value in the table is 0 lbf
      Final value is 1000 lbf
      The increment is 100 lbf
      The conversion factor is 1 lbf = 4.4482216 N
   Output:
      Table listing pounds force (lbf) and newtons (N)
3. Develop a Hand Example (3 are presented below)
   0*4.4482216 = 0
   100*4.4482216 = 444.82216
   1000*4.4482216 = 4448.2216
4. Develop a MATLAB Solution
   clc, **clear**
   lbf = (0:100:1000)
   N = lbf*4.4482216
   (lbf',N')
5. Confirm your MATLAB solution matches the calculation you did by hand (i.e., the output in the Command Window)

Preparatory Problem MATLAB Module 3 (Items 1 – 4)

Using MATLAB built-in functions described in the examples, determine the following:

1. Factor the number 322
2. Find the greatest common denominator of 332 and 6
3. Is 322 a prime number?
4. How many prime numbers occur between 0 and 322?

Preparatory Problem MATLAB Module 4

Create MATLAB variables to represent the following matrices, and use them in the exercises that follow.

a = [12 17 3 6]
b = [5 8 3; 1 2 3; 2 4 6]
c = [22;17; 4]

1. Assign to the variable x1 the value in the second column of matrix **a**. This is sometimes represented in mathematics textbooks as element $a_{1,2}$ and could be expressed as x1 = $\mathbf{a}_{1,2}$.
2. Assign to the variable x2 the third column of matrix **b**.
3. Assign to the variable x3 the third row of matrix **b**.
4. Assign to the variable x4 the values in matrix **b** along the diagonal (i.e., elements $\mathbf{b}_{1,1}$, $\mathbf{b}_{2,2}$, and $\mathbf{b}_{3,3}$).

Preparatory Problem MATLAB Module 5

Create a MATLAB function to evaluate the following mathematical function (make sure you select a meaningful function name) *and* test it. To test your function, you will need to call the function from the command window, or use it in a script M-file program. Remember, the function requires its own M-file.

$y(x) = x^2$

Preparatory Problem MATLAB Module 6

Use the following matrices to answer these questions.

x = [1 10 42 6; 5 8 78 23; 56 45 9 13; 23 22 8 9]

y = [1 2 3; 4 10 12; 7 21 27]

z = [10 22 5 13]

1. Using single-index notation, find the index numbers of the elements in each matrix that contain values greater than 10.
2. Find the row and column numbers (sometimes called subscripts) of the elements in each matrix that contain values greater than 10.
3. Find the values in each matrix that are greater than 10.

Preparatory Problem MATLAB Module 7

1. Plot *x* versus *y* for y = sin(x). Let x vary from 0 to 2π in increments of 0.1π.
2. Add a title and labels to your plot.

APPENDIX E: HISTORICAL HOMEWORK COMPLETION DATA

Historical Homework Completion Data for Engineering Concepts and Methods

	Excel Homework Assignments							MATLAB Homework Assignments							Final	Missing
Student	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**Grade**	**Assignments**
History 1	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	0
History 2	S	S	S	M	M	M	M	S	M	M	M	M	M	M	F	10
History 3	L	S	S	S	S	S	S	S	L	S	S	L	S	S	A	0
History 4	M	M	M	S	M	M	M	W	W	W	W	W	W	W	W	6
History 5	S	S	M	W	W	W	W	W	W	W	W	W	W	W	W	1
History 6	S	S	M	L	S	S	S	S	M	M	M	M	M	M	F	7
History 7	S	S	S	S	S	S	S	S	S	S	S	S	S	M	B	1
History 8	S	S	S	M	S	S	S	S	M	S	S	S	S	L	C	2
History 9	S	S	S	S	S	S	S	S	S	S	S	L	S	S	A	0
History 10	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 11	S	S	S	S	S	S	S	S	S	S	S	L	S	S	A	0
History 12	S	S	S	S	L	L	S	S	L	M	S	L	S	S	B	1
History 13	S	S	S	S	S	S	S	S	L	L	S	S	S	S	A	0
History 14	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 15	S	S	L	S	S	L	S	S	S	S	S	L	L	S	A	0
History 16	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	0
History 17	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	0
History 18	S	S	M	S	S	S	S	S	S	M	M	M	M	M	F	6
History 19	S	S	L	S	S	S	S	S	M	M	S	L	M	M	F	4
History 20	S	S	L	M	L	M	M	S	M	W	W	W	W	W	W	4
History 21	S	L	L	S	S	S	S	S	L	S	S	S	S	L	B	0
History 22	M	M	M	M	M	M	M	M	M	M	M	M	M	M	F	14
History 23	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	0
History 24	L	S	S	S	S	L	S	S	L	L	M	L	L	L	C	1
History 25	S	S	S	S	S	S	S	S	M	M	M	M	M	M	F	6
History 26	S	S	S	S	S	L	S	S	L	S	S	L	S	S	A	0
History 27	S	S	S	S	S	S	S	S	L	S	S	S	S	S	A	0
History 28	S	S	S	S	S	S	M	S	S	S	S	M	S	S	C	2
History 29	S	S	S	M	M	W	W	W	W	W	W	W	W	W	W	2
History 30	S	S	L	S	S	S	S	S	S	S	S	S	S	S	A	0
History 31	S	L	L	S	S	S	S	S	L	L	L	L	L	S	A	0
History 32	L	S	M	M	M	W	W	W	W	W	W	W	W	W	W	3
History 33	S	S	M	M	M	W	W	W	W	W	W	W	W	W	W	3
History 34	S	M	M	M	M	M	M	M	M	W	W	W	W	W	W	8
History 35	S	S	L	L	L	L	S	S	M	M	W	W	W	W	W	2
History 36	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 37	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 38	S	S	S	S	S	S	S	S	S	L	S	L	S	S	C	0
History 39	S	S	S	S	S	S	S	S	S	S	S	S	S	S	B	0
History 40	S	S	S	S	S	S	M	S	S	S	S	S	S	S	A	1
History 41	S	S	S	S	S	S	S	S	L	L	S	L	S	S	A	0
History 42	S	S	M	L	S	L	L	S	M	M	S	W	W	W	W	3
History 43	M	M	M	M	M	M	W	W	W	W	W	W	W	W	W	6
History 44	M	L	S	S	L	S	L	S	L	S	S	M	L	S	D	2
History 45	S	S	L	S	L	L	S	S	L	L	L	L	L	L	B	0
History 46	M	M	S	M	S	S	M	S	M	S	S	S	S	S	F	5
History 47	S	S	L	S	L	L	S	S	M	S	S	S	S	S	B	1
History 48	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 49	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 50	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 51	L	M	L	L	M	M	M	M	M	M	W	W	W	W	W	7
History 52	M	L	S	L	L	L	S	S	M	M	M	M	M	M	F	7
History 53	S	S	S	S	S	S	S	S	M	M	M	M	M	M	F	6
History 54	S	S	S	L	S	S	S	S	S	S	S	S	S	S	B	0
History 55	S	S	S	S	S	S	S	S	S	S	L	S	S	M	A	1
History 56	S	S	S	S	S	S	L	S	S	S	S	S	S	S	A	0
History 57	S	S	S	S	S	S	M	M	M	M	M	M	M	M	F	8
History 58	M	M	S	S	M	S	S	S	M	M	M	M	M	M	F	9

Historical Homework Completion Data for Engineering Concepts and Methods

	Excel Homework Assignments							MATLAB Homework Assignments							Final	Missing
Student	#1	#2	#3	#4	#5	#6	#7	#1	#2	#3	#4	#5	#6	#7	Grade	Assignments
History 59	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 60	S	L	L	L	L	M	M	M	M	W	W	W	W	W	W	4
History 61	S	S	S	L	S	S	S	S	S	S	S	S	S	S	B	0
History 62	S	S	S	S	S	S	S	L	S	S	S	S	M	S	A	1
History 63	S	S	W	M	M	M	M	M	M	W	W	W	W	W	W	6
History 64	S	S	S	S	S	S	S	L	S	S	S	S	S	S	A	0
History 65	M	S	S	M	M	S	S	M	M	M	M	M	M	M	F	10
History 66	S	S	M	M	M	M	M	M	M	W	W	W	W	W	W	7
History 67	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 68	M	M	M	M	M	M	M	W	W	W	W	W	W	W	W	7
History 69	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 70	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 71	S	S	M	M	M	M	M	M	M	W	W	W	W	W	W	7
History 72	S	M	S	S	S	S	M	L	S	S	S	S	S	S	A	2
History 73	M	L	M	N	M	M	M	M	M	W	W	W	W	W	W	7
History 74	M	S	S	S	S	S	S	S	S	S	S	S	S	S	B	1
History 75	S	S	S	S	L	M	S	L	S	S	L	M	M	S	B	3
History 76	M	M	M	M	M	M	M	M	M	W	W	W	W	W	W	9
History 77	S	M	S	S	M	S	S	M	M	M	M	M	M	M	F	9
History 78	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 79	S	S	S	S	S	S	S	L	S	S	S	S	S	S	A	0
History 80	S	S	S	S	S	S	M	M	W	W	W	W	W	W	W	2
History 81	S	S	S	S	L	S	S	S	L	S	M	S	S	L	B	1
History 82	S	S	S	S	S	W	W	W	W	W	W	W	W	W	W	0
History 83	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 84	D	L	S	D	S	S	S	L	S	S	S	S	S	S	A	0
History 85	S	S	L	L	L	S	M	L	S	S	S	S	S	S	A	1
History 86	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 87	S	S	S	S	S	S	S	L	S	S	S	S	S	S	A	0
History 88	S	S	S	S	S	S	S	S	S	S	M	S	S	S	A	1
History 89	S	S	S	S	S	S	S	L	S	S	S	S	S	S	A	0
History 90	S	S	L	S	S	L	S	L	L	S	S	M	L	S	B	1
History 91	S	S	S	S	S	S	S	L	S	S	S	S	S	S	A	0
History 92	S	L	S	S	S	S	S	S	M	S	M	S	M	M	F	4
History 93	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 94	S	L	S	S	S	S	S	S	S	S	S	L	S	S	B	0
History 95	S	L	L	S	M	M	M	M	M	W	M	W	W	W	W	6
History 96	S	S	S	S	S	S	S	L	L	L	L	S	S	S	B	0
History 97	S	S	S	M	S	S	S	S	S	S	M	M	S	L	B	3
History 98	S	M	M	M	M	M	M	M	M	M	W	W	W	W	W	9
History 99	S	S	S	S	S	S	S	L	S	S	S	S	S	S	C	0
History 100	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	0
History 101	S	S	S	S	M	L	L	S	L	L	L	M	M	M	D	4
History 102	M	M	M	M	M	M	M	M	M	M	M	M	M	M	F	14
History 103	S	S	S	S	S	S	S	L	L	S	S	S	S	S	A	0
History 104	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 105	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
History 106	M	S	M	M	M	M	M	M	M	W	W	W	W	W	W	8
History 107	S	S	M	S	S	S	S	S	S	S	M	M	M	S	C	4
History 108	S	S	S	L	S	S	S	S	S	S	S	S	S	J	A	0
History 109	S	S	S	S	S	S	S	S	S	S	S	M	S	S	A	1
History 110	S	S	L	S	S	S	S	S	S	S	S	S	S	S	A	0
History 111	S	M	L	M	S	S	M	L	S	S	L	S	S	S	C	3
History 112	S	S	S	S	S	S	L	S	S	S	S	S	S	S	A	0
History 113	S	S	S	M	S	L	S	M	M	M	S	M	S	L	D	5
History 114	S	S	S	S	S	S	S	L	S	S	S	S	S	S	A	0
History 115	S	S	S	S	S	S	S	S	L	S	S	M	M	M	F	3
History 116	S	S	S	S	L	S	S	S	M	W	W	W	W	W	W	1

APPENDIX F: DATA IN SUPPORT OF RESEARCH QUESTION ONE

Fall 2018 Data in Support of RQ1 (Plan & Reflect Section 70845)

Fall 2018 Homework Assignment Completion Data for Engineering Concepts and Methods Data (IV1)

	Excel Homework Assignments							MATLAB Homework Assignments							Final	Missed
Student	#1	#2	#3	#4	#5	#6	#7	#1	#2	#3	#4	#5	#6	#7	Grade	Assignments
IV1 1	S	L	S	S	S	S	S	S	S	S	S	S	S	S	C	0
IV1 2	S	S	S	S	S	S	S	S	S	S	S	L	S	S	A	0
IV1 3	S	S	M	L	S	L	M	S	S	M	M	M	M	M	F	7
IV1 4	S	M	M	M	M	M	M	M	W	W	W	W	W	W	W	7
IV1 5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
IV1 6	M	M	M	M	M	M	M	M	W	W	W	W	W	W	W	8
IV1 7	M	M	M	M	M	M	M	M	W	W	W	W	W	W	W	8
IV1 8	S	S	S	L	S	S	S	S	S	S	S	S	S	S	A	0
IV1 9	S	S	S	M	S	S	S	S	S	S	M	L	L	S	B	2
IV1 10	L	L	M	M	M	M	M	M	M	W	W	W	W	W	W	7
IV1 11	S	S	S	S	S	S	S	M	S	S	L	L	S	S	A	1
IV1 12	S	M	S	S	S	M	S	S	M	M	M	M	M	S	C	7
IV1 13	L	S	S	S	M	S	S	S	S	S	S	S	S	S	A	1
IV1 14	S	L	S	S	M	S	S	S	S	S	M	M	S	S	A	3
IV1 15	S	S	M	S	S	S	S	L	S	S	S	S	S	S	B	1
IV1 16	S	S	S	S	S	M	S	L	S	S	S	S	S	S	C	1
IV1 17	S	S	S	S	S	M	S	S	S	S	S	S	S	S	C	1

APPENDIX G: DATA IN SUPPORT OF RESEARCH QUESTION TWO

Fall 2018 Data in Support of RQ2 (Quiz and Prep Problem Section 70894)

Fall 2018 Homework Assignment Completion Data for Engineering Concepts and Methods Data (IV2)

	Excel Homework Assignments							MATLAB Homework Assignments							Final	Missed
Student	#1	#2	#3	#4	#5	#6	#7	#1	#2	#3	#4	#5	#6	#7	Grade	Assignments
IV2 1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
IV2 2	S	S	S	S	S	L	S	S	S	S	S	S	S	S	C	0
IV2 3	S	S	S	S	S	S	S	L	S	S	S	S	S	S	A	0
IV2 4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
IV2 5	M	M	M	M	M	M	W	W	W	W	W	W	W	W	W	6
IV2 6	S	S	S	S	S	S	S	M	S	S	S	S	S	S	A	1
IV2 7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
IV2 8	M	M	M	M	M	M	W	W	W	W	W	W	W	W	W	6
IV2 9	S	S	S	S	S	S	S	S	S	S	M	M	M	S	B	3
IV2 10	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	0
IV2 11	S	S	S	S	S	S	L	S	S	S	S	S	S	S	A	0
IV2 12	S	S	S	S	S	S	S	S	S	S	S	S	L	S	A	0
IV2 13	S	M	S	S	S	S	S	S	S	S	S	S	S	S	A	1
IV2 14	S	S	S	S	S	S	S	S	S	S	S	S	S	S	F	0
IV2 15	S	S	S	S	M	S	S	S	S	S	S	S	S	S	A	1
IV2 16	S	M	M	S	S	S	S	L	S	S	S	S	M	S	A	3
IV2 17	S	S	S	S	S	L	S	L	S	S	S	M	S	S	C	1
IV2 18	S	M	M	M	M	M	M	M	W	W	W	W	W	W	W	7
IV2 19	S	S	S	S	S	S	S	S	S	M	S	S	S	S	B	1

APPENDIX H: PRE-COURSE SURVEY RESULTS

Q2	In general, I believe that homework assignments are	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q2a	are an important part of my coursework.	2	4	1	1	0
Q2b	help me meet course objectives better than no homework assignments.	3	3	1	1	0
Q2c	help me prepare for exams and projects better than no homework assignments.	3	5	0	0	0
Q2d	are a productive use of my time.	2	2	3	1	0
Q3	**In general, I believe that**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q3a	if I study appropriately, then I will be able to successfully meet course objectives.	4	3	1	0	0
Q3b	if I study appropriately, then I will understand the homework assignment material.	3	3	1	1	0
Q3c	I have the knowledge, skills, and support to complete homework assignments.	1	6	1	0	0
Q3d	it is my own fault if I don't learn the homework assignment material.	2	4	1	1	0
Q4	**Typically, I**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q4a	study and prepare my homework assignments in a place where I can concentrate.	2	5	0	1	0
Q4b	complete homework assignments early.	1	5	1	1	0
Q4c	would do homework assignments, even if they did not count as part of my grade.	0	2	3	3	0
Q4d	complete almost all of my homework assignments.	5	3	0	0	0

Q5	**In general, I**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q5a	find it hard to stick to a study and homework schedule.	0	2	1	4	1
Q5b	work hard on homework assignments, even if I don't like what we are doing.	2	4	2	0	0
Q5c	may miss important points because I am thinking of other things while I am doing homework assignments.	0	3	1	3	1
Q5d	regret not spending more time on homework assignments when I don't do well on a quiz, exam, or project.	1	1	3	3	0

Q6	**Prior to this course,**	Extremely knowledgeable	Very knowledgeable	Moderately knowledgeable	Slightly knowledgeable	Not knowledgeable
Q6a	my self-assessment of Excel is	0	2	4	1	1
Q6b	my self-assessment of MATLAB is	0	0	1	1	6

Q7	**Based on the course description, I expect the following grade in this class**	Number of Students
	A	4
	B	4
	C	0
	D	0
	F	0

Q8	**What is your age as of 8/21/2018?**	Number of Students
	18 – 24	5
	25 – 34	2
	35 – 44	1
	45 +	0

Q9	**According to MyLiveOak, my current program and plan are**	Number of Students
	Associate in Arts Degree – AA General – General	3
	Associate in Science/Applied Science – Chemical Technology	0
	Associate in Science/Applied Science – Engineering Technology	1
	Other Degree Program (AA or AS)	0
	Bachelor of Science – Engineering Technology	3
	Other Degree Program (BS)	1
	Non-Degree Seeking	0

Q10	How many credit hours have you have completed at Live Oak including this semester?	Number of Students
	This is my first semester	0
	1 – 12	0
	13 – 24	1
	25 – 36	1
	37 – 48	3
	49 – 60	2
	More than 60	1

Q11	What is your approximate overall GPA after this semester	Number of Students
	3.6 – 4.0	1
	3.1 – 3.5	5
	2.6 – 3.0	1
	2.1 – 2.5	0
	2.0 or less	1
	This is my first semester	0

Q12	This semester, on average, how many hours do you expect to work for an employer?	Number of Students
	I do not plan to work this semester	3
	1 – 10	0
	11 – 20	1
	21 – 30	3
	31 – 40	1
	More than 40	0

APPENDIX I: POST-COURSE SURVEY INSTRUMENT

Welcome to the survey.

I am interested in understanding engineering student attitudes regarding homework assignments. You will be asked to answer questions about this topic. Please note that your responses will be kept completely confidential.

The survey should take you less than 5 minutes to complete. Your participation is voluntary but greatly appreciated. You have the right to withdraw at any point and for any reason. If you would like to contact me, please e-mail me at sawyerk@liveoakstate.edu.

Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

Thank you very much.

Q1.

- ❍ I consent to begin the study and that I am 18 years or older
- ❍ I do not consent, I do not wish to participate

Condition: If participant does not wish to participate, skip to, "Thank you for taking the survey."

Q2	**In general, I believe that homework assignments are**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q2a	are an important part of my coursework.					
Q2b	help me meet course objectives better than no homework assignments.					
Q2c	help me prepare for exams and projects better than no homework assignments.					
Q2d	are a productive use of my time.					

Q3	**In general, after completing this course, I believe that homework assignments**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q3a	were an important part of the coursework.					
Q3b	helped me meet course objectives better than no homework assignments					
Q3c	helped me prepare for exams and project better than no homework assignments.					
Q3d	were a productive use of my time.					

Q4	**In general, I believe that**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q4a	if I study appropriately, then I will be able to successfully meet the course objectives.					
Q4b	if I study appropriately, then I will understand the homework assignment material.					
Q4c	I have the knowledge, skills, and support to complete homework assignments.					
Q4d	it is my own fault if I don't learn the homework assignment material.					

Q5	**In general, I believe that**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q5a	if I had studied appropriately, then I would have been able to successfully meet the course objectives.					
Q5b	if I had studied appropriately, then I would have understood the homework assignment material.					

Q6	**Typically, I**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q6a	study and prepare my homework assignments in a place where I can concentrate.					
Q6b	complete homework assignments early.					
Q6c	would do homework assignments, even if they did not count as part of my grade.					

Q7	**In general, I**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q7a	find it hard to stick to a study and homework schedule.					
Q7b	work hard on homework assignments, even if I don't like what we are doing.					
Q7c	may miss important points because I am thinking of other things while I am doing homework assignments.					
Q7d	regret not spending more time on homework assignments when I don't do well on a quiz, exam, or project.					

Q8	**Prior to this course,**	Extremely knowledgeable	Very knowledgeable	Moderately knowledgeable	Slightly knowledgeable	Not knowledgeable
Q8a	my self-assessment of Excel is					
Q8b	my self-assessment of MATLAB is					

Q9	**After taking this course,**	Extremely knowledgeable	Very knowledgeable	Moderately knowledgeable	Slightly knowledgeable	Not knowledgeable
Q6a	my self-assessment of Excel is					
Q6b	my self-assessment of MATLAB is					

Q10. Based on the course description, I expect the following grade in this class.

❍ A
❍ B
❍ C
❍ D
❍ F

Q11. Based on my effort in this course, I expect the following grade in this class.

❍ A
❍ B
❍ C
❍ D
❍ F

Q12 What is your age as of 8/21/2018?

❍ 18-24
❍ 25-34
❍ 35-44
❍ 45+

Q13. According to MyLiveOak, my current program and plan are

❍ Associate in Arts Degree – AA General – General
❍ Associate in Science/Applied Science – Chemical Technology
❍ Associate in Science/Applied Science – Engineering Technology
❍ Other Degree Program (AA or AS)
❍ Bachelor of Science – Engineering Technology
❍ Other Degree Program (BS)
❍ Non-Degree Seeking

Q14. How many credit hours have you have completed at Live Oak *including* this semester?
❍ This is my first semester
❍ 1-12
❍ 13-24
❍ 25-36
❍ 37-48
❍ 49-60
❍ More than 60

Q15. What is your approximate overall GPA after this semester?
❍ 3.6-4.0
❍ 3.1-3.5
❍ 2.6-3.0
❍ 2.1-2.5
❍ 2.0 or less
❍ This is my first semester

Q16. This semester, on average, how many hours do you expect to work for an employer?
❍ I do not plan to work this semester
❍ 1-10
❍ 11-20
❍ 21-30
❍ 31-40
❍ More than 40

Thank you for participating in this survey.

APPENDIX J: POST-COURSE SURVEY RESULTS

Q2	**In general, I believe that homework assignments are**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q2a	are an important part of my coursework.	3	5	1	0	0
Q2b	help me meet course objectives better than no homework assignments.	6	2	1	0	0
Q2c	help me prepare for exams and projects better than no homework assignments.	5	3	1	0	0
Q2d	are a productive use of my time.	4	4	1	0	0

Q3	**In general, after completing this course, I believe that homework assignments are**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q3a	were an important part of the coursework.	3	6	0	0	0
Q3b	helped me meet course objectives better than no homework assignments.	6	3	0	0	0
Q3c	helped me prepare for exams and projects better than no homework assignments.	7	1	1	0	0
Q3d	were a productive use of my time.	4	5	0	0	0

Q4	**In general, I believe that**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q4a	if I study appropriately, then I will be able to successfully meet course objectives.	7	2	0	0	0
Q4b	if I study appropriately, then I will understand the homework assignment material.	7	2	0	0	0
Q4c	I have the knowledge, skills, and support to complete homework assignments.	7	2	0	0	0
Q4d	it is my own fault if I don't learn the homework assignment material.	6	1	2	0	0

Q5	**In general, I believe that**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q5a	if I had studied appropriately, then I would have been able to successfully meet the course objectives.	6	2	1	0	0
Q5b	if I had studied appropriately, then I would have understood the homework assignment material.	6	2	1	0	0

Q6	**Typically, I**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q6a	study and prepare my homework assignments in a place where I can concentrate.	2	7	0	0	0
Q6b	complete homework assignments early.	2	3	3	1	0
Q6c	would do homework assignments, even if they did not count as part of my grade.	1	2	4	2	0
Q6d	complete almost all of my homework assignments.	5	3	0	1	0

Q7	**In general, I**	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Q7a	find it hard to stick to a study and homework schedule.	1	2	2	2	2
Q7b	work hard on homework assignments, even if I don't like what we are doing.	4	3	2	0	0
Q7c	may miss important points because I am thinking of other things while I am doing homework assignments.	2	2	1	3	1
Q7d	regret not spending more time on homework assignments when I don't do well on a quiz, exam, or project.	4	2	2	1	0

Q8	**Prior to this course,**	Extremely knowledgeable	Very knowledgeable	Moderately knowledgeable	Slightly knowledgeable	Not knowledgeable
Q8a	my self-assessment of Excel is	0	1	5	1	2
Q8b	my self-assessment of MATLAB is	0	0	0	0	9

Q9	**After taking this course,**	Extremely knowledgeable	Very knowledgeable	Moderately knowledgeable	Slightly knowledgeable	Not knowledgeable
Q9a	my self-assessment of Excel is	1	7	1	0	0
Q9b	my self-assessment of MATLAB is	2	4	3	0	0

Q10	Based on the course description, I expect the following grade in this class	Number of Students
	A	8
	B	1
	C	0
	D	0
	F	0

Q11	Based on my effort in this course, I expect the following grade in this class	Number of Students
	A	8
	B	0
	C	1
	D	0
	F	0

Q12	What is your age as of 8/21/2018?	Number of Students
	18 – 24	7
	25 – 34	1
	35 – 44	1
	45 +	0

Q13	According to MyLiveOak, my current program and plan are	Number of Students
	Associate in Arts Degree – AA General – General	4
	Associate in Science/Applied Science – Chemical Technology	1
	Associate in Science/Applied Science – Engineering Technology	3
	Other Degree Program (AA or AS)	0
	Bachelor of Science – Engineering Technology	1
	Other Degree Program (BS)	0
	Non-Degree Seeking	0

Q14	How many credit hours have you have completed at Live Oak including this semester?	Number of Students
	This is my first semester	0
	1 - 12	0
	13 - 24	0
	25 - 36	2
	37 - 48	2
	49 - 60	4
	More than 60	1

Q15	What is your approximate overall GPA after this semester	Number of Students
	3.6 – 4.0	4
	3.1 – 3.5	5
	2.6 – 3.0	0
	2.1 – 2.5	0
	2.0 or less	0
	This is my first semester	0

Q16	This semester, on average, how many hours do you expect to work for an employer?	Number of Students
	I do not plan to work this semester	3
	1 - 10	0
	11 - 20	1
	21 - 30	2
	31 – 40	2
	More than 40	1

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