Fall 2023

The Effects of Self-Regulated Learning on Community College Students Metacognition, Motivation and Achievement in Geoscience Courses

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THE EFFECTS OF SELF-REGULATED LEARNING ON COMMUNITY COLLEGE STUDENTS METACOGNITION, MOTIVATION AND ACHIEVEMENT IN GEOSCIENCE COURSES

by

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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY
EDUCATIONAL PSYCHOLOGY AND PROGRAM EVALUATION

OLD DOMINION UNIVERSITY
December 2023

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Abstract

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Old Dominion University, 2023
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This study investigated the impact of training in self-regulated learning on community college, geoscience students' achievement, metacognition, time management, and science motivation scales. The study also investigated the impact of SRL training on these outcomes as a function of gender and ethnicity. During the Fall of 2022, 70 community college geoscience students from 9 different classes participated in the study. The classes were bifurcated with one half of the students in each class randomly assigned to the SRL treatment and the other half to the control condition. Each week, for 10 weeks during the semester, students in the treatment group utilized a component from each of the three phases of Zimmerman's (2002) cyclical self-regulated learning model as one of their geoscience class assignments. At the beginning of the week students in the treatment group would set instructional goals and create a calendar that included class time, study time, work, and relaxation time. During the week the same students would monitor their class attendance and study practices. At the end of the week, students would reflect on whether they attained their goals set at the beginning of the week and reflect on the reasons for their success or failure. As an alternate activity students in the control group were assigned to write a brief summary of a famous geoscientist's biography. All students' final exam and final course grades were examined to determine the impact of SRL training on science achievement. Study participants completed a questionnaire containing metacognition, time

management, and science motivation items. No significant differences were found between students in the SRL treatment and those in the control group.

ACKNOWLEDGEMENTS

This dissertation would not have been possible without the support, guidance, and encouragement of a number of individuals who I would like to thank.

My family was instrumental in my dissertation success and I would like to begin by thanking them. My husband, Mr. Michael Lyle, went above and beyond any expectations I may have had in all aspects of encouragement and support. Not only did he offer unwavering emotional support throughout the process, but he also provided technical support through the incorporation of his geoscience classes in this study. After the study, he provided the emotional support necessary to complete the writing component. Without him, this dissertation would not have happened and I thank him with all my heart. My son provided an example to follow, through his unwavering determination for success in his program of study. The encouragement of both my husband and son helped to carry me through working many late nights and weekends.

My next thank you is to my dissertation chair, Dr. Linda Bol. Her understanding kept me focused and her guidance provided me with the tools necessary for success in all aspects of the dissertation process. I learned quite a bit from her during the dissertation writing process and am very thankful that she agreed to work with me.

I would also like to thank my dissertation committee Dr. Joanna Garner and Dr. Tony Perez, for their direction and feedback which led to a robust study and comprehensive dissertation document.

Finally, I would like to thank the geoscience instructors who participated in this dissertation for agreeing to modify their classes for this study.

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Chapter 1

Introduction

STEM in the US

In 2005, the United States Congress requested a report from the National Academies to address the state of national readiness in the areas of Science, Technology, Engineering and Mathematics (STEM), and the ability of the United States to compete in those areas on the global stage (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007). The request prompted the National Academies to create a committee to investigate the issue. Based on that work, the National Academies produced the report, *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (2007). The report concluded that for the United States to remain competitive on the world stage it must produce more scientists, engineers, and computer scientists. Education was seen as the best method of generating student interest and producing a technologically advanced workforce (National Academies, 2007).

In 2010 the report was revisited, and a follow-up report was requested. The new report found that even though there was great interest nationally in the information contained in first report, little progress had been made in producing students who were proficient in STEM. Moreover, the United States was found to be even less competitive in the area of STEM on the global stage than reported in the previous publication (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2010).

Today, the United States does not produce enough STEM professionals to fill all the positions in business and government sectors (Lazio & Ford, 2019). STEM jobs are a key component of the United States economy with 33% of the jobs requiring a bachelor's degree or higher (McEntee, 2020). As technology increasingly becomes an important part of the economy, so does the need for workers who possess the knowledge and skills to fill technical positions.

College Students and STEM

To fill highly technical STEM positions, which are an important component of the U.S. economy, individuals need to be educated in the STEM disciplines of science, engineering, and computer science. Student interest in STEM careers can begin as early as elementary school, but more often in middle and high school, where they are introduced to STEM through hands-on science experiments, robotics, and computer programming (Christensen et al., 2015). While these disciplines capture the interest of students in the K-12 arena, students who go on to major in STEM often struggle because of science and mathematics requirements (Redmond-Sanogo et al., 2016). At the college level, undergraduate students who struggle with these disciplines tend to change their majors to a non-STEM subject area leading to a "leaky STEM pipeline" (Turnball et al., 2019). However, students who remain in the STEM pipeline and obtain STEM jobs experience higher salaries and lower unemployment upon their entrance into the workforce (Hussar et al., 2020).

Women are less likely to pursue majors in STEM fields (Chang et al., 2014; Nix & Perez-Felkner, 2019; Witnerer et al., 2020). Moreover, Black and Latino students are less likely than European American or Asian American students to pursue science majors (Chang et al., 2014). This low participation is especially evident in science subjects, such as chemistry or physics, requiring the use of higher-level mathematics (Nix & Perez-Felkner, 2019). In addition, minority female students enrolled in STEM undergraduate programs may not have the science role models that their European and Asian male counterparts do or external academic support which may reduce science identity, perceived competence, and self-efficacy (Chang et al., 2014; Hurtado et al., 2011). In cases such as this, female students must utilize internal strategies to succeed in first year science courses.

Self-Regulated Learning and College Students

Self-regulated learning (SRL) is the process by which students positively manipulate their learning performance through direct action (Zimmerman, 2002). Through the processes of SRL students can control their learning and be successful in their coursework, which builds student confidence. SRL has come to be recognized as one of the most important components of educational psychology (Panadero, 2017). While some undergraduate students possess SRL skills when they enter college, many students lack an understanding of how to regulate their learning when they enter college. Successful implementation of SRL strategies requires students to make judgments, referred to as metacognition, about their performance to make changes if necessary (Peverly et al., 2003). Many undergraduate college students have an unrealistic view of their learning, believing that they have successfully completed a task or exam only to find that they performed poorly (Bol et al., 2005; Miller, 2015). Inaccurate metacognitive judgments can affect student self-efficacy leading to students believing they are not capable of completing a degree program in a STEM discipline (Turnball et.al., 2019).

Time management is a component of SRL that includes behaviors to help organize time spent on content associated with courses taken during a semester and other daily activities (Adams & Blair, 2019). These activities can include class attendance, study time, working a part time job, and leisure time. When students enter college, they may not possess an awareness of time requirements as they relate to their coursework (Thibodeaux et al., 2017). Procrastination can also negatively impact college students' time management (Wolters et al., 2017). Students who understand and enact methods for managing their time have greater success in college and experience less course related stress (Hafner et al., 2014; Thibodeaux et al., 2017).

Integrating SRL strategies as a component of STEM coursework may provide undergraduate students with the tools to enhance their motivation, self-efficacy, and success in undergraduate STEM courses. DiBenedetto and Bembenutty (2013) examined changes in student motivational beliefs as a result of implementing SRL strategies over the course of a semester in a General Biology course. Study findings showed that student self-efficacy was positively related to course grades and calibrated with performance. Students who felt that they had greater control over their own learning were more proactive in attaining course objectives (DiBenedetto & Bembenutty, 2013).

Zimmerman's SRL Model

The Zimmerman model of SRL, which will be used in this study, is based on cyclical phases that include learner metacognition and motivation (Zimmerman, 2002). The model is composed of a forethought phase, a performance phase, and a self-reflection phase and involves students setting learning goals, moving through the learning process by monitoring their time and learning activities, and then reviewing their success or failure and making appropriate modifications (Zimmerman, 2002). This model and its phases will be explored in more depth in the next chapter and used as a theoretical framework underpinning treatment design and selection of measures. However, it is critical for students to develop SRL skills sooner rather than later in their academic careers.

Problem and Significance

Transitioning from high school to college is an adjustment for all students. Students entering college expect to complete their programs with the same level of effort and understanding that they utilized in high school, but quickly realize that the level of effort required in a university program of study is much greater (DeClerq et al., 2018). Those who choose to major in science enter their programs with enthusiasm for the major. However, many quickly become discouraged due to a less than stellar performance on tests and exams (Stupnisky et al., 2011). This is especially true for underrepresented women (Whitcomb & Singh, 2020). Prior research indicates that female student underperformance in college level science courses is due to external factors, such as lack of interaction with faculty and low participation in academic clubs, study groups, and undergraduate research opportunities (Chang et al., 2014; Hurtado et l., 2011; Winterer et al., 2020). However, limited research has been conducted on the underperformance of students, especially females, in science courses based on internal factors, such as those associated with self-regulation. Increasing students' self-regulation skills can lead to success in science courses and retention in undergraduate science programs, increasing the diverse pool of qualified STEM graduates who will enter the workforce.

Research Questions and Hypotheses

This study was designed to investigate the impact of incorporating self-regulated learning strategies as a component of a freshman level science course to promote the academic achievement, metacognition and science motivation of community college students. An experimental method was used to investigate whether SRL training affects course achievement, metacognition, time management, science self-efficacy, perceived competence, and identity. The researcher included all students in the study but will conduct additional analyses to determine whether the SRL treatment is differentially effective for females versus males. More specifically, the following research questions were addressed and hypotheses tested.

1. Is there a statistically significant difference in community college students' achievement in their Geoscience courses between students in the SRL training group and those in the comparison group?

   The SRL training will enhance community college students' achievement in geoscience courses (e.g., Lukes et al., 2020).

2. Is there a statistically significant difference in community college students' metacognition and time management scales in their Geoscience courses between students in the SRL training group and those in the comparison group?

   SRL training will enhance community college students' metacognition and time management in their geoscience courses (e.g., Hoops & Artrip, 2016).

3. Is there a statistically significant difference in community college students' science identity, science self-efficacy, and academic perceived competence scales in their Geoscience courses between students in the SRL training group and those in the comparison group?

   SRL training will enhance community college students' interest, self-efficacy and perceived competency in geoscience (e.g., DiBenedetto & Bembenutty, 2013).

4. Does SRL training differentially impact male and female students on their metacognition, time management, science identity, academic perceived competence, and science self-efficacy scales in their Geoscience courses?

   SRL training impact will be greater for females, as they practice goal setting and planning as well as self-monitoring more often than males (e.g., Ahlam et al.,2020).

Overview of Study

This quantitative, true experimental study was conducted at an urban community college on the East coast of the United States. The study included students in nine geoscience classes. A total of 225 students will be invited to participate in the study. Within each class, students were randomly assigned so one group received self-regulated learning training and the other group completed an alternative assignment. Those in the treatment group were assigned class exercises related to SRL aligned with different phases of Zimmerman's model. Those in the comparison group spent approximately the same amount of time writing very brief biographies of famous geoscientists. The study was conducted in the fall session and lasted 10 weeks in duration. All participating students were administered questionnaires on metacognition, time management and science motivation constructs prior to the training and a survey at the end of the semester. Demographic information was collected on a separate form. The items include gender, ethnicity, high school GPA, and academic level (e.g., freshman or sophomore).

Final exam and final course grades for students were provided by the instructors of the geoscience courses.

Summary and Overview of Subsequent Chapters

Chapter 1 summarized the national need for students educated in STEM subjects, as well as students' reluctance to participate in STEM majors in college. Self-regulated learning was discussed as a method for increasing both student metacognition, self-efficacy, and science identity. Zimmerman's (2002) model was identified as the framework for the study. Finally, the overview of the study was presented. A literature review of Zimmerman's SRL model and tasks associated with the cyclical phases, as well as research on science identity, self-efficacy, and perceived competence will be discussed in Chapter 2. The methodology will be described in

Chapter 3. Chapter 4 will present the investigation results. Chapter 5 will provide a discussion of the findings as well as study limitations and suggestions for future research.

Chapter 2

Literature Review

This chapter begins by presenting an overview of the need for STEM educated adults in the workforce and the role of college students and their choice of introductory science courses in the process. The section is followed by academic practices that have proven successful for students in science courses. Self-regulated learning (SRL) is then addressed as an academic practice that can increase student success in academic college courses, with a specific focus on science courses. Zimmerman's (2002) cyclical model of SRL is discussed, including each phase of the model. Each phase is discussed along with the role of self-efficacy, science identity, gender, and race in students selecting and remaining in the STEM academic pipeline.

STEM and College Students

The United States is facing a workforce shortage of qualified individuals in STEM (science, technology, engineering, and mathematics) sectors. While all students complete STEM subjects as a requirement for graduation during their K-12 education (NCES, 2019), many of those students leave the "STEM Pipeline" in college because they are dissatisfied with their performance in introductory science classes (Lukes & McConnell, 2014).

Selecting an introductory science course can be daunting for first-year college students, especially those who do not intend to become science majors (Duis et al., 2013). Students can choose laboratory-based courses such as chemistry and physics or field-based courses such as geology, earth science, or environmental science. Students who choose an introductory biology course will experience both lab and field-based components, as the course involves both the microscopic and macroscopic environments (Spell et al., 2014). Specific skills, both laboratory and field skills, are required for success in a science course (Duis et al., 2013). Students who do not possess the requisite skills will struggle through a science course and may find themselves in jeopardy of failing.

Lower achieving students may feel especially overwhelmed when faced with selecting an introductory science course (Ye et al., 2016). These students enter college with less of an understanding of successful strategies and tools for academic success than their higher achieving counterparts (DiFrancesca et al., 2016). Low achieving students often study at a surface level, incorporating memorization instead of deep understanding as a study tool (Ye et al., 2016).

Due to a lack of success in science, these students may not feel confident taking laboratory-based science courses containing a strong mathematics component, such as physics and chemistry, and may opt for introductory science courses such as those taught in the geosciences believing that they are less rigorous (Gilbert et al., 2012).

Practices for Success in Introductory Science Courses

To be successful in introductory science courses, students need to possess effective learning and studying practices including the use of paraphrasing, prediction, and self-explanation. In a study by Morrison et al. (2015), introductory physics students used paraphrasing, prediction, and self-explanation to improve learning in an interactive virtual environment. Students who paraphrased or predicted and self-explained assignment results had better performance on an achievement test than students who did not incorporate the strategies. Moreover, the quality of self-explanations was strongly correlated with high test performance (Morrison et al., 2015).

The ability to quickly locate and identify information from textbooks or other reference materials is another skill needed for success in introductory science courses (Phillips, 2006). Phillips (2006) investigated whether incorporating open book tests in an introductory biology course would encourage textbook reading and could be used to strengthen students' study skills. Students were taught study skill strategies prior to the first course test and then the study skills were reviewed after the test was handed back. It was found that open-book tests could be used to determine a student's ability to locate information in the literature quickly and improve their study skills. Students who had weak study skills at the beginning of the semester demonstrated a dramatic improvement in study skills over the course of the semester, with the greatest improvement seen between the first and second test (Phillips, 2006).

Study skills are extremely important in introductory science courses, but students must have the academic motivation to incorporate the study skills as a means to enhance academic success. Lukes and McConnell (2014) examined student motivation and found there are two types of motivation: performance goal orientation and mastery goal orientation. Students with performance goal orientation see a task as a means to an end, the end being passing the test. Students with mastery goal orientation see the end goal of the task as the acquisition of knowledge and understanding. Students who are academically high performing are mastery goal oriented and are motivated by their interest in the topic, learning in general, or how their learning process contributes to society in general (Lukes & McConnell, 2014).

Finally, by incorporating learning goals as a tool for success in science courses, students gain an understanding of course expectations leading to greater academic success (Duis et al., 2013). Instructor delivered learning goals and student developed learning goals related to course content and required tasks help students focus their learning. Moreover, when learning goals are aligned to course activities and assessments, students achieve more success in introductory science courses (Duis et al., 2013).

Students and SRL

When students self-regulate their learning, they directly implement strategies to positively manipulate their learning performance (Zimmerman, 2002). SRL involves student awareness of their knowledge of subject area content. To achieve self-regulation, students must analyze the task, incorporate task related strategies and self-observation, and then self-reflect. (Zimmerman, 2002). This process can take the form of students setting goals, monitoring their learning, and controlling their cognition (Kaplan, Lichtinger & Gorodetsky, 2009).

Many students who do not use SRL believe that they are doing much better than they are in their course work (Peverly et al., 2003). To incorporate SRL as a strategy for success, students must employ calibration accurately. Calibration is the degree to which judgments of performance correctly reflect performance (Peverly, et al., 2003). Overall, higher achieving college students are more accurate in their calibration than lower achieving students (Bol et al., 2005).

Self-regulation is also related to student motivation. Wolters and Benzon (2013) studied motivational regulation as a key component of self-regulation in college students. Their findings indicated that students who view subject area information as important are more likely to self-regulate their motivation for completing tasks associated with course work . Through the regulation of motivation, students are more likely to remain current with their assignments leading to less missing or incomplete work and greater success in a course.

High achieving students tend to be much better self-regulators than low achieving students. DiFrancesca et al. (2016) studied the self-regulation strategies of high and low achievers and found that low achieving students exhibited a lack of control over their learning but believed that they were much more successful in their learning than they actually were. Conversely, high achieving students' judgments of learning was much better calibrated. High achieving students set specific goals for the course and selected more effective study strategies for understanding subject area content (DiFrancesca et al., 2016).

Incorporating SRL strategies as course components can provide low achieving students with the tools to successfully guide their learning. SRL was incorporated as part of a developmental math course for low achieving students (Bol et al., 2015). Students involved in the study completed self-regulated learning exercises in addition to the course content. At the end of the course the students were administered a final exam. Scores on the final exam for students receiving instruction in self-regulated learning were above average for the course (Bol et al., 2015).

SRL and Science

SRL can be an important strategy for success in college level science courses. DiBenedetto and Bembenutty (2013) examined SRL strategies involving academic delay of gratification, homework self-regulation, and help-seeking strategies in students in a college level biology course. The study involved changes in student motivational beliefs and self-regulation strategies as a result of implementing self-regulation strategies over the course of a semester. Findings revealed that students' self-efficacy was positively related to their course grades and was calibrated with their performance (DiBenedetto & Bembenutty, 2013). Students who felt that they had greater control over their own learning were more proactive in attaining course objectives. Therefore, structuring course content and instruction to promote motivational beliefs and facilitate self-regulated learning can provide a means for success in introductory science courses (DiBenedetto & Bembenutty, 2013).

Students begin their college introductory science courses possessing prior knowledge gained from high school science courses (NCES, 2019). The challenge that students encounter is transferring the prior knowledge to effectively support positive college science course outcomes. Greene et al. (2010) investigated the link between self-regulated learning, implicit theory of intelligence, and prior knowledge. The findings indicated that prior knowledge and implicit theories of intelligence are directly related. Self-beliefs also influence how self-regulation is enacted. As students engaged in self-regulated learning processes during learning, the positive effects of student characteristics were amplified, while the negative effects were mitigated. In addition, SRL was found to be recursive, providing a means for self-monitoring and control to interact with student characteristics throughout the learning process (Greene et al., 2010).

Group collaboration is an important component of science instruction both in field work and in the laboratory setting. Self-regulation in group settings has been found to be a beneficial component of science instruction. In a study by Bol et al. (2012) involving IB Biology students, guidelines were incorporated into the instructional process to increase calibration accuracy and achievement in both individual and group settings. Students in classes reviewed for a test either individually or in groups, with or without self-regulation guidelines. After studying for twenty minutes, students made calibration judgments regarding their performance on the test. Students who worked in groups with guidelines were able to calibrate their success before and after the test with greater accuracy than students of similar ability who worked individually and with no guidelines. Moreover, the incorporation of group collaboration and self-regulation guidelines was found to increase student academic achievement (Bol et al., 2012).

Inquiry-based instruction, a common component of science courses, may contain components that cause some students to struggle. As part of a study conducted by Eilam et al. (2009) involving an inquiry-based ecology course, students provided online reports of their self-regulated learning, incorporating both self-control and self-efficacy. Students were required to be aware of the goals for each lesson, construct a work plan for each lesson, and monitor their progress toward the identified goals. The findings showed that there was a significant correlation between self-regulated learning and student conscientiousness. In addition, a positive correlation was found between self-regulated learning and student agreeableness (Eilam et al., 2009).

Many science topics are complex in nature, and the use of self-regulated learning strategies can help students to better understand scientific complexities. In a study involving students' understanding of the circulatory system, Greene et al. (2012) investigated how task definitions and student created plans related to self-regulation during the planning phase of learning. Greene et al. found that self-regulation strategies helped the learners process the initial task definitions of a problem, providing an opportunity for refinement and improvement for increased understanding of the task. This clarification of the task provided at-risk students with a greater understanding of the processes required when making plans for knowledge acquisition. (Greene et al., 2012).

Zimmermans Model of SRL

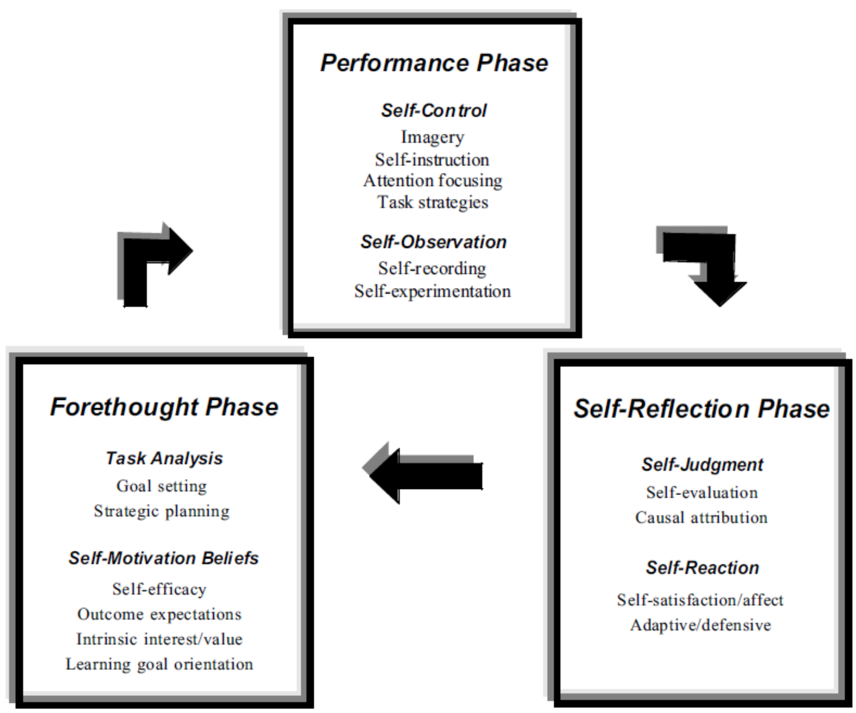
Zimmermans (2002) model of SRL provides researchers with a window into successful strategies that first year college students can utilize to enhance their internal control over their study skills. First year students who have effective study skills and a high frequency of studying have been shown to perform better overall in science classes than those who do not have these skills or study infrequently (Ye et al., 2016). Moreover, those who have a strong science identity and self-efficacy also perform better in science classes (Perez et al, 2014). This is especially true for underrepresented students (Chen et al., 2021). Both strong science identity and self-efficacy can be achieved through the inclusion of the SRL process in a student’s study regimen (DiBenedetto & Bembenutty, 2013).

SRL is a student-driven process in which skills are utilized proactively by students to engage in the learning process (Wolters & Benzon, 2013). By monitoring their individual learning and making adjustments in the learning environment, students are able to achieve academically (Zimmerman & Martinez-Pons, 1990). SRL can be an important strategy for success in college level science courses, which can be complex, assisting students meet the challenges associated with STEM “gatekeeper” courses (Redmond-Sanogo et al., 2016).

Figure 2.1 shows the Zimmerman (2013) model containing forethought, performance, and self-reflection phases, forming a cycle. The model is followed by literature on specific components implemented in the current study.

Figure 2.1

Zimmermans cyclical phases model (Zimmerman, 2002)



Goal Setting

Goal setting takes place during the forethought phase of study (Zimmerman, 2002). Goals can take different forms. Performance goals focus on demonstrating competence in the completion of a task, whereas learning goals are oriented toward the mastery of the task (Taing, et al., 2013). While setting both types of goals will assist students in meeting objectives, the goals should be as clear as possible to be effective in the performance phase. McCardle et al. (2017) included the components of time management, student actions, content standards, and content knowledge and skills as important elements of high-quality goals. This study will build on the work of McCardle et al. by including the planning of student actions and time management as a component of goal setting.

Greene and associates (2010) found goal setting to be beneficial in STEM-S courses by helping students understand the task at hand and the processes required to plan their learning. In a study involving students' understanding of the circulatory system, Greene et al. investigated how task definitions and student-created plans related to SRL during the planning phase of learning and knowledge acquisition. SRL strategies helped learners process the initial task definitions of a problem, providing an opportunity for refinement and improvement for increased understanding of the task (Greene et al., 2010).

Time Management

Time management is an important component of strategic planning during the performance phase. First year students spend their time preparing for class, attending class, studying, perhaps working a job, commuting, volunteering, participating in clubs and organizations, and relaxing and socializing (Fosnacht et al., 2018). Some first-year students may spend more time on socializing than on academics (Thibodeaux et al., 2017). Many students procrastinate, which is another time sensitive action that impacts both self-efficacy and motivation (Wolters et al., 2017). Because various social and academic activities in college put demands on students' time, effective time management can mean the difference between success and failure in college. Through the incorporation of time management strategies, students can understand where their time is being spent and redirect unproductive time to activities that are more beneficial to college course success (Thibodeaux et al., 2017).

Hafner et al. (2014) studied the effects of time management training on undergraduate students' stress and control of time. The researchers found that the time management training increased students perceived control of time and decreased students perceived stress. As a result of the training, students felt they had greater control over managing the various responsibilities of college, experienced increased success in their course work, and were less likely to consider dropping out of college due to overwhelming stress (Hafner et al., 2014).

Self-Monitoring

Once the planning in the forethought phase has taken place, the student moves to the second phase or performance phase of Zimmerman's (2012) model where self-monitoring takes place. Self-monitoring involves students gaining an explicit awareness of their actions prior to the task or event, during the task or event, and after the task or event (Bercher, 2012). Preparing for a class by reading before-hand, taking notes during class, and reviewing the notes are examples of tasks or events that can be self-monitored by students (Campbell et al, 2013).

Leggett et al. (2012) studied the effects of a short and simple self-monitoring intervention on the academic achievement of undergraduate medical students. In this quantitative study, students were divided into two groups with one group receiving a workbook that contained weekly self-monitoring exercises and the other group receiving a workbook without the self-monitoring exercises. Students who completed the weekly self-monitoring exercises improved their calibration accuracy and overall performance in the class. By monitoring their actions weekly, the students had a better understanding of how specific learning activities impacted their concept understanding (Leggett et al., 2012).

Self-monitoring has also been found to increase minority college student achievement (Covarrubias & Stone, 2015). Undergraduate students at a large southwestern university were given a survey that included an 18-item scale measuring self-monitoring. The same students also provided their SAT math scores. Findings from the analysis showed that in Latino males specifically, the higher the self-monitoring practice, the higher the SAT Math score (Covarrubias & Stone, 2015). The study demonstrated the effectiveness of self-monitoring strategies for students to adjust their learning strategies based on the self-monitoring feedback (Covarrubias & Stone, 2015).

Self-Reflection

The third phase in the Zimmerman (2002) model is self-reflection. At the conclusion of a course or learning experience, students can assess their choice of goals, the methods for reaching those goals, and their overall academic performance through self-reflection. Self-reflection provides students with an opportunity to evaluate their learning as a result of implementing strategies in the forethought and performance phases of self-regulated learning (Zimmerman, 2012).

The most prevalent form of self-assessment is journaling, which can provide students with detailed information about their learning. Lew and Schmidt (2011) studied the effect of self-reflection through journaling on undergraduate students in science over the course of one academic year. Self-reflection through journaling was successful in assessing the effectiveness of both the learning strategies utilized and the content learned based on students' learning styles (Lew & Schmidt, 2011).

In another study by Yan et al. (2020), students utilized a journaling diary as a component of class. The diary exercise included prompts designed to lead students through a process that would allow them to analyze their performance on homework assignments. The researchers found that the journaling diary positively impacted students' academic achievement, self-efficacy, and intrinsic value. The impact of the journaling was greatest for students who had previously experienced low academic achievement (Yan et al., 2020). Each of the components of Zimmerman's (2002) SRL model will be incorporated in the learning strategy contained in Appendix B in Chapter 3 of this proposal.

Self-Efficacy

Self-efficacy refers to an individual's belief that he or she can successfully accomplish a task (Bandura, 1986). Students' self-efficacy impacts their academic performance by influencing the choices they make, as well as their effort, persistence, and resilience when pursuing their academic goals (Pajaras, 2002). Self-efficacy, a component of self-regulation, is important to student success during the first year of college. Students can gain self-efficacy through mastery experiences, vicarious experiences, social persuasion, and psychological or physiological feedback (McBride et al., 2020). Students with high academic self-efficacy, both in the general and underrepresented populations, have been shown to have better academic achievement than students with low self-efficacy (Craft-DeFreitas, 2012). In some cases, however, student self-efficacy may not be reflective of actual achievement, leading some students to overestimate their performance. This can happen with students who are new to the college academic environment (Talsma et al., 2020).

Science self-efficacy can lead students to major in science and ultimately become employed in the STEM fields (Deemer et al., 2017). Students who possess science self-efficacy have confidence in their ability to understand science concepts and perform scientific practices . A strong science self-efficacy is believed to enhance student persistence when pursuing a science major by connecting with their science identities (Beck & Blumer, 2021).

Science Identity and SRL

When individuals feel they can successfully complete tasks involving science knowledge and skills, they have a strong science identity (Chen et al., 2021). Students who possess a strong science identity when entering college tend to pursue science degrees while in college and science careers upon graduation. These students comprise the STEM pipeline, but when students do not have a strong science identity, they may change their course of study resulting in a leaky STEM pipeline (Johnson & Walton, 2015). Students from underrepresented racial/ethnic groups and females tend to have moderate to low science identities entering college, and as a result many pursue non-science degrees and careers (Robinson, et.al, 2018). These students might benefit from the inclusion of self-regulation strategies to strengthen their science identities.

Possessing effective self-regulation strategies can help students feel they can effectively complete science courses (Sebastia & Speth, 2017). Students in an introductory Biology course took part in a study on the relationship between SRL and test grades (Sebastia & Speth, 2017). The students were provided with a survey to determine their SRL practices before every test. Academically successful students and students with improved grades used specific cognitive and metacognitive strategies that were not utilized by lower achieving students (Sebastia & Speth, 2017). Sebastia and Speth (2017) recommended imbedding course specific SRL interventions into introductory science courses.

Peng (2012) also found academic achievement in science was closely related to student SRL strategies. In a study designed to examine student motivation, test anxiety, and test performance in relation to self-regulation strategies, Peng found that students who practiced self-regulated learning had higher test scores, leading to greater self-efficacy and science identity, as well as reduced test anxiety.

Academic Competence and SRL

While many students believe that they are self-regulating their learning, many do not effectively apply successful SRL strategies (Cervin-Ellqvist et al, 2020). Cervin-Ellqvist et al. (2020) investigated the level in which SRL was utilized by engineering students during their classes. Students completed a questionnaire containing items that mapped the learning strategies they used, explored their awareness of the effectiveness of the selected strategies, and investigated the reasons they chose the strategies. Many STEM students tried to self-regulate their learning, but many times were not as successful as they thought they were, selecting ineffective learning strategies instead of effective ones (Cervin-Ellqvist et al, 2020).

Other researchers have investigated the outcome of the implementation of SRL strategies utilizing components of STEM courses. Andaya et al. (2017) studied the value of post-exam reviews to support students' development of self-regulation strategies in an introductory biology class. Student tests were graded and returned to students who were encouraged to correct their answers. During the next step in the process, students identified tools used to aid in studying. Finally, students answered open-ended reflection questions. The researchers found that students have misconceptions about their performance and would benefit from a course that included exercises to promote self-regulation (Andaya et al., 2017).

However, when students are trained in SRL strategies that utilize the Zimmerman cyclic phase model (2013) academic competence and achievement increase. In a study by Bol et al. (2015), community college students in a developmental mathematics course received SRL scaffolding imbedded as a component of the course. Students were required to complete SRL exercises each week for four weeks. Each week students would set academic goals, review good study habits, manage their time using a calendar, and reflect on the attainment of their academic goals. The researchers found that the students who received instruction in SRL as a component of the mathematics course had higher mathematics achievement, higher metacognition, and a better understanding of time management than students who did not receive the training (Bol et al, 2015).

Gender and SRL

Gender impacts the implementation of SRL strategies by undergraduate students in both face-to-face and online courses (Algamdi, 2020). While male students have been found to implement SRL strategies in their undergraduate coursework, female students demonstrate a greater use of SRL strategies as a component of their daily study habits (Bidjerano, 2005). Additionally, females have been found to display more goal setting, planning, and self-monitoring strategies than their male counterparts when studying for undergraduate courses (Pajares, 2002; Panadero et al., 2017).

Self-reflection is also utilized more often by female students than their male counterparts (Pandero et al., 2017). In a meta-analysis, Pandero et al. (2017) examined the effects of self-assessment or self-reflection on SRL and student self-efficacy. Findings from the meta-analysis showed that females benefited more from the implementation of SRL, especially self-assessment exercises including self-monitoring and self-reflection. Both learning interventions increased student motivation and self-efficacy (Pandero et al., 2017).

Women, however, tend to experience higher levels of anxiety in STEM courses when compared to their male counterparts (Pelch, 2018). The negative influence of anxiety related to academic emotions, may be one explanation for the increased utilization of SRL strategies in female students. Anxiety that is not addressed in science courses can impact student performance and science identity (Cotner et al., 2020). In a study involving introductory science students, it was found that females experienced test anxiety more often than their male counterparts, which negatively impacted the females' science identity, confidence, and self-efficacy (Cotner et al, 2020). Females may intuitively manage their learning and learning environments through the inclusion of SRL strategies to reduce anxiety related to science coursework (Pajares, 2002).

Summary and the Benefit of SRL in STEM Coursework

There is an urgent need for STEM professionals in the United States, and the training for these positions begins with student success in STEM undergraduate courses (Lazio & Ford, 2019; Redmond-Sanogo et al., 2016). Community college science courses can be difficult for first year students, those students who may not have had success with science courses in the past, and underrepresented demographic groups such as women and minorities (Gilbert et al., 2012; Peverly et al., 2003; Ye et al., 2016). Many students do not enter college with study skills for success in rigorous and demanding science courses (Duis et al., 2013). SRL skills such as those contained in Zimmermans (2002) cyclic model may assist undergraduate students with success in their STEM coursework, leading to higher self-efficacy, science identity, and possibly a STEM undergraduate degree (Beck & Blumer, 2021; DiBenedetto & Bembenutty, 2013; Sebastia & Speth, 2017).

Chapter 3

Methodology

Purpose of Study

The purpose of this study was to investigate the impact of training in self-regulated learning on community college students' achievement, metacognition, time management, science self-efficacy, science identity and perceived competency in science. This study also investigated the impact of SRL training on students based on their gender. In this chapter, the methodology for the study is presented. The research design is identified and justified. The research setting, participants, and measures are described. The chapter concludes with data collection procedures, and data analyses.

Research Design

The researcher utilized a quantitative, true experimental design to examine community college students in geoscience classes during the fall of 2022. An experimental design is appropriate when testing for differences between groups, in which there is random assignment of participants into treatment or control groups (Bordens & Abbott, 2008).

Table 3.1 illustrates the breakdown of the course sections, instructors, and number of students participating at the beginning versus end of the study. The design involved three sections of a Physical Geology course, two sections of a Historical Geology course, one section of an Environmental Science course, and five sections of an Oceanography course. Students in each course who agreed to participate in the study were randomly assigned to SRL training groups (treatment) treatment or non-treatment groups (control). While all of the geoscience courses in the study had a laboratory component, the focus of this research was the lecture part of the class. One instructor (A) taught the Historical Geology classes, and one instructor taught the Environmental Geology class. Multiple instructors (A, B, C, D, E) taught the Physical Geology and Oceanography classes.

Table 3.1

Participating Students by Class at Beginning and End of Study

Course	Instructor	Number of Students at Beginning of Study by Class	Number of Students at End of Study by Class
Historical Geology	A	7	3
Historical Geology	A	8	0
Physical Geology	A	13	7
Physical Geology	A	8	5
Physical Geology	C	10	2
Environmental Geology	B	11	10
Oceanography	B	17	15
Oceanography	B	24	17
Oceanography	C	10	2
Oceanography	D	10	9
Oceanography	E	7	0
Total Number		125	70

Training in self-regulated learning was the independent variable and consisted of students' weekly completion of SRL training; planning study time on a calendar; monitoring activities before, during and after class; and reflecting on weekly progress and meeting goals. The weekly exercises can be accessed in Appendix B. These strategies are aligned to the three phases of Zimmerman's (2008) cyclic model of self-regulated learning described earlier as the conceptual framework underpinning the present study.

The dependent variables for the study include final exam and course grades as well as pre and post treatment surveys measuring self-regulated learning and science motivation variables. The pre-treatment survey responses were used as the covariate when analyzing the student post-treatment SRL and science identity survey responses. Students' self-reported GPA was used as the covariate in the analysis of student final exam and final course grades.

The research questions and hypotheses are presented below. Citations to support the hypotheses are also presented.

Research Questions and Hypotheses

1. Is there a statistically significant difference in community college students' achievement in their Geoscience courses between students in the SRL training group and those in the comparison group?

The SRL training will enhance community college students' achievement in geoscience courses (e.g., Lukes et al., 2020).

2. Is there a statistically significant difference in community college students' metacognition and time management scales in their Geoscience courses between students in the SRL training group and those in the comparison group?

SRL training will enhance community college students' metacognition and time management in their geoscience courses (e.g., Hoops & Artrip, 2016).

3. Is there a statistically significant difference in community college students' science identity, science self-efficacy, and academic perceived competence scales in their Geoscience courses between students in the SRL training group and those in the comparison group?

SRL training will enhance community college students' interest, self-efficacy and perceived competency in geoscience (e.g., DiBenedetto & Bembenutty, 2013).

4. Does SRL training differentially impact male and female students on their metacognition, time management, science identity, academic perceived competence, and science self-efficacy scales in their Geoscience courses?

SRL training impact will be greater for females, as they practice goal setting and planning as well as self-monitoring more often than males (e.g., Alghamdi et al.,2020).

Setting

The study was conducted in geoscience classes at an urban community college in a Virginia urban/suburban setting. In 2019-2020 the college served 27,726 students comprising 36% of South Hampton Roads residents enrolled in higher education with 35% of students being full-time and 65% part time. The average student age was 25 years old with 49% of the student population being between the ages of 19 and 24 years. Other demographic student information includes 40% male, 59% female, 47% white, 29% African American, and 24% other minorities (Fact Book, 2020).

Students taking the geoscience classes were mostly non- science majors. Many of the students in these courses were humanities majors. Physical Geology, Historical Geology, Environmental Science were 100 level, freshman classes. Nearly all of the students enrolled in these classes were freshmen, first year students. The Oceanography class was a 200-level class and students taking this class were sophomore's and may have had a previous science class.

Participants

The sample of students were enrolled in either (1) Physical Geology, (2) Historical Geology, (3) Environmental Science or (4) Oceanography courses. Physical Geology and Historical Geology consisted of two sections, Environmental Science consisted of one section and Oceanography consisted of five sections. Students enrolled in each of the classes were randomly assigned to be in the treatment or non-treatment group conditions. Participants' demographic information was determined at the time of the study.

A power analysis was conducted in G*Power 3.1.9.7 to determine the minimum sample size requirement (Faul, Erdfelder, Buchner, & Lang, 2014). A series of ANCOVAs were used as the primary inferential analysis. The ANCOVAs involved a two-group comparison (treatment and control) and two covariates (survey pretest scores and student GPA). In addition, a medium effect size was utilized ($f = 0.25$), a significant alpha level of .05, and a power of .80. Applying the above parameters, it was determined that a minimum of 128 students would be sufficient for detecting potential differences.

Measures.

The dependent variables included measures of self-regulated learning and science motivation. Demographic information was also be collected from the participants. Table 3.2 lists the variables and the associated measures.

Table 3.2

Study Variables and Associated Measures

Variable	Measure	Type of Variable	Level of Measurement	Coding/ Possible range
SRL treatment		Independent	Nominal	Treatment or control (1 or 2)
Gender	Demographics	Independent	Nominal	Gender (1 or 2),
GPA	Demographics	Control	Continuous	0.00-4.00
Achievement	Final exam	Dependent	Continuous	0%-100%
Achievement	Final course Grade	Dependent	Continuous	0%-100%
Metacognition	MSLQ	Dependent*	Continuous	1.00-5.00 (Likert-type rating scale)
Time Management	MSLQ	Dependent*	Continuous	1.00-5.00 (Likert-type rating scale)
Science identity	Science Identity Scale	Dependent*	Continuous	1.00-5.00 (Likert-type rating scale)
Academic self-confidence	Academic Perceived Competence Scale	Dependent*	Continuous	1.00-5.00 (Likert-type rating scale)
Science self-efficacy	Science Self-Efficacy Scale	Dependent*	Continuous	1.00-5.00 (Likert-type rating scale)

*Dependent variables consist of posttest values. The pretest values will be utilized as control or covariates.

Achievement

Final exam and course grades were used to measure student achievement. The final exam consisted of 50 multiple choice items and were cumulative for each of the courses. Both the treatment group and the non-treatment group took the same final exam within their courses. Final exams for each of the four courses reflected the specific information taught in each of the courses over the semester.

Course grades for the semester were used as another measure of student achievement. They were computed as the total percentage of points earned in the course.

Self-regulated Learning

The Metacognition and Time Management scales from the Motivated Strategies for Learning Questionnaire (MSLQ) were used to measure the dependent variables related to self-regulated learning (Jackson, 2018). The Metacognition scale is comprised of 6 items measuring student self-regulation The Time Management scale consists of 4 items measuring student's management of study time and location. Students rated the items using a 5-point Likert type scale with "1" as strongly disagree, "2" as disagree, "3" as neither agree or disagree, "" agree, and "5" as strongly agree. Final scores for Metacognition and Time Management ranged from 1.00 to 5.00.

Jackson (2018) conducted a Confirmatory Factor Analysis (CFA) on the overall MSLQ to establish construct validity. The fit indices for the model identified as adequate fit with standardized root mean square residual (SRMR) = .05, Comparative Fit Index (CFI) = .84, and root mean square error of approximation (RMSEA) = .06 (Jackson, 2018). Cronbach alpha test of reliability was used to establish an acceptable level of internal consistency. The Cronbach alpha coefficients ranged from .64 to .93 (Jackson, 2018). The two MSLQ scales appear in Appendix A.

Science Motivation

The dependent variables related to Science Motivation were measured using items related to Science Identity, Academic Perceived Competence, and Science Self-Efficacy developed by Robinson and colleagues (2018). The Science Identity scale was comprised of 4 items measuring student's belief that science is a component of their academic identity. The Academic Perceived Competence scale consisted of 5 items measuring a student's perceived ability to learn science. Finally, the science self-efficacy scale consisted of 6 items measuring student confidence when utilizing scientific knowledge and skills. Students rated the items using a 5-point Likert type scale with "1" as strongly disagree, "2" as disagree, "3" as neither agree or disagree, "" agree, and "5" as strongly agree. Final scores for Science Identity, Academic Perceived Competence, and Science Self Efficacy will range from 1.00 to 5.00. The three Science Motivation scales appear in Appendix B. Robinson and colleagues (2018) established construct validity through a CFA, which identified an excellent fit, RMSEA = .064, CFI = .931, TLI = .941, SRMR = .092. Chronbach alpha for science identity ranged from .83-.90 and science self-efficacy ranged from .84-.87.

Demographic Information

Demographic information was collected by asking students to respond to six close-ended items. Gender and ethnicity were identified using the demographics section of the survey. These variables were represented in the research questions. Also included in the demographics section of the survey were current community college GPA, age, whether English is a second language, and year in their current academic program. These variables help describe the sample and its generalizability (see Appendix C).

Procedure

During the second week of class students were notified about the study by their instructor. Informed Consent was available to students on the Canvas course site in the form of a letter with a blank for student signature (See Appendix D). Students who were interested in participating in the study received extra credit consisting of 10 points added to their final course grade. Students who did not participate in the study had an opportunity to receive the 10 points extra credit by completing an alternative scientific writing assignment that took approximately the same amount of time as completing the pre and post study surveys.

The ID numbers for students agreeing to participate in the study in each class were randomly assigned to either the treatment or control group using a random number selector. Students in the treatment group completed the weekly SRL exercise (training). Students in the comparison group wrote a two-page paper each week about an assigned geoscientist (non-treatment). Both assignments took approximately the same amount of time to complete.

Both the treatment and non-treatment exercises were completed by students on the google drive platform. After receiving the signed informed consent forms, the researcher sent students and their instructors a link to access a google folder. Students in the treatment group received a google folder that contained a PowerPoint presentation with instructions for completing the SRL exercises and blank weekly SRL exercise worksheets. Students in the control group received a google folder containing instructions for writing each of the weekly essays about a selected geoscientist. All of the geoscientist names were provided on a document that included the week they were due in a checklist format. Instructions and associated documents for the treatment and control groups can be found in Appendix F.

Students completed and uploaded their weekly exercises to their assigned google folder. Instructors from each of the classes graded the student assignments and return them to the folders. The researcher kept a spreadsheet for each of the classes containing student names and numbers. The completion status of the exercises by week was recorded on the spreadsheet by the researcher. Each week, at the end of the week, the researcher sent the spreadsheet to the instructor for confirmation of correctness. At the end of the semester the instructors added the final exam grade and final course grade to the spreadsheet. The researcher assigned numbers to participating students and removed the names and any other identifying information. A master list of student names and assigned numbers kept in a secure location known only by the researcher. A copy of the excel spreadsheets containing assigned numbers can be found in Appendix G.

All students participated in one of the exercises as a component of the courses with the value of the weekly exercises being a classwork grade. Students who opted out of participating in the study, completed the geoscientists essays as their classwork assignments. Only those students who agreed to be in the study had their exercises and completion data utilized.

Students who agreed to be involved in the study completed the pre-treatment MSLQ and science motivation scales during the fourth week of class after completing the informed consent forms. The survey, housed on Old Dominion Universities' Qualtrics Site, consisted of scales used to measure self-regulated learning and science motivation. The survey began with a demographics section containing items about gender, ethnicity, GPA, and year in program.

Students accessed the survey using a link which was sent to their email. The instructors were not given access to the survey link.

SRL Training.

Table 3.3 presents the components and phases for the SRL treatment. The SRL treatment began on Monday of the fourth week of class after students completed the pretreatment survey. Students in the treatment group accessed the SRL documents, consisting of four components, and will complete the components on a weekly basis for 9 weeks. The components were based on Zimmerman’s model of SRL which consisted of a forethought or planning stage, a performance phase, and a self-reflection phase (Zimmerman, 2002).

Table 3.3

SRL Treatment Components and Phases

SRL Phase	Component	Time of Week	Day and Time
Forethought	Goal setting	Beginning	Sunday by 11:59pm
Forethought	Weekly Calendar	Beginning	Sunday by 11:59pm
Performance	Self-monitoring checklist	End	Saturday by 11:59pm
Self-Reflection	Responses to prompts	End	Saturday by 11:59pm

For the forethought phase students set goals, and then created a weekly calendar with a focus on time management during the planning phase. After the initial week of the study, these were due on the Sunday before the beginning of the week by 11:59 pm.

During the performance phase, students completed a self-monitoring checklist. The self-monitoring checklist, consisting of a good study habits checklist, allowed students to monitor their actions before, during and after class. Students were encouraged to complete each of the good study habits at least once a week.

The final SRL activity took place during the self-reflection phase. During the self-reflection phase, students reflected on their SRL performance during the week through a series of prompts contained on the self-reflection worksheet. Both the self-monitoring and self-reflection forms were due at the end of the week on Saturday by 11:59 pm. The SRL component worksheets can be found in appendix H.

A PowerPoint presentation was provided for students, explaining in detail the process for completion of the SRL exercises. The PowerPoint presentation can be found in Appendix I.

Comparison Conditions

Students participating in the non-treatment activity completed a weekly writing assignment. The weekly writing assignment was the same each week for all students in the non-treatment group. To submit their completed essays, students were instructed to submit their papers to their Google folder. Some instructors also required the students to submit their papers to Canvas. The writing assignment was due at the end of the week, on Saturday night at 11:59 pm. The directions for the weekly writing assignment can be found in Appendix J.

Student Identification

During the study, student names and numbers were used by instructors and the researcher when collecting exercise information and data. Student numbers were used when completing the pretreatment and post-treatment surveys. The treatment and non-treatment exercises were scored by the instructors as a completion grade. The researcher monitored the google folders and indicated student weekly completion of the exercises and essays on an excel spreadsheet with a

“Complete”. Students who did not complete the exercises and essays were identified by a blank. At the end of the study all student identifiers were removed and a randomly generated number was assigned to distinguish their study data.

Achievement Scores and Post Questionnaires

Final exam grades and course grades were collected at the end of the semester. Instructors from each of the classes submitted final exam scores and the percentage of total points earned in the class for the students participating in the study using an excel spreadsheet . To maintain the confidential nature of the data collection, student names were replaced by a randomly generated number. Students completed the post-treatment surveys during the last two weeks of the semester. Students were sent a link to the survey through their email and were provided information for completing the survey.

Analysis

The raw data was collected from Qualtrics by the researcher and instructors sent the completed Excel spreadsheets to the researcher. The data was uploaded into SPSS version 28.0 for Windows. The data was cleaned to account for non-responses and outliers. Participants who failed to respond to a majority of the pre and post-test questionnaires (> 50%) were removed from further descriptive and inferential analysis.

Composite scores were developed for Metacognition, Time Management, Science Identity, Academic Perceived Competence, and Science Self-Efficacy through computation of a mean of the respective items comprising each of the scales. Potential outliers were identified through standardization of the variables around the mean. Tabachnick & Fidell (2019) indicate that standardized values, or *z*-scores, exceeding ± 3.29 standard deviations from the mean are considered outliers and should be removed from inferential analyses.

Cronbach alpha test of internal consistency was computed for each of the scales. The strength of the alpha values was evaluated through use of the guidelines suggested by George and Mallery (2020), in which $\alpha \geq .9$ Excellent, $\alpha \geq .8$ Good, $\alpha \geq .7$ Acceptable, $\alpha \geq .6$ Questionable, $\alpha \geq .5$ Poor, and $\alpha < .5$ Unacceptable.

Frequencies and percentages were used for the nominal-level variables. Means and standard deviations were presented for the continuous-level data. The analyses that were utilized to address the research questions are presented below. To describe the achievement of the community college students enrolled in Geoscience courses after training in SRL, an exploratory data analysis was used to examine trends. Exam and final course grades were converted to Z scores for the analysis.

To address the research questions, a series of ANCOVAs were conducted. Prior to analysis, the assumptions for the inferential analyses were assessed. A Pearson correlation matrix was examined to establish whether the MSLQ scales, motivational variables, and achievement variables are correlated. Normality was assessed with a series of Shapiro-Wilk tests on the dependent variables. The Shapiro-Wilk test compares the test data to a true bell-shaped distribution (Field, 2013). Non-significance ($p > .05$) on the Shapiro-Wilk test indicated that the assumption of normality is supported. Homogeneity of variance was tested with a series of Levene's tests. Levene's test compared the spread of the dependent variables between the groups of interest (Howell, 2013). Non-significance ($p > .05$) on the Levene's test indicated that the assumption of normality is met. If the assumptions were not supported, non-parametric analyses such as the Mann-Whitney U test, were conducted to further examine the differences by participation in the training group. The analytic approaches were organized by research question.

RQ1. Is there a statistically significant difference in community college students' achievement in their Geoscience courses between students in the SRL training group and those in the comparison group?

To address research question one, two ANCOVAs were conducted to assess differences in final exam and course grades (total percent) between students in the SRL training group and those in the comparison group, while controlling for GPA. An ANCOVA is an appropriate analysis when testing for differences in a continuous dependent variable between groups, while controlling for additional factors (Pallant, 2020). The dependent variables corresponded to final exam and course grades. The independent grouping variable corresponded to group (treatment and control). The control variable corresponded to GPA. Finally, Z-scores were calculated for the final exam grades and the final course grades for each of the classes.

The F test was used to make the overall determination on whether there are significant differences between groups. The estimated marginal means was examined for each of the dependent variables to compare between the two groups, while accounting for GPA. Statistical significance for the F test was evaluated using the conventional significance threshold, $\alpha = .05$.

RQ2. Is there a statistically significant difference in community college students' metacognition and time management scales in their Geoscience courses between students in the SRL training group and those in the comparison group?

To address research question two, two ANCOVAs were conducted to assess for differences in the MSLQ posttest measures (metacognition and time management) between students in the SRL training group and those in the comparison group, while controlling for

MSLQ pretest scores and GPA. The dependent variables corresponded to posttest scores on metacognition and time management. The independent grouping variable corresponded to group (treatment and control). The control variables included pretest scores on the two MSLQ measures and GPA.

The *F* test was used to make the overall determination on whether there are significant differences between groups. The estimated marginal means was examined for each of the dependent variables to compare between the two groups, while accounting for MSLQ pretest scores and GPA. Statistical significance for the *F* test was evaluated using a family-wise error rate, $\alpha = .025$ (.05/2).

RQ3. Is there a statistically significant difference in community college students' science identity, science self-efficacy, and academic perceived competence scales in their Geoscience courses between students in the SRL training group and those in the comparison group?

To address research question three, a series of ANCOVAs were conducted to assess for differences in the academic motivation posttest measures (science identity, science self-efficacy, and academic perceived competence) between students in the SRL training group and those in the comparison group, while controlling for science motivation pretest scores and GPA. The dependent variables corresponded to posttest scores on science identity, science self-efficacy, and academic perceived competence. The independent grouping variable corresponded to group (treatment and control). The control variables included pretest scores on the three academic motivation measures and GPA.

The *F* test was used to make the overall determination on whether there are significant differences between groups. The estimated marginal means was examined for each of the dependent variables to compare between the two groups, while accounting for pretest scores and

GPA. Statistical significance for the *F* test was evaluated using a family-wise error rate, α = .017 (.05/3).

RQ4. Is there a statistically significant difference in community college students' metacognition, time management, science identity, academic perceived competence, and science self-efficacy scales in their Geoscience courses between students in the SRL training group and those in the comparison group and between males and females?

To address research question four, a series of factorial ANCOVAs were developed to assess for differences in the MSLQ posttest measures (metacognition and time management) and the academic motivation measures (science identity, science self-efficacy, and academic perceived competence) by participation in the SRL training and gender, while controlling for pretest MSLQ scores and GPA. The dependent variables corresponded to posttest scores on metacognition, time management, science identity, science self-efficacy, and academic perceived competence. The independent grouping variables corresponded to group (treatment and control) and gender. The control variables included pretest scores on the five measures and GPA.

The *F* test was used to make the overall determination on whether there are significant differences between groups. The estimated marginal means was examined for each of the dependent variables to compare between the two groups, while accounting for pretest scores and GPA.

Statistical significance for the *F* test was evaluated using family-wise error rates α = .025 (.05/2) and α = .017 (.05/3), for the MSLQ and academic motivation measures, respectively. None of the results were found to be statistically significant. The findings will be discussed in Chapter 4.

Chapter 4

Results

The purpose of this study was to investigate the impact of training in self-regulated learning on community college students' achievement, metacognition, time management, science self-efficacy, science identity and perceived competency in science. This study also investigated the impact of SRL training on students based on their gender and ethnicity. In this chapter, the findings of the data analyses will be presented. Frequencies and percentages were used to examine the trends in the demographic variables. To address the research questions, a series of ANCOVAs were conducted.

Descriptive Statistics

The initial sample size consisted of 125 students. Forty-seven students did not complete the posttest questionnaire. Seven students did not have final course grades or final exam grades. Potential outliers were identified by standardizing the variables of interest. Tabachnick & Fidell (2020) indicate that standardized values, or *z*-scores, exceeding $\pm$ 3.29 standard deviations from the mean are considered outliers. There was one outlier identified for academic perceived competence, which was subsequently removed. The final sample consisted of 70 participants. A total of 37 students were in the treatment group (SRL) and 33 students were in the control group (paper). Demographics for the participants by group are presented in Table 4.1.

Table 4.1

Frequency Table for Demographic Variables by Group

	Group	
Variable	Treatment (SRL)	Control (Paper)
Gender		
Female	17 (45.95%)	21 (63.64%)
Male	18 (48.65%)	11 (33.33%)
Non-binary / third gender	1 (2.70%)	1 (3.03%)

Prefer not to say	1 (2.70%)	0 (0.00%)
Age		
18-24	29 (78.38%)	31 (93.94%)
25-31	6 (16.22%)	1 (3.03%)
32-38	2 (5.41%)	0 (0.00%)
39-45	0 (0.00%)	1 (3.03%)
Current GPA		
0.0-2.00	2 (5.41%)	3 (9.09%)
2.1-2.5	3 (8.11%)	9 (27.27%)
2.6-3.0	10 (27.03%)	2 (6.06%)
3.1-3.5	10 (27.03%)	4 (12.12%)
3.6-4.0	12 (32.43%)	15 (45.45%)
Years in academic degree program		
First year	8 (21.62%)	11 (33.33%)
Second year	29 (78.38%)	22 (66.67%)

The Cronbach alpha values exceeded the acceptable threshold for pretest and posttest scales. Table 4.2 presents the findings of the Cronbach alpha tests.

Table 4.2

Cronbach Alpha Tests of Reliability for Scales

Variable	Pretest		Posttest	
	Number of items	α	Number of items	α
Metacognition	6	.81	6	.87
Time management	4	.79	4	.82
Science identity	4	.90	4	.90
Science self-efficacy	5	.86	5	.89
Academic perceived competence	6	.80	6	.88

Descriptive statistics for the interval-level variables of interest are presented in Table 4.3. Kline (2010) suggests that skew and kurtosis values falling between ± 2.00 indicate that the variables approximately follow a normal distribution. The skewness and kurtosis values for all the variables fell between the acceptable thresholds for normality.

Table 4.3

Descriptive Statistics for Interval-Level Variables

Variable	*n*	Max	Min	*M*	*SD*	Skewness	Kurtosis
Final exam grade	70	100.00	55.00	84.57	10.50	-0.45	-0.41
Final course grade	70	98.97	68.00	83.89	8.11	0.01	-1.07
Metacognition pretest	70	5.00	1.83	3.75	0.76	-0.35	-0.52
Metacognition posttest	70	5.00	1.50	3.90	0.77	-0.56	0.09
Time management pretest	70	5.00	2.00	3.90	0.81	-0.37	-0.80
Time management posttest	70	5.00	1.75	3.95	0.89	-0.70	-0.20
Science identity pretest	70	5.00	1.00	3.08	0.97	-0.23	-0.35
Science identity posttest	70	5.00	1.00	3.18	1.02	0.02	-0.58
Science self-efficacy pretest	70	5.00	2.67	3.95	0.53	-0.20	-0.34
Science self-efficacy posttest	70	5.00	3.00	4.09	0.58	-0.24	-0.87
Academic perceived competence pretest	70	5.00	2.00	4.11	0.66	-0.93	0.72
Academic perceived competence posttest	70	5.00	2.60	4.16	0.64	-0.40	-0.66

The assumption of normality was further tested with Shapiro-Wilk tests on the variables of interest. Statistically significant findings ($p < .05$) on the Shapiro-Wilk test indicate that the data may deviate from a normal distribution (Pallant, 2019). The findings of the Shapiro-Wilk tests were statistically significant for several of the variables, indicating that the normality assumption may not be supported. Howell (2013) indicates that violations of normality are not problematic if the sample size for the research exceeds 50 cases. Due to the sufficient sample size and the skewness and kurtosis values being acceptable, the inferential analyses conducted to analyze the research questions were conducted as initially proposed. Table 4.4 presents the findings of the Shapiro-Wilk tests.

Table 4.4

Shapiro-Wilk Tests for Variables of Interest

Variable	Shapiro-Wilk Test Statistic	*p*
Final exam grade	.96	.044

Final course grade	.97	.060
Metacognition pretest	.97	.124
Metacognition posttest	.95	.007
Time management pretest	.94	.004
Time management posttest	.91	<.001
Science identity pretest	.97	.171
Science identity posttest	.97	.101
Science self-efficacy pretest	.98	.204
Science self-efficacy posttest	.95	.006
Academic perceived competence pretest	.93	<.001
Academic perceived competence posttest	.94	.002

The assumption for homogeneity of variance was tested with a series of Levene's tests on the variables of interest by group (treatment and control). A statistically significant result on Levene's test indicates that the variance in the variables of interest is significantly different between the groups (Field, 2013). The results for all of the Levene's tests were not statistically significant ($p > .05$), indicating that the assumption for homogeneity of variance was supported. Table 4.5 presents the findings of the Levene's tests.

Table 4.5

Levene's Tests for Variables of Interest

Variable	Levene's Test Statistic	*p*
Final exam grade	0.21	.651
Final course grade	0.30	.585
Metacognition pretest	0.09	.766
Metacognition posttest	3.29	.074
Time management pretest	0.21	.651
Time management posttest	1.15	.287
Science identity pretest	1.52	.223
Science identity posttest	0.00	.963
Science self-efficacy pretest	0.49	.487
Science self-efficacy posttest	0.06	.808
Academic perceived competence pretest	1.60	.211
Academic perceived competence posttest	0.21	.650

Bias effect. To test for fidelity of implementation independent sample t-tests were conducted. The findings demonstrated that there were no significant differences in scores based on completion of SRL weekly activities. The findings were not statistically significant with all *p* values being greater than .05 *(p* >.05). Table 4.6 presents the results of the independent sample t-tests for variables by completion of the SRL weekly activities.

Table 4.6

Independent Sample t-tests for Variables by Completion of SRL Weekly Activities Scores

Variable	Completed SRL Weekly Activities					
	No (n = 25)		Yes (n = 12)			
	M	*SD*	*M*	*SD*	$t(35)$	*p*
Academic perceived competence pretest	4.05	0.80	4.17	0.68	-0.44	.661
Academic perceived competence pretest	4.11	0.68	4.38	0.62	-1.17	.248
Metacognition pretest	3.83	0.76	3.93	0.77	-0.39	.699
Metacognition posttest	4.03	0.63	4.18	0.63	-0.66	.512
Time and study pretest	3.92	0.76	4.19	0.95	-0.93	.361
Time and study posttest	4.07	0.76	4.46	0.65	-1.53	.135
Science identity pretest	3.16	0.91	3.46	0.82	-0.96	.343
Science identity posttest	3.31	1.04	3.50	0.97	-0.53	.598
Science self-efficacy pretest	4.03	0.55	3.89	0.39	0.77	.444
Science self-efficacy posttest	4.09	0.53	4.14	0.76	-0.21	.833

Research Question 1

Is there a statistically significant difference in community college students' achievement in their Geoscience courses between students in the SRL training group and those in the comparison group?

To address research question one, two ANCOVAs were conducted to assess for differences in final exam grades and final course grades between the treatment (SRL) and control groups (paper), while controlling for GPA. The independent variable corresponded to group:

treatment and control. The dependent variables correspond to final exam grade and final course grade. The control variable corresponds to GPA.

Final exam grade. Z-scores were computed using final exam grade raw scores for students in each class. Table 4.7 illustrates the minimum and maximum z-scores by class and instructor.

Table 4.7

Z-Scores Ranges for Final Exam Scores by Class and Instructor

Class	Instructor	*n*	Min *Z*-score	Max Z-score
Environmental Geology	B	8	-2.32	0.54
Historical Geology	A	4	-1.01	1.24
Oceanography I	C	2	-0.71	0.71
Oceanography I	D	9	-1.75	1.14
Oceanography I	B	15	-2.14	1.42
Oceanography I	B	17	-2.02	1.66
Physical Geology	C	2	-0.71	0.71
Physical Geology	A	7	-2.17	0.61
Physical Geology	A	6	-1.61	1.06

The findings of the ANCOVA for final exam grade were not statistically significant, $F(1, 67) = 0.01$, $p = .946$, partial $\eta^2 = 0.001$, indicating that there were not significant differences in final exam grades by group, while controlling for GPA. Table 4.8 presents the results of the ANCOVA.

Table 4.8

ANCOVA for Final Exam Grades by Group While Controlling for GPA

Term	*Num df*	*Den df*	*F*	*p*	η_p2
Group	1	67	0.01	.946	.001

Note. ANCOVA includes control variable of GPA.

Means and standard deviations for final exam grades by group are presented in Table 4.9. The marginal means for final exam grades were 84.49 for the treatment group and 84.65 for the control group. A bar chart for the marginal means is presented in Figure 4.1.

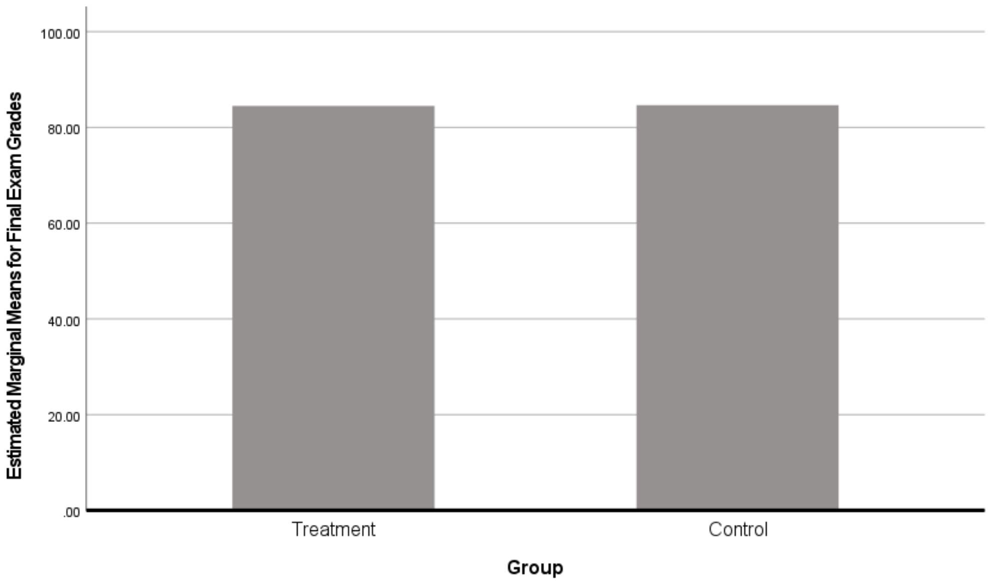
Table 4.9

Marginal Means for Final Exam Grades by Group While Controlling for GPA

Variable	Treatment		Control	
	M	*SE*	*M*	*SE*
Final exam grade	84.49	1.61	84.65	1.70

Figure 4.1

Bar chart for final exam grades by group.



Final course grade. Z-scores were computed using final course grade raw scores for students in each class. Table 4.10 illustrates the minimum and maximum z-scores by class and instructor.

Table 4.10

Z-Scores Ranges for Final Course Grade by Class and Instructor

Class	Instructor	*n*	Min *Z*-score	Max Z-score
Environmental Geology	B	8	-2.21	0.87

Historical Geology	A	4	-1.11	1.12
Oceanography I	C	2	-0.71	0.71
Oceanography I	D	9	-1.50	1.49
Oceanography I	B	15	-1.76	1.63
Oceanography I	B	17	-1.72	1.78
Physical Geology	C	2	-0.71	0.71
Physical Geology	A	7	-2.12	0.77
Physical Geology	A	6	-1.64	1.09

The findings of the ANCOVA for final course grades by group were not statistically significant, $F(1, 67) = 0.35$, $p = .556$, partial $\eta^2 = 0.005$, indicating that there were not significant differences in final course grades by group, while controlling for GPA. Table 4.11 presents the results of the ANCOVA.

Table 4.11

ANCOVA for Final Course Grades by Group While Controlling for GPA

Term	*Num df*	*Den df*	*F*	*p*	$\eta_p 2$
Group	1	67	0.35	.556	.005

Note. ANCOVA includes control variable of GPA.

Means and standard deviations for final course grades by group are presented in Table 4.9. The marginal means for final course grades were 84.38 for the treatment group and 83.34 for the control group. A bar chart for the marginal means is presented in Figure 4.2.

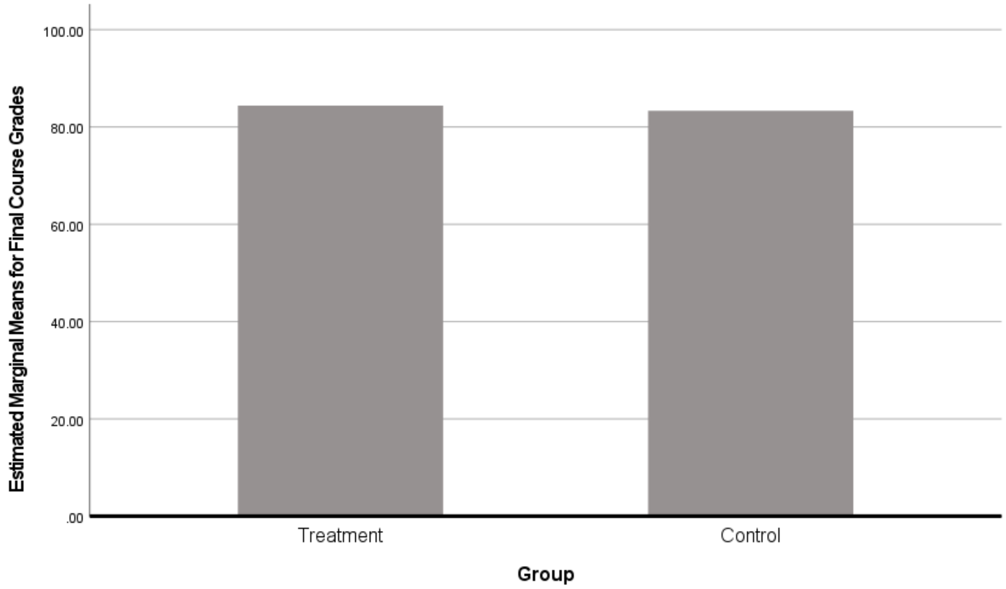
Table 4.12

Marginal Means for Final Course Grades by Group While Controlling for GPA

Variable	Treatment		Control	
	M	*SE*	*M*	*SE*
Final course grades	84.38	1.21	83.34	1.28

Figure 4.2

Bar chart for final course grades by group.



Research Question 2

Is there a statistically significant difference in community college students' metacognition and time management scales in their Geoscience courses between students in the SRL training group and those in the comparison group?

No statistically significant findings were obtained for metacognition by group, $F(1, 65) = 2.36$, $p = .130$, partial $\eta^2 = 0.035$; or time management by group, $F(1, 65) = 5.00$, $p = .029$, partial $\eta^2 = 0.071$, after conducting the ANCOVAs. Table 4.13 presents the findings of the ANCOVAs for metacognition and time management posttest scores.

Table 4.13

ANCOVAs for Metacognition and Time Management Posttest Scores by Group While Controlling for Pretest Scores and GPA

Independent Variable	Dependent Variable	*Num df*	*Den df*	*F*	*p*	η_p^2
Group	Metacognition posttest	1	65	2.36	.130	.035
	Time management posttest	1	65	5.00	.029	.071

Note. ANCOVAs include control variables of pretest scores and GPA.

Means and standard deviations for metacognition and time management by group are presented in Table 4.14. The marginal means for time management posttest scores were 4.11 for the treatment group and 3.78 for the control group. While the findings of the ANCOVA for metacognition and time management were not statistically significant, the scores were slightly higher in the treatment control in comparison to the control group. A bar chart for the marginal means is presented in Figures 4.3 and 4.4.

Table 4.14

Marginal Means for Metacognition and Time Management Posttest Scores by Group While Controlling for Pretest Scores and GPA

Variable	Treatment		Control	
	M	*SE*	*M*	*SE*
Metacognition	4.00	0.09	3.79	.097
Time management	4.11	0.10	3.78	.105

Figure 4.3

Bar chart for metacognition scores by group.

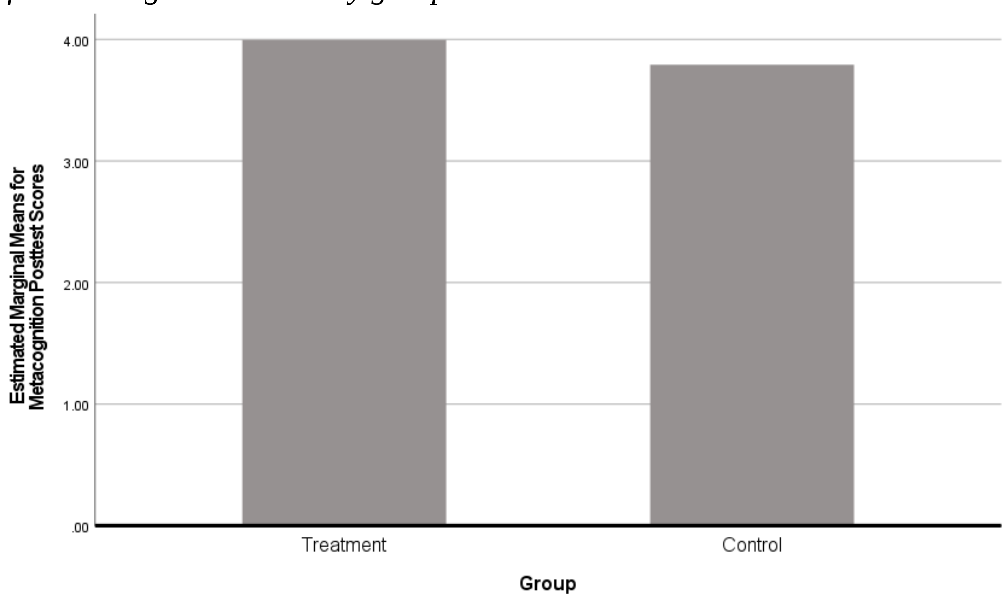
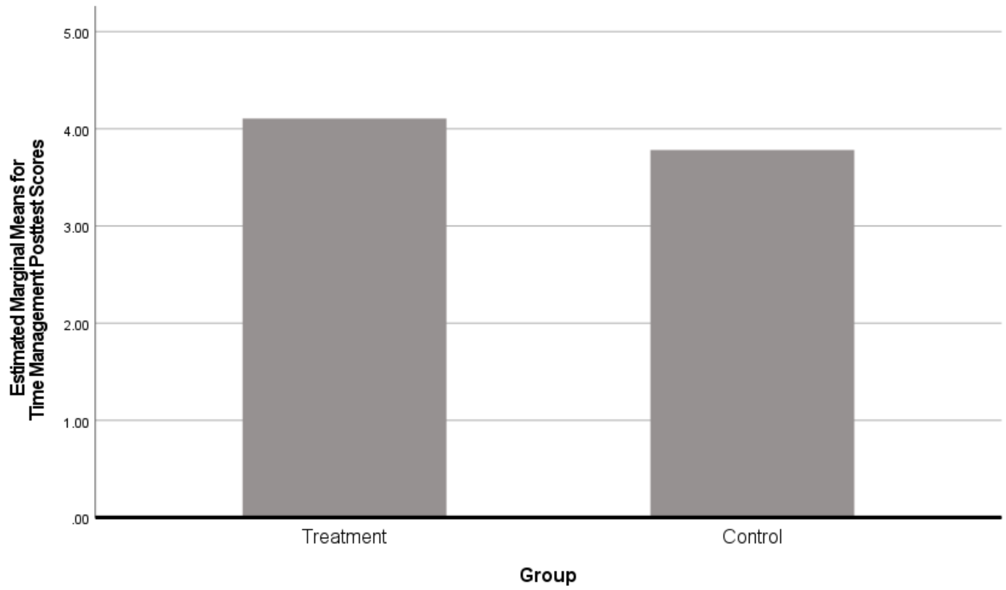


Figure 4.4
Bar chart for time management scores by group.



Research Question 3

Is there a statistically significant difference in community college students' science identity, science self-efficacy, and academic perceived competence scales in their Geoscience courses between students in the SRL training group and those in the comparison group?

The findings of the ANCOVAs for science identity, $F(1, 64) = 0.42$, $p = .519$, partial $\eta^2 = 0.007$; science self-efficacy, $F(1, 64) = 0.11$, $p = .740$, partial $\eta^2 = 0.002$; and academic perceived competence, $F(1, 64) = 0.61$, $p = .436$, partial $\eta^2 = 0.010$ were not statistically significant indicating that there were not significant differences in posttest scores by group, while controlling for pretest scores and GPA. Table 4.15 presents the findings of the ANCOVAs for science identity, science self-efficacy, and academic perceived competence.

Table 4.15

ANCOVAs for Science Identity, Science Self-Efficacy, and Academic Perceived Competence Posttest Scores by Group While Controlling for Pretest Scores and GPA

Independent Variable	Dependent Variable	*Num df*	*Den df*	*F*	*p*	η_p^2
Group	Science identity posttest	1	64	0.42	.519	.007
	Science self-efficacy posttest	1	64	0.11	.740	.002
	Academic perceived competence	1	64	0.61	.436	.010

Means and standard deviations for science identity, science self-efficacy, and academic perceived competence by group are presented in Table 4.16. Although the findings of the ANCOVA were not statistically significant, the marginal means for science identity, science self-efficacy, and academic perceived competence were slightly higher for the treatment group in comparison to the control group. A bar chart for the marginal means is presented in Figures 4.5-4.7.

Table 4.16

Marginal Means for Science Identity, Science Self-Efficacy, and Academic Perceived Competence Posttest Scores by Group While Controlling for Pretest Scores and GPA

Variable	Treatment		Control	
	M	*SE*	*M*	*SE*
Science identity posttest	3.22	0.10	3.13	0.10
Science self-efficacy posttest	4.11	0.09	4.07	0.09
Academic perceived competence	4.21	0.09	4.10	0.09

Figure 4.5

Bar chart for science identity scores by group.

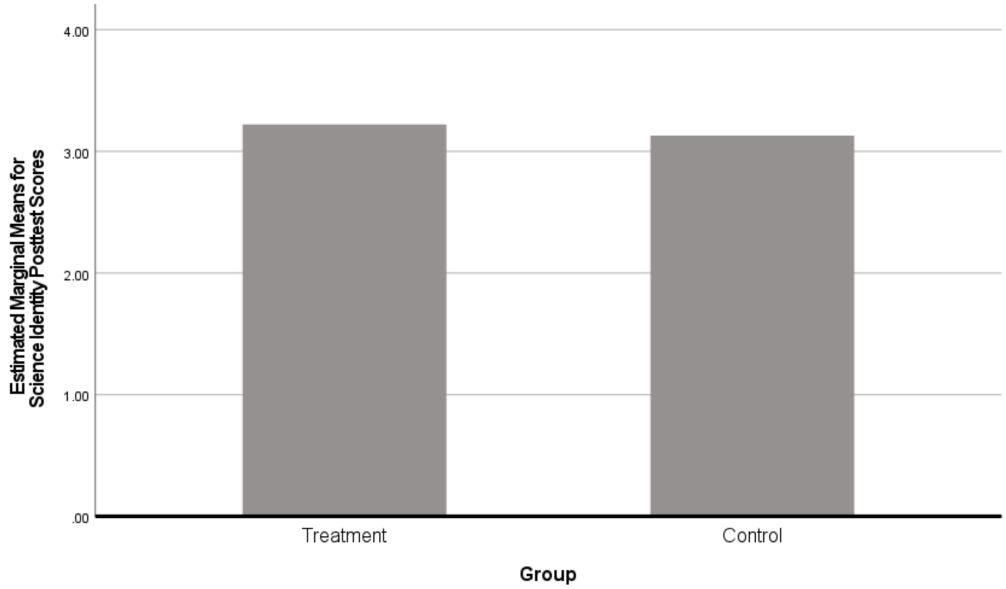


Figure 4.6

Bar chart for science self-efficacy scores by group.

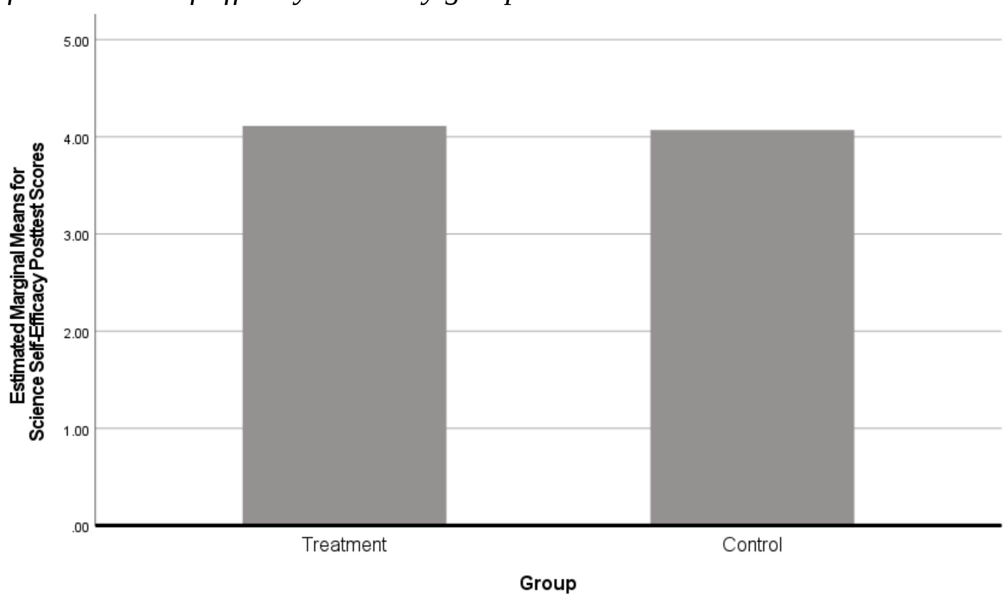
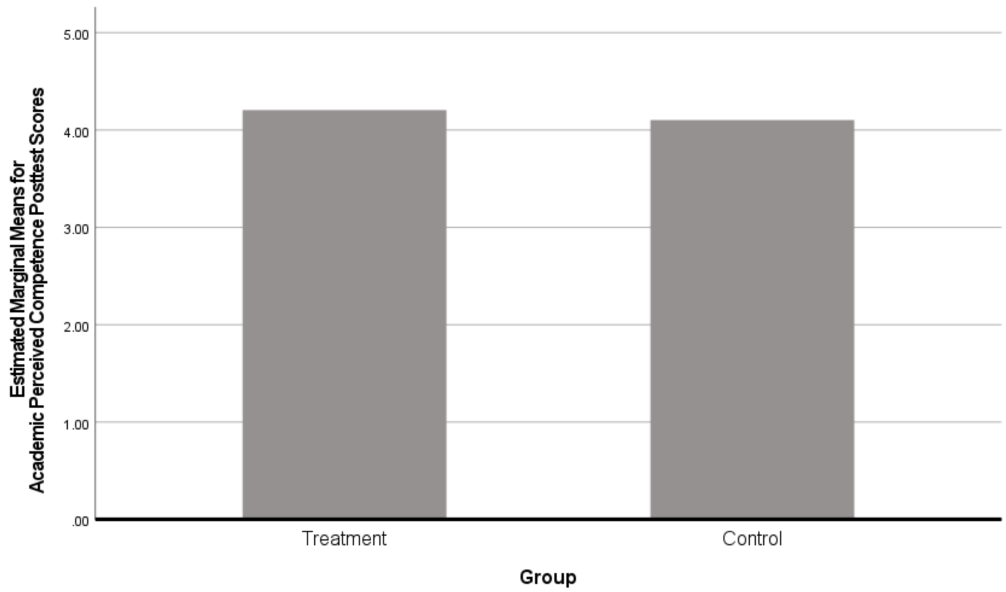


Figure 4.7

Bar chart for academic perceived competence scores by group.



Research Question 4

Does SRL training differentially impact male and female students on their metacognition, time management, science identity, academic perceived competence, and science self-efficacy scales in their Geoscience courses?

To address research question four, two factorial ANCOVAs were conducted to assess for differences in metacognition, time management, science identity, science self-efficacy, academic perceived competence posttest measures by group and gender, while controlling for pretest scores and GPA. The control variable corresponded to the metacognition pretest scores, time management pretest scores, science identity pretest scores, science self-efficacy pretest scores, academic perceived competence pretest scores, and GPA.

Factorial ANCOVAs for Metacognition and Time Management. The findings of the factorial ANCOVA for metacognition by group, $F(1, 60) = 2.05$, $p = .157$, partial $\eta^2 = 0.033$; and time management by group, $F(1, 60) = 4.18$, $p = .045$, partial $\eta^2 = 0.065$, were not statistically significant. Additionally, the findings of the factorial ANCOVA for metacognition by gender, $F(1, 60) = 0.35$, $p = .559$, partial $\eta^2 = 0.006$, and time management by gender $F(1, 60) = 0.15$, $p = .702$, partial $\eta^2 = 0.002$, were not statistically significant. Finally, factorial ANCOVA findings for the interaction for metacognition by group*gender, $F(1, 60) = 0.02$, $p = .904$, partial $\eta^2 = 0.001$, and time management by group*gender $F(1, 60) = 0.29$, $p = .590$, partial $\eta^2 = 0.005$ was not statistically significant. Table 4.17 presents the findings of the factorial ANCOVAs for metacognition and time management.

Table 4.17

*ANCOVAs for Metacognition and Time Management by Group, Gender, and Group*Gender While Controlling for Pretest Scores and GPA*

Independent Variable	Dependent Variable	*Num df*	*Den df*	*F*	*p*	$\eta_p{}^2$
Group	Metacognition posttest	1	60	2.05	.157	.033
	Time management posttest	1	60	4.18	.045	.065
Gender	Metacognition posttest	1	60	0.35	.559	.006
	Time management posttest	1	60	0.15	.702	.002
Group*Gender	Metacognition posttest	1	60	0.02	.904	.001
	Time management posttest	1	60	0.29	.590	.005

Note. ANCOVAs include control variables of pretest scores and GPA.

Means and standard deviations for metacognition and time management by group are presented in Table 4.18. While the interaction effect group*gender was not statistically significant, females in the treatment group tended to have higher metacognition and time management scores in comparison to males in the treatment group. A bar chart for the marginal means is presented in Figures 4.8 and 4.9.

Table 4.18

*Marginal Means for Metacognition and Time Management by Group, Gender, and Group*Gender While Controlling for Pretest Scores and GPA*

Variable	Treatment		Control	
	M	*SE*	*M*	*SE*
Metacognition posttest				
Male	3.95	0.14	3.76	0.18
Female	4.05	0.14	3.83	0.12
Time management posttest				
Male	4.04	0.15	3.80	0.19
Female	4.19	0.15	3.77	0.14

Figure 4.8

Bar chart for metacognition scores by group and gender.

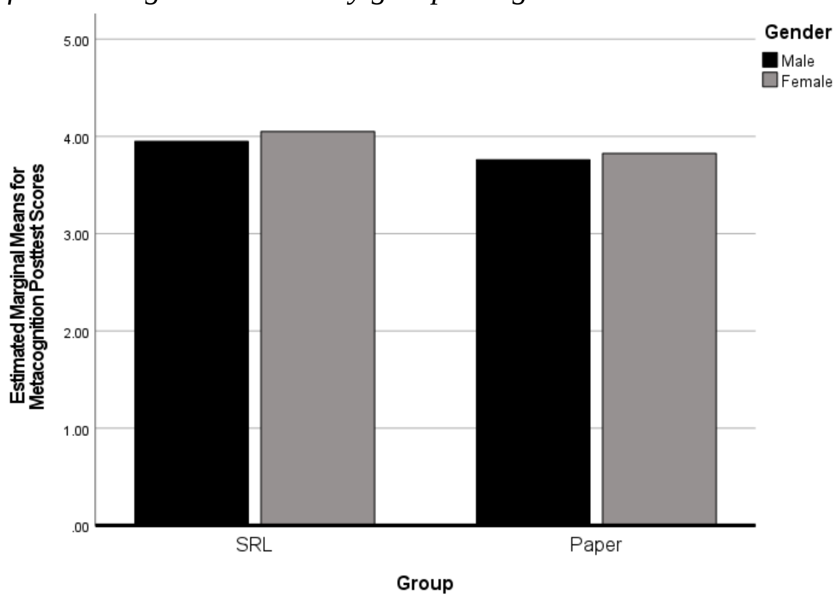
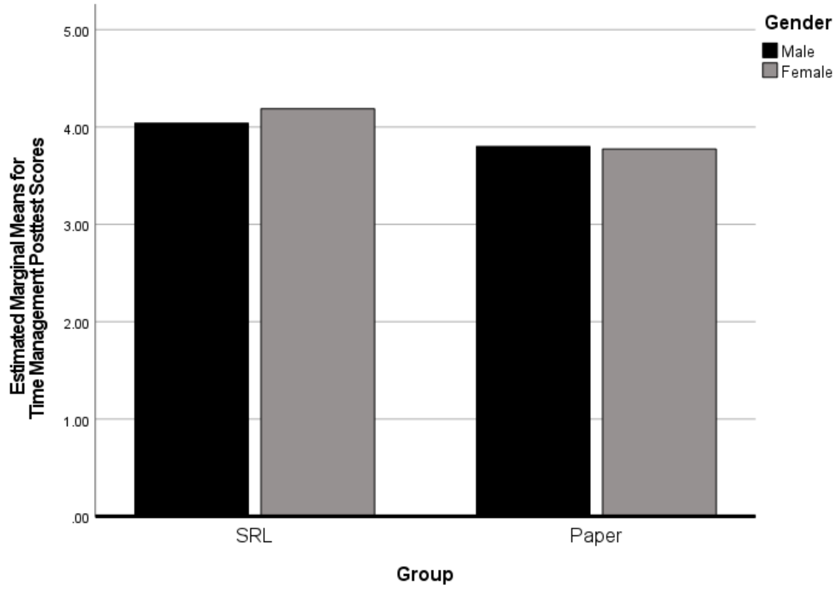


Figure 4.9
Bar chart for time management scores by group and gender.



Factorial ANCOVAs for Science Identity, Science Self-Efficacy, and Academic Perceived Competence. The findings of the factorial ANCOVA for science identity by group, $F(1, 59) = 1.20$, $p = .277$, partial $\eta^2 = 0.020$; science self-efficacy by group, $F(1, 59) = 0.16$, $p = .691$, partial $\eta^2 = 0.003$; and academic perceived competence by group, $F(1, 59) = 0.21$, $p = .645$, partial $\eta^2 = 0.004$, were not statistically significant indicating that there were not significant differences in academic perceived competence posttest scores by group, while controlling for pretest scores and GPA.

Factorial ANCOVA findings for science identity by gender, $F(1, 59) = 0.01$, $p = .998$, partial $\eta^2 = 0.001$; science self-efficacy by gender, $F(1, 59) = 0.01$, $p = .969$, partial $\eta^2 = 0.001$; and academic perceived competence by gender, $F(1, 59) = 0.39$, $p = .537$, partial $\eta^2 = 0.007$, were not statistically significant indicating that there were not significant.

Finally, factorial ANCOVA findings for science identity by group*gender, $F(1, 59) = 0.74$, $p = .394$, partial $\eta^2 = 0.012$; science self-efficacy by group*gender, $F(1, 59) = 0.74$, $p = .393$, partial η^2 = 0.012; and academic perceived competence by group*gender, $F(1, 59) = 2.14$, p = .149, partial η^2 = 0.035, was not statistically significant indicating that there were not significant differences in academic perceived competence posttest scores by group*gender, while controlling for pretest scores and GPA. Table 4.19 presents the findings of the factorial ANCOVAs for science identity, science self-efficacy, and academic perceived competence.

Table 4.19

*ANCOVAs for Metacognition and Time Management by Group, Gender, and Group*Gender While Controlling for Pretest Scores and GPA*

Independent Variable	Dependent Variable	*Num df*	*Den df*	*F*	*p*	η_p^2
Group	Metacognition posttest	1	60	2.05	.157	.033
	Time management posttest	1	60	4.18	.045	.065
Gender	Metacognition posttest	1	60	0.35	.559	.006
	Time management posttest	1	60	0.15	.702	.002
Group*Gender	Metacognition posttest	1	60	0.02	.904	.001
	Time management posttest	1	60	0.29	.590	.005

Note. ANCOVAs include control variables of pretest scores and GPA.

Means and standard deviations for science identity, science self-efficacy, and academic perceived competence by group and gender are presented in Table 4.20. While the interaction effect group*gender was not statistically significant, males in the treatment group tended to have higher science identity and science self-efficacy scores, while females in the treatment group tended to have higher academic perceived competence scores. A bar chart for the marginal means is presented in Figures 4.10-4.12.

Table 4.20

*Marginal Means for Science Identity, Science Self-Efficacy, Academic Perceived Competence Posttest Scores by Group, Gender, and Group*Gender While Controlling for Pretest Scores and GPA*

Variable	Treatment		Control	
	M	*SE*	*M*	*SE*
Science identity posttest				
Male	3.27	0.13	3.00	0.16
Female	3.15	0.14	3.12	0.12
Science self-efficacy posttest				
Male	4.18	0.13	4.01	0.16
Female	4.06	0.13	4.12	0.12
Academic perceived competence posttest				
Male	4.16	0.13	4.30	0.16
Female	4.28	0.14	4.02	0.12

Figure 4.10
Bar chart for science identity scores by group and gender.

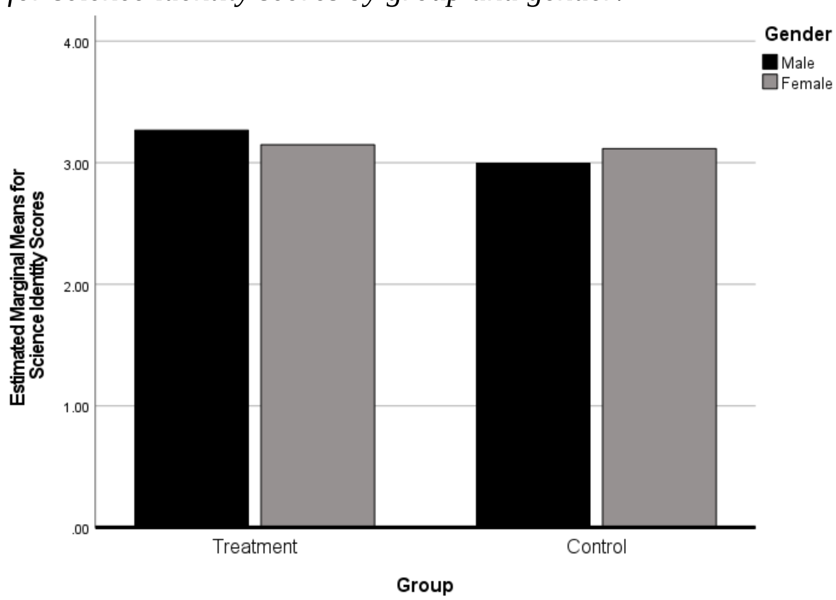


Figure 4.11

Bar chart for science self-efficacy scores by group and gender.

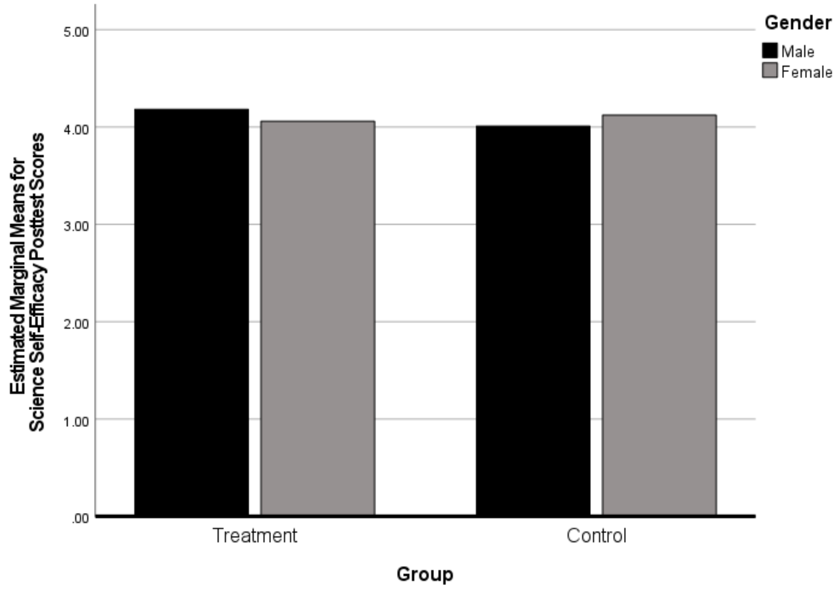
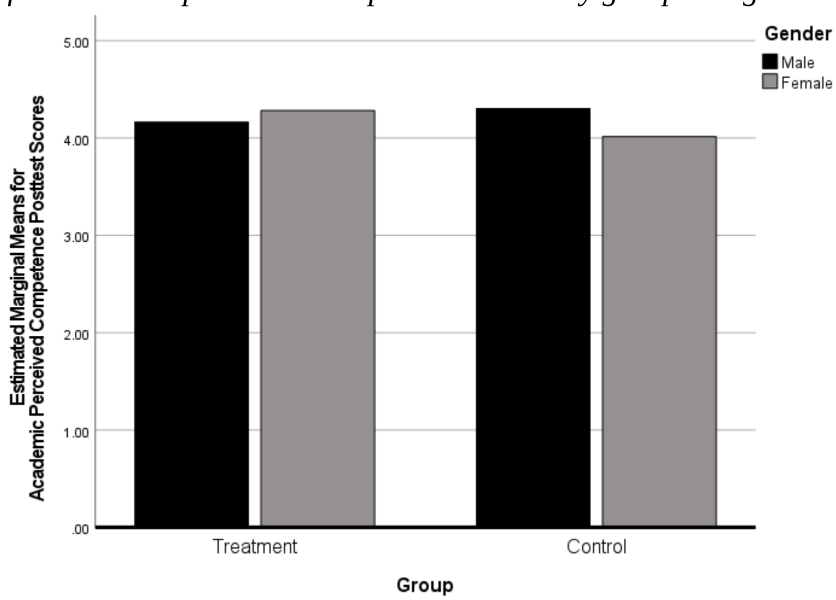


Figure 4.12

Bar chart for academic perceived competence scores by group and gender.



Summary of Statistical Analysis

The purpose of this study was to investigate the impact of training in self-regulated learning on community college students' achievement, metacognition, time management, science self-efficacy, science identity and perceived competency in science. This study also investigated the impact of SRL training on students based on their gender. None of the ANCOVAs were statistically significant. There was no empirical support for the hypotheses that SRL training would enhance student achievement, metacognition, time management, or science motivational constructs. In the next chapter, the findings discussed in connection with the literature. Limitations and recommendations for future research will be provided.

Chapter 5

Discussion

Overview

The purpose of this study was to investigate the impact of training in self-regulated learning on community college students' achievement, metacognition, time management, science self-efficacy, science identity, and perceived competency in science. The impact of self-regulated learning instruction was investigated further through the lenses of gender . Students from 9 different community college geoscience classes taught by five different instructors participated in the study.

For this study, self-regulated learning was based on Zimmerman's (2002) model consisting of a forethought phase, performance phase, and self-reflection phase. The SRL exercises consisted of four components. The first two components made up the forethought exercises, including both goal setting and time management exercises (Appendix H). The third component took place during the week when students examined their progress through the self-monitoring exercise (Appendix H). At the end of that week, students completed the fourth component by reflecting on their progress toward reaching their goals and discussing methods for future improvement using the reflection exercise (Appendix H). Students in the treatment group were asked to complete SRL exercises for a period of 10 weeks. The findings of this study were inconsistent with the study hypotheses. Students in geoscience classes who participated in the treatment SRL exercises for 10 weeks did not experience increases in metacognition, time management or science motivation constructs. And the interaction effects by gender were not significant, indicating no differential effects for females versus males.

This chapter will provide a discussion about how the current findings align with other research in the field related to how SRL training impacts student achievement, metacognition, and science motivation. Additionally, the literature on differences of the impact of SRL on these variables by gender is explored. Finally, this chapter will close with a discussion of the study limitations, implications for educational practice, and implications for future research.

The SRL Treatment

The treatment for this study consisted of four treatment components corresponding to the three stages of Zimmermans (2002) SRL model. During the first phase or forethought phase, students recorded their goals for the week at the beginning of the week using the *Goal Setting* form and determined the time they would set aside for studying during the week using the *Time Management* form. McCardle et al. (2017) found goal setting and time management to have a positive effect on student achievement. The *self-monitoring* form, completed during the week, allowed students to monitor their class participation during the week. Self-monitoring takes place during the second stage of Zimmerman's SRL model (Zimmerman, 2012). Self-monitoring provides students with an understanding of specific learning content (Leggett et al., 2012). At the end of the week students completed a reflection using the *Self-Reflection* form, providing a discussion about whether they were able to reach the goals set at the beginning of the week. This journaling exercise represented the third phase of Zimmerman's model (2002) and provided an opportunity for student contemplation that has been shown to impact students' academic achievement, metacognition (Winnie, 2022), and self-efficacy (Yan et al., 2020).

SRL Treatment Effects on Achievement in Science

The first hypothesis of this study proposed that the academic achievement of science students in the treatment group would increase as a result of the SRL treatment. Previous studies revealed a relationship between SRL and academic achievement in science for first- and second-year college students (Miller, 2015; Peng, 2012; Wang & Kao, 2022). However, the findings of the present study do not align with previous research that indicated a relationship between SRL and academic achievement; the findings of the present study revealed no significant differences for academic achievement between the treatment and non-treatment group. To help explain this finding, other factors are discussed below that could have had an impact on students' academic achievement.

Most students taking the geoscience courses in this study were not majoring in the sciences and were taking the courses as a requirement for their program of study. These students may not have been successful in the sciences in high school or may have not retained the science knowledge from previous classes (NCES, 2019), thus impacting their overall self-efficacy in science courses (Greene et al., 2010). One goal of the study was to increase student self-efficacy and thus academic achievement. However, the impact of negative science related emotions (Pekrun et al., 2002) for marginally successful science students may have had a much greater impact on students' overall science confidence and academic success than the SRL strategies (Higgins et al., 2021).

SRL Treatment Effects on Metacognition and Time Management

The second hypothesis of this study proposed was that there would be a statistically significant difference between treatment and non-treatment groups of community college geoscience students in the areas of metacognition and time management. This study did not reveal a significant difference between the groups in the findings for metacognition or time management.

Metacognition

Metacognition is an important component of self-regulated learning. Through the process of metacognition students develop a strategy for learning (Winne, 2022). Past studies have shown that self-regulated learning positively impacts student metacognition (Bol et al, 2015; Fullmer & Sperling, 2016). The findings of this study did not support significant differences between the metacognition of students in the treatment group and students in the non-treatment group. The findings on metacognition did not support previous research that indicate that self-regulated learning positively impacts student metacognition. The non-significant findings may be due to the small to medium effect size, leading to a less meaningful relationship between groups (Field, 2014). The following information provides additional explanations for the findings of non-significance.

Questions from a modified version of the MSLQ, used in a previous study, were used in the pretreatment and post treatment surveys (Jackson, 2018). Previous studies found that the planning scale of the original MSLQ items (Pintrich & DeGroot, 1990) may not provide an accurate measurement of student metacognition (Berger & Karabenick, 2016; Karabenick et al., 2007). Even though a modified version of the MSLQ survey items was used for this study, the modification might not have been extensive enough for the target population. This is especially important because community college students may be unfamiliar with thinking about their planning and therefore could have provided responses that may not reflect their intended answers to the survey (Berger & Karabenick, 2016; Karabenick et al., 2007).

Students may be self-regulating effectively or ineffectively based on their prior knowledge of study strategies (Cervin-Ellqvist et al., 2021). While self-regulated learning teaches students how to set learning goals, monitor their learning, and reflect on their learning, it does not teach strategies for learning content. Students may have faulty illusions of successful strategies for managing their learning, which will impact their metacognition even when utilizing SRL (Bjork et al., 2013). When students do not understand which study techniques work best, they tend to default to learning strategies that may be ineffective, such as those obtained from previous educational endeavors (Yan et al., 2016). Even though half of the students in each instructor's section were randomly assigned to the SRL condition and half to the comparison condition, some noise or error may have been introduced by having multiple instructors, with different teaching styles and levels of student support. Instructor input can help students recognize effective study strategies for specific content and increase the effectiveness of SRL (Cervin-Ellqvist et al., 2021).

Time Management

Time management promotes success by encouraging students to plan and provide ample time each day to complete their required school-related tasks. The findings of this study did not support significant differences between the time management of students in the treatment group and students in the non-treatment group, which was inconsistent with previous research indicating SRL enhances students' time management (Brady et al., 2022; Hsu et al., 2023; Limone et al., 2020). Time management is especially important for community college students because many are employed in addition to attending classes. If they do not consider their schedules for the week, they may not spend enough time completing schoolwork (Kelly et al., 2022).

Wolters and Brady (2020) stated that time management is an important component of SRL that can provide students with the means for achieving their academic goals. In the present study, students in the treatment group completed a weekly time management calendar at the beginning of the week that indicated when the student would attend class, work, study, and have leisure time. When reflecting at the end of the week, students in the treatment group would discuss the amount of time spent on studying for an upcoming assignment, quiz or test and if they thought it was adequate.

Additionally, Kelly et al. (2022) found that time management works best when goal setting is included as part of the process. Results from the present study reinforced this conclusion. At the beginning of the week students would set their goals and then sketch out their time management for the week based on their goals. An example of the process was when a student would make the weekly goal to study for a test. Then the student would plot out the time they intended for studying based on the goal. At the end of the week the student would reflect on the grade they received on the test and whether they felt that they had spent enough time studying.

SRL Treatment Effects on Science Identity, Science Self-Efficacy, and Academic Perceived Competence

The third hypothesis of this study stated that there would be statistically significant differences in community college students' science scores on science motivation items targeting identity, self-efficacy, and academic perceived competence scales as a function of group assignment. The results showed that collectively there was no statistical difference between the SRL treatment group and those in the non-treatment group on these science motivation scales. This finding may be related to the negative past performance of some students in science courses leading to low science motivation which can be difficult to improve with a one semester intervention (Higgins et al., 2021). The sections below expand upon this explanation for the findings of non-significance.

Science Identity

Science Identity for many students is developed during middle and high school (Vincent-Ruz & Schunn, 2018). While a student's science identity can change while they are in undergraduate school, a significant event or academic success must take place to enable the change (Chen et al., 2021; Perez et al., 2013).

This study revealed no significant differences between students in the SRL treatment group and the non-treatment group in the area of science identity, which does not support previous research indicating that self-regulation practices positively impact students' science identity (Sebastia & Speth, 2017). However, when looking closely at the components of the study, the activity for the non-SRL group may have played an unintended role in the findings. The SRL alternate activity for the non-treatment group consisted of researching and writing weekly one-page papers about various scientists. Average scores for students in both the treatment and non-treatment groups showed a slight increase in science identity, but not enough of an increase to be significant. Students in the non-treatment group could have identified with one or more of the scientists on the list and developed a science identity through the writing experience. If that is the case, and the SRL treatment also caused students to identify as a science person, then the results may not be significant because both groups' science identity changed because of their study activities (Sandrone, 2022).

Science Self-Efficacy

Science self-efficacy is the confidence that a student has in their ability to perform tasks associated with science (Beck & Blumer, 2021). Self-monitoring, a component of SRL, has been shown to have a positive impact on students' self-efficacy (Panadero et al., 2017). Content mastery and relating a science practice to everyday life have been especially helpful in attaining science self-efficacy for students who are not science majors (McBride et al., 2020).

While the study hypothesis stated that there would be a significant difference between the SRL treatment and SRL non-treatment groups in science self-efficacy, no significant differences were found. Findings from this study did not support previous research on SRL practices and science self-efficacy (Panadero et al., 2017). Possible explanations for this finding could again have to do with the alternative activity for the non-SRL group. Prior lack of achievement in science courses could have impacted the science self-efficacy of both the SRL treatment and non-treatment groups (McBride et al., 2020). Moreover, academic achievement in science has been directly related to science self-efficacy (DiBenedetto & Bembenutty, 2013; Perez et al., 2019), and this study did not reveal a significant difference between the groups in academic achievement.

Academic Perceived Competence

Student perceptions of their academic competence in science impact their motivation and academic learning (Ferla et al., 2010). In many cases, student anxiety over past performance in science can negatively impact their academic perceived competence (Worley et al., 2023). Perceptions of academic competence during the first year of college can have an impact on a students' performance throughout their college career (Reason et al., 2006).

In the present study, no significant differences were found between the SRL treatment group and the non-treatment group in academic perceived competence. This finding does not support much of the previous research that indicated there are differences between groups in academic perceived competence (Andaya et al., 2017; Cervin-Ellqvist et al., 2020). However, it has been found that differences between groups may not be present if students' self-perceived level of understanding becomes overconfidence leading to learning material at a surface level with no concept mastery (Fera et al., 2010). The finding of non-significance in the present study could be attributable to the students being first- and second-year community college students. During this time, students' academic competence gains are based on their perceived levels of instructor support and academic engagement (Reason et al., 2006). As mentioned in the context of other findings, the alternative exercise in which students wrote about different geoscientists may have also impacted those students' academic perceived competence so that they also felt that they could succeed in the geosciences.

Treatment Effects by Gender

The fourth hypothesis of this study was that there would be a statistically significant difference between female students and male students receiving SRL training. Alghamdi et al. (2020) found that significant differences were observed between males and females in an online environment. Because the present study involved a partial online environment using Google Folders, the researcher felt that the impact for female students would be greater than that of their male counterparts. This hypothesis was not supported as no significant differences were found between students of different genders in their geoscience courses.

The finding is consistent with those from previous studies. For example, Kitsantas and Zimmerman (2009) examined the relationship between homework completion, self-efficacy, and students' self-regulatory practices and found no significant differences between students of different genders in the areas of student self-regulation, self-efficacy, and assignment completion. In another study, Bembenutty (2007) investigated the relationship between academic achievement, motivation, delay of gratification and the use of SRL practices between students of different genders and also found no significant differences between students of different genders.

Some studies have revealed that student gender impacts the effectiveness of the implementation of SRL strategies and the resulting positive impacts on their learning (Algamdi, 2020; Bidjerano, 2005; Pajares, 2002; Panadero et al., 2017). It has also been found that female students practice goal setting, planning, and self-monitoring, all important components of SRL, more often than male students (Algamadi et al., 2020). It might be that even though female students tend to openly practice some of the learning strategies associated with SRL, male students may do the same in a less obvious manner.

Limitations

All studies have limitations, and the present study is no exception. Study findings should be interpreted with the following limitations in mind.

The Study Was Underpowered

At the beginning of the study, 132 geoscience students completed the informed consent form. The power analysis conducted prior to the start of the study determined that the minimum sample size for the study was 128. Overall, 125 students completed the pretreatment survey. At the conclusion of the study, 78 students completed the posttreatment survey. When the final class achievement data were analyzed, the researcher noticed that there were no final exam grades for students participating in the study from one of the classes. The instructor for that class decided to not give the students a final exam, so eight additional students from that class were removed from the study. This left the total number of students participating in the study at 70, which is below the minimum sample size determined by the power analysis using the family-wise error rates for the MSLQ and academic motivation measures. This low number of study participants may have impacted the study findings and diminished their statistical certainty.

Internal Validity

While it is the goal of every study to reduce the chance of error by carefully designing and monitoring all components, internal factors may present themselves resulting in study impacts.

Participant Selection. Participation in the study was voluntary and not all of the students elected to participate. The students who chose to participate in the study may have been high achievers, entering the study possessing skills for self-regulated learning. Since the semester long SRL training was a classwork grade, students who did not participate were automatically given the paper writing assignment as their classwork assignment and were not exposed to the SRL training. The students who chose not to participate in the study could have been low achieving students who would have benefitted most from the SRL training.

Historical Events. This study was conducted in the fall semester of 2022 when students were returning to in-person learning after more than a year of online instruction due to the COVID-19 pandemic. Challenges related to the impact on academic performance and student self-efficacy when moving students from a face-to-face learning environment to an online learning environment and back again may have influenced student performance and responses to survey questions (Hadwin et al., 2022; Turner et al., 2020).

Measures. The measures used in this study were obtained from two different, previous studies. Items for metacognition and time management were obtained from MSLQ questions that had been revised to better fit a diverse group of students (Jackson, 2018). After the revision, a confirmatory factor analysis (CFA) of the items was conducted. While these questions were found to have a better score than the CFA for the original MSLQ questions, the CFA score was not a strong score. The second group of items was obtained from a study that involved a 5-year longitudinal design involving students' science identity (Robinson, 2018). While the CFA for these items was well within the acceptable range, the study did not involve participants' use of SRL strategies. Additionally, some of the items were unintentionally redundant, which could have also had an impact on the findings.

Comparison Group Task. Students in the control group were asked to conduct research and write a paper about a famous geoscientist as their weekly task. While it was not the intent, this choice of comparison group task may have impacted the study results. Because the paper writing task was closely related to geoscience content, it may have led the comparison group students to provide answers on the survey that were more closely related to competence in geoscience. Had the students been provided with a weekly task that involved rules for writing a research paper the responses might have been different.

Treatment Fidelity. The SRL activities and the scientist paper activities were part of a semester class and were counted as a weekly homework grade. Even with the activities counting as part of the course grade, some students chose not to complete the weekly assignments, while other students sporadically completed the assignments. Two instructors played more of an active role in monitoring student completion than the other instructors. The first instructor was also a high school science teacher. This instructor built multiple scaffolds into the classwork submission process, including weekly reminders. The other instructor took extra time to review the weekly student completed SRL documents and add questions and notes of encouragement such as "Look's good. Keep at it.". This instructor took extra time to add comments on all the scientist papers for the non-treatment group as well. Over time, the students started to look forward to the comments, and it appeared that the exercise helped the students build a bond with the instructor. The active monitoring of the weekly SRL and scientist paper assignments encouraged an increased level of student participation with the least number of students dropping out of the study. The attrition and completion rates help support this observation. The attrition rate for these two instructors was 82% compared to 35% for the other instructors. Not only were the students with more supportive instructors retained at higher rates, but they also had a higher completion rate of the SRL exercises. These were 70% and 48%, respectively. There were too few students to afford an analyses of other dependent measures but descriptively there was a trend favoring the student engagement among students of instructors who were more encouraging and provided more feedback.

External Validity

Factors pertaining to external validity can have a considerable impact on studies. The following factors should be noted as they could have had an impact on the results of this study.

Sample Representation. Students in the study population were recruited from the community college geoscience classes for the fall 2022 semester from the roster of students who had registered for those classes. Had the subjects been recruited from the broader population of science students or over a period of multiple semesters there may have been a more diverse sample representation leading to different study results.

Hawthorne Effect. Students involved in the study were asked to participate in the study at the beginning of the semester. Knowing that they were participating in a study involving the effects of SRL training could have influenced the way students completed the study components. Had the study components, either the weekly SRL training or the paper completion, been part of the geoscience course and not part of a study, the level of student response might have been different.

Implications for Educational Practice

Much of the previous research on the impact of incorporating SRL to enhance student performance in college courses has been conducted in four-year institutions (Bol et al., 2005; DiFrancesca et al., 2016; Wolters & Benzon, 2013). Students attending four-year institutions, in many cases, have a different educational perspective than those attending community colleges. Many community college students may choose to begin their academic journey in the two-year college environment because they are concerned about their ability to be successful at a four-year institution or have other life responsibilities (Crow-Brauer & Singer-Foust, 2020; Ye et al., 2016). While none of the findings were significant, students in this study demonstrated increases in all categories from the pre-treatment survey to the posttreatment survey. Building SRL strategies into community college science courses as a component of the courses could help increase student engagement and reach the students who need it the most.

While implementing SRL into a first- or second-year STEM course can help train students in methods that will benefit their learning, it is important to note that the student activities should have the active support of the instructor. It is important that the instructor plays an active role in monitoring the SRL activities. Reason et al. (2006) found that student gains in perceived competence are based on instructor support.

Additionally, many community college students are first generation college students (Bamberger & Smith, 2023). In a study that compared SRL characteristics in first generation college students to non-first-generation college students, it was found that there are profound differences based on parent’s educational levels (Antonelli et al., 2020). For most first-generation college students, the acquisition of SRL skills requires additional training such as the SRL training conducted during this study. However, an intervention in only one class may not be adequate to demonstrate a significant difference between those students receiving the SRL treatment and those not receiving the SRL treatment (Antonelli et al., 2020).

Implications for Future Research

While many researchers have investigated the impact of time management on undergraduate academic performance, there are currently very few studies that focus on the impact of time management in the overall success of community college students (Fosnacht et al., 2018; Shostak et al., 2021; Thibodeaux et al., 2017; Wolters et al., 2017). After reviewing the time management calendars of community college students in this study, a pattern of responsibilities that differ from traditional students began to emerge. Future research might involve conducting a qualitative study on student perceptions of their time utilizing the weekly student reflections, cross referenced with the weekly time management calendars.

This study took place in geoscience classes, where many of the students were not pursuing STEM majors (Gilbert et.al., 2012). Future research might investigate the impact of embedding SRL strategies as a course component, over a semester, in STEM courses that tend to have students who are majoring in STEM subjects.

While the short-term effects of disruptions to learning are currently being researched, the long-lasting effects are unknown (Sukhawathanakul et al., 2022; Turner et.al., 2020). Many of the students who participated in this study were juniors and seniors in high school during the COVID-19 pandemic. Researchers could replicate this study with students who were in elementary school or middle school during the pandemic to determine what impact SRL integration in an undergraduate course might have on their achievement, metacognition, time management, science identity, academic perceived competence, and science self-efficacy.

Finally, further research on the impact of SRL on community college students' academic achievement, metacognition, science self-efficacy, science identity, and academic competence in science is suggested. In the present study, the results in each of the areas were not significant and at odds with previous research, suggesting inconclusiveness. Additional research may provide a greater understanding of the impact that the SRL components have on community college students' learning.

Conclusion

In this study I investigated the impact of implementing SRL training into a semester-long geoscience course as a course component on student achievement, metacognition, time management, science identity, academic perceived competence, and science self-efficacy. While all areas demonstrated increases after instruction in SRL, those increases were not enough to be significant. The findings of this study were inconsistent with previous findings (Brady et al., 2022; Fullmer & Sperling, 2016; Wang & Kao, 2022). Future research might focus on the inconsistencies and provide a greater understanding of the role of SRL in community college students learning.

Finally, an unexpected finding was the impact that instructor involvement had on student responses and student completion of the weekly treatment and control exercises. Students who had active support from their instructors completed the exercises consistently, while those without instructor support were less consistent. Instructor support may be key to SRL and warrants further research.

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Appendix A

Motivated Strategies for Learning (MSLQ) Scales

Self-Regulated Learning

Time and study (Jackson, 2018)

16. I usually study in a place where I can concentrate on my course work.
17. I make good use of my study time for this course.
18. I have a regular place set aside for studying.
19. I make sure that I keep up with the weekly readings and assignments for this course.

Metacognition (Jackson, 2018)

20. When I become confused about something I'm reading for this class, I go back and try to figure it out.
21. If course readings are difficult to understand, I change the way I read the material.
22. Before I study new course material thoroughly, I often skim it to see how it is organized.
23. I ask myself questions to make sure I understand the material that I have been studying in this class
24. When studying for this course I try to determine which concepts I don't understand well.
25. When I study for this class, I set goals for myself in order to direct my activities in each study period.

Appendix B

Science Motivation Scales

Science Motivation

Science Identity (Robinson et al, 2018)

1. I consider myself a science person.
2. Being involved in science is a key part of who I am.
3. Being someone who is good at science is important to me.
4. Being good in science is an important part of who I am.

Academic Perceived Competence (Robinson et al, 2018)

5. I'm certain I can master the skills taught in science classes.
6. I'm certain I can figure out how to do the most difficult class work in science.
7. I can do almost all the work in science classes if I don't give up.
8. Even if the work in science is hard, I can learn it.
9. I can do even the hardest work in science if I try.

Science Self-Efficacy (Robinson et al, 2018)

I am confident that I can . . .

10. use technical science skills (tools, instruments, and/or techniques).
11. generate a research question to answer.
12. figure out what data/observations to collect and how to collect them.
13. create explanations for the results of the study.
14. use scientific literature and/or reports to guide research.
15. develop theories (integrate and coordinate results from multiple studies).

Appendix C

Demographic Information

1. My gender is

A. Male

B. Female

C. Other

2. My age is

A. 18-24

B. 25-31

C. 32-38

D. 39-45

E. 46+

3. My ethnicity is

A. Caucasian

B. African-American

C. Latino or Hispanic

D. Asian

E. Native American

F. Native Hawaiian or Pacific Islander

G. Other/Unknown

4. My current GPA is

A. 0 – 0.5

B. 0.5 – 1.0

C. 1.0 – 1.5

D. 1.5 – 2.0

E. 2.0 – 2.5

F. 2.5 – 3.0

G. 3.0 – 3.5

H. 3.5 – 4.0

5. Years in academic degree program

A. First Year

B. Second Year

6. English is my first language

A. Yes

B. No

7. The geoscience course I am taking is

A. Environmental Science

B. Oceanography

C. Historical Geology

D. Physical Geology A

E. Physical Geology B

8. My Student number is ________________.

Appendix D

Participant Information Letter

The Effects of Self-Regulated Learning on Community College Students Metacognition, Self-Efficacy, Perceived Competency and Science Identity in Geoscience Courses

Dear Science Student,

My name is Melani Loney, and I am a doctoral student in the PhD program Educational Psychology and Program Evaluation at Old Dominion University. You are invited to take part in this research study which I am conducting as a requirement of my degree.

This study will investigate the impact of self-regulated learning strategies, as a component for student success in geoscience classes. If you choose to take part in the study you will be asked to complete an online survey which will take about 15 minutes to complete at the beginning of the study and then again at the end of the semester. The 2 surveys will be accessed using a link provided by the researcher. You will also be tasked with completing a weekly assignment. All students in the class regardless of their involvement in the study will complete the weekly assignment which count as part of your grade for the course.

All information collected as part of this study will be treated confidentially and all personal identifiers will be removed. The data collected will be used for my dissertation study and may be used as a presentation, publication, or report.

There are no foreseen risks for participating in this study. If you agree to participate in the study, you will receive 10 points extra credit added to your final course grade. If you decide not to participate in this study and would like the 10 points extra credit, your professor will provide you with an alternative assignment to complete that will take about the same amount of time. Your participation in the study is voluntary. You may stop at any time if you decide you do not want to participate in the research.

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should contact Melani Loney, Student Researcher at mloney@odu.edu or Dr. John Bakki, the current chair of DCEPS HSRC at jbakki@odu.edu or call 757-683-5491.

Should you have any further questions about this research study, please contact:

Student Researcher: Melani Loney

Email: mloney@odu.edu

Phone: 757-683-7020

Dissertation Committee Chair: Dr. Linda Bol

Email: lbol@odu.edu

Phone: 757-683-4584

Sincerely,

Melani Loney

PhD Student

Old Dominion University

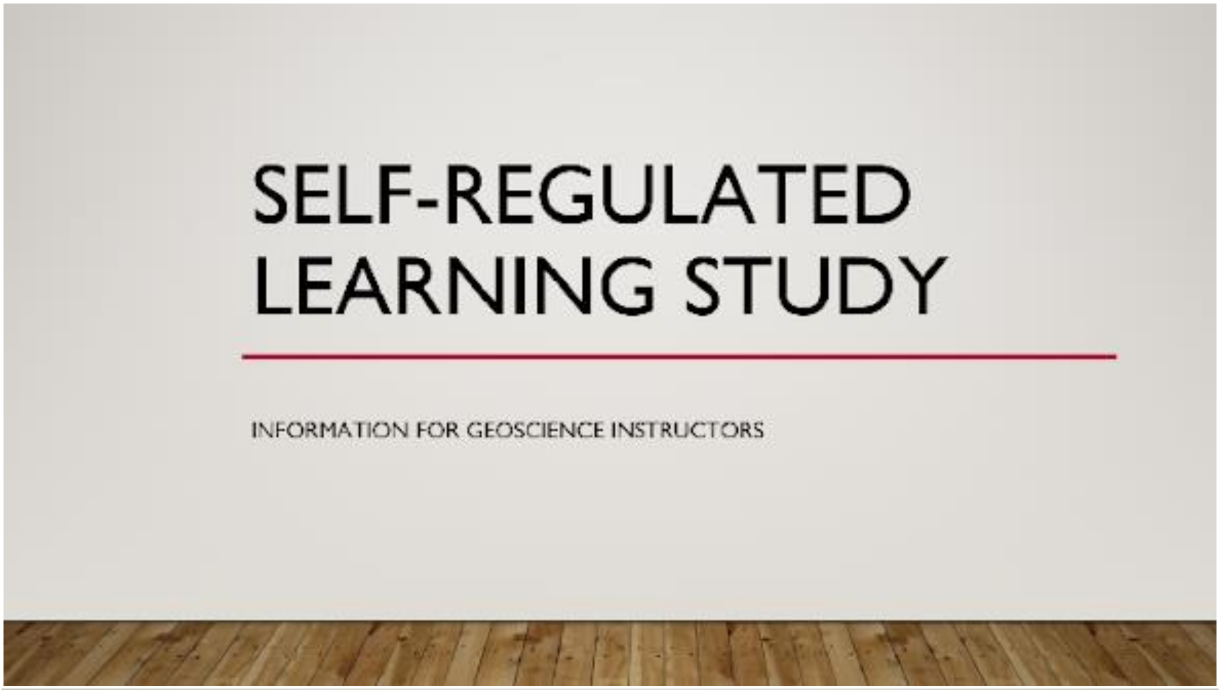
Student Signature:

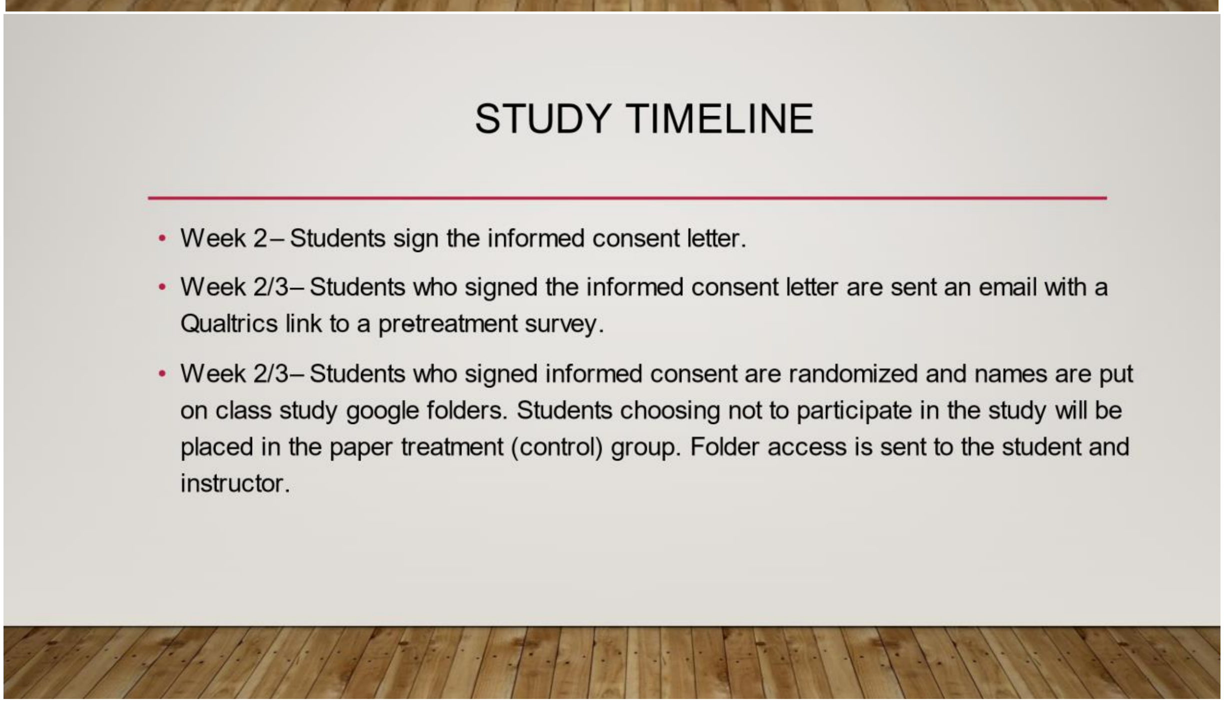
I agree to participate in the study ____

Date ______________________________

Appendix E

Instructor Directions



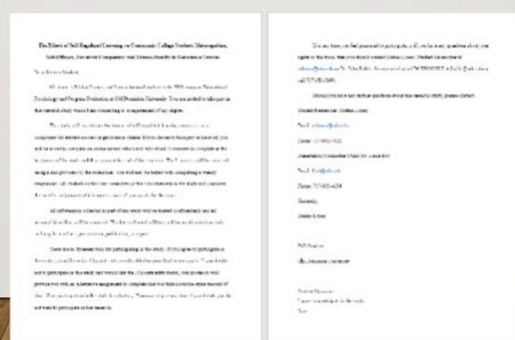


STUDY TIMELINE

- Week 4 – Study begins
- Week 13 – Last day of students completing the study components
- Week 14 – Students are sent a Qualtrics link for a post treatment survey
- Week 15/16 send researcher students final exam grades and final course grades.

THE STUDY INTRODUCTION

- During the second week of classes students will be introduced to the study by the Instructor.
- Students will sign the informed consent letter which will be housed on the Canvas site for the course.
  - Instructors load the signed documents into a google folder or send them via email to the researcher.

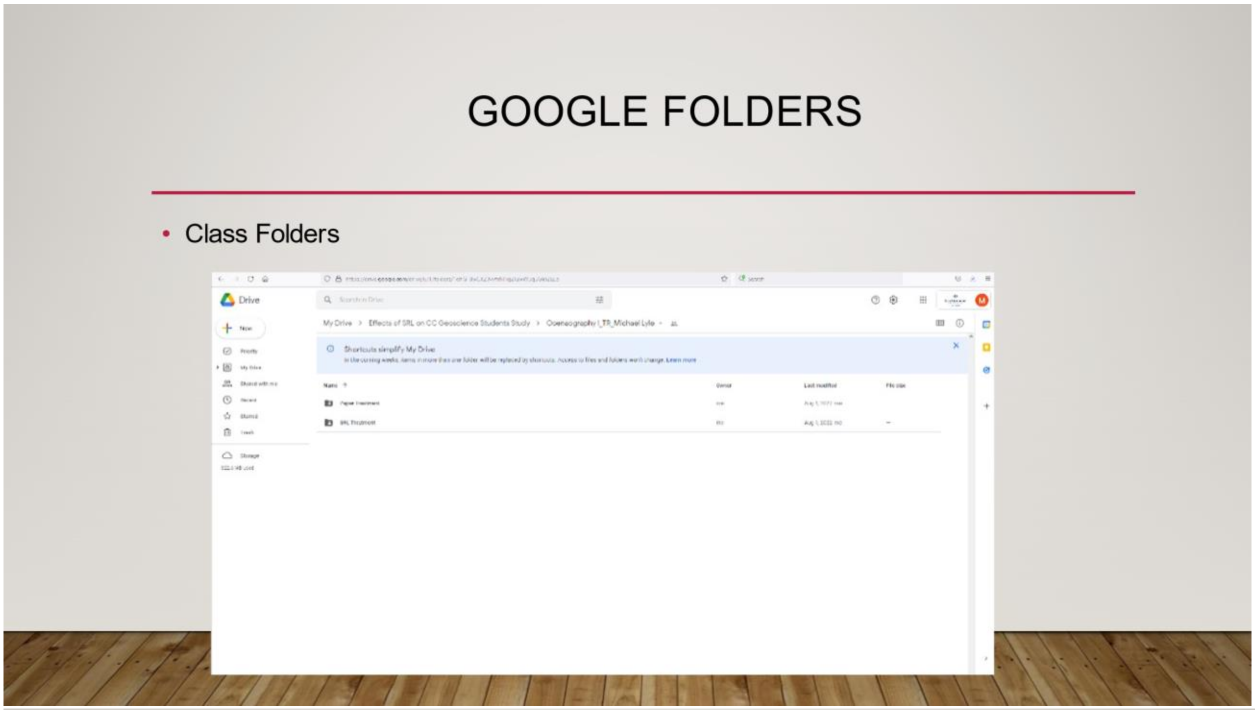


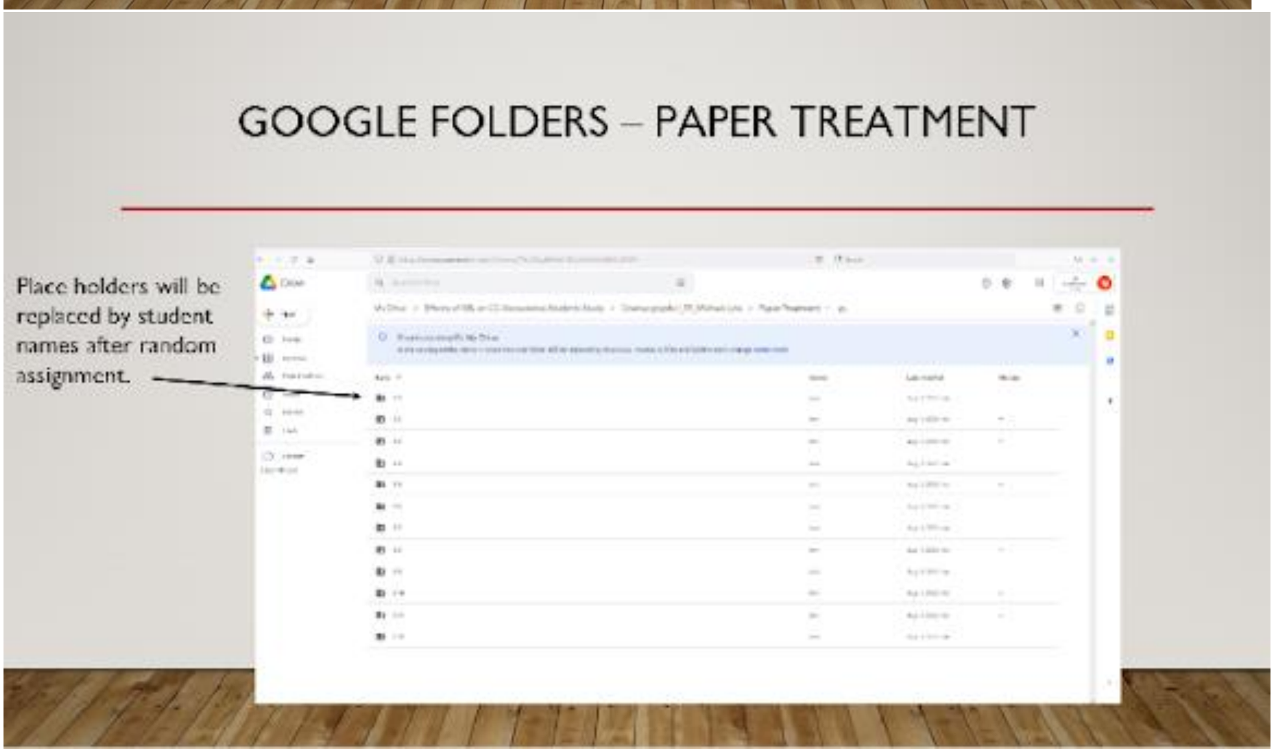
STUDENTS

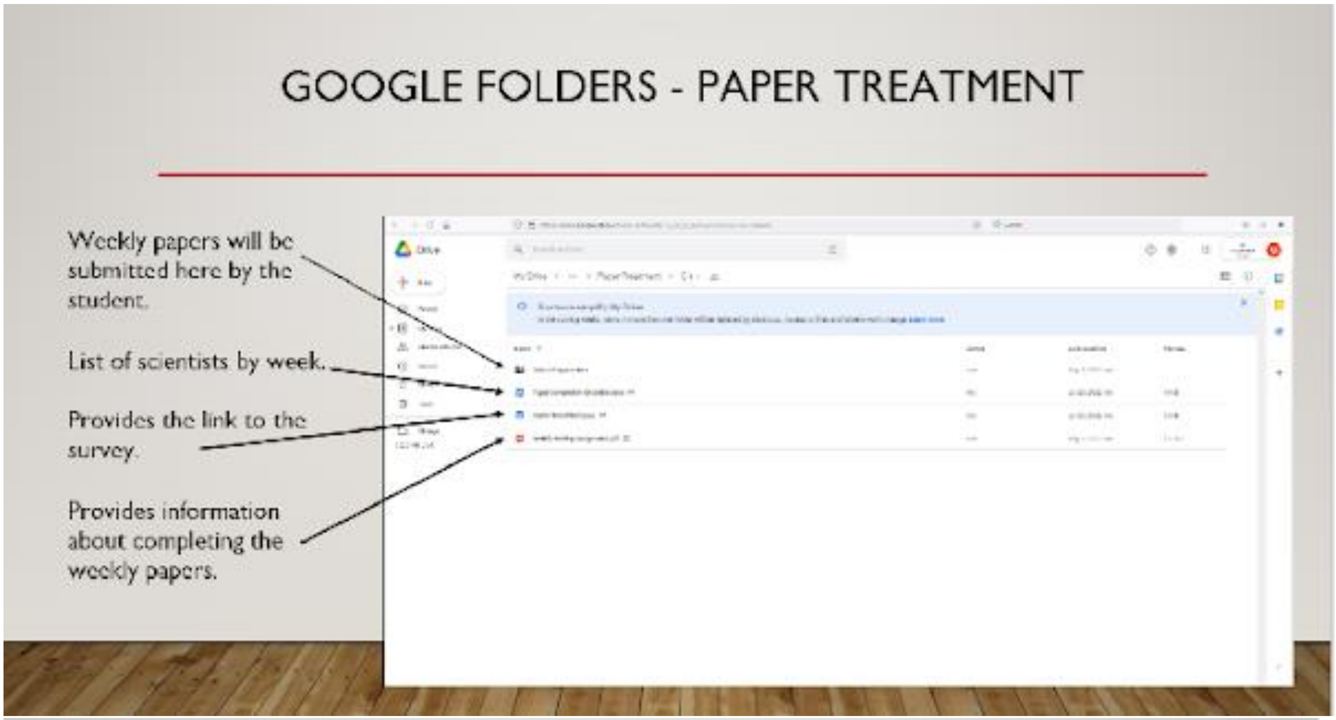
- Students who agree to be in the study in each of the classes will be randomized into two equal groups, SRL treatment and paper assignment.
- Before treatment begins students who agree to participate in the study will receive an email, containing a link, instructing them to complete a survey on ODU's Qualtrics site.
- Students who agree to participate in the study will receive 10 points added to their final grade. Please see Michael Lyle for more information.
- Students who don't agree to be in the study will complete the paper assignment.
- Weekly SRL activities and papers will receive a classwork grade.

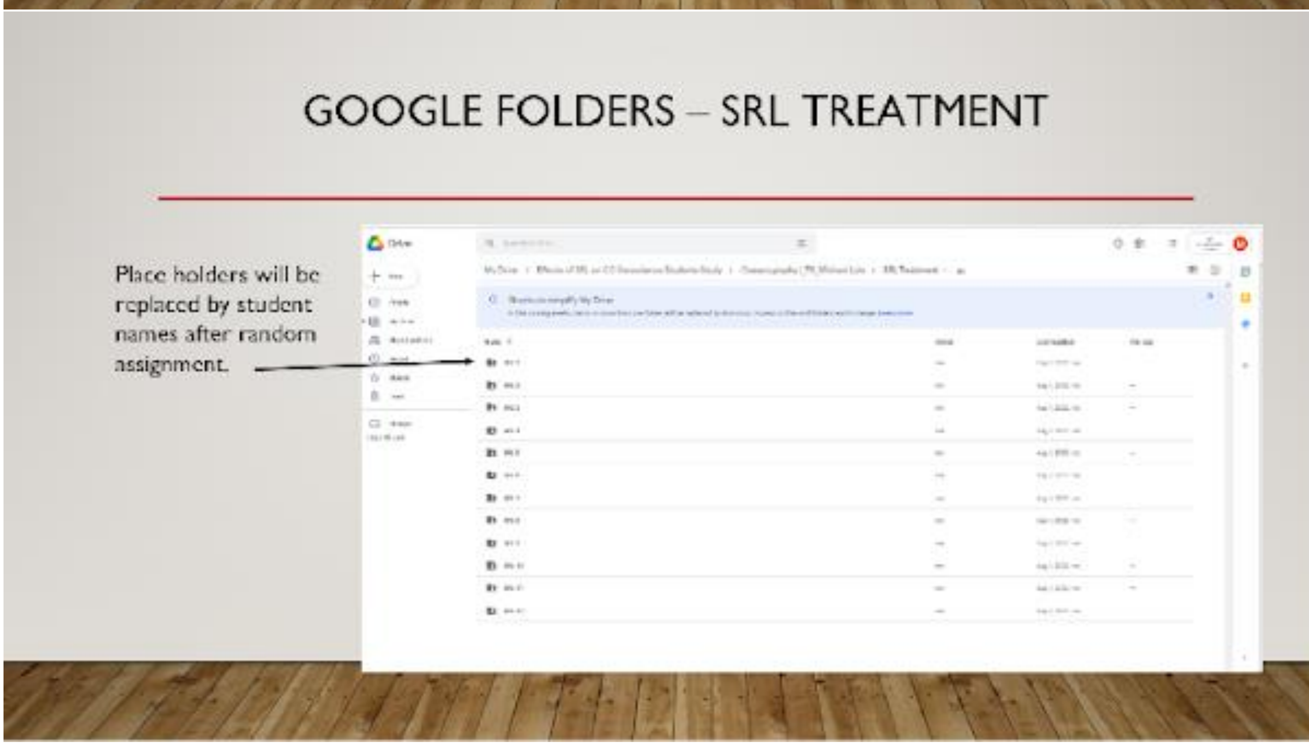
GOOGLE FOLDERS

- Instructors will receive an invitation to their class folders.
- The class folders will contain 2 groups.
- Student names will be on the folders. This is the folder where the student will submit their work.
- Each student will receive an invitation to a google folder.

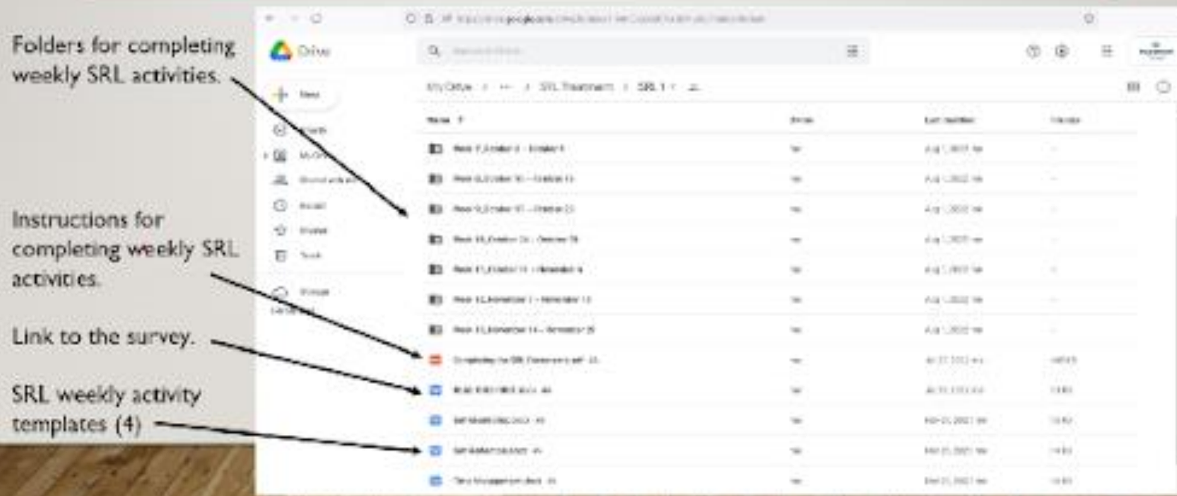

GOOGLE FOLDERS
• Class Folders


GOOGLE FOLDERS – PAPER TREATMENT
Place holders will be replaced by student names after random assignment.


GOOGLE FOLDERS - PAPER TREATMENT
Weekly papers will be submitted here by the student.
List of scientists by week.
Provides the link to the survey.
Provides information about completing the weekly papers.


GOOGLE FOLDERS – SRL TREATMENT
Place holders will be replaced by student names after random assignment.

GOOGLE FOLDERS – SRL TREATMENT



SRL TREATMENT

Student Instructions

STUDY TIMELINE

- The study starts on week 4 of the Fall Semester
- The study ends on week 13 of the Fall Semester
- The first submission will consist of the Goal Setting Document and the Time Management document on September 11, 2022 by 11:59. You may submit the documents earlier.
- The next submission will consist of the Self-Monitoring and Reflection documents on September 17 by 11:59. You may submit the documents anytime after your last class/lab for the week.

EXERCISE 1: GOAL SETTING

Week # ______

Exercise 1 - Goal Setting

Goals are accomplishments you want to reach. You may set goals so that you know that you know your purpose and motivation for undertaking a specific activity. Some goals are long-term while others are more immediate or short-term goals.

Instructions: Complete parts 1 and 2 of this assignment, save it to your files, and submit a copy to Canvas by 11:59 on Sunday at the beginning of each week. At the end of the week revisit your goals and indicate if you met the goal and if not why.

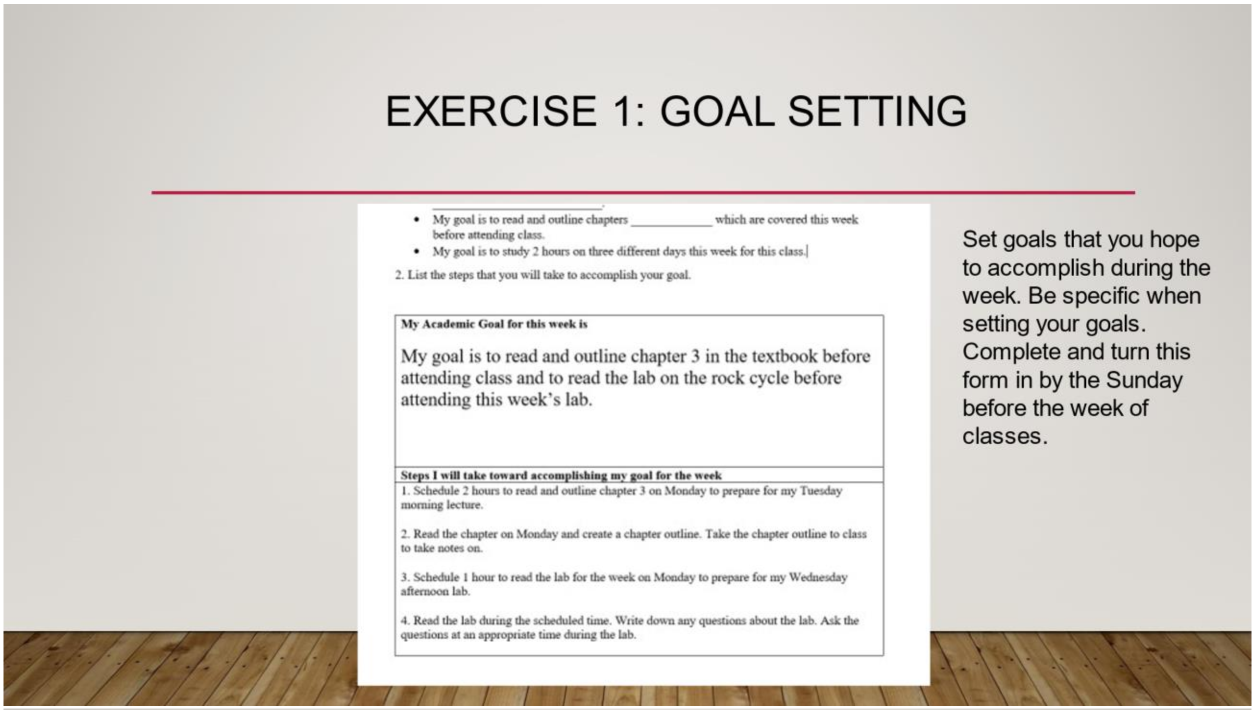
1. To begin this exercise set one academic goal for the week for this course. Some examples of goals might include:

- My goal is to understand ________________ topic by ________________.
- My goal is to read and outline chapters ____________ which are covered this week before attending class.
- My goal is to study 2 hours on three different days this week for this class.

2. List the steps that you will take to accomplish your goal.

My Academic Goal for this week is
Steps I will take toward accomplishing my goal for the week
1. 2. 3. 4.

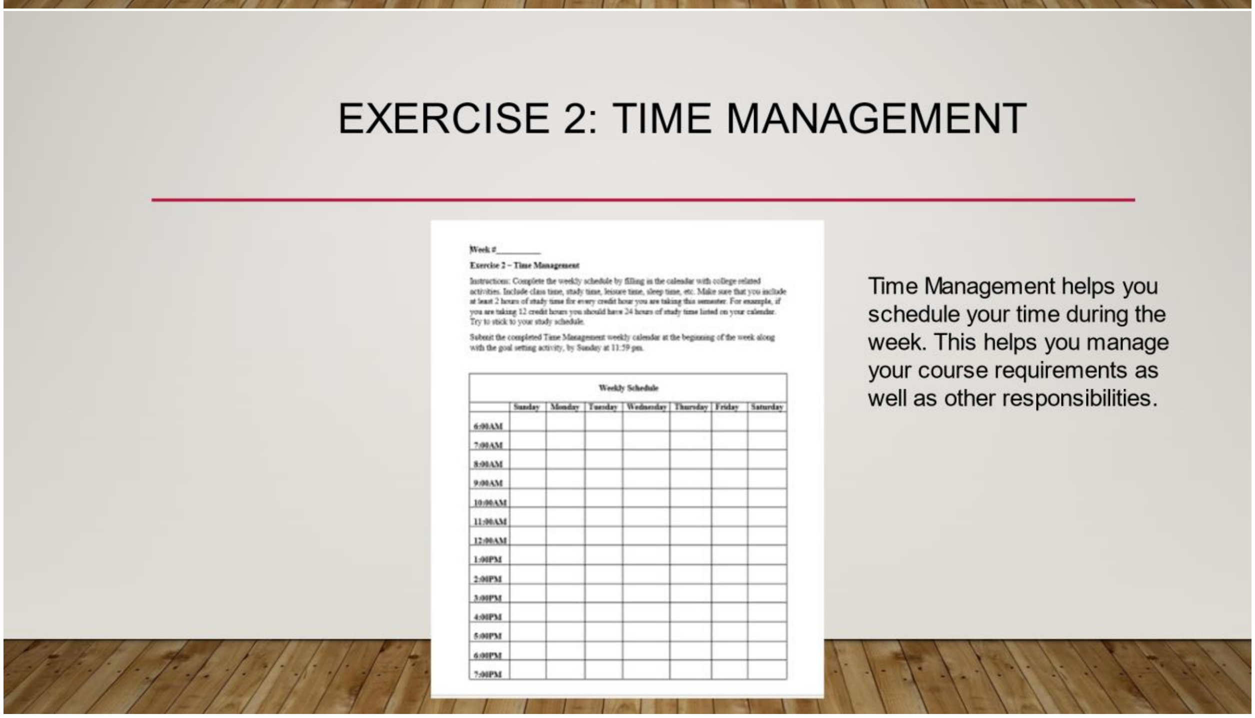
Goal setting involvesmaking a planfor what you hope to accomplish during the week. This form will help you set your weekly goals and then will provide a method for accomplishing those goals.



- My goal is to read and outline chapters ____________ which are covered this week before attending class.
- My goal is to study 2 hours on three different days this week for this class.

2. List the steps that you will take to accomplish your goal.

My Academic Goal for this week is
My goal is to read and outline chapter 3 in the textbook before attending class and to read the lab on the rock cycle before attending this week's lab.
Steps I will take toward accomplishing my goal for the week
1. Schedule 2 hours to read and outline chapter 3 on Monday to prepare for my Tuesday morning lecture. 2. Read the chapter on Monday and create a chapter outline. Take the chapter outline to class to take notes on. 3. Schedule 1 hour to read the lab for the week on Monday to prepare for my Wednesday afternoon lab. 4. Read the lab during the scheduled time. Write down any questions about the lab. Ask the questions at an appropriate time during the lab.



Week #__________

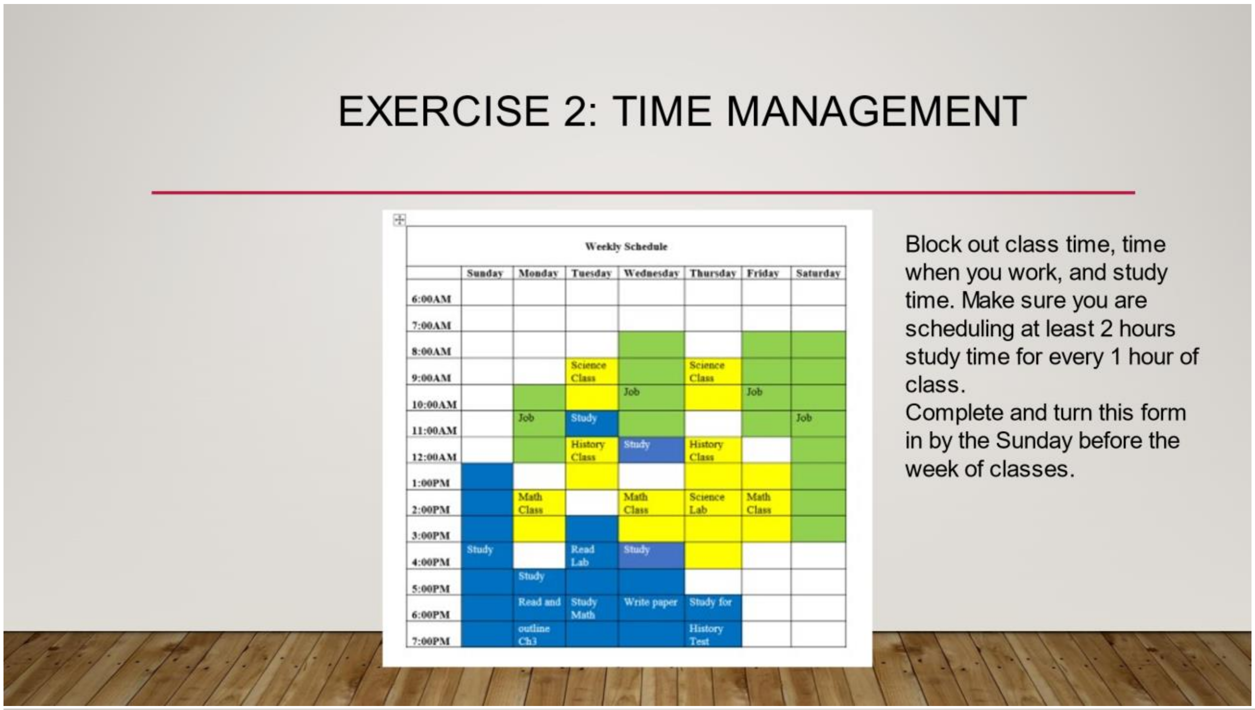
Exercise 2 – Time Management

Instructions: Complete the weekly schedule by filling in the calendar with college related activities. Include class time, study time, leisure time, sleep time, etc. Make sure that you include at least 2 hours of study time for every credit hour you are taking this semester. For example, if you are taking 12 credit hours you should have 24 hours of study time listed on your calendar. Try to stick to your study schedule.

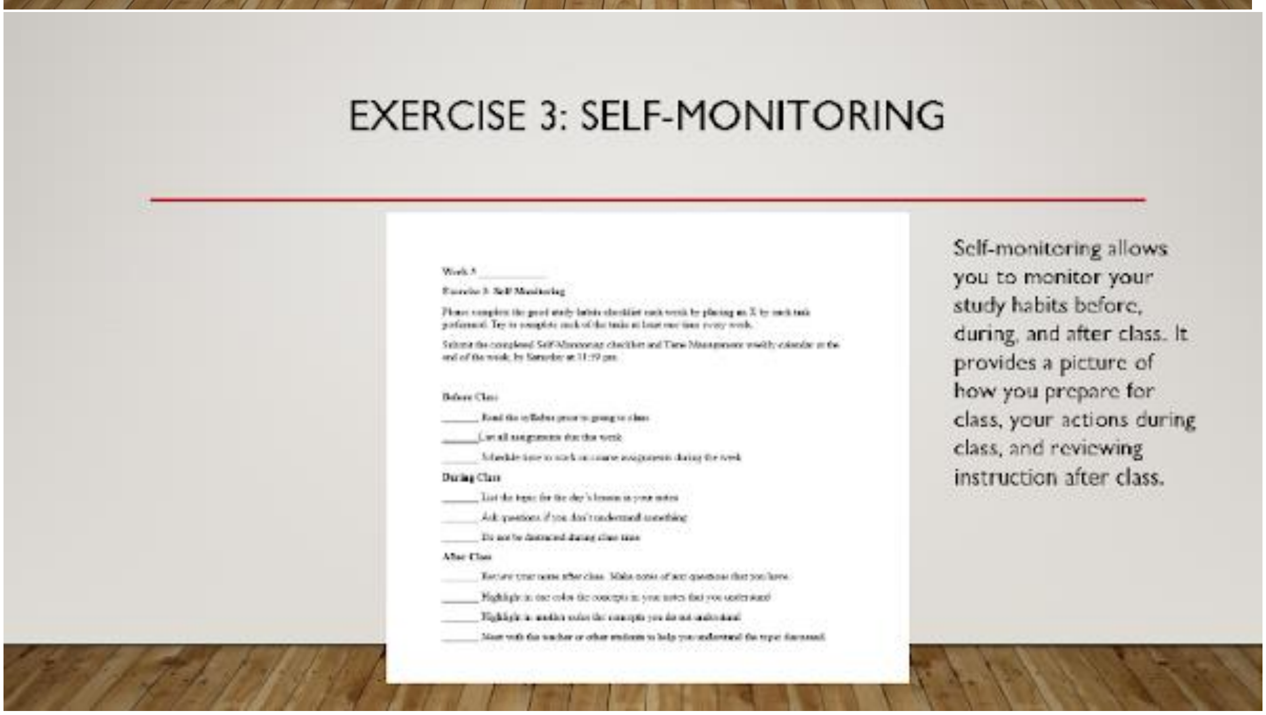
Submit the completed Time Management weekly calendar at the beginning of the week along with the goal setting activity, by Sunday at 11:59 pm.

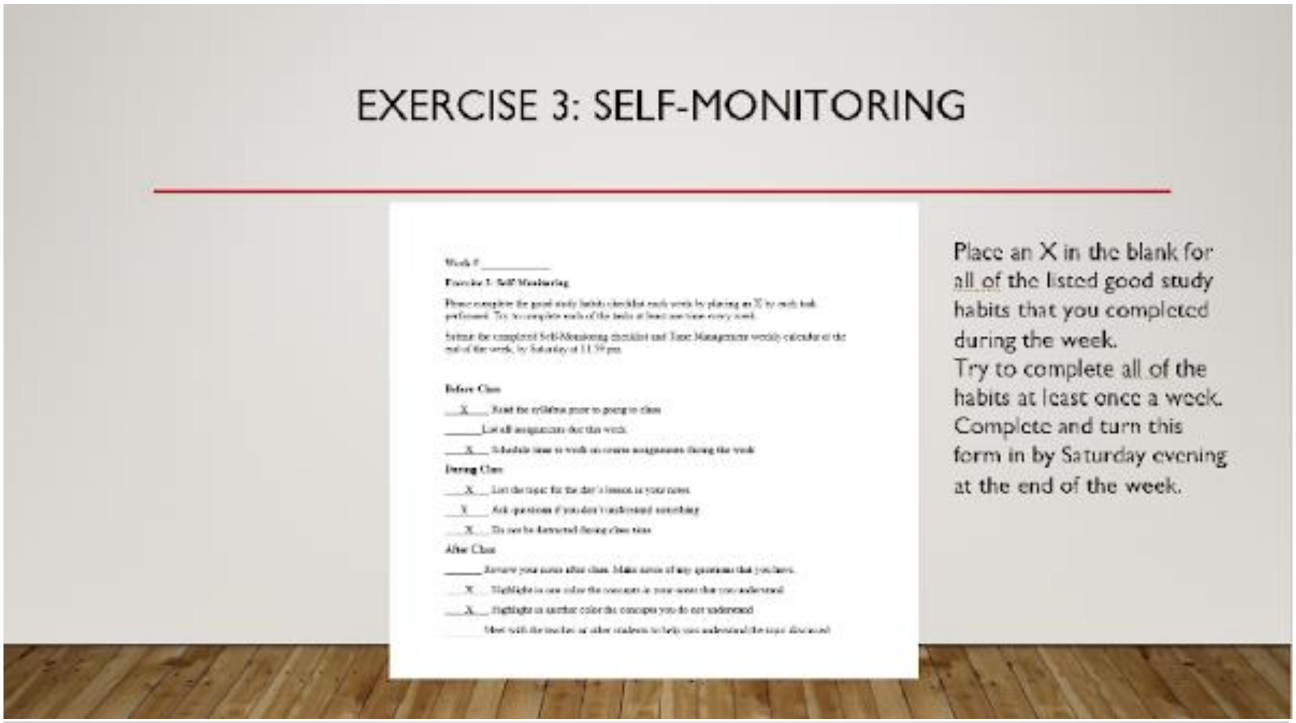
Weekly Schedule

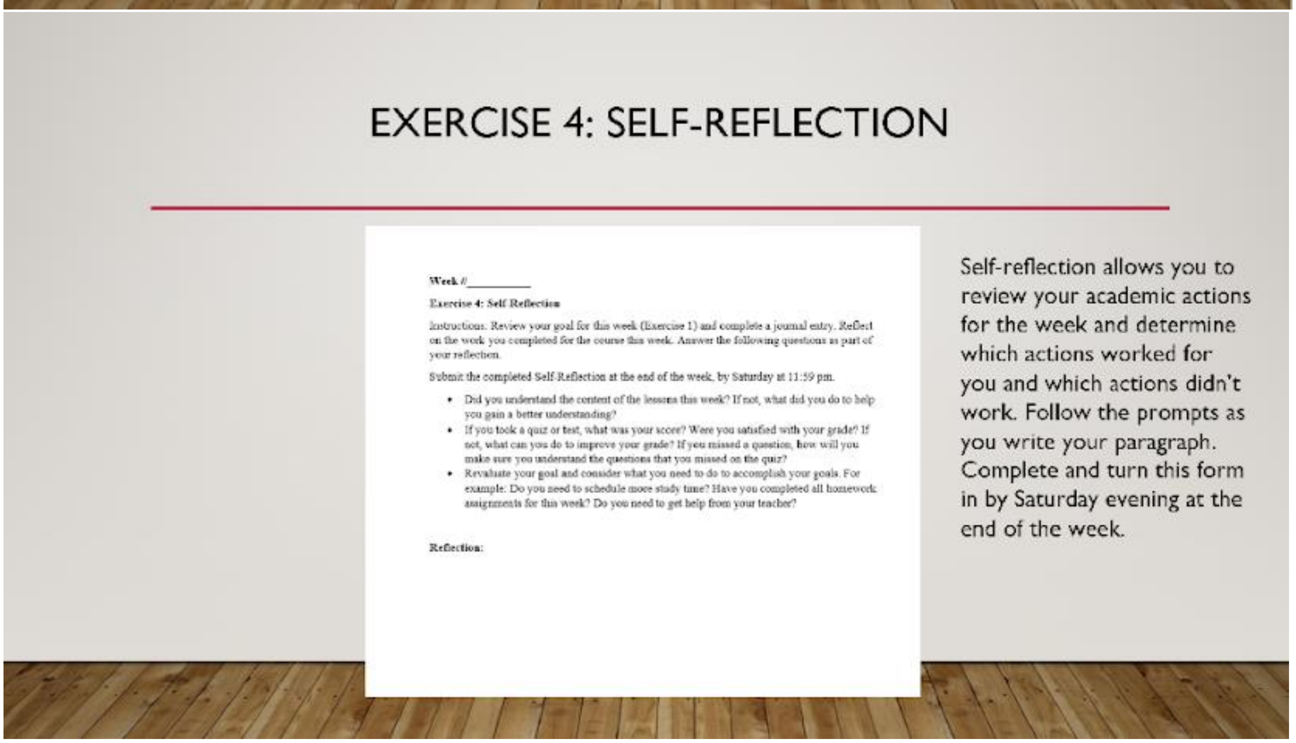
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
6:00AM							
7:00AM							
8:00AM							
9:00AM							
10:00AM							
11:00AM							
12:00AM							
1:00PM							
2:00PM							
3:00PM							
4:00PM							
5:00PM							
6:00PM							
7:00PM							



	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
6:00AM							
7:00AM							
8:00AM							
9:00AM			Science Class		Science Class		
10:00AM				Job		Job	
11:00AM		Job	Study				Job
12:00AM			History Class	Study	History Class		
1:00PM							
2:00PM		Math Class		Math Class	Science Lab	Math Class	
3:00PM							
4:00PM	Study		Read Lab	Study			
5:00PM		Study					
6:00PM		Read and	Study Math	Write paper	Study for		
7:00PM		outline Ch3			History Test		




EXERCISE 3: SELF-MONITORING
Before Class
During Class
After Class
Place an X in the blank for all of the listed good study habits that you completed during the week.
Try to complete all of the habits at least once a week.
Complete and turn this form in by Saturday evening at the end of the week.


EXERCISE 4: SELF-REFLECTION
Week #___________
Exercise 4: Self Reflection
Instructions: Review your goal for this week (Exercise 1) and complete a journal entry. Reflect on the work you completed for the course this week. Answer the following questions as part of your reflection.
Submit the completed Self-Reflection at the end of the week, by Saturday at 11:59 pm.
• Did you understand the content of the lessons this week? If not, what did you do to help you gain a better understanding?
• If you took a quiz or test, what was your score? Were you satisfied with your grade? If not, what can you do to improve your grade? If you missed a question, how will you make sure you understand the questions that you missed on the quiz?
• Revaluate your goal and consider what you need to do to accomplish your goals. For example: Do you need to schedule more study time? Have you completed all homework assignments for this week? Do you need to get help from your teacher?
Reflection:
Self-reflection allows you to review your academic actions for the week and determine which actions worked for you and which actions didn't work. Follow the prompts as you write your paragraph. Complete and turn this form in by Saturday evening at the end of the week.

GOOGLE DRIVE

- Shared with you and your Instructor
- Submit your completed documents in the folder for the week

TIMELINE FOR SUBMITTING DOCUMENTS IN WEEKLY FOLDERS

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Turn in Goal Setting Exercise (1) and Time Management Exercise (2)						Turn in Self-Monitoring Exercise (3) and Self Reflection Exercise (4)

QUESTIONS

Contact Melani Loney at mloney@odu.edu

PAPER TREATMENT

Student Instructions

DIRECTIONS

- Write a 1-to-2-page paper (double spaced, 12pt Arial font) each week about a geoscientist
- Geoscientist name will be provided for each week
- Follow the protocol provided for the paper elements on the next slide
- Papers are due on Sunday night of each week by 11:59 pm

PAPER COMPONENTS

- The paper must have an introduction, main body, conclusion, and references cited section.
- Elements include:
  - Scientist Name
  - Time/era scientist lived
  - Research interest and discovery
  - Contribution to science and how it enhanced our understanding of the natural world
  - Use scientific writing and GSA formatting style (preferred)
    - https://libguides.com.edu/c.php?g=649323&p=4554176 (General Information)
    - https://libguides.com.edu/gsa/GSARefrence (Reference List)
    - https://libguides.com.edu/c.php?g=649323&p=4554176 (In-Text Citations)

SCIENTIST AND DUE DATES

Name	Date Due	Due by Time
Eratosthenes	September 11,2022	11:59 pm
Nicholas Steno	September 18,2022	11:59 pm
Nicholas Copernicus	September 25,2022	11:59 pm
James Dwight Dana	October 2, 2022	11:59 pm
Mary Anning	October 9, 2022	11:59 pm
Charles Lyell	October 16, 2022	11:59 pm

SCIENTISTS AND DUE DATES CONTINUED

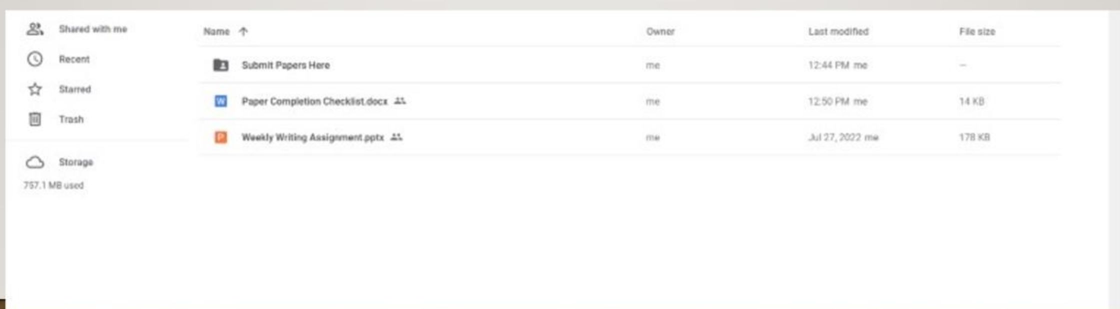
Name	Due Date	Due by Time
Matthew Fontaine Maury	October 30,2022	11:59 pm
Harry Hess	November 6, 2022	11:59 pm
Marie Tharp	November 13,2022	11:59 pm
Maurice Ewing	November 20,2022	11:59 pm

PAPER SUBMISSION INSTRUCTIONS

- Submit the final paper in the folder titled “submit papers here” in your google folder.
- List the scientistname and due date as the google document name.

GOOGLE FOLDER

- Shared with you and your Instructor
- Submit your weekly papers in the “Submit Papers Here” folder



PAPER COMPLETION CHECKLIST

Use the checklist in your google folder to track your paper submissions.

Scientist Paper Completion Checklist

Fall 2022

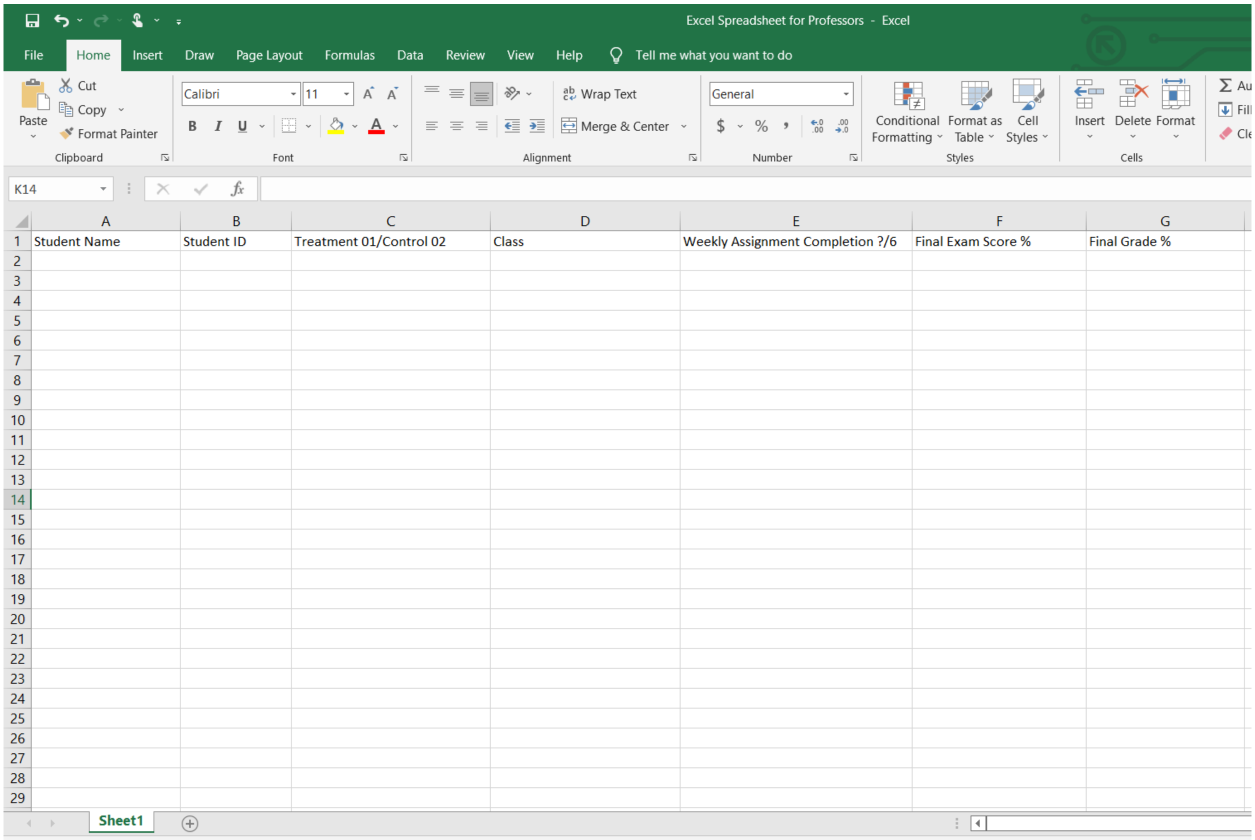
Scientist	Date Due	Submitted
Eratosthenes	September 11	
Nicholas Steno	September 18	
Nicholas Copernicus	September 25	
James Dwight Dana	October 2	
Mary Anning	October 9	
Charles Lyell	October 16	
Matthew Fontaine Maury	October 23	
James Hutton	October 30	
Harry Hess	November 6	
Marie Tharp	November 13	
Maurice Ewing	November 20	

QUESTIONS

Contact Melani Loney at mloney@odu.edu

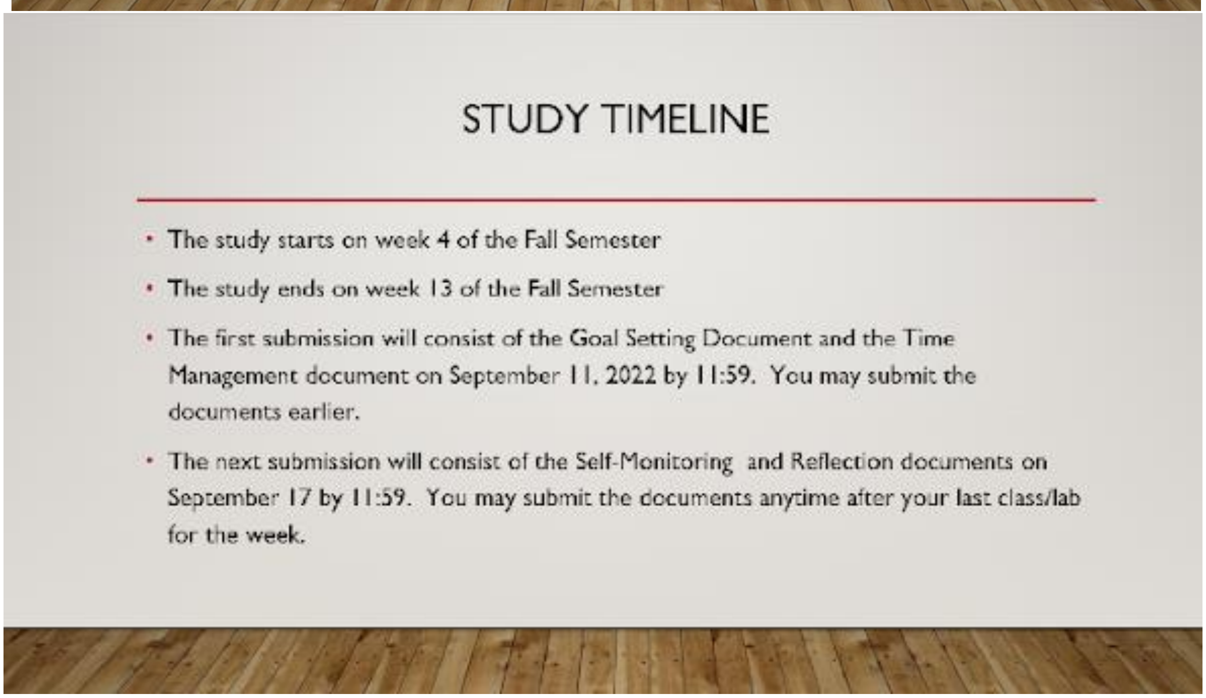
Appendix F

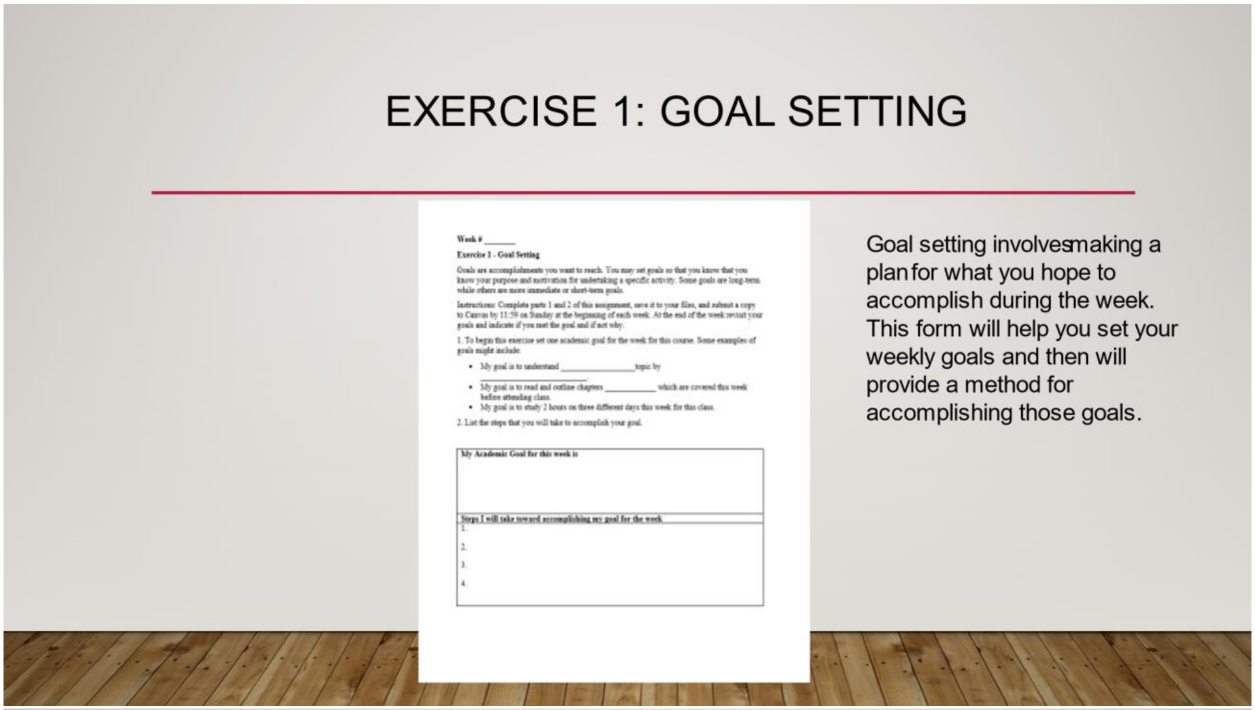
Instructor Excel Spreadsheet

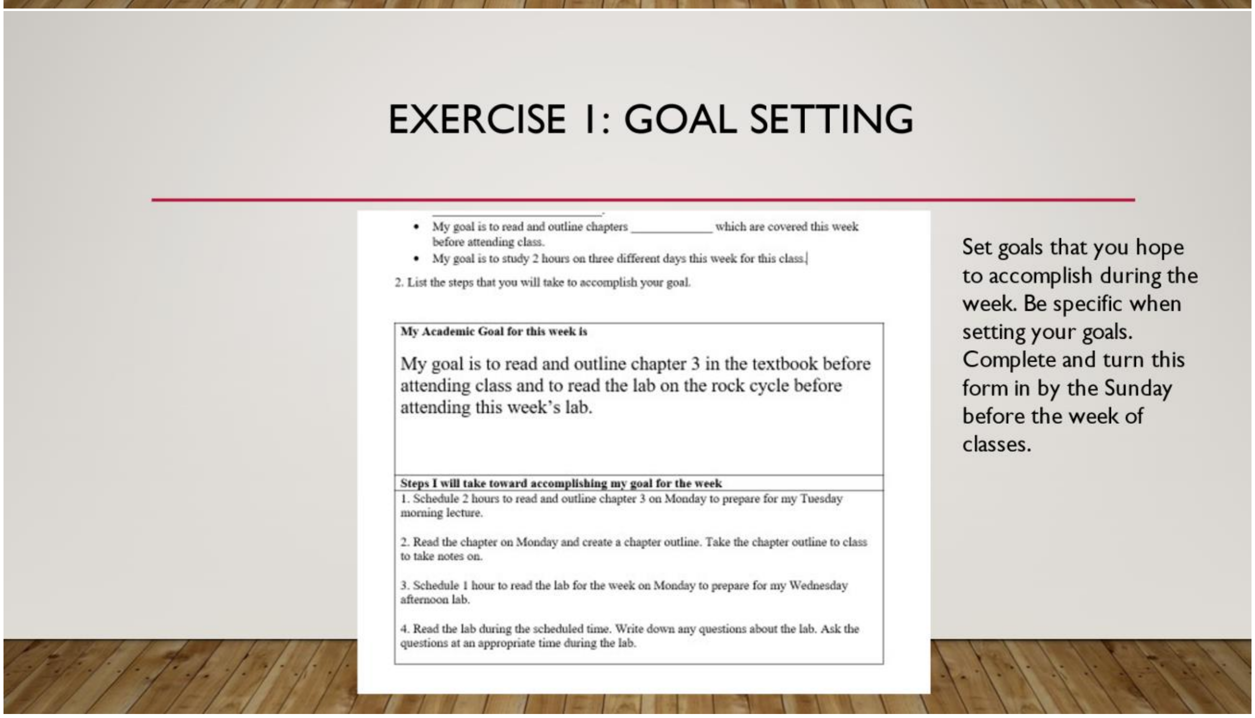


Appendix G

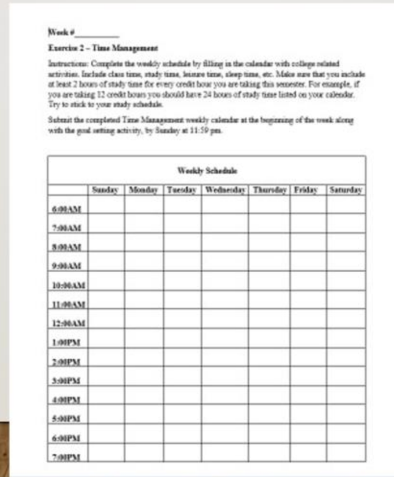
SRL Treatment Student Instructions




EXERCISE 1: GOAL SETTING
Week # ______
Exercise 1 - Goal Setting
Goals are accomplishments you want to reach. You may set goals so that you know that you know your purpose and motivation for undertaking a specific activity. Some goals are long-term while others are more immediate or short-term goals.
Instructions: Complete parts 1 and 2 of this assignment, save it to your files, and submit a copy to Canvas by 11:59 on Sunday at the beginning of each week. At the end of the week revisit your goals and indicate if you met the goal and if not why.
1. To begin this exercise set one academic goal for the week for this course. Some examples of goals might include:
• My goal is to understand ________________ topic by ________________.
• My goal is to read and outline chapters ___________ which are covered this week before attending class.
• My goal is to study 2 hours on three different days this week for this class.
2. List the steps that you will take to accomplish your goal.
My Academic Goal for this week is
Steps I will take toward accomplishing my goal for the week
1.
2.
3.
4.
Goal setting involvesmaking a planfor what you hope to accomplish during the week. This form will help you set your weekly goals and then will provide a method for accomplishing those goals.


EXERCISE 1: GOAL SETTING
• My goal is to read and outline chapters ____________ which are covered this week before attending class.
• My goal is to study 2 hours on three different days this week for this class.
2. List the steps that you will take to accomplish your goal.
My Academic Goal for this week is
My goal is to read and outline chapter 3 in the textbook before attending class and to read the lab on the rock cycle before attending this week's lab.
Steps I will take toward accomplishing my goal for the week
1. Schedule 2 hours to read and outline chapter 3 on Monday to prepare for my Tuesday morning lecture.
2. Read the chapter on Monday and create a chapter outline. Take the chapter outline to class to take notes on.
3. Schedule 1 hour to read the lab for the week on Monday to prepare for my Wednesday afternoon lab.
4. Read the lab during the scheduled time. Write down any questions about the lab. Ask the questions at an appropriate time during the lab.
Set goals that you hope to accomplish during the week. Be specific when setting your goals. Complete and turn this form in by the Sunday before the week of classes.

EXERCISE 2: TIME MANAGEMENT



Week #__________

Exercise 2 – Time Management

Instructions: Complete the weekly schedule by filling in the calendar with college related activities. Include class time, study time, leisure time, sleep time, etc. Make sure that you include at least 2 hours of study time for every credit hour you are taking this semester. For example, if you are taking 12 credit hours you should have 24 hours of study time listed on your calendar. Try to stick to your study schedule.

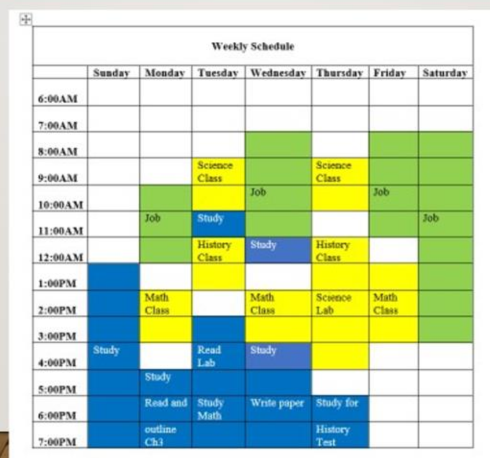
Submit the completed Time Management weekly calendar at the beginning of the week along with the goal setting activity, by Sunday at 11:59 pm.

Weekly Schedule

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
6:00AM							
7:00AM							
8:00AM							
9:00AM							
10:00AM							
11:00AM							
12:00AM							
1:00PM							
2:00PM							
3:00PM							
4:00PM							
5:00PM							
6:00PM							
7:00PM							

Time Management helps you schedule your time during the week. This helps you manage your course requirements as well as other responsibilities.

EXERCISE 2: TIME MANAGEMENT

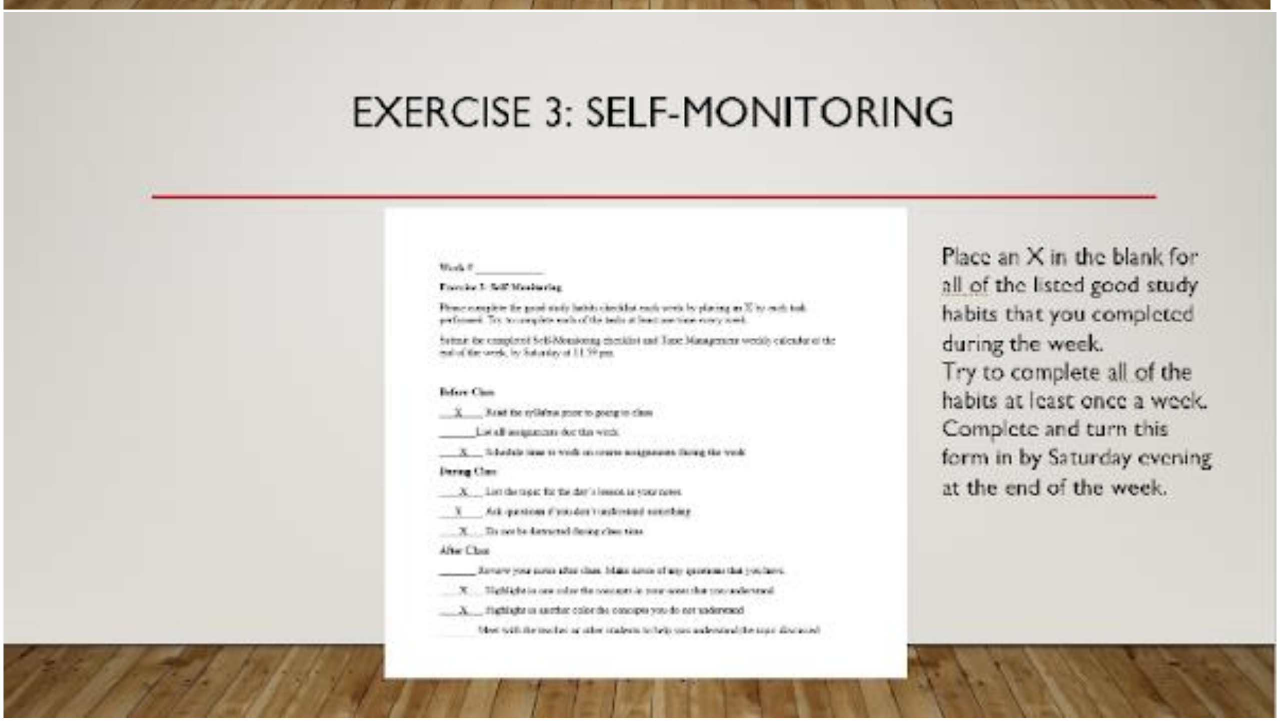


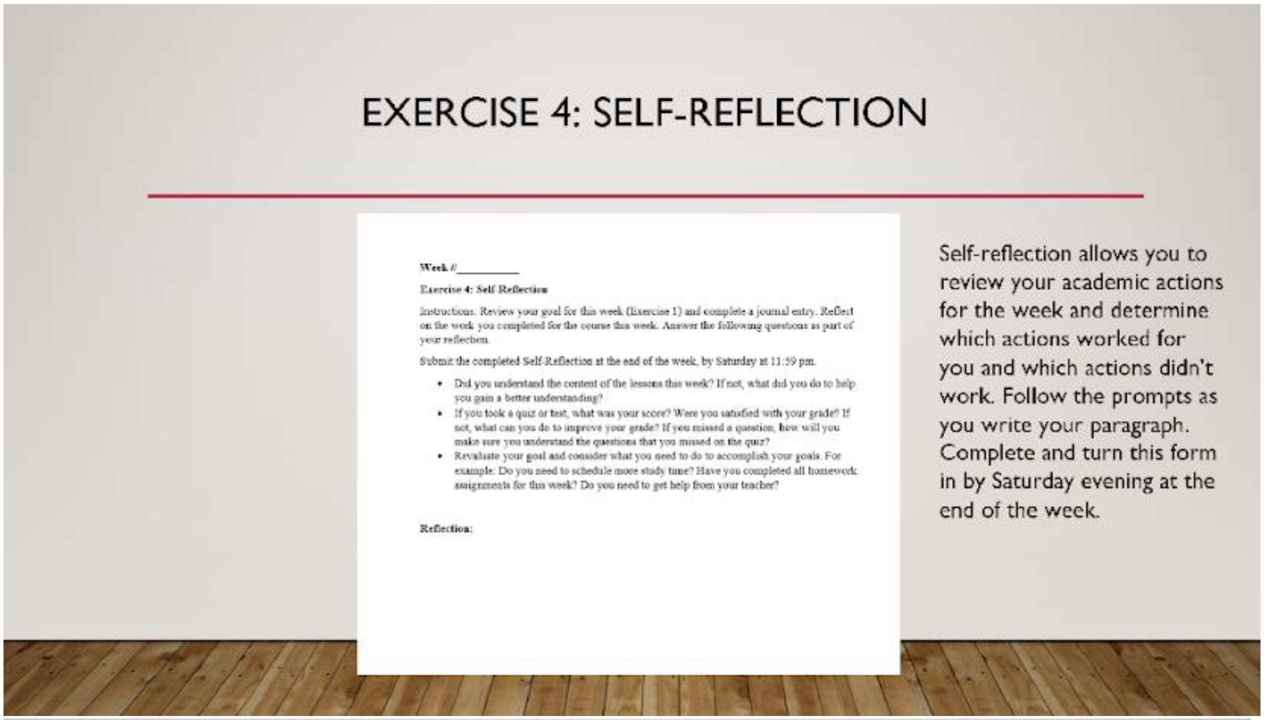
Weekly Schedule

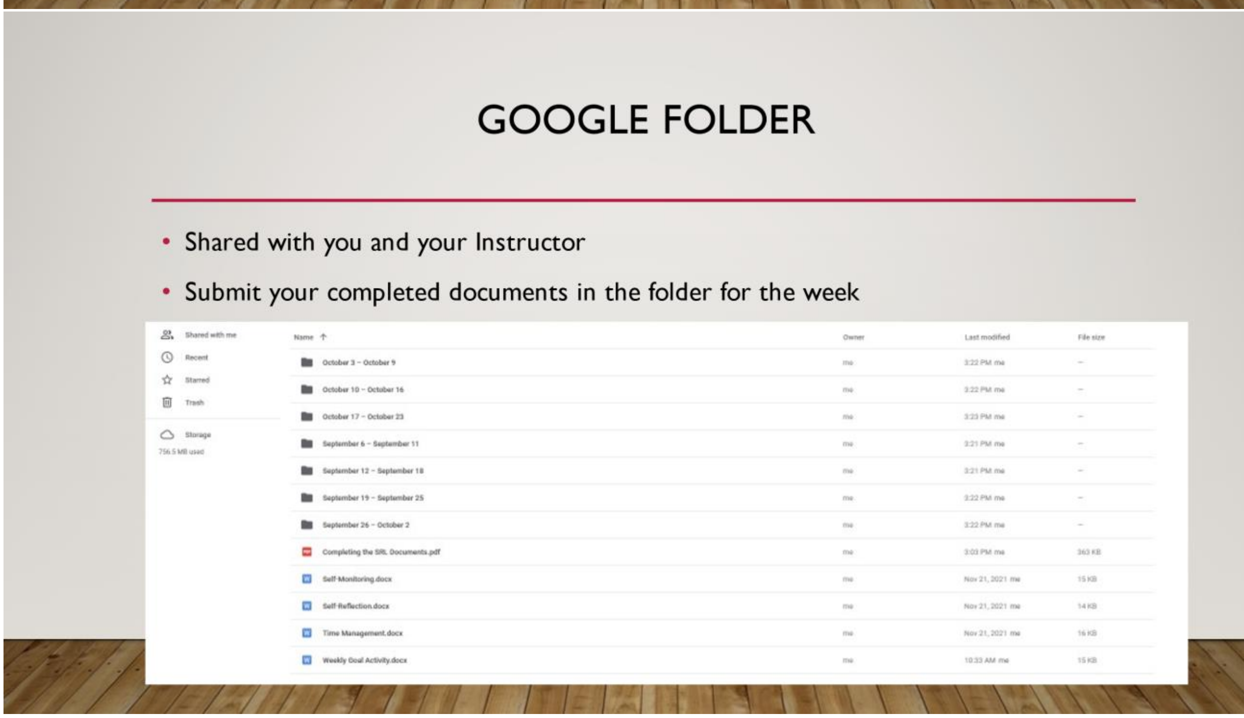
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
6:00AM							
7:00AM							
8:00AM							
9:00AM			Science Class		Science Class		
10:00AM				Job		Job	
11:00AM		Job	Study				Job
12:00AM			History Class	Study	History Class		
1:00PM							
2:00PM		Math Class		Math Class	Science Lab	Math Class	
3:00PM							
4:00PM	Study		Read Lab	Study			
5:00PM		Study					
6:00PM		Read and	Study Math	Write paper	Study for		
7:00PM		outline Ch3			History Test		

Block out class time, time when you work, and study time. Make sure you are scheduling at least 2 hours study time for every 1 hour of class.
Complete and turn this form in by the Sunday before the week of classes.


EXERCISE 3: SELF-MONITORING
Self-monitoring allows you to monitor your study habits before, during, and after class. It provides a picture of how you prepare for class, your actions during class, and reviewing instruction after class.


EXERCISE 3: SELF-MONITORING
Place an X in the blank for all of the listed good study habits that you completed during the week.
Try to complete all of the habits at least once a week.
Complete and turn this form in by Saturday evening at the end of the week.


EXERCISE 4: SELF-REFLECTION
Week #__________
Exercise 4: Self Reflection
Instructions: Review your goal for this week (Exercise 1) and complete a journal entry. Reflect on the work you completed for the course this week. Answer the following questions as part of your reflection.
Submit the completed Self-Reflection at the end of the week, by Saturday at 11:59 pm.
• Did you understand the content of the lessons this week? If not, what did you do to help you gain a better understanding?
• If you took a quiz or test, what was your score? Were you satisfied with your grade? If not, what can you do to improve your grade? If you missed a question, how will you make sure you understand the questions that you missed on the quiz?
• Revaluate your goal and consider what you need to do to accomplish your goals. For example: Do you need to schedule more study time? Have you completed all homework assignments for this week? Do you need to get help from your teacher?
Reflection:
Self-reflection allows you to review your academic actions for the week and determine which actions worked for you and which actions didn't work. Follow the prompts as you write your paragraph. Complete and turn this form in by Saturday evening at the end of the week.


GOOGLE FOLDER
• Shared with you and your Instructor
• Submit your completed documents in the folder for the week
Shared with me
Recent
Starred
Trash
Storage
756.5 MB used
Name
Owner
Last modified
File size
October 3 – October 9
October 10 – October 16
October 17 – October 23
September 6 – September 11
September 12 – September 18
September 19 – September 25
September 26 – October 2
Completing the SRL Documents.pdf
Self-Monitoring.docx
Self-Reflection.docx
Time Management.docx
Weekly Goal Activity.docx

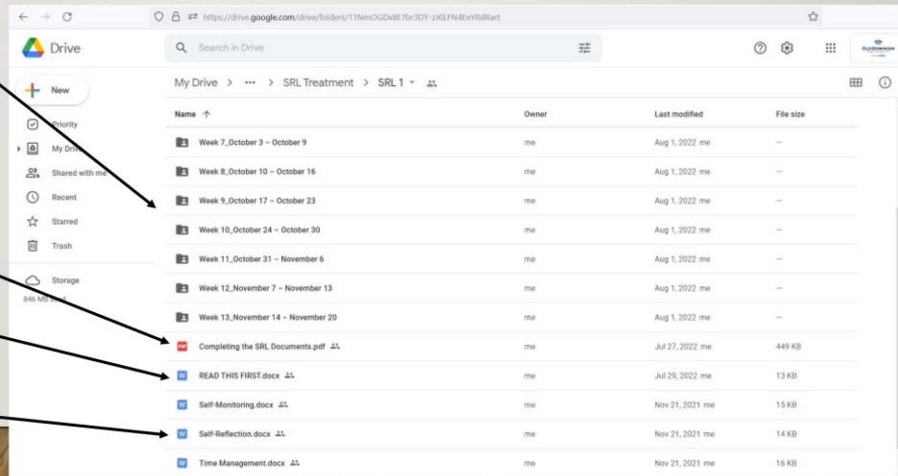
GOOGLE FOLDER

Folders for completing weekly SRL activities.

Instructions for completing weekly SRL activities.

Link to the survey.

SRL weekly activity templates (4)



QUESTIONS

Contact Melani Loney at mloney@odu.edu

Appendix H

Self-Regulated Learning Weekly Exercises (Treatment Group)

The following strategies were modified from a study conducted by Karen Campbell (2013).

Exercise 1 - Weekly Goals

Week # ________

Goals are accomplishments you want to reach. You may set goals so that you know that you know your purpose and motivation for undertaking a specific activity. Some goals are long-term while others are more immediate or short-term goals.

Instructions: Complete parts 1 and 2 of this assignment, save it to your files, and submit a copy to Canvas by 11:59 on Sunday at the beginning of each week. At the end of the week revisit your goals and indicate if you met the goal and if not why.

1. To begin this exercise set one academic goal for the week for this course. Some examples of goals might include:

A. My goal is to understand ____________________topic by ____________________________.

B. My goal is to read and outline chapters ______________ which are covered this week before attending class.

C. My goal is to study 2 hours on three different days this week for this class.

2. List the steps that you will take to accomplish your goal.

My Academic Goal for this week is

Steps I will take toward accomplishing my goal for the week

1.

2.

3.

4.

Exercise 2 – Time Management

Week # ________

Instructions: Complete the weekly schedule by filling in the calendar with college related activities. Include class time, study time, leisure time, sleep time, etc. Make sure that you include at least 2 hours of study time for every credit hour you are taking this semester. For example, if you are taking 12 credit hours you should have 24 hours of study time listed on your calendar. Try to stick to your study schedule.

Submit the completed Time Management weekly calendar at the beginning of the week, by Sunday at 11:59 pm.

Weekly Schedule							
	Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
6:00AM							
7:00AM							
8:00AM							
9:00AM							
10:00AM							
11:00AM							
12:00AM							
1:00PM							
2:00PM							
3:00PM							
4:00PM							
5:00PM							
6:00PM							
7:00PM							
8:00PM							

9:00PM							
10:00PM							
11:00PM							
12:00PM							

Exercise 3- Self-Monitoring

Week # _____________

Good study habits before, during and after class prepare students for success in a course by providing information about class topics, active participation during class and an opportunity to review content taught during class.

Please complete the good study habits checklist each week by placing an X by each task performed. Try to complete each of the tasks at least one time every week.

Submit the self-monitoring exercise to Canvas by 11:59 on Saturday night at the end of the week.

Before Class

_______ Read the syllabus prior to going to class

_______List all assignments due this week

_______ Schedule time to work on course assignments during the week

During Class

_______ List the topic for the day's lesson in your notes

_______ Ask questions if you don't understand something

_______ Do not be distracted during class time

After Class

_______ Review your notes after class. Make notes of any questions that you have.

_______ Highlight in one color the concepts in your notes that you understand

_______ Highlight in another color the concepts you do not understand

_______ Meet with the teacher or other students to help you understand the topic discussed.

Exercise 4 - Self-Reflection

Week #___________

Instructions: Review your goal for this week and complete a journal entry. Reflect on the work you completed for the course this week. Answer the following questions as part of your reflection.

Submit the self-monitoring exercise to Canvas by 11:59 on Saturday night at the end of the week.

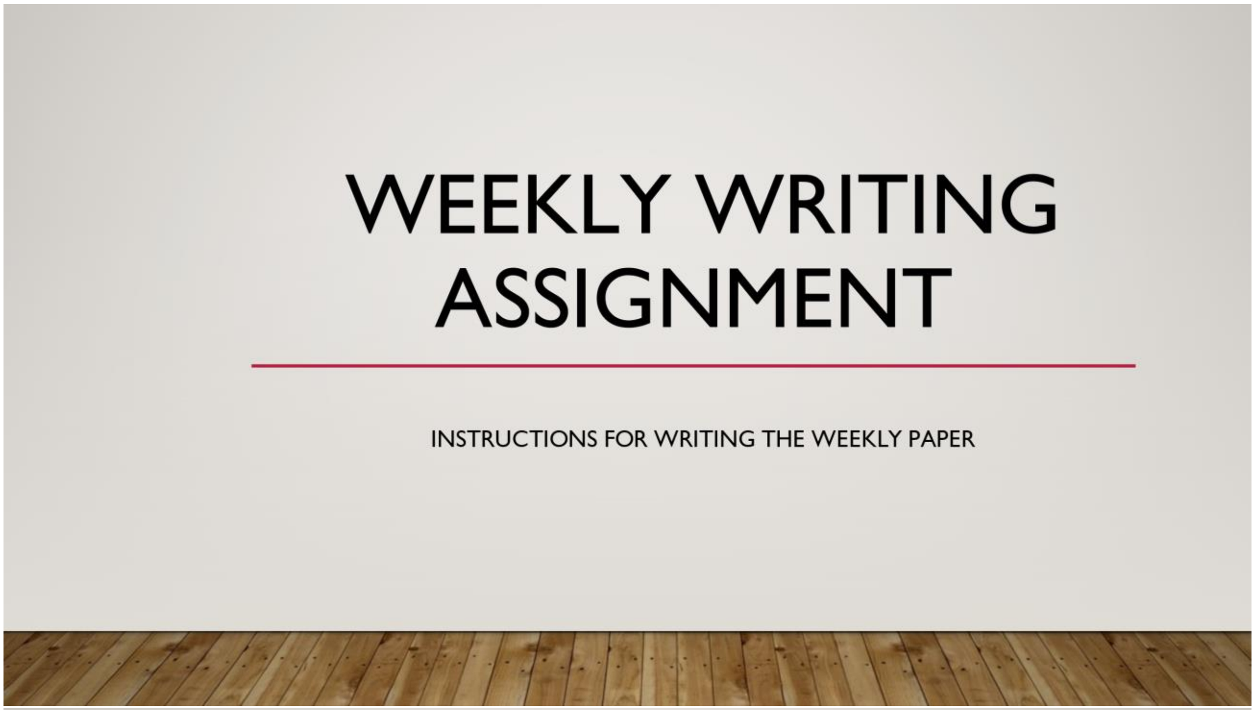
1. Did you understand the content of the lessons this week? If not, what did you do to help you gain a better understanding?
2. If you took a quiz or test, what was your score? Were you satisfied with your grade? If not, what can you do to improve your grade? If you missed a question, how will you make sure you understand the questions that you missed on the quiz?
3. Revaluate your goal and consider what you need to do to accomplish your goals. For example: Do you need to schedule more study time? Have you completed all homework assignments for this week? Do you need to get help from your teacher?

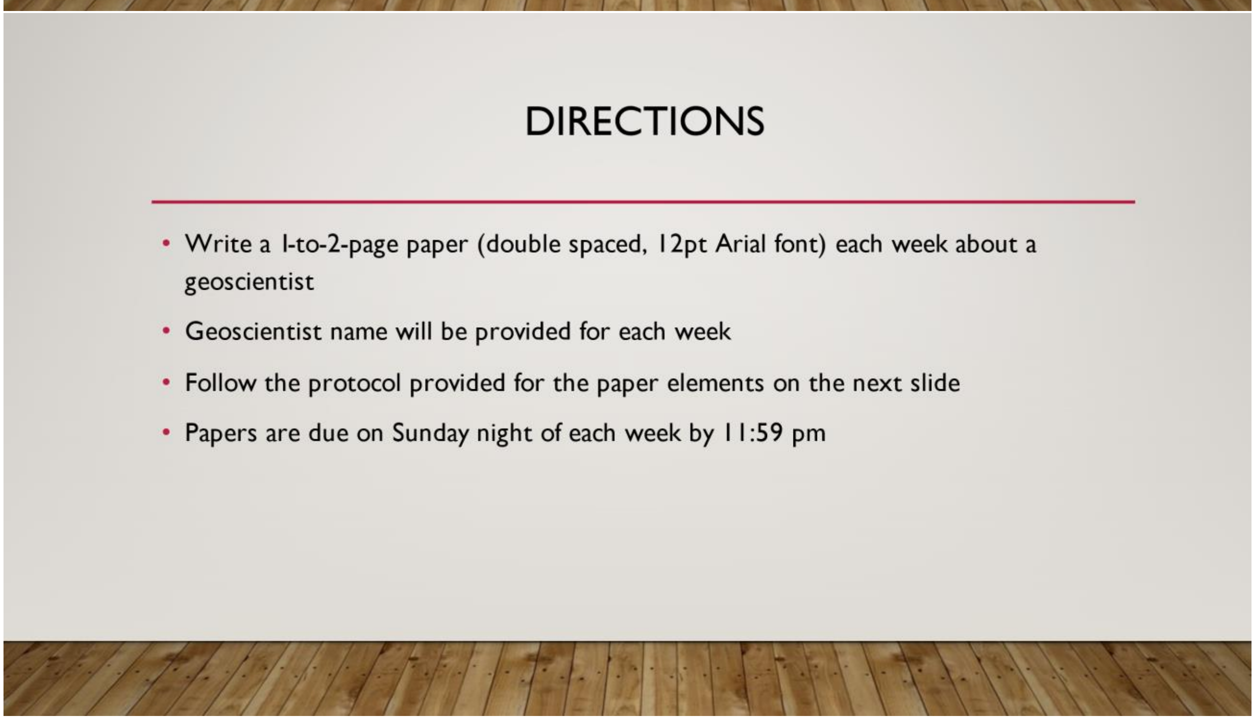
Turn this self-reflection in to Canvas by 11:59 on Saturday night.

Reflection:

Appendix I

Instructions to Subjects for Non-treatment (Control) Group





PAPER COMPONENTS

- The paper must have an introduction, main body, conclusion, and references cited section.
- Elements include:
  - Scientist Name
  - Time/era scientist lived
  - Research interest and discovery
  - Contribution to science and how it enhanced our understanding of the natural world
  - Use scientific writing and GSA formatting style (preferred)
    - https://libguides.com.edu/c.php?g=649323&p=4554576(General Information)
    - https://libguides.com.edu/gsa/GSARefrenceList (Reference List)
    - https://libguides.com.edu/c.php?g=649323&p=4554578(In Text Citations)

SCIENTIST AND DUE DATES

Name	Date Due	Due by Time
Eratosthenes	September 18, 2022	11:59 pm
Nicholas Steno	September 25, 2022	11:59 pm
Nicholas Copernicus	October 2, 2022	11:59 pm
James Dwight Dana	October 9, 2022	11:59 pm
Mary Anning	October 16, 2022	11:59 pm
Charles Lyell	October 23, 2022	11:59 pm

SCIENTISTS AND DUE DATES CONTINUED

Name	Due Date	Due by Time
Matthew Fontaine Maury	October 30,2022	11:59 pm
Harry Hess	November 6,2022	11:59 pm
Marie Tharp	November 13,2022	11:59 pm
Maurice Ewing	November 20,2022	11:59 pm

PAPER SUBMISSION INSTRUCTIONS

- Submit the final paper in the folder titled “submit papers here” in your google folder.
- List thescientistname and due date as the google document name.

GOOGLE FOLDER

- Shared with you and your Instructor
- Submit your weekly papers in the "Submit Papers Here" folder

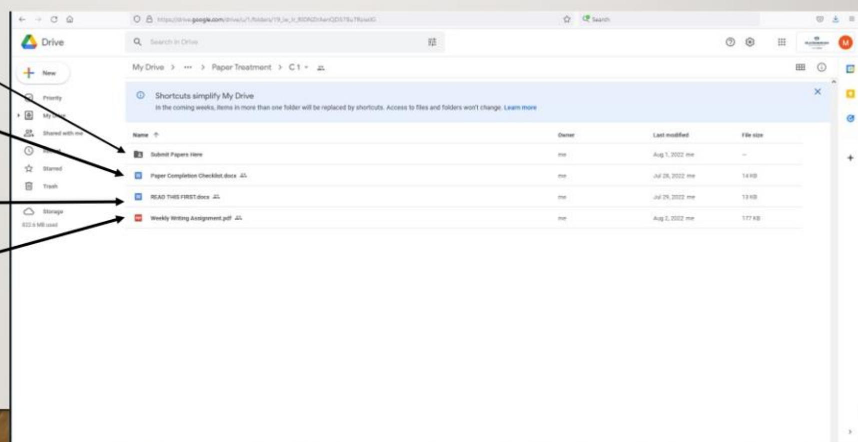
GOOGLE FOLDER

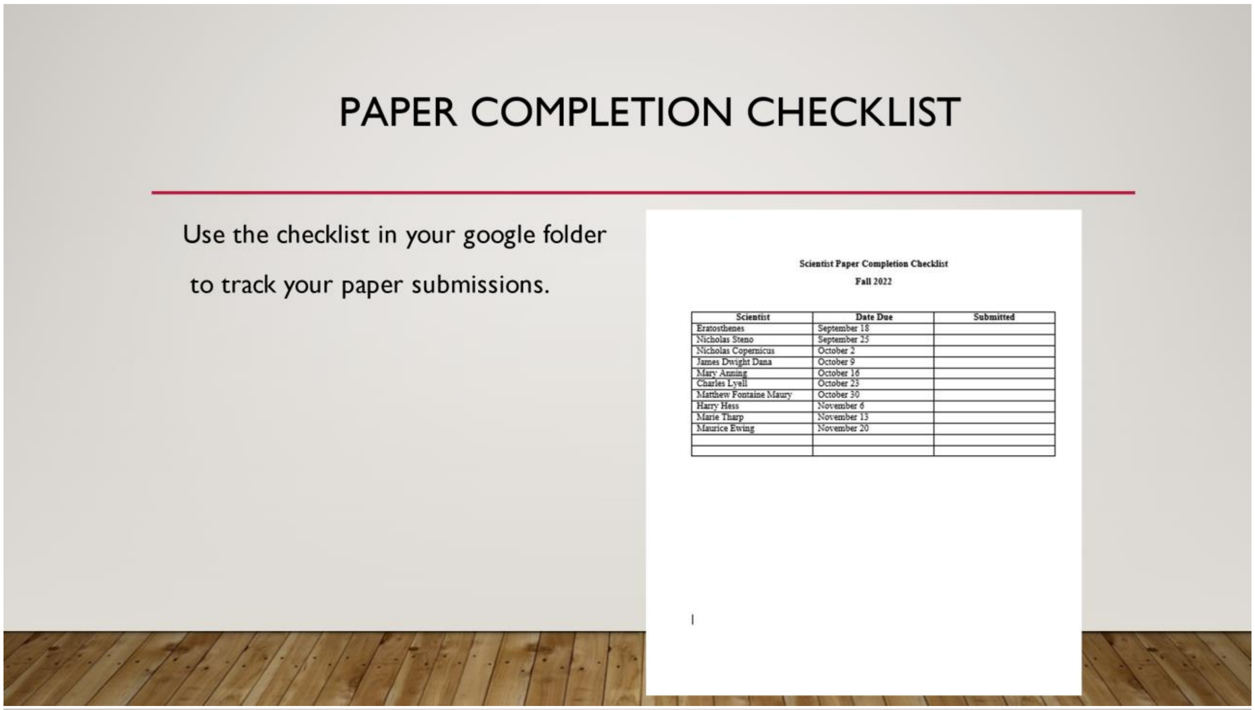
Weekly papers will be submitted here.

List of scientists by week.

Provides the link to the survey.

Provides instructions for completing the weekly papers.





Scientist Paper Completion Checklist

Fall 2022

Scientist	Date Due	Submitted
Eratosthenes	September 18	
Nicholas Steno	September 25	
Nicholas Copernicus	October 2	
James Dwight Dana	October 9	
Mary Anning	October 16	
Charles Lyell	October 23	
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Marie Tharp	November 13	
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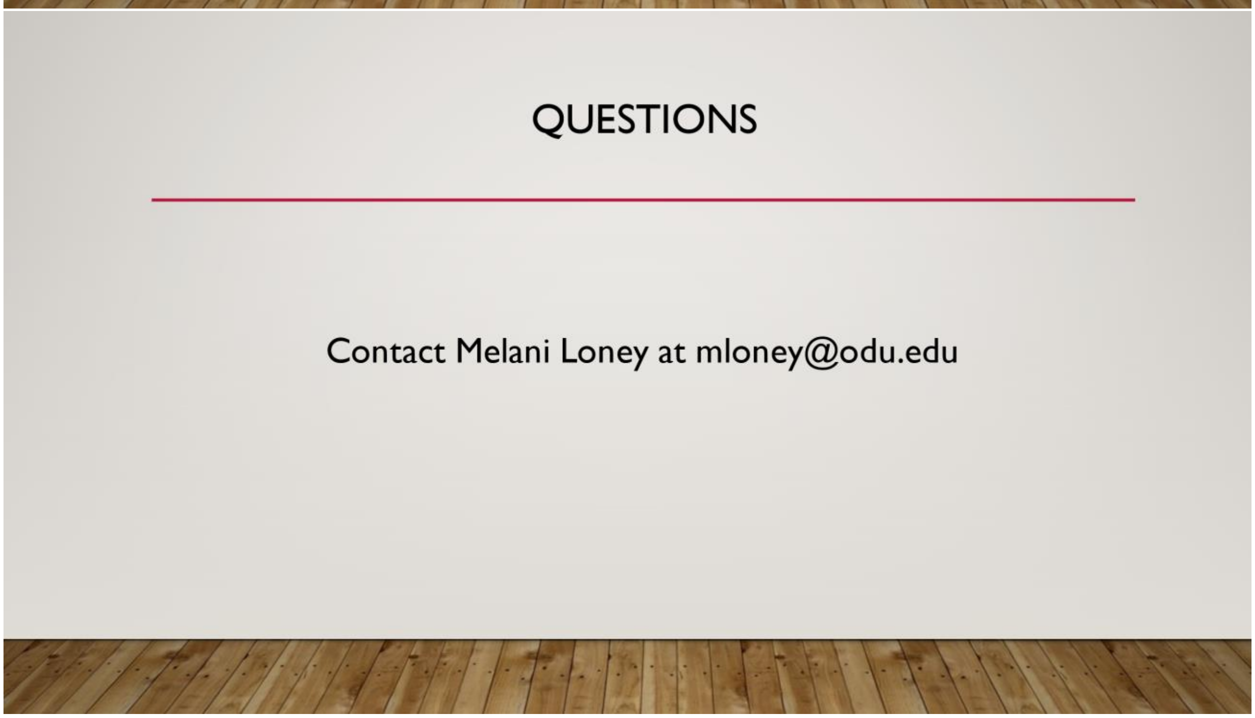

Appendix J

Control Group

Scientist Paper Completion Checklist

Fall 2022

Scientist	Date Due	Submitted
Eratosthenes	September 18	
Nicholas Steno	September 25	
Nicholas Copernicus	October 2	
James Dwight Dana	October 9	
Mary Anning	October 16	
Charles Lyell	October 23	
Matthew Fontaine Maury	October 30	
Harry Hess	November 6	
Marie Tharp	November 13	
Maurice Ewing	November 20	

VITA

Melani A. Loney

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Old Dominion University, 2300 Education Building, Norfolk, VA 23529

EDUCATION

Graduate Certificate, Integrative STEM Education	Virginia Polytechnic Institute and State University, Blacksburg, VA,	2016
EdS, Administration and Supervision	University of Virginia, Charlottesville, VA	2006
M.S. Education	Old Dominion University, Norfolk, VA	1991
B.S. Secondary Education	Old Dominion University, Norfolk, VA	1988
B.S. Biology	Old Dominion University, Norfolk, VA	1982

PROFESSIONAL EXPERIENCE

Old Dominion University

Program Manager Science Technology Engineering and Mathematics Education Initiatives — 2017- Present

Old Dominion University

Program Manager Science and Technology Education Initiatives — 2015-2017

Virginia Beach City Public Schools

Science Coordinator — 2004-2015

Science Teacher — 1988-2004

Regent University

Adjunct Faculty, Science Education — 2004

ENDORSEMENTS/LICENSURE

- **Virginia Postgraduate Professional License – Virginia Department of Education**
  General Science I & II, Biology, Earth and Space Science, Administration and Supervision