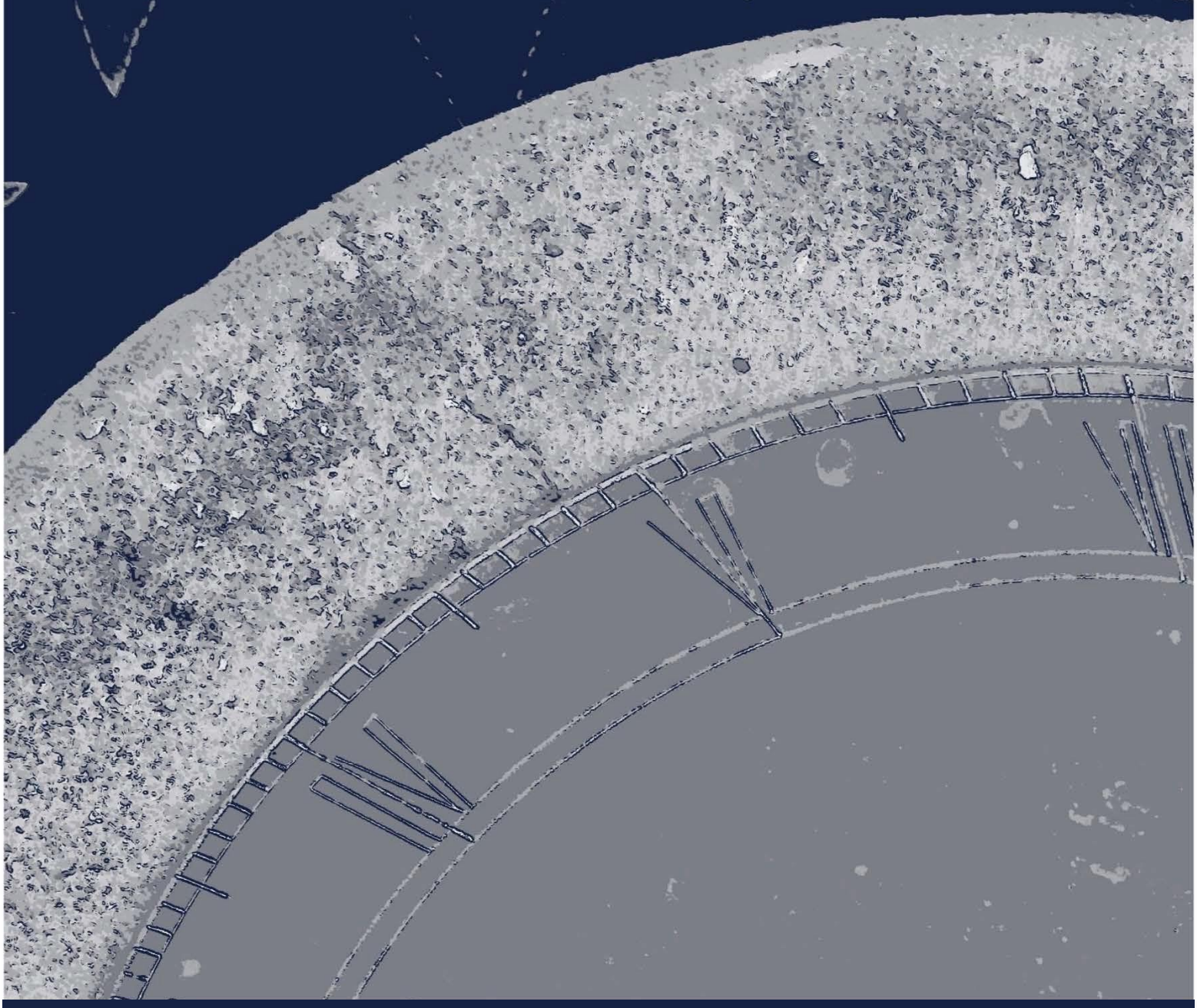
Fall 2023

Volume 6 Issue 2

THE ARSENAL

Augusta University's Undergraduate Research Journal



About *The Arsenal*

The Arsenal: The Undergraduate Research Journal of Augusta University is a peer-reviewed, open access, interdisciplinary journal for undergraduate research conducted at Augusta University. This journal is managed in collaboration by the Center for Undergraduate Research (CURS), University Libraries, and the student organization On the Shoulder of Giants.

Created in Fall 2016, *The Arsenal* represents and highlights undergraduate research of academic and scholarly value from various disciplines at Augusta University. Each article undergoes a peer-review process facilitated by the journal's Editorial Review Board and must be approved by an appointed faculty reviewer in the article's respective discipline.

Volume 6, Issue 2 (2023)

EDITORIAL

RESEARCH ARTICLES

EDITORIAL

Empowering Student Leaders Through Experiential Learning: *The Arsenal*

Dr. Alex St. Louis, Coordinator, Center for Undergraduate Research and Scholarship

Dr. Alex T. St. Louis is an instructor in the College of Education and Human Development as well as coordinator in the Center for Undergraduate Research and Scholarship. Her research interests include mentorship, understanding the nature of science, and improving scientific relations within the greater community. Dr. St. Louis loves working with undergraduate students, advocates for inclusion in science education, and finds great value in helping students learn research skills to become the next generation of leaders and scholars.

INTRODUCTION

The Arsenal is a peer-reviewed, open-access, interdisciplinary journal dedicated to publishing manuscripts from undergraduate researchers at Augusta University. The journal is the product of interdisciplinary collaboration between the Center for Undergraduate Research (CURS) and the AU Libraries.

In 2015, students at Augusta University began to express their desire to establish an undergraduate research (UR) journal, citing an increase in the UR culture across campus (Johnson et al., 2017). The first issue was published in the Fall of 2016. To date, there have been 19 published research articles and 178 published research abstracts from 204 undergraduate student authors (Center for Undergraduate Research and Scholarship, 2023).

The Arsenal is an example of a hybrid publishing model in which students and faculty work together to organize, publish, and maintain the journal (Hart, 2012). Students participating in this process are integral to the success and longevity of the journal, and this process acts as a form of experiential learning. Experiential learning is when an intentional experience creates knowledge (Kolb, 1984; 2012).

https://doi.org/10.21633/issn.2380.5064/f.2023.06.02.01

Katula and Threnhauser (1999) describe experiential learning in the undergraduate curriculum as a place beyond the norms of a traditional classroom where a student's intellectual growth can occur. The benefits of experiential learning transcend different stakeholders. Students benefit by developing 21st century skills (i.e., collaboration, communication skills (oral, listening, written), decision-making, personal responsibility, problem-solving, professionalism, and technology/digital literacy), gaining authentic, real-world experiences that apply to their future in the workforce while also improving academic performance; mentors benefit through increased and intentional pedagogy, filled with insights and connections that can be used to improve practice; and university systems benefit through an increased and enhanced reputation of providing unique and authentic learning experiences for students and potential increased graduate employment (Chan, 2023).

Multiple learning and educational theories support experiential learning. Collins et al. (1991) developed the Cognitive Apprenticeship Model, which supports novices' learning a skill set or practice from an expert. The model is broken down into six "strategies," which, when utilized appropriately, allow for a novice to develop a skill: modeling, coaching, scaffolding, articulation, reflection, and exploration (Figure 1).

Modeling is the beginning stage of the Cognitive Apprenticeship Model. Students participating in experiential learning need a foundation and model of the practice or skill set that they will be learning. Mentors must demonstrate the skill(s) appropriately. Next, students get to put their skill(s) into practice. Mentors are still very much involved in this process, coaching students and giving direct feedback in order for the students to develop and hone their skills continuously. Mentors continue to scaffold support, pulling back or providing additional support based on the work completed by the student. The remaining three stages primarily focus on students' reflection on their participation and work. During the articulation phase, students reflect on their learning while being coached and scaffolded. The students continue to reflect on and evaluate their performance of the task at hand. In doing so, the students can continue developing their skills and practice through exploration and continued work utilizing the skills they have learned and implemented through practice.

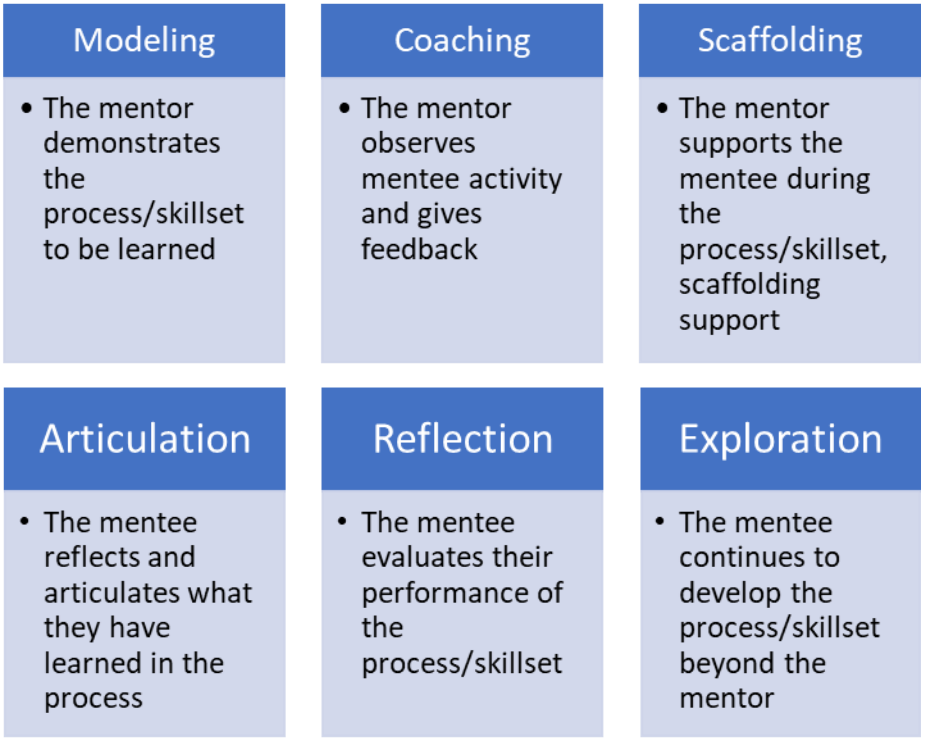


Figure 1:

Cognitive Apprenticeship Model

Note: Explanation of the Cognitive Apprenticeship Model. Adapted from Cognitive Apprenticeship by Dr. Serhat Kurt, 2021. https://educationaltechnology.net/cognitive-apprenticeship/

EMPOWERING STUDENT LEADERS THROUGH EXPERIENTIAL LEARNING

During the 2022-2023 academic year, CURS revived the CURS Ambassador Program. The student ambassadors are an extension of the CURS mission, committed to advocating and promoting research to all disciplines and under-represented students. They attend CURS-sponsored events, guide students pursuing research, model research practices through presenting original research at various events, and serve on the Arsenal Student Editorial Board or as reviewers for the journal. Following the hybrid publishing model, we intentionally set forth to make the work on the Arsenal an experiential learning experience for the CURS Ambassadors.

Our office benefited from the fact that all our CURS Ambassadors had previous experience in UR and that they represented various disciplines across Augusta University's four campuses. The first cohorts of the revived program included students with majors and academic interests in art, biochemistry, biology, computer science, cyber security, elementary education, kinesiology, mathematics, nursing, and psychology. I had the privilege of serving as their mentor for reviving the journal and ensuring that the students learned about the publication process—beginning with writing a call for manuscripts and finishing with sending the accepted manuscripts to the library for publication. We appointed one CURS Ambassador as the student representative and liaison between the faculty and students. Tanish Kumar (B.S., Kinesiology '25) helped assist our office during this first year and laid the foundation for two students to take over as Co-Chairs for the current academic year, Vanessa Browning (B.S., Psychology '25) and Trinity Johnson (B.S., Kinesiology '24).

THE PROCESS

Our student chair/co-chairs begin by creating and sending a call for manuscripts at the beginning of each academic semester. The Arsenal Editorial Board re-evaluated the guidelines and submission process and set forth explicit parameters for student authors while acknowledging that research and scholarship can take different forms in different disciplines. Therefore, we welcome submissions that are 1) situated in the field, 2) make an original contribution, 3) clearly articulate the nature of the original contribution, and 4) convince the reading audience of the importance and interest of the research described (Center for Undergraduate Research, 2023b). The submissions can be a traditional scholarly research article or a feature article. The CURS Ambassadors learned first-hand the importance of having clear, communicated guidelines that serve as the standard for developing and publishing an intentional publication and ensured that the call for manuscripts accurately reflected the guidelines for the journal.

Once the call was placed, manuscripts began to be submitted via our online system, and the CURS Ambassadors received training on the journal's editorial process. Manuscripts for the Arsenal are not immediately accepted for publication; instead, they must undergo an extensive double-blind peer review process: the reviewers do not know the identity of the manuscript's author(s), and the authors do not know the identity of the reviewers. Our student chair/co-chairs were integral during this step, assisting with collecting and distributing blinded manuscripts to reviewers. The Arsenal enlists assistance from faculty on the CURS Faculty Advisory Committee and students serving as CURS Ambassadors to act as reviewers. Each manuscript is reviewed by at least three people, including one faculty member. Most of our students have never participated in a formal review process before, and modeling and coaching them through peer review was essential. I created a workshop that focused on the importance of peer review, the process, and the components of research manuscripts. This workshop allows the students to engage with the individual components of the process in an experiential setting to develop their foundation and participate in peer review.

The CURS Ambassadors learned valuable information, including how to use tracked changes in Microsoft Word (an important skill utilized in the real world and I realized was not necessarily formally taught in the curriculum).

The peer review resulted in feedback and critiques for the manuscript authors. *The Arsenal*

chair/co-chairs organize the reviews into one document to send to the student authors. The Editorial Board must also take the critiques from each reviewer and determine if the manuscripts fit the journal's scope and should be accepted. An important idea taught during this process was that academic writing can constantly be improved, and a reader should always ask questions and critique work. Constructive criticism is integral to progressing scientific and creative thought forward; without it, our academic disciplines would suffer greatly. Each first author received a decision letter, explaining the thoughts of the Editorial Board and the future direction of their manuscript. Most manuscripts were accepted with revisions, and the student authors were able to make changes to their writing and strengthen their overall work. Revised manuscripts were reviewed by the faculty and accepted. The CURS Ambassadors are the foundation of the Arsenal, emersed in the process from the beginning planning stages to the final acceptance of manuscripts to form a complete issue. Table 1 gives examples of the 21st century skills that the students develop through this experiential learning process.

RELATIONSHIP TO AU'S STRATEGIC PLAN

Experiential learning experiences, like our students participating in the Arsenal, should not exist without structure or intentionality. They must be structured and rooted within a greater value or purpose. Our student's experience works in synergy with the university's strategic plan. Augusta University has five strategic priorities and three interwoven priorities for Creating a Legacy Like No Other: learning, discovery, student success, community, stewardship, and innovation, engagement, diversity/equity/inclusion (Augusta University, 2022). The examples and description of *The Arsenal* above provide concrete evidence that the journal experience serves as an impactful learning experience (learning), interdisciplinary and collaborative discovery (discovery), and personalized student connection (student success).

Table 1 Mapping Experiential Learning Activity to 21st Century Skill

Experiential learning activity	21st century skill(s) used
Developing a call for manuscripts	Written communication skills
	Technology/digital literacy
	Collaboration
	Professionalism
Organizing the review process between authors and reviewers	Collaboration
	Written communication skills
	Decision making
	Professionalism
	Problem solving
Communicating with student authors	Written communication skills
	Professionalism
	Technology/digital literacy
Working with CURS and Library faculty	Oral communication skills
	Collaboration
	Problem solving
	Communication skills, including listening
	Decision making
	Personal responsibility
	Professionalism

CONCLUSION

I am excited to see how our students continue to grow and develop through participation in the CURS Ambassador Program and the Arsenal. The most rewarding part of being in this position and working with these students is their collection expression of wanting to be a part of this process. These students want to volunteer their time and their minds to serve as an extension of our office. CURS is located on the third floor of Allgood Hall, in the Summerville Research Office. At any one time, there is a high likelihood that you can walk into the research suite and find a CURS Ambassador engaging with us in one way or another. This positive engagement stems from the environment that we have intentionally worked to establish, an outcome of experiential learning.

REFERENCES

Augusta University. (2022). *Creating a legacy like no other: Augusta University strategic plan 2022-2027*. Retrieved from https://www.augusta.edu/about/planning/strategic-plan/

Center for Undergraduate Research and Scholarship. (2023a). *The Arsenal*. https://www.augusta.edu/curs/arsenal-home.php

Center for Undergraduate Research and Scholarship (2023b). *Manuscript guidelines*. https://www.augusta.edu/curs/arsenal-subguidelines.php

Hart, D. A. (2012). *How to start an undergraduate research journal*. Council on Undergraduate Research.

Chan, C. K. Y. (2023). *Assessment for experiential learning*. Routledge.

Collins, A., Brown, J. S., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. *American Educator*, *15*(3), 6–11, 38–46.

Johnson, M. E., Mears, K., & Drescher, A. (2017). Creating the Arsenal: Augusta University's undergraduate research journal. *The Serials Librarian*, *72*(1-4): 128-133. https://doi.org/10.1080/0361526X.2017.1297590

Katula, R. A., & Threnhauser, E. (1999). Experiential education in the undergraduate curriculum. *Communication Education*, *48*(3), 238-255. https://doi.org/10.1080/03634529909379172

Kolb, D. A. (2012). *What is experiential learning?* Retrieved September 27, 2023, from https://www.youtube.com/watch?v=1ZeAdN4FB5A

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall.

Pilot Study: The Relationship Between Self-Efficacy and Adherence to an Exercise Program

Erin Quick

Abstract

Obesity has exponentially increased over the last few decades within the United States. In relation to obesity, several of the top leading causes of death in the United States are directly related to obesity, including cardiovascular diseases, type II diabetes, and variations of cancer. To combat chronic obesity and comorbidities, current guidelines for management of obesity propose a multi-modal approach, including lifestyle modification and behavioral counseling. In this, self-efficacy is considered to be a reliable predictor of adherence or withdrawal from an exercise program. This study utilized the General Self-Efficacy scale (GSE) to observe an individual's self-efficacy in relation to adherence to the exercise protocol. The fitness data was collected via provided FitBit, analyzing the participant's daily active minutes, steps, and calories burned. The individual's adherence was measured based on whether the individual met their assigned weekly exercise protocol. The individual's self-provided GSE scale score and rate of adherence were analyzed at the end of the study. It was determined that no participant truly met all their weekly goals; however, some participants had higher step and moderate-to-vigorous (MTV) exercise averages compared to others. The preliminary data was inconclusive between the long-term relationship between self-efficacy and adherence to an exercise program due to limitations within the study; however, predictive conclusions can be drawn. This paper also discusses future practical implications for revision of this study to improve the quality of future results.

https://doil.org/10.21633/issn.2380.5064/f.2023.06.02.06

Student Author

Erin Quick

0009-0006-3363-3930

Erin Quick graduated from Augusta University with a BA in kinesiology, and is now enrolled in AU's Doctorate of Physical Therapy (DPT) program. Quick believes her career as a physical therapist will allow her to be a light for individuals within her community. She explains that physical therapy revolves around providing quality patient education, healthcare, and developing genuine relationships that build trust and serve as professional support for patients. Quick is excited to start her journey in becoming a physical therapist and to see the lives she impacts and those that impact her throughout her career.

Faculty Mentor

Hannah Bennett, PhD

0009-0000-1611-1168

Dr. Hannah Bennett is an assistant professor in the Department of Kinesiology. She graduated with a bachelors in psychology from the University of Connecticut and earned an MS in kinesiology with a concentration in sport and exercise psychology from Georgia Southern University. She earned her PhD n human performance from Middle Tennessee State University. Dr. Bennett is currently the program coordinator for the undergraduate health and physical education degree within her department and teaches classes ranging from elementary physical education teaching methods to sport and exercise psychology. Dr. Bennett's research interests include social justice and diversity within sport and physical education, LGBTQ+ student-athletes, body image and psychological dispositions of female CrossFit athletes, and mental skills training within the performing arts. She continues to consult with athletes and exercisers in the surrounding areas.

BACKGROUND

Obesity has exponentially increased over the last few decades within the United States. According to the Centers for Disease Control and Prevention (2021), as of 2020, 42.2% of American adults are classified as obese, compared to just 16.2% in 2008. An individual is classified as obese when their body mass index (BMI) is more than 30 kg/m2. Obesity affects all ethnic groups; however, it is most prevalent in female non-Hispanic black adults and male Hispanic adults (Petersen, Pan, & Blanck, 2019). Furthermore, several of the top leading causes of death in the United States are directly related to obesity, including cardiovascular diseases, type II diabetes, stroke, asthma, and certain variations of cancer. Although it affects nearly half of the United States' population, obesity is still considered an untreated medical condition and is a significant economic burden on the United States, costing the health care system approximately 150 billion dollars annually (Finkelstein et al., 2009).

Current guidelines for weight loss and management of obesity propose a multi-modal approach, including lifestyle modification, behavioral counseling, pharmacotherapy, and surgery (Garvey, et al., 2016). According to the 2016 American Association of Clinical Endocrinologists and American College of Endocrinology (AACE/ACE) guidelines, the first recommended step for treating obese individuals is an active lifestyle intervention, which includes adding exercise, modifying the individual's diet, decreasing caloric intake, and adding behavioral or motivational intervention. The next steps include pharmacotherapy and surgical management; however, surgical management is only suggested for individuals with a BMI of greater than 40 kg/m2 (Garvey et al., 2016). The overall goal of multi-step intervention is to promote weight management, patient wellness, and enhance the patient's quality of life (Seger et al., 2016).

There are various methods to preventing and treating individuals with chronic obesity; however, exercise is the number one prevention tool as well as behavior modification. According the 2020 World Health Organization (WHO) and Physical Activity Sedentary Behavior Guidelines, physical activity

recommendations are 150 to 300 minutes of moderate exercise or 75 to 150 minutes of vigorous exercise, and 2 or more days of strength training each week. Unfortunately, approximately 1 out of every 5 adults in the United States meet these recommended guidelines (Sullivan & Lachman, 2017). These activity levels may not reverse the chronic effects of obesity, but they can help improve cardiovascular health and physical fitness. To transition from obese to overweight, it is recommended to participate in at least 60 minutes per day of moderate intensity and between 45 to 60 minutes per day to transition from overweight to a normal BMI for an individual's height and weight. A normal weight loss is approximately 1–2 pounds (0.5–1 kg) per week, which means decreasing caloric intake by 500–1,000 kcal per day for a period of time, varying per individual (Stone, DiPietro, & Stachenfeld, 2021). Exercise alone is not enough to maintain weight overtime, but nutrition plays an active role in weight loss and maintenance.

Poor nutrition can result in the development of obesity, its comorbidities, and nutritional deficiencies. Today, many individuals overconsume high-calorie, low-nutritional food that is overly processed. Overweight and obese individuals, compared to normal-weight individuals, report low intake of fruit, micronutrient intake, and lower quality diets (Astrup & Bügel, 2019). These lack of vitamins and minerals affect the function of important physiological systems and support the development of chronic diseases. For instance, a higher body fat percentage, lack of physical activity, and poor nutrition may contribute toward 87% of newer cases of type II diabetes because of how the lack of micronutrients affect glucose metabolic pathways and pancreatic β-cell function (Astrup & Bügel, 2019). Although further research is needed to understand the effects of micronutrient deficiencies and obese individuals, it is important to note the influence of nutrition on an individual's overall health.

Pharmacotherapy is an additional option that incorporates modification of maintaining weight, preventing unhealthy weight gain, and eating behaviors. Modern pharmacology suggests different versions of antiobesity drugs to focus on treating obesity-associated comorbidities in individuals, such as hypertension or hyperglycemia; however, it does not have significant evidence due to the lack of obese individuals in clinical trials. Antiobesity drugs focus on treating obesity-associated comorbidities in individuals over a specific BMI who fail to respond to lifestyle intervention after six months of treatment (May, Schindler, & Engeli, 2020). The goal is not solely to reduce the individual's weight. In fact, individuals taking prescribed antiobesity drugs may only see a weight decrease of only 5-10% over a 12-month period or experience even a slight weight gain (May, Schindler, & Engeli, 2020). Furthermore, depending on the prescribed drug, individuals may see a weight regain after weight loss treatment. Therefore, antiobesity medications should be categorized as a next step treatment for individuals and not the only treatment option.

Self-efficacy is defined as the extent to which an individual believes they can carry out an action or behavior (Bandura & Walters, 1977). Self-efficacy is considered a reliable predictor of adherence or withdrawal from an exercise program. Self-efficacy expectations consist of performance accomplishments, vicarious experiences (i.e., modeling), verbal persuasion, imaginal experiences, physiological states, and emotional states, which determine an individual's athletic performance (Feltz, 1984). According to Bandura's Social Learning Theory (1977), behavioral changes and adherence can be mediated by an individual's self-efficacy (Desharnais, Bouillon, & Godin, 1986). Self-efficacy judgments are determinants because they are hypothesized to influence an individual's thoughts and emotional patterns, including pride, shame, happiness, sadness, which directly affect an individual's motivation to complete a task (Feltz & Öncü, 2014). Whether in an athletic competition or a weight loss program, an individual's self-efficacy beliefs can surpass their actual performance, potentially resulting in enhanced performance. In contrast, if the individual has no incentive to complete the goal, this could result in poor performance. The formation of self-efficacy judgments is based upon the individual's perception of their surrounding environment (Bandura, 1997). Additionally, past

performances on specific tasks are significant in forming future self-efficacy judgments (Feltz & Öncü, 2014). If an individual has successfully performed a specific task in the past, then the individual's self-efficacy will increase if presented the same task in the future; however, if the individual experienced failure with the task, then self-efficacy will decrease and hinder performance (Weinberg & Gould, 2019; Bandura & Locke, 2003).

An individual's perceived self-efficacy can affect their behavior in several ways, including (1) whether the individual attempts to perform the task, (2) the individual's level of determination to complete a task when faced with difficulty, and (3) how successful an individual performs a given task (Desharnais, Bouillon, & Godin, 1986; Maddux, 1995). The Bandura theory (1986) suggests that when an individual's self-efficacy increases, they become more dedicated to the presented task. The strength of self-efficacy is reflective of how likely an individual is to continue working toward their goal or outcome expectancy. With this said, the expectation of self-efficacy and expectation of outcome is important to distinguish (Bandura, 1986). The expectation of outcome is defined as, "[a] person's given behavior that will lead to certain outcomes" (Desharnais, Bouillon, & Godin, 1986; Bandura, 1978). Furthermore, Bandura (1978) discusses how the expectation of self-efficacy is a more reliable determining factor of behavior compared to the expectation of outcome for an individual.

Desharnais et al. (1986) studied the prediction of an individual's rate of adherence to an exercise program based on the individual's initial expectation of outcome and self-efficacy. Using Social Learning Theory (1986), they determined that self-efficacy was a more reliable determinant factor compared to the individual's outcome expectancy. Participants who withdrew from the program displayed lower levels of self-efficacy, exhibiting lower self-confidence, less certainty of task completion, and high expectations from the program. Similarly, Dennis and Goldberg (1996) studied the relationship between self-efficacy types and weight loss outcomes in overweight and obese women. They found in the pre-and post-treatment measures, women with positive self-efficacy lost approximately twice the weight compared to woman with a lower self-efficacy. At the end of the study, obese individuals, who completed the study, demonstrated improved self-efficacy similar to non-obese individuals who were not a part of the study.

In summary, these studies demonstrate that obese individuals often display lower levels of self-efficacy compared to non-obese individuals. If an individual's self-efficacy is perceived as lower, then the individual is more likely to withdraw from the exercise program or goal (Bandura, 1997; Jones et al., 2005). Through behavioral intervention and evaluation of self-efficacy, participants within the exercise program can experience improved adherence rates, successful weight loss and control, and participant wellness education (Sullivan & Lachman, 2017). Intervention, overall, can enhance participants' quality of life by helping participants lose and maintain weight, improve self-efficacy, and live a healthier lifestyle.

OBJECTIVE

The objective of this study was to analyze the relationship between self-efficacy and adherence to an exercise program, particularly the exercise prescription guidelines. It was hypothesized that individuals who scored higher on the General Self-Efficacy Scale (GSE) would meet or surpass their recommended protocol, which was measured via the participant's Fitbit. The goal of this study was to provide future recommendations to practitioners and encourage patients and clients, allowing them to feel valued and supported throughout their health journey.

METHODS

Participants and Recruitment

The study's criteria included 20 participants, male and female, enrolled at the General Internal Medicine Faculty Clinic between the ages of 18-65 years old, with a BMI between 25 to 30 kg/m2 and have commercial insurance. All participants were given a pseudonym, which are utilized within the

results and discussion sections to protect participant confidentiality. Exclusions were made for pregnancy, individuals who were oxygen-dependent at home, those who were immobile, and those who experienced moderate to advanced systemic disease that prevented the use of anti-obesity medications. Within this study, mobility, and medical intervention were necessary and deemed valid exclusions by doctors. The candidate's primary physicians consulted them about this opportunity within this study. If the candidate was interested in the research project, they were informed of the study and consented by their primary care physician. The physicians were an active part of the research team, and if their candidate agreed to participate in this research project, they would be enrolled for one year. This aspect of the study focused on the first three months of intervention.

Table 1: Participant Demographics

Measure	All N = 8	Females N =8	Males N = 1
Age (yrs.)	43.5 ± 6.33	44.43 ± 6.21	37
Weight (kg)	102.99 ± 20.14	98.40 ± 16.64	135.1
Estimated BMI*	36.88 ± 5.63	36.79 ± 6.08	37.5

*BMI = Body Mass Index

Measures and Instruments

This study was a yearlong multipronged wellness intervention; however, this pilot study utilized the GSE to observe a participant's self-efficacy in relation to their adherence to the established protocol. For the yearlong research project, participants were assessed at months 0, 3, 6, and 12. Throughout the 12 -month intervention, team members analyzed and collected various health markers of participants along with physical activity data from the Fitbit. During fitness measurements, height, weight, and BMI were collected via an InBody Scanner. Fitbit technology was used to organize and present knowledge to participants to track their sedentary time, active minutes, and overall daily steps. If participants already had a Fitbit, already had a Fitbit, they were allowed to use their personal accounts. The American College of Sports Medicine (ACSM) recommends 225 to 420 minutes of moderate to vigorous (MTV) activity each week to maintain a healthy lifestyle. With that being said, participants were given a protocol of 300 minutes of MTV activity each week. The goal for the step protocol was based on the participant's baseline. Specifically, participants were encouraged to walk three 10-minute walks at a brisk pace. Each week, 10-minute increments were be added based on participants' progress.

Furthermore, each participant was given a General Anxiety Disorder (GAD-7) questionnaire, a Patient Health Questionnaire (PHQ-9), a Profile of Mood States (POMS), an adult General Self-Efficacy Scale (GSE), a Physical Activity Enjoyment Scale (PACES), and a Beck Depression Inventory (BDI). Each of the following measurements were given to patients every three months. These measurements allowed the research team to assess changes in the participant's quality of life, wellness, and fitness level, and affect toward the program in general. While this was a yearlong study, the purpose of this project focused on the participant's self-scoring on the GSE and adherence to the exercise protocol. It was hypothesized that participants would demonstrate positive changes within the measurements collected, suggesting an improved quality of life and wellness.

PROCEDURES

Participants were required to meet with the kinesiology and behavioral health team once in the beginning of the study. Here, they participated in testing and received their Fitbit to log guided exercises through a provided log-in, unless the participant had a personal account prior. The participant's data was collected via the Fitbit software so fitness trends and overall wellness could be analyzed. Participants were encouraged to view provided modules and guidance related to behavioral counseling, motivation, and adherence techniques. These were provided in the MetricWire software. The

Table 2: Timeline of Pilot Study Events

Event	Date of Study (Month of Week Marker
Pre-visit Assessment	Pre-study
Physician, Collecting Anthropometric Measurements, Vital Signs, Basic Blood Work	0, 3, 6, 12
Control Group: General Nutrition Education Treatment Group: Nutrigenomics	Month 1: 1 visit Monthly check-in via EMA
Exercise/Behavioral Counseling	Month 0 -3: Guided weekly video Month 4-6: Guided biweekly video Month 7-9: Guided monthly video Month 10-12: No guided videos. There will be open access to the resource library.
Guided Exercise Intervention	Participants will receive EMA notifications each week through metric wire system.

exercise regimen is a step count progression based on the participant's current exercise level. Participants could choose to walk or participate in activity of choice in their preferred environment, such as in their neighborhood or fitness center. The only requirement for participant physical activity was to remain within the target heart rate zones of a 70-85% maximal heart rate, which would be estimated from individual's resting heart rate. This pace was suggested to meet the minimal activity ACMS guidelines.

General Self-Efficacy Scale (GSE)

The General Self-Efficacy Scale (GSE) is a 10-question scale designed by Matthias Jerusalem and Ralf Schwarzer in 1981 that is globally available in 33 different languages. The purpose of the scale is to assess one's self-belief of how they approach and manage different stressors in life. Furthermore, the GSE also assesses an individual's optimism and accounts for personal agency (i.e., the belief that one's actions are responsible for successful outcomes), which is highly representative of one's self-efficacy. To take this assessment, an individual responds to 10 questions asking how capable they feel within a given specific situation by ranking themselves on a 1 to 4 scale, with 1 being "not true at all" and 4 being "exactly true." The GSE ranges from scoring a minimum of 10 points to a maximum of 40 points. To score the scale, take the sum from each column, calculate the total, and find the mean score.

Data Analysis and Timeline of Analysis

The anthropometrics, General Anxiety Disorder (GAD-7) questionnaire, Patient Health Questionnaire (PHQ-9), Profile of Mood States (POMS), and the adult General Self-Efficacy Scale (GSE) were analyzed every three months to address changes in the participant's quality of life and wellness based on the collected scores and measurements. This was where the relationship between self-efficacy and exercise program adherence was observed. At each checkpoint of the study, data was analyzed to produce an overall trend of participants to see if their self-efficacy was associated with adherence to their weekly exercises within the program.

For this study, participants' scores on the GSE from baseline (month 0) to month 3 were compared and their daily step count observed. Preliminary observations about the score compared to their step count was also made. To do this, the participants Fitbit data was downloaded and organized into

From here, the data was analyzed to see which participants did or did not complete both their weekly step count and MTV activity minutes. Furthermore, the GSE scale was scored for each participant and entered a new spreadsheet (Figure 1). Two average means of participant scores were calculated. One column including all participants and one column not including participants who withdrew from the study.

RESULTS

Figure 1 displays the mean average of self-efficacy scores of participants from study. The mean average of participants within the study was 3.41, which is an average score of 34.1 out of 40 on the GSE. Participants who withdrew from the study were not included within the average.

Participants Tracy, Mary, Daniel, and Shannon had the highest report self-score on the GSE with a 39 to 40 on the scale. Data from participants who withdrew from the study data was not included in the study. In Figure 2, Daniel's data from the first month of the study is displayed. Daniel did not meet the recommended 10,000 steps every day for the first month; however, he was close to reaching his goal. Daniel also had the highest average of MTV activity minutes of out of all participants within the study. In Figure 3, Tara did not meet her recommended daily steps and had a high average of 1,256 sedentary minutes. She also had only 0.83 fairly active minutes (i.e., moderate activity) and 0.92 very active minutes (i.e., vigorous activity) for the first month. In Figure 4, Delora had a higher average step count and MTV activity compared to participant Tara.

Figure 1: Mean Average of Self-Efficacy Scores of Participants from Study

Participant Pseudonym	Self-Score (Out of 40)	Dropped Out	Mean Average
Tracy*	39		3.9
Delora	30		3.0
Tara	36		3.6
Emily	34		3.4
Edward	38		3.8
Cecile	38		3.8
Mary*	39		3.9
Elaine	37		3.7
Kathleen	31		3.1
Jennifer	32		3.2
Cathy	29		2.9
Ruth	29		2.9
Rachel	37		3.7
Paul	37		3.7
Erica	38		3.8
Wendy	36	Yes	
Deborah	30		3.0
Peggy	34		3.4
Carmen	37	Yes	
Daniel*	39		3.9
Charles	28		2.8
Doris	35		3.5
Marla	31		3.1
Chris	30		3.0
Shannon*	40	Yes	
Mean Averages of Score:	**34.56**		**3.413636364**

Figure 2: Data from Daniel during First Month of Study

Daniel					
Date	Daily Steps	Minutes Sedentary	Minutes Lightly Active	Minutes Fairly Active	Minutes Very Active
8/12/21	9,394	735	267	38	35
8/13/21	9,814	743	339	55	9
8/14/21	5,189	813	233	0	0
8/15/21	7,356	695	221	26	6
8/16/21	8,659	742	315	38	12
8/17/21	7,622	745	274	19	8
8/18/21	6,003	805	236	13	6
8/19/21	6,341	745	254	24	6
8/20/21	7,678	695	357	24	1
8/21/21	542	1,269	32	0	0
8/22/21	0	1,440	0	0	0
8/23/21	9,366	677	305	89	37
8/24/21	8,771	720	272	51	22
8/25/21	7,926	631	303	19	6
8/26/21	6,998	803	277	0	0
8/27/21	11,394	498	461	136	37
8/28/21	4,674	805	209	24	4
8/29/21	6,817	857	215	6	19
8/30/21	5,948	615	248	16	7
8/31/21	8,114	682	303	39	8
9/1/21	11,373	765	256	35	42
9/2/21	11,199	574	254	66	54
9/3/21	11,623	969	364	73	34
9/4/21	9,806	641	385	49	24
9/5/21	9,617	707	285	36	8
9/6/21	9,055	756	267	45	13
9/7/21	8,192	753	240	33	23
9/8/21	6,461	867	229	20	14
9/9/21	9,762	780	276	51	32
9/10/21	6,659	775	356	7	1
9/11/21	11,616	689	386	49	20
Averages:	7,869.97	773.9	271.58	34.87	15.74

Figure 3: Data from Tara during First Month of Study

Tara					
Date	Steps	Minutes Sedentary	Minutes Lightly Active	Minutes Fairly Active	Minutes Very Active
10/4/21	4,885	1,252	188	0	0
10/5/21	4,872	1,239	201	0	0
10/6/21	7,589	1,109	331	0	0
10/7/21	1,656	1,358	82	0	0
10/8/21	1,203	1,205	74	0	0
10/9/21	2,021	1,322	118	0	0
10/10/21	438	1,419	21	0	0
10/11/21	6,844	1,138	302	0	0
10/12/21	6,593	1,142	298	0	0
10/13/21	5,670	1,188	252	0	0
10/14/21	0	1,440	0	0	0
10/15/21	1,635	1,214	97	0	0
10/16/21	4,489	1,059	221	0	0
10/17/21	281	1,423	17	0	0
10/18/21	7,268	1,146	294	0	0
10/19/21	8,099	1,086	354	0	0
10/20/21	6,753	1,135	305	0	0
10/21/21	0	1,440	0	0	0
10/22/21	0	1,440	0	0	0
10/23/21	0	1,440	0	0	0
10/24/21	0	1,440	0	0	0
10/25/21	7,319	1,177	248	5	10
10/26/21	8,968	1,114	310	11	5
10/27/21	6,527	1,213	216	4	7
Averages:	3,880	1,256	163.7083333	0.833333333	0.916666667

Figure 4: Data from Delora during First Month of Study

Delora						
Date	Steps	Minutes Sedentary	Minutes Lightly Active	Minutes Fairly Active	Minutes Very Active	
8/25/21	0	1,440	0	0	0	
8/26/21	12,194	1,174	138	17	111	
8/27/21	5,920	742	200	19	4	
8/28/21	10,319	575	203	7	53	
8/29/21	14,133	732	148	6	91	
8/30/21	14,523	720	253	4	92	
8/31/21	12,861	613	194	30	59	
9/1/21	12,404	749	130	15	71	
9/2/21	4,948	768	256	0	0	
9/3/21	13,026	781	215	1	66	
9/4/21	5,324	574	279	0	0	
9/5/21	12,263	728	145	2	80	
9/6/21	14,375	545	165	17	86	
9/7/21	15,659	621	305	4	77	
9/8/21	6,589	646	323	9	0	
9/9/21	6,882	820	318	15	2	
9/10/21	3,701	1,440	0	0	0	
9/11/21	3,664	1,440	0	0	0	
9/12/21	4,973	1,440	0	0	0	
9/13/21	4,018	1,440	0	0	0	
9/14/21	7,352	1,440	0	0	0	
9/15/21	5,979	1,440	0	0	0	
9/16/21	3,857	1,440	0	0	0	
9/17/21	14,694	1,440	0	0	0	
9/18/21	5,001	1,440	0	0	0	
9/19/21	10,888	1,440	0	0	0	
9/20/21	13,041	1,440	0	0	0	
9/21/21	14,215	1,440	0	0	0	
9/22/21	15,219	1,440	0	0	0	
9/23/21	12,065	1,440	0	0	0	
9/24/21	5,405	1,440	0	0	0	
Averages:	9,209	1,091	105.5483871	4.709677419	26.4	

DISCUSSION

As previously mentioned, the goal of this study was to analyze the relationship between self-efficacy and the level of adherence GSE. It was hypothesized that participants who had a higher self-efficacy (30 <) would demonstrate a higher level of adherence to the exercise program's step protocol. The Fitbit data was analyzed from the baseline to month three to show whether participants met their step protocol each week. This relationship could demonstrate their level of adherence to the exercise program. Given the purpose of the GSE centered around the self-efficacy, one could argue that this relationship demonstrates the participant's level of adherence. Figures 1, 2, and 3 are of three participants who best represent the observed trends.

Overall, 88% of participants scored themselves higher on the GSE (30<). Less than four participants scored themselves moderately (20 - 30) on the GSE scale. The average of the self-efficacy, including participants who withdrew, was a 34.56 out of 40. The highest self-scored participants within the study are marked with an asterisk in Figure 1. Most participants met their goals for the first two weeks of the program; however, the data became inconsistent toward the end of the 3-month study. Despite this, Daniel was the only outlier. He scored a 39 out of 40, met 90% of his weekly goals, and earned relatively high MTV activity minutes. In contrast, 89% of participants had higher average sedentary minutes and light activity minutes compared to fairly active minutes or very active minutes.

In this study, Daniel's preliminary data best represented Bandura's Social Learning Theory (1977). He highly scored himself and met more of the assigned goals compared to other participants. In contrast, Delora scored herself lower on the GSE compared with Tara; however, Delora (Figure 4) had higher average steps and activity minutes than Tara (Figure 3). Furthermore, in Figure 1, participants Shannon, Carmen, and Wendy each ranked them-

selves higher on the GSE; however, they withdrew from the study. This trend directly contradicts Desharnais et al. (1986) and Bandura (1986), which suggests that as an individual's self-efficacy increases, their adherence directly increases. Participant adherence during the first month could be related to different variables, including required meetings with the research team or staff involvement. Participants were required to meet once with the kinesiology research team at the beginning of the study to discuss the goals of the study and for general assessment. After the required meeting in the first month, the following participant data became more inconsistent. Having required in-person or online meetings with participants could potentially increase adherence to an exercise program. These meetings could serve as check-in points to see how the participant is managing the study. These adaptations to the protocol could also hold participants accountable to meeting their weekly goals and provide a clearer relationship between self-efficacy and level of adherence.

CONCLUSION

In conclusion, the preliminary data was inconclusive between the long-term relationship between self-efficacy and adherence to an exercise program due to limitations within the study. Furthermore, the preliminary data observed yielded varied results that aligned, yet contradicted Albert Bandura's Social Cognitive Theory (1986) and Jones et al. (2005). Participants, such as Daniel, ranked himself highly on the GSE and met most of his assigned goals within the study; however, participants, such as Delora and Tara, had an inverse relationship in their self-efficacy scores. This is common pattern for participants who volunteer in intervention studies. They often score themselves highly because they often seek out exercise interventions, but they fail to meet the provided goals. The higher self-scores could potentially represent an inaccurate self-reflection of self-efficacy of participants, meaning that individuals believe they are more capable of a task than they truly are. Although this study focused on the preliminary data from the first month of the pilot study, predictive conclusions could be drawn for the upcoming months of the study. As the 12 months of the study are completed, participants with a higher self-efficacy score should demonstrate a higher level of adherence to study goals. Although self-efficacy is considered to be a reliable predictor of adherence, a longer study is needed to observe the long-term relationship between self-efficacy and adherence.

PRACTICAL IMPLICATIONS

This study was initially a 12-month multipronged approach effective with lifestyle change study; however, due to limitations was reduced to 3-months. Limitations included, but not limited to moderate participant withdrawal, limited access and follow-up with participants, and limited controllability of participants as well as FitBits. As a result, there was a lack of quality data analysis to draw definite conclusions for this pilot study. Despite this the limitations of this study, revisions will be made so a second study can take place.

ACKNOWLEDGEMENTS

I would like to acknowledge and thank my thesis panel at Augusta University, Dr. Hannah Bennett, Dr. Daniel Greene, Dr. Trent Kays, and Dr. Tim Sadenwasser, for their support and time throughout this study. I will now acknowledge each for their contributions to this paper. Dr. Bennett served as my thesis advisor, assisting in the construction of the procedure and method sections. She also was a vital part of the revision process of this study. Dr. Greene, the in-field reader, assisted in the development of the participant demographic data table and overall background research. Dr. Kays, the HP chair, was responsible for revising and formatting this paper for grammatical and contextual errors from an outside perspective. Lastly, Dr. Sadenwasser served as my honors advisor, providing counseling and guidance throughout the research and publication process.

REFERENCES

Astrup, A., & Bügel, S. (2019). Overfed but undernourished: Recognizing nutritional inadequacies/deficiencies in patients with overweight or obesity. *International Journal of Obesity*, *43*(2), 219-232. doi: 10.1038/s41366-018-0143-9.

Bandura, A., & Walters, R. H. (1977). *Social Learning Theory* (Vol. 1). Prentice Hall.

Bandura, A. (1978). Self-efficacy: Toward a unifying theory of behavioral change. *Advances in Behavior Research and Therapy*, *1*(4), 139-163. https://doi.org/10.1016/0146-6402(78)90002-4

Bandura, A. (1982). Self-efficacy mechanism in human Agency. *American Psychologist*, *37*(2), 122-147. https://doi.org/10.1037/0003-066X.37.2.122

Bandura, A. (1986). *Social foundations of thought and action*. Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

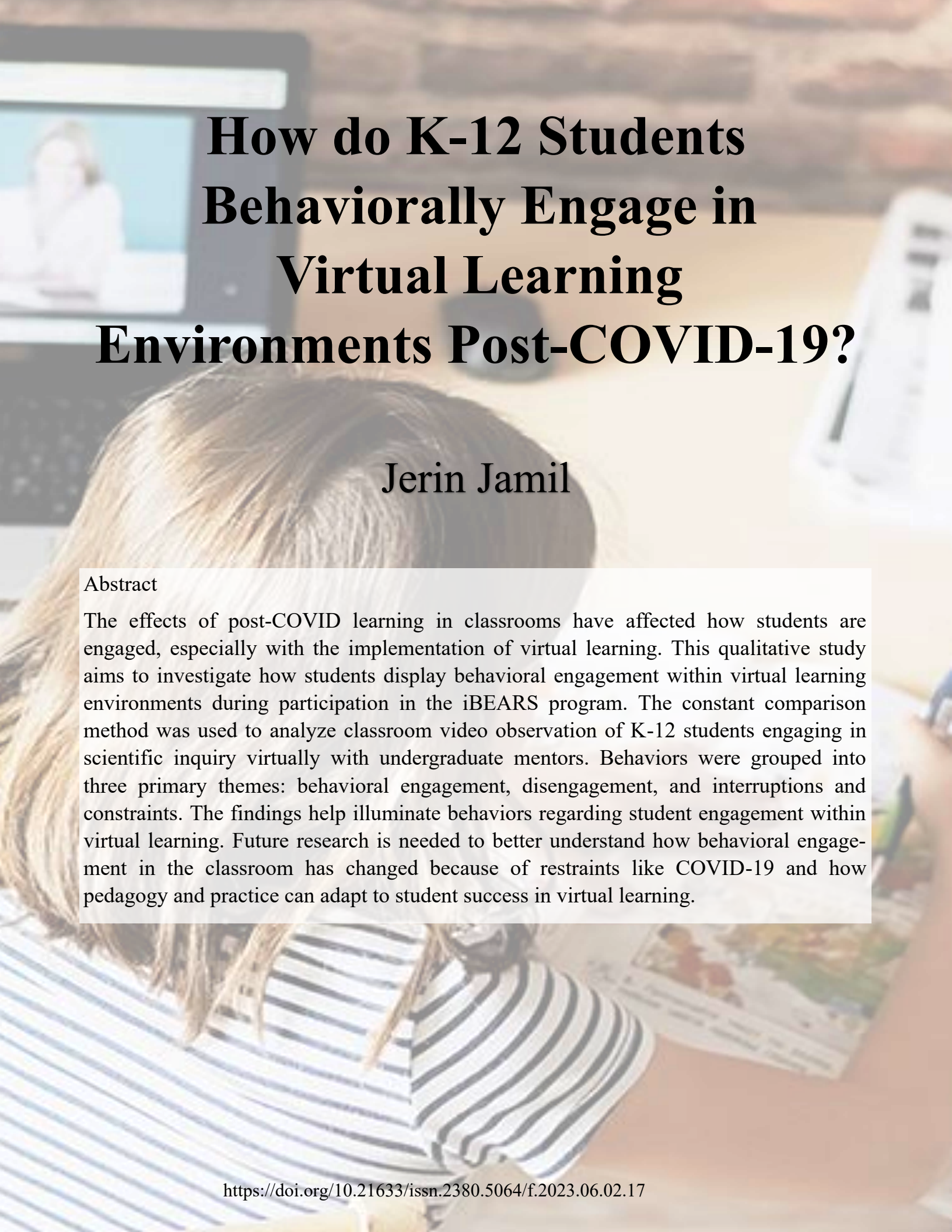
Bandura, A., & Locke, E. A. (2003). Negative self-efficacy, and goal effects revisited. *Journal of Applied Psychology*, *88*(1), 87– 99. https://doi.org/10.1037/0021-9010.88.1.87

Centers for Disease Control and Prevention. (2021). *Adult Obesity Facts*. Centers for Disease Control and Prevention. https://www.cdc.gov/obesity/data/adult.html

Dennis, K. E., & Goldberg, A. P. (1996). Weight control self-efficacy types and transitions affect weight-loss outcomes in obese women. *Addictive Behaviors*, *21*(1), 103-116. DOI: 10.1016/0306-4603(95)00042-9

Desharnais, R., Bouillon, J., & Godin, G. (1986). Self-efficacy and outcome expectations as determinants of exercise adherence. *Psychological Reports*, *59*(3), 1155-1159. https://doi.org/10.2466/pr0.1986.59.3.1155

Feltz, D. L. (1984). Self-efficacy as a cognitive mediator of athletic performance. In W. F. Straub & J. M. Williams (Eds.), *Cognitive sport psychology*, 191-198. Sport Science Associates.



How do K-12 Students Behaviorally Engage in Virtual Learning Environments Post-COVID-19?

Jerin Jamil

Abstract

The effects of post-COVID learning in classrooms have affected how students are engaged, especially with the implementation of virtual learning. This qualitative study aims to investigate how students display behavioral engagement within virtual learning environments during participation in the iBEARS program. The constant comparison method was used to analyze classroom video observation of K-12 students engaging in scientific inquiry virtually with undergraduate mentors. Behaviors were grouped into three primary themes: behavioral engagement, disengagement, and interruptions and constraints. The findings help illuminate behaviors regarding student engagement within virtual learning. Future research is needed to better understand how behavioral engagement in the classroom has changed because of restraints like COVID-19 and how pedagogy and practice can adapt to student success in virtual learning.

https://doi.org/10.21633/issn.2380.5064/f.2023.06.02.17

Student Author

Jerin Jami

Jerin Jamil graduated in May 2023 from Augusta University with a BA in Health, Society, and Policy. She is currently pursuing a Doctor of Pharmacy degree from the University of Georgia College Pharmacy. While at Augusta University, Jamil completed research investigating student engagement in virtual learning environments, specifically how students interact in these environments post-COVID.

Faculty Mentor

Dr. Alex T. St. Louis

0000-0002-1775-0276

Dr. Alex T. St. Louis is an instructor in the College of Education and Human Development and serves as the coordinator in the Center for Undergraduate Research and Scholarship (CURS). Dr. St. Louis' research interests include mentorship, understanding the nature of science, and improving scientific relations within the greater community. She loves working with undergraduate students, advocates for inclusion in science education, and finds great value in helping students learn research skills to become the next generation of leaders and scholars.

INTRODUCTION

The COVID-19 pandemic caused a shift from what society knew as "normal" to a world of constant change. The impact of the new accommodations of life affected every part of society, especially education. In accordance with COVID-19 guidelines, teaching was done through virtual settings to minimize the spread of infection (Centers for Disease Control, 2019). Engagement in the physical classroom versus online platforms is significantly different due to pedagogical constraints. Students were placed in virtual learning environments, often requiring students to not be easily distracted in order to retain important material. As our society adjusts to life post-COVID-19, understanding the effects of virtual learning on engagement, especially with K-12 students, can help shape future learning environments that encompass all of a student's needs. To further aid the process, this study aimed to answer the following question: How do K-12 students participating in the iBEARS (Inclusive Biologist Exploring Active Research) program engage in virtual learning environments post-COVID-19? By conducting this study, it was expected that while behavioral engagement in the classrooms would still be prevalent in the observations, a decrease in students' attention spans would also be expected with the mentors teaching from a distance.

PARTICIPANTS

The participants were nine undergraduate mentors who participated in the iBEARS program, and three K-12 student classrooms in elementary school classrooms.

METHODS AND MATERIALS

This qualitative study aimed to investigate how students exhibit behavioral engagement within the iBEARS program, which utilized project-based learning for undergraduate students (St. Louis et al., 2021). Undergraduate mentors were tasked to develop a science experiment with fifth grade students via Zoom. Mentors met with their K-12 students virtually once a week for one semester.

All meetings were recorded on Zoom. All three K-12 classrooms that participated in this study met for an average of 12 weeks, with recorded meetings ranging from 10 to 45 minutes. The behavioral analysis of the students engaging with their peers and mentors was done using the Constant Comparison method (Glasser & Strauss, 1967), which organized excerpts of the raw data into groups based on similar characteristics. Researchers' observations and changes in behavior during virtual classes were recorded on Microsoft Excel. In-vivo coding, a process where codes are derived from the participant's actual actions, was utilized since observations were noted based on raw behaviors, not assumptions (Given, 2008). A range of observations at certain timestamps were recorded from each weekly video. Once coding was complete, themes for each group were developed based on similar behavioral patterns. The overarching themes were then narrowed by certain characteristics into sub-themes.

Afterwards, the researchers met to discuss the validity of each code and work out any discrepancies, which established an inter-rater reliability of >90% and finalized the overall grouping. Once analyzed, descriptive statistics were used to characterize the themes and then graphed to show a visual aid.

RESULTS

The Constant Comparison method (Glasser & Strauss, 1967) was used to group similar observations done by in-vivo coding into categories. Three themes emerged from the data:

1. Disengagement
2. Interruptions/Constraints
3. Behavioral engagement

With some of the themes having characteristics that differentiated them from each other, 8 narrower subthemes were devised to group them even further in a simplistic manner:

1. Positive feedback from students: Students are seen as being excited or giving a more active/ excited response than usual.
2. Negative feedback from students: Students are silent when asked something that would usually require a response/shaking their heads.
3. Hands raised for questions asked: Nonverbal action of raising hands to questions asked by mentors/teachers.
4. Verbal communication between mentors and peers: Students work with each other and the undergraduate mentors on experiments.
5. Prior knowledge: Students offer feedback to questions and statements from mentors with the knowledge they had previously learned somewhere else.
6. Disengagement: Disinterest in class activities.
7. Interruption/constraints: A brief hindrance (in-class difficulties & technical difficulties) during class time that causes the students to lose focus.
8. Clarification by mentors/teachers: Follow up by mentors/teachers to redirect students to the task(s) at hand; can also be a brief explanation by mentors/teachers if students are confused over something.

Behavioral Engagement

The theme of behavioral engagement is characterized by students being actively involved in their learning. This includes the physical desire observed to continue learning. Subthemes in this category consisted of:

- Positive feedback: Students respond positively to the mentors by displaying genuine interest, and/or students are seen being excited or giving a more active/excited response than usual. An example of this would be: The UNDERGRADUATEs ask the students if they know what Newton discovered and they all get excited by jumping out of their seats and shout "Gravity!" (Classroom 5, Week 10). This subtheme appeared at an overall 9% in the study.

- Hands raised for questions asked: Nonverbal action of raising hands to answer questions asked by mentors/teachers. An example of this would be: An undergraduate asks the students if they remembered the discussion about symbiotic relationships last week, and 2 students in the back raise their hands. (Classroom 9, Week 4). This subtheme appeared at an overall 12.8% in the study.
- Prior knowledge: Students apply prior knowledge to the tasks presented to better build on the concept. The knowledge was acquired before the current discussions. An example of this would be: The undergraduates ask where roly-polys are found, and the class collectively answers "under rocks" (Classroom 8, Week 2). This subtheme appeared at an overall 4.4% in the study.
- Verbal communication among peers and mentors: The mentors and students communicated verbally as a way of exhibiting engagement as students are able to voice their thoughts and be actively engaged. An example of this would be: The groups go up to give their sentences, and the UNDERGRADUATEs help them write down what was required and how to find information. (Classroom 8, Week 7). This subtheme appeared at an overall 22.9% in the study.

Disengagement

The overarching theme of disengagement is characterized by students exhibiting disinterest in the activities presented. An example of this would be: Two students are seen putting their heads down in the front, focusing on other things as the undergraduates speak. (Classroom 9, Week 1). This theme appeared at an overall 21.8% in the study.

- Negative feedback from students: The subtheme highlights how students are silent when asked something that would usually require a response/ shaking their heads. An example of this would be: The undergraduates ask the students if they know who the woman is, the students stay quiet and look at each other. (Classroom 5, Week 8). This subtheme appeared at an overall 4.36% in the study.

Interruptions/constraints

The overarching theme of interruptions/ constraints is characterized as a brief hindrance (in-class difficulties & technical difficulties) during class time that causes the students to lose focus. An example of this would be: Another teacher walks in to observe the class, and the students turn their heads to see who it is. (Classroom 5, Week 4). This theme appeared at an overall 11.9% in the study.

- Clarification by mentors/teachers: The subtheme highlights the follow-up given by mentors/ teachers to redirect students to the task(s) at hand; can also be a brief explanation by mentors/ teachers if students are confused over something. This is usually followed after something interrupts the class and causes a hindrance in the flow of learning. An example of this would be: The undergraduates ask a question about the language used, and the teacher repeats it to the students with more background information. (Classroom 5, Week 8). This theme appeared at an overall 12.8% in the study.

DISCUSSION

The behaviors of the K-12 students expressed in classrooms varied throughout the duration of the iBEARS program. Virtual learning was a necessity for all levels of school to continue education safely after the pandemic. However, with the transition from in-person learning environments to virtual learning environments occurring so quickly, it was expected that the levels of student engagement would vary. A study involving German students who signed up with the learning environment Bettermarks, (Spitzer et al., 2021) found that while registration for the virtual-learning platform increased, self-reported student engagement decreased rapidly with the implementation of asynchronous learning. Wester et al. (2021) found that STEM undergraduates around the United States reported that their emotional engagement with their science courses decreased significantly after the pandemic, and their ability to utilize behavioral engagement in new, online courses staggered. Our findings are similar to that of the literature, where we found disengagement to be the

second-highest observed behavior among students (Figure 2). According to CNLD Testing and Therapy (2022), the feeling of disengagement can be due to a multitude of reasons, as the average fifth grader has an attention span of 20-30 minutes, leaving great room for the mind to roam in an hour-long class. In concurrence, interruptions and constraints in the classroom were followed by brief periods of disengagement from students, which caused mentors/ teachers to provide clarification to get the students' attention refocused on the task(s) at hand.

Although the primary findings gave virtual learning a bad connotation for its effects on K-12 learning, it is important to note that these studies were only considering students in higher education in the time period right after the pandemic, during which restrictions were slightly relaxed and engagement levels for online environments varied for all students. In another qualitative study observing university students' engagement during an online workshop, preprogrammed learning content was found to have lower learning effectiveness, and online-mediated teaching had no discernible effects on the students' level of engagement. (Hu & Hui, 2012). Upon completion of our study, it was found that there may be strengths and weaknesses in a student's engagement level that allows them to be proficient in certain areas, and their approach to learning makes the greatest difference.

According to Hu and Li (2017), the biggest determining factor for a student's overall engagement was their willingness to learn because positive emotions in the student would stimulate their use of knowledge and effective means to accomplish the academic tasks. This would, in turn, create interest in the next learning task. Due to virtual learning requiring a stronger approach to keep students engaged, the quality and quantity of how often the students collaborated with each other, understood the expectations, and respected boundaries was as important in influencing their levels of engagement as was the utilization of technology. As shown in Figure 2, communication between the students and their mentors was the highest observed behavior. This grounded the assumption that students were eager to participate in class by inputting previous knowledge they knew into figuring out new tasks and gave positive feedback to the learning styles set up by the iBEARS mentors. A YouTruth survey from 2012-2017 gathered from over 230,000 students from different grade levels on how they perceived their level of engagement was analyzed, and 78% of elementary schoolers felt engaged in their learning, whereas 60% of high schoolers felt engaged in theirs (YouTruth, 2022). It is possible that since elementary students are learning new concepts that are more foundational to further their learning, their interests are peaked, but older students may not feel the same way.

Limitations of the study were that many of the publications on post-COVID effects on student learning are not centralized around lower education levels, and it is important to note that school-age children learn primarily through active engagement, which can hone their cognitive abilities and self-regulation (Parker et al., 2022). Other limitations of our study were the study's scope and number of participants. Students will actively participate if the content piques their interest, whether it be through virtual settings or in-person classrooms.

CONCLUSION

The implementation of technology with online learning enacts an overall positive response from K-12 students, but discrepancies in paying attention is also expected. Students exhibit behavioral engagement in several ways, and the study signifies if the current approach to teaching kids is ideal. The pedagogy used for the new normal of online environments is continuously changing to fit the needs of students, and how the material is taught is now understood as a defining factor for the retention of material. Further research should include how different levels of elementary school students feel about online learning environments to detect trends, as well as more observational analysis of classroom behavior during online classes. The new research would further expand our understanding of how the pandemic affected school-aged students, especially during their prime learning years. Adjustments to online pedagogy could be made, and a new framework of how the material is presented could be established.

Table 1: Developed Themes and Examples

Themes	Subthemes	Definition	Examples
Behavioral engagement	Positive feedback from students	Students are seen being excited or giving a more active/excited response than usual	1. The undergraduates ask the students if they know what Newton discovered and they all get excited by jumping out of their seats and shout "Gravity!" (Classroom 5, Week 10) 2. Students express excitement for working on the science project. (Classroom 8, Week 2)
Disengagement	Negative feedback from students	Students are silent when asked something that would usually require a response/shaking their heads	1. The undergraduates ask the students if they know who the woman is, the students stay quiet and look at each other. (Classroom 5, Week 8) 2. The undergraduate asks if anyone wants to make edits to the research poster. No one says anything. (Classroom 9, Week 10)
Behavioral engagement	Hands raised for questions asked	Nonverbal action of raising hands to answer questions asked by mentors/teachers	1. An undergraduate asks the students if they remembered the discussion about symbiotic relationships last week, 2 students in the back raise their hands. (Classroom 9, Week 4) 2. Students are asked to raise their hands to call out their answers, and many hands go up, some stand out of their seats so they can be seen and picked. (Classroom 8, Week 3)
Behavioral engagement	Verbal communication between mentors and peers	Students work with each other and the undergraduate mentors on experiments	1. The groups go up to give their sentences, and the undergraduates help them write down what was required and how to find information. (Classroom 8, Week 7) 2. As the experiment continues, the students are actively watching and asking questions as to why the reaction didn't proceed. (Classroom 5, Week 5)
Behavioral engagement	Prior knowledge	Students take notes of what is being discussed in class and do what they can to better build upon the concept. They offer insightful comments, pulling information from prior knowledge they have acquired.	1. A student has her hand raised to answer the question, but only remembers one of the variables. 3 hands go up to answer the other. (Classroom 5, Week 4) 2. The undergraduates ask where roly-polys are found, and the class collectively answers "under rocks" (Classroom 8, Week 2)
Disengagement	Disengagement	Disinterest in class activities	1. 2 students are seen putting their heads down in the front, focusing on other things as the undergraduates speak. (Classroom 9, Week 1) 2. Students in the front are talking to students in the back while the undergraduates explain Excel. (Classroom 8, Week 12)

Table 1 Continued: Developed Themes and Examples

Themes	Subthemes	Definition	Examples
Interruptions/ constraints	Interruption/constraints	A brief hindrance (in-class difficulties & technical difficulties) during class time causes the students to lose focus	1. Another teacher walks in to observe the class, and the students turn their heads to see who it is. (Classroom 5, Week 4) 2. As the undergraduates ask another question, the lesson is paused due to another announcement. 2 students leave to take their pictures. The question is asked again to bring the attention back to the lesson. (Classroom 5, Week 2)
Interruptions/ constraints	Clarification by mentors/teachers	Follow-up by mentors/teachers to redirect students to the task(s) at hand; can also be a brief explanation by mentors/teachers if students are confused over something	1. The undergraduates ask a question about the language used, and the teacher repeats it to the students with more background information. (Classroom 5, Week 8) 2. The undergraduates ask who wants to do food, 2 hands go up, the teacher repeats the question and more hands go up. (Classroom 9, Week 3)

Figure 1: Overall Themes Observed in K-12 Online Mentorship Program

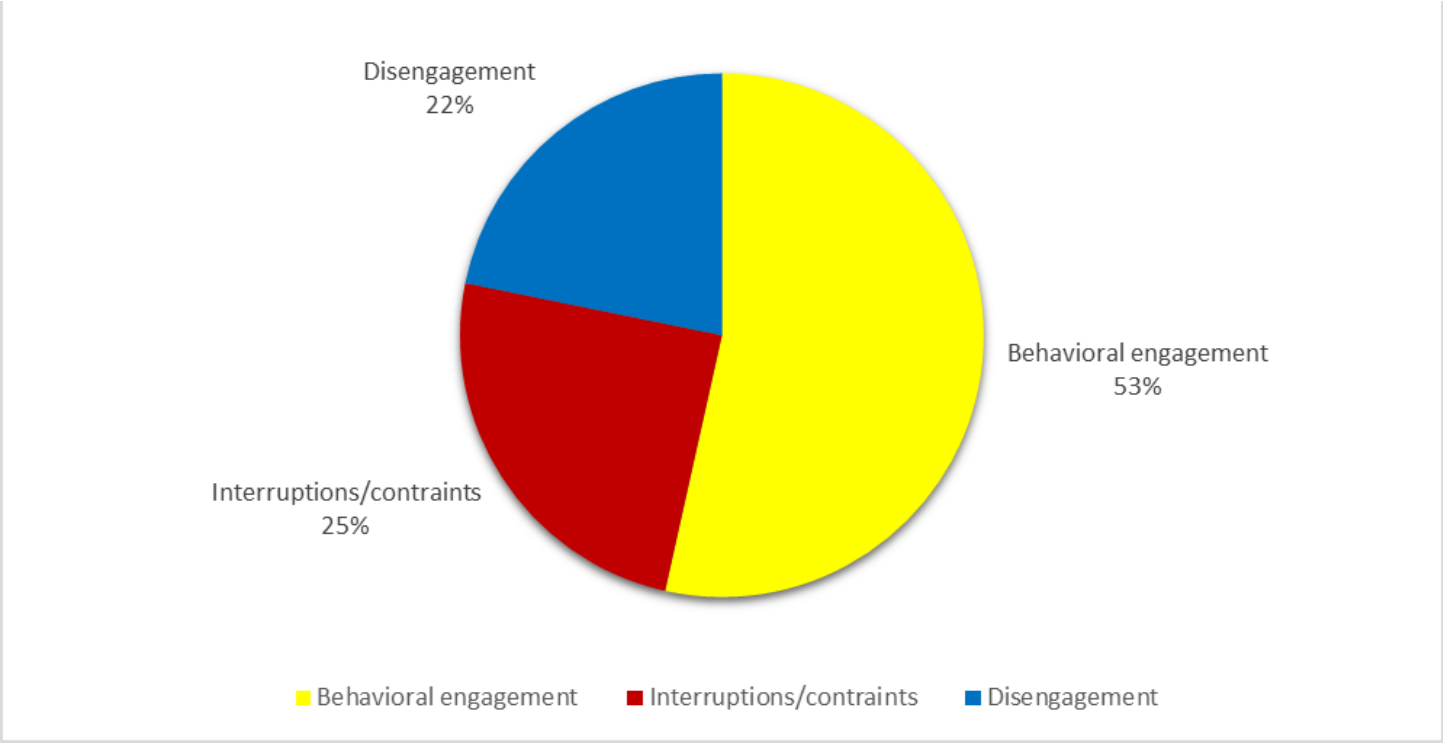
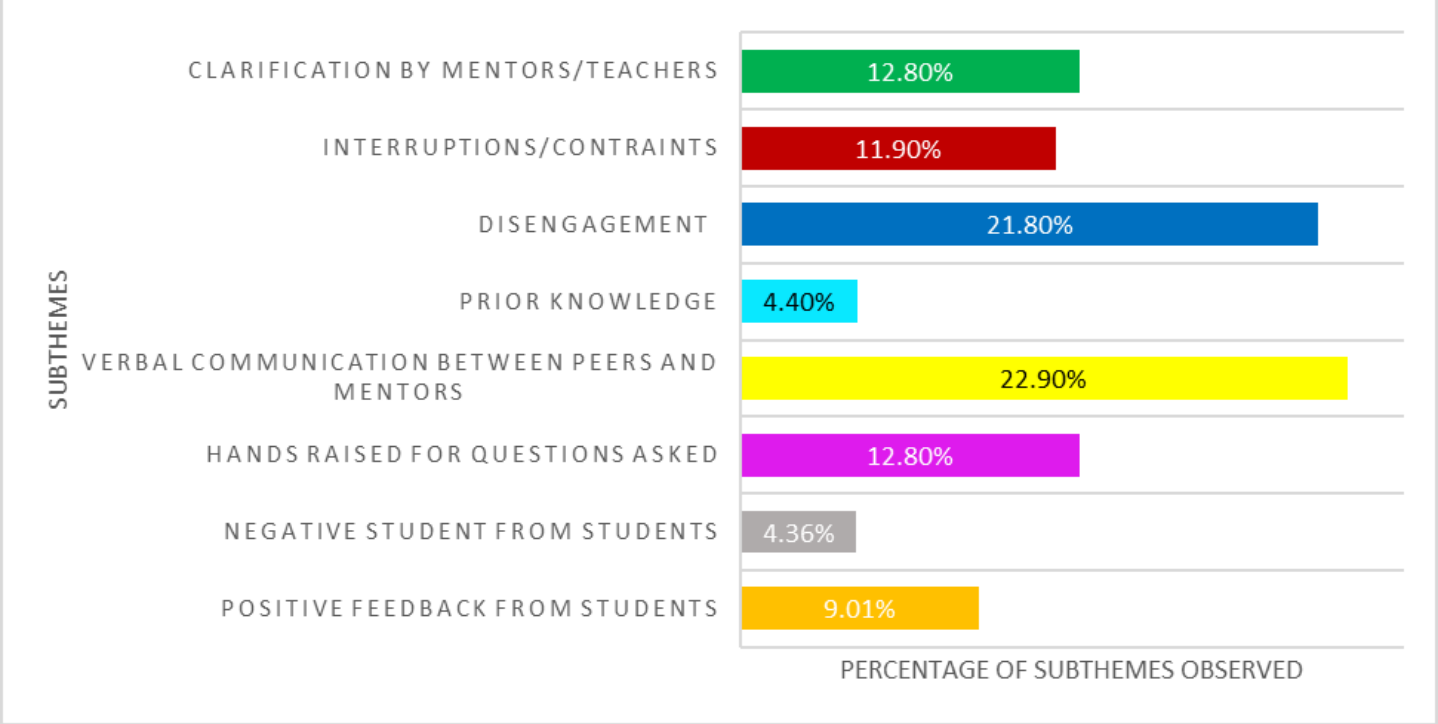


Figure 2: Subthemes From Themes Observed in K-12 Online Mentorship Program



REFERENCES

Centers for Disease Control and Prevention. (2019). *Isolation and precautions for people with COVID-19*. https://www.cdc.gov/coronavirus/2019-ncov/your-health/isolation.html

CNLD Testing and Therapy. (2022). *How long should a child's attention span be?* https://www.cnld.org/how-long-should-a-childs-attention-span-be/

Given, L. (2008). Postpositivism. *The Sage Encyclopedia of Qualitative Research Methods*, 660-665. SAGE Publications. http://dx.doi.org/10.4135/9781412963909.n332

Glauser, B. G., & Strauss, A. L. (1967). The discovery of grounded theory. *Strategies for Qualitative Research*. Aldine.

Hu, M, and Li, H. (2017). Student engagement in online learning: A review. *International Symposium on Educational Technology* (*ISET*), 39-43. doi: 10.1109/ISET.2017.17.

Hu, P. J., and Hui, W. (2012). Examining the role of learning engagement in technology-mediated learning and its effects on learning effectiveness and satisfaction. *Decision Support Systems*, *53* (4), 782-792. https://doi.org/10.1016/j.dss.2012.05.014

Parker, R., Stjerne Thomson, B., & Berry, A. (2022). Learning through play at school – A framework for policy and practice. *Frontiers in Education*, 7. https://doi.org/10.3389/feduc.2022.751801

Spitzer, M. W. H., Gutsfeld, R., Wirzberger, M., & Moeller, K. (2021). Evaluating students' engagement with an online learning environment during and after COVID-19 related school closures: A survival analysis approach. *Trends in Neuroscience and Education*, *25*, 1-8. https://doi.org/10.1016/j.tine.2021.100168

St. Louis, A. T., Thompson, P., Sulak, T., Harvill, M. L., & Moore, M. E. (2021). Infusing 21st century skill development into the undergraduate curriculum: The formation of the iBEARS network. *Journal of Microbiology & Biology Education*, 22:e00180-21. https://doi.org/10.1128/jmbe.00180-21

Wester, R. E., Walsh, L. L., Arango-Caro, S., & Callis-Duehl, L. K. (2021). Student engagement declines in STEM undergraduates during COVID-19-driven remote learning. *Journal of Microbiology and Biology Education*, *22*(1), 1-11. https://doi.org/10.1128/jmbe.v22i1.2385

YouTruth. (2022). *Learning from student voice: Are students engaged?* https://youthtruthsurvey.org/wp-content/uploads/2022/10/P21-VERSION-LFSV_Student_Engagement_FINAL-P21-version-2.pdf

The Effects of Urbanization on Euchee Creek Macroinvertebrate Populations

Kayla Floyd

Abstract

This study aims to determine the effects of urbanization on freshwater streams. Fresh water is a vital resource for a variety of species including humans. Euchee Creek in Evans, GA was selected as the primary focus for this study because the creek travels through several neighborhoods, a golf course, a housing construction site, and a paved walking trail. This study assessed several biological and chemical factors to determine the water quality at selected sample sites along the creek over four seasons. Abundance and diversity of macroinvertebrate populations inhabiting creeks have been shown to serve as good biomarkers because some macroinvertebrates are more sensitive to changes in water quality. This study did not find definitive evidence of water quality issues in Euchee Creek, but the limited abundance and diversity found in some of the macroinvertebrate samples suggest that there may be water quality issues present and that further studies are warranted.

https://doi/org/10.21633/issn.2380.5064/f.2023.06.02.27

Student Author

Kayla Floyd
0009-0002-0295-7829

Kayla Floyd is pursuing a Bachelor of Arts in Integrated Studies with a minor in Biology at Augusta University. Floyd is a member of the Honors Program, in which she has had the opportunity to work on her first independent research project and present at conferences. She has also assisted in other diverse research projects that have deepened her interest in the One Health Initiative, which explores the interconnectedness of human health, animal welfare, and the environment.

Faculty Mentor

Jessica Reichmuth, PhD
0000-0003-2643-8572

Dr. Reichmuth, or Dr. R to her students, earned her PhD in Biological Sciences with a specialization in Ecology and Evolution from Rutgers University-Newark in 2009, where she spent several years chasing blue crabs. She currently teaches courses in General Biology, Marine Ecology, and Community Ecology. Her research students are currently answering questions ranging from crustacean population genetics to invertebrate animal behavior.

The various impacts of urbanization have devastating effects on water quality and reduce the capacity of aquatic ecosystems to provide a wide range of ecosystem services (Meyer, 2009). Freshwater is one of the most valuable natural resources to life on earth. Freshwater is essential to food production and human consumption while also playing significant roles in manufacturing, sanitation, medical use, power generation, and recreational use. Freshwater also has great ecological importance as it serves as hotspots that support approximately 10% of all known species, and one third of all vertebrate species that inhabit the earth (Strayer & Dudgeon, 2010). Despite its widespread importance, freshwater constitutes only 2.5% of the total water on Earth and only a fraction of this is accessible (Petersen et al., 2019).

Several global studies on water quality have been able to make a connection between urbanization and degradation of freshwater resources. One study performed near Detroit obtained water samples from local wells and they found that the influence on the decrease in ground-water quality appeared to be from septic-system effluent (domestic sewage, household solvents, water-softener backwash) and infiltration of storm-water runoff from paved surfaces (Thomas, 2007). The study also found pesticides in several samples as well as spikes in salinity levels around areas of human development. Another study collected tissue samples from frogs in various regions in the United States to measure the effects of pesticides that wash into waterways. Georgia was one of the states included in the study. They found that pesticides and pesticide degradates were detected frequently in frog breeding habitats (water and sediment) as well as in frog tissue in areas with greater ratios of urbanization (Battaglin et al., 2016). Many other articles were able to show a decrease in water quality in correlation with human presence and urbanization.

This degradation of water quality endangers a variety of native species as well as humans who use the water for drinking and agricultural purposes. Decrease in freshwater quality caused severe declines in the range and abundance of many freshwater species, who are now far more imperiled than their marine or terrestrial counterparts (Strayer & Dudgeon, 2010).

Poor water quality has been linked with the transmission of heavy metals through food production and is a major public health issue, resulting in food toxicity, biological abnormalities and risk of cancer in the long-term (Withanachchi, 2018). Drinking water contaminants also pose a harm to public health, such as the 16 million cases of acute gastroenteritis that occur each year at US community water systems (Allaire et al., 2018).

Many different biological communities can serve as good indicators of stream health and water quality. Abundance and diversity of macroinvertebrate populations is a frequently used and effective method. This is due to these creatures spending most or all of their lives in the water, the length of their lifespan, the ease of collecting these organisms, and their varying levels of sensitivity to specific changes in water quality.

Aquatic macroinvertebrates are a large group of creatures in lower taxa (that lack vertebra) who spend all or most of their lives in water. These organisms consist of creatures like crayfish, leaches, aquatic worms, and many larval and nymph stages of flying insects. They are important members of their ecological communities due to their role in the consumption and conversion of organic debris into a food source for many species of fish, amphibians, birds, and mammals (Sumudumali, 2021).

These aquatic macroinvertebrates have been thoroughly sampled and studied in a variety of waterways (Raposeiro, 2022). They possess relatively long lifespans and have an inability to voluntary leave polluted waters. These macroinvertebrates also react to disturbances in water quality in predictable ways due to their body plans and adaptations (Liz Ortiz Contreras, 2021). Organisms with a high sensitivity to water quality changes often possess characteristics like passive gills that require moving water with high levels of oxygen in order for the organism to breathe. Organisms that possess low sensitivity to water quality changes have evolved to have adaptations such as lunglike sacs, breathing tubes, or hemoglobin. These adaptations will allow them to survive and sometimes flourish in habitats with poor water quality.

Variations in their sensitivity contribute to the effectiveness of aquatic macroinvertebrate sampling (Sumudumali, 2021). Healthy streams will have a wide variety of organisms, including those sensitive to pollution. Streams with low amounts of biodiversity or primarily filled with populations of tolerant organisms suggest a degradation in water quality and overall stream health.

While aquatic macroinvertebrates populations react to many of the issues that arise with water quality degeneration (changes in pH, dissolved oxygen, nitrates, and temperature) they do not react to all pollutants (Liz Ortiz Contreras, 2021). This means that extremely low amounts of macroinvertebrates can aid in proving water quality issues, but normal population values cannot rule out some types of pollutants present in the stream. Population shifts in macroinvertebrates can also be due to factors other than pollution, such as unfavorable water currents, type of substrate, and drought. Macroinvertebrates can also be subject to oversampling and can be harder to collect in colder seasons due to some burrowing deeper in sediment or clinging to rocks. Implications of these issues can be minimized by repeat monitoring of the same sample site over time (to compare it to its own data), samples collected over different seasons, and sample collection spaced out with enough time to give populations time needed to reestablish the habitat that was disturbed during sampling. This will allow for the observation of normal populations in the sampled stream to be determined and changes in this data can indicate water quality degradation or improvement.

This study aims to assess the effects of urbanization on aquatic macroinvertebrate populations and will focus on Euchee Creek in Columbia County, Georgia. Euchee Creek is a tributary of the Savannah River, a river which is known locally for its drinking water and recreational use as well as its issues with water quality. Columbia County is well known for its recent spike in population as well as its rapid urban growth over the past 15 years. Columbia County has had several issues with water quality in the past and scholarly articles addressing the subject are hard to come by for the region. Local news articles discuss complaints on water quality in Columbia County where locals say the water tastes

and smells terrible (Johnson, 2020).

Recent local water quality studies have been hard to come by and this study aims to give a more recent analysis on the creek's water quality. The predication is that the population numbers and sensitivity of the macroinvertebrates inhabiting the creek will decrease downstream of the golf course and the housing construction site suggesting an issue with water quality.

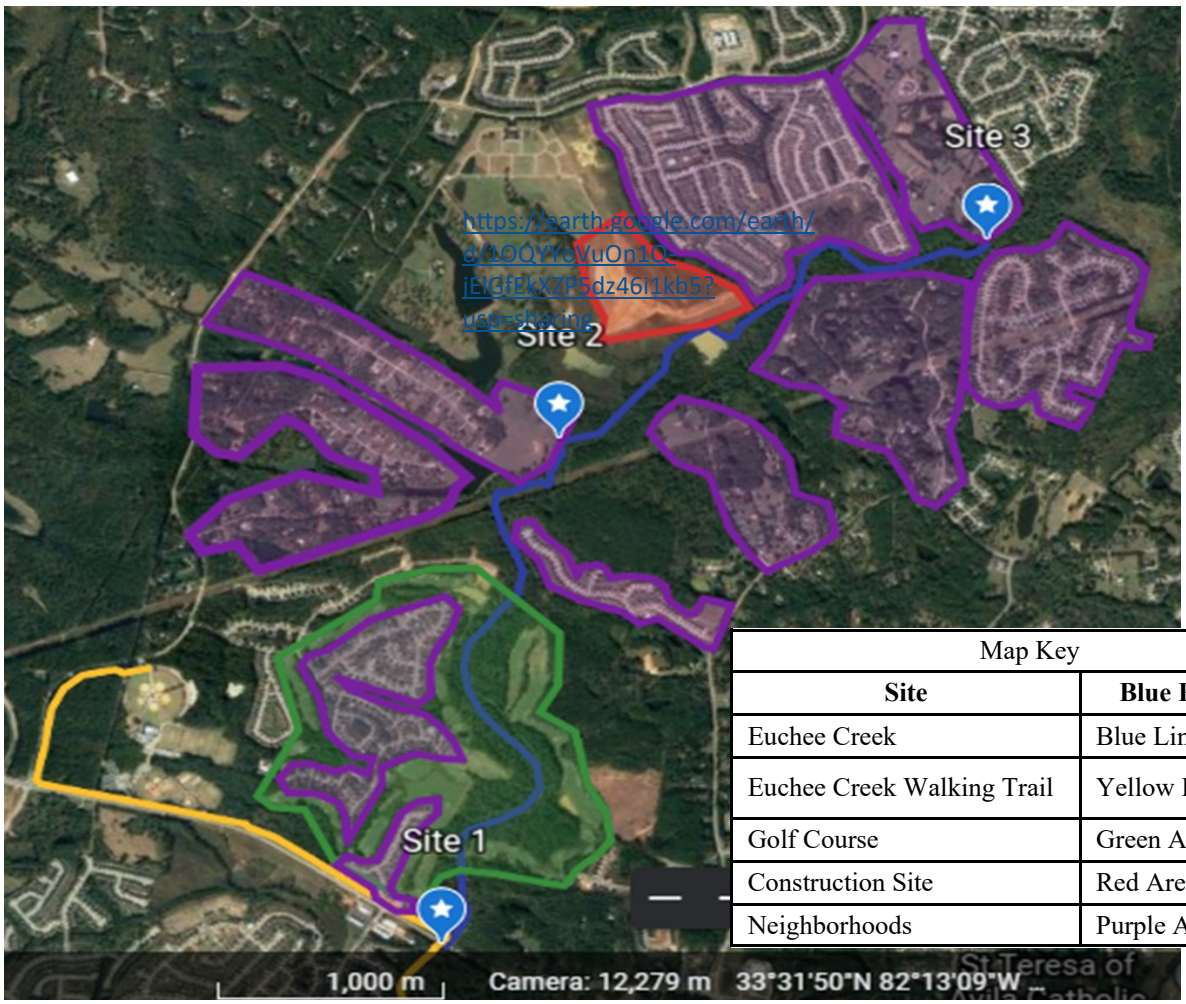
METHODS

Due to the large size of Euchee Creek and the limitations of this study, a distance of approximately 5828.59m was selected as the primary focus of this research. This section of the creek travels through a golf course as well as a green space bordered by neighborhoods, neighborhood construction, and a local walking trail. Three sample sites were selected located on the local walking trail, 440.4m upstream from the golf course. Sample Site Two is located at the back of a neighborhood 1044.35m downstream from the golf course and 939.49m upstream from the construction site. Sample Site Three is located at the end of another neighborhood 132.73m downstream from the construction site. Sample site one is considered public land and formal landowner permission sheets were completed for the use of sample sites two and three.

Table 1: Approximate Coordinates of Sample Sites, Golf Course, and Housing Construction Site

Collection Sites	Coordinates Obtained from Google Maps
Sample Site 1	33.5102783, -82.2153666
Golf Course	33.5125719, -82.2128122
Sample site 2	33.5338835, -82.2098049
Housing Construction Site	33.539028, -82.2028677
Sample Site 3	33.5426697, -82.1891342

Image 1: Sample Sites and Areas of Urbanization Adjoining Euchee Creek



Map Key	
Site	**Blue Pin Mark**
Euchee Creek	Blue Line
Euchee Creek Walking Trail	Yellow Line
Golf Course	Green Area
Construction Site	Red Area
Neighborhoods	Purple Area

This study focuses on population numbers and sensitivity of various species of aquatic macroinvertebrates as well as basic water chemical parameters to determine the effects of urbanization on Euchee Creek. To obtain enough data while trying to minimize damage to local macroinvertebrate populations, four samples were collected over the course of four seasons. Samples were collected by working at sites downstream first in order to not reacquire the same macroinvertebrates that may have been dislodged during the netting process.

Table 2: Sampling Dates

Time of Year	Dates
Winter	3/14/2021
Spring	6/16/2021
Summer	8/22/2021
Fall	10/16/2021

Muddy bottom stream sampling for macroinvertebrates

A D-ring net was used to collect samples. A sample consist of 20 jabs in productive habitats. A single jab consists of aggressively thrusting the net into the target habitat for a distance of approximately one meter. The jab is followed by two to three sweeps of the same area to collect dislodged organisms. Four different habitats were included in each sample and had a designated number of jabs to ensure consistency in the data collected between the sites.

Once organisms were acquired, they were sorted by species and population counts of each were documented. The macroinvertebrates were sorted into three categories based on their sensitivity to changes in water quality that was outlined by the Izaak Walton League of America, Resources for stream monitors. These three categories include sensitive, less sensitive, and tolerant. Some examples of these organisms include mayflies and stoneflies as sensitive, damselflies and dragonflies as less sensitive, and black flies and midge flies as tolerant organisms.

The typical equations for determining water quality were ineffective when used on the numbers

Table 3: Sample Collection Methods

Habitat	Method Used	Number of Jabs
Steep bank/ vegetated margin	Move the dip net in a bottom-to-surface motion, jabbing at the bank to loosen organisms.	Ten jabs are needed for the sample.
Woody debris with organic matter	Jab the net into sticks and branches. Scrape along the surface of large logs.	Four jabs and/or scrapes are needed for the sample.
Gravel/sand substrate	Push the net upstream with a jabbing motion to dislodge the first few inches of gravel, sand, or rocks.	Three jabs are needed for the sample.
Silty bottom with organic matter	Push the net upstream with a abbing motion to dislodge the first few inches of organic layer.	Three jabs are needed for the sample.

gathered from sample sites two and three. This is because a sample needs to have 100 non-scud organisms (Izaak Walton League of America, Resources for stream monitors 2021). Sample site one met this requirement but sample sites two and three did not, so a new way to measure biological sensitivity was needed for this study. To accomplish this, points were allocated to organisms based on their sensitivity rating and then added together to compare water quality values. This allowed population, variation, and pollution sensitivity to be considered, but the limitation of this method is that it is only useful in comparing the water quality between different sites. It does not serve as a good general water quality rating score as there is not enough outside data to assign ratings to specific biological sensitivity scores. Sensitivity rating scores and their associated species are featured in table 4 below.

Water chemistry sampling

Water chemistry sampling was also performed and included measurements of the percent dissolved

oxygen (%DO) and measurements of the amount of nitrate (ppmN) in the water. %DO and ppmN measurements were obtained using the LaMotte Dissolved Oxygen Test Kit and the LaMotte Nitrate-Nitrogen Test Kit. Due to shipping issues associated with the global pandemic, the water chemistry kits did not arrive in time for the winter samples and so the data is limited to spring, summer, and fall samples.

Table 4: Method Used for Biological Sensitivity

Organisms	Sensitivity Rating*
Caddisflies (except net spinners) Mayflies Stoneflies Watersnipe flies Riffle beetles Water pennies Gilled snails	Sensitive, +3 points
Dobsonflies Fishflies Crane flies Damselflies Dragonflies Alderflies Common net spinning Caddisflies Crayfish Scuds Aquatic sowbugs Clams Mussels	Less Sensitive, +2 points
Aquatic worms Black flies Midge flies Leeches Lunged snails	Tolerant, +1 point

*Organism sensitivity scale is based on the specified sensitivity created by Izaak Walton League of America, Resources for stream monitors 2021.

The kits include easy to follow instructions and conversions associated with obtaining accurate measurements due to the different effects that altitude and temperature have on the %DO. Water temperature was obtained using a DT302 Digital Temperature Logger. Water chemistry samples were taken along with the aquatic macroinvertebrate samples. Statistical analysis was performed using Vassar Stats. A One-Way ANOVA was performed for water chemistry results and a Kruskal-Wallis was performed on macroinvertebrate sensitivity groups.

RESULTS

Site one, the upstream location, had higher macroinvertebrate populations than sites two and three. Site two, located below the golf course and above the housing construction site, had the lowest population counts. A similar trend is seen when looking at the biological sensitivity as site one had the highest biological sensitivity rating and site two generally had the lowest. A statistical analysis on the population numbers was performed using Vassar stats while a Kruskal-Wallis test was performed on the macroinvertebrate sensitivity groups. These tests found a lack in extreme variation between the sample sites. This means that the data obtained is suggestive of issues of water quality but not conclusive.

Aside from population counts and biological sensitivity scores, several other observations about the macroinvertebrates collected were made. Some groups of macroinvertebrates were not observed in any of the samples obtained. These include water pennies, gilled snails, alderflies, mussels, and blackflies. Some groups of macroinvertebrates were only located at site one. These include dobsonflies, crayfish, leaches, and lunged snails. Another trend observed was damselflies, scuds, and aquatic worms were primarily found at site one. They often decreased in population at site two, and a small number of these organisms were found at site three.

The difference in percent dissolved oxygen and nitrate/nitrite was also measured. No obvious variation between the sites can be observed through this data. This data was processed through a one-way ANOVA which found no significant variation in the

amounts of %DO and ppmN measured at each site. Even though differences in the physical appearance of the water was observed, no significant difference was found in DO and N.

DISCUSSION

The data acquired from the sample sites suggest the possibility of water quality issues, but the lack of extreme variation between sample data does not provide definitive evidence of this. Seasonal variations were considered when collecting samples, but the study was conducted on a limited time frame and the accuracy of the results would benefit from an increase in the duration of the study.

Streambank erosion was observed at sites two and three. Site two, located below the golf course and above the housing construction site, appeared to have the most issues with erosion. Site two possessed a steep bank with limited foliage and large amounts of exposed soil. Site two generally had a lower population count of macroinvertebrates and a lower biological sensitivity score in comparison with sites one and two. Past studies have found that nutrients and pesticides are commonly used to maintain golf course turf systems and may be transported through surface runoff or through subsurface drainage to surface waters (Grande, 2019). This may account for the decrease in macroinvertebrate populations and foliage along the streambank, but further studies are warranted to determine the exact causes for this.

Site three was observed to have muddy red water after rain events but no significant variation in %DO and ppmN was observed between the sample sites. Nitrates are naturally found in aquatic ecosystems but when too much nitrogen enters an environment, it allows for the rapid reproduction of algae and aquatic plants. This is known as eutrophication and many ecosystems cannot support this rapid growth. Streams affected by an excess of algal growth were found to have issues with water quality, food resources and habitats, and an overall decrease of dissolved oxygen (Camargo & Alonso, 2006). Future studies might benefit from an increase in the frequency of water chemistry samples collected, particularly after heavy rain events to account for runoff.

The populations of scuds and crayfish followed the trend of appearing in higher numbers at site one and becoming scarce at sites two and three. In total, 184 scuds and six crayfish were found at site one over the four seasons. No scuds or crayfish were found at site two and one scud was found at site three. This trend is of particular interest as they both belong to the subphylum crustacea. The exact reason behind their observed decrease is unknown and warrants further studies into the sensitivities of freshwater crustaceans and possible impacts of urbanization upstream from site two.

Euchee Creek has many reports of extreme flooding, which may increase erosion and contribute to poor water quality. There was also a safety alert issued on Oct. 4, 2021, urging locals who use the Euchee Creek Trail or live near the subdivision to use caution. This alert also urged people to stay out of the water and keep their pets out of the water due to a sewer leak (Public works monitoring Euchee Creek after manhole overflows; Avoid water on Euchee Creek Trails).

Data on the water quality of Euchee Creek are limited. The Savanah Riverkeeper has a sample site located at Betty's Branch directly downstream of Euchee Creek. Samples that were collected at Betty's Branch throughout 2021 by the Savanah Riverkeeper showed that the water quality failed to meet the minimum state standards for swimmable water in 58% of the samples collected (https://www.theswimguide.org/beach/8752). This means that the level of E. coli bacteria in the water is greater than 360 units per 100mL.

Global water quality studies commonly indicate that urbanization and development can have negative consequences on local water quality as pesticides, leachates, fertilizer, and erosion change the chemical makeup of the water (Sumudumali, 2021). A large portion of Euchee Creek is surrounded by numerous housing construction sites, local parks, and a golf course. Large densely populated neighborhoods and sewer mains are also a common sight along the waterway. A recent political push for the extension of a paved recreational walking trail alongside the creek is also in motion. All of these can potentially be detrimental to the water quality of Euchee Creek.

While our data are not conclusive, it is suggestive of water quality issues. This warrants further into the decrease in macroinvertebrate populations in Euchee Creek as well as the potential causes of this decline.

CONCLUSION

The purpose of this study was to observe the effects of urbanization on Euchee Creek's water quality by measuring its macroinvertebrate populations. The prediction was that the population numbers and sensitivity of the macroinvertebrates inhabiting the creek would decrease downstream of the golf course and the housing construction site. This would have been suggestive of an issue with the water quality.

Data collection focused on populations of macroinvertebrates that inhabit the creek as well as their sensitivity to water quality issues. %DO and ppmN were also observed but no significant variation was noted. Data collection was spaced out over four seasons and taken from three sample sites. The data collected from all three sites suggest the presence of water quality issues at sites two (below the golf course) and three (below the construction site). The lack of extreme variation in the data collected does not allow for any conclusions to be made at this time and further studies into issues of water quality in this area are warranted.

Figure 1: Seasonal Macroinvertebrate Populations Collected form Euchee Creek

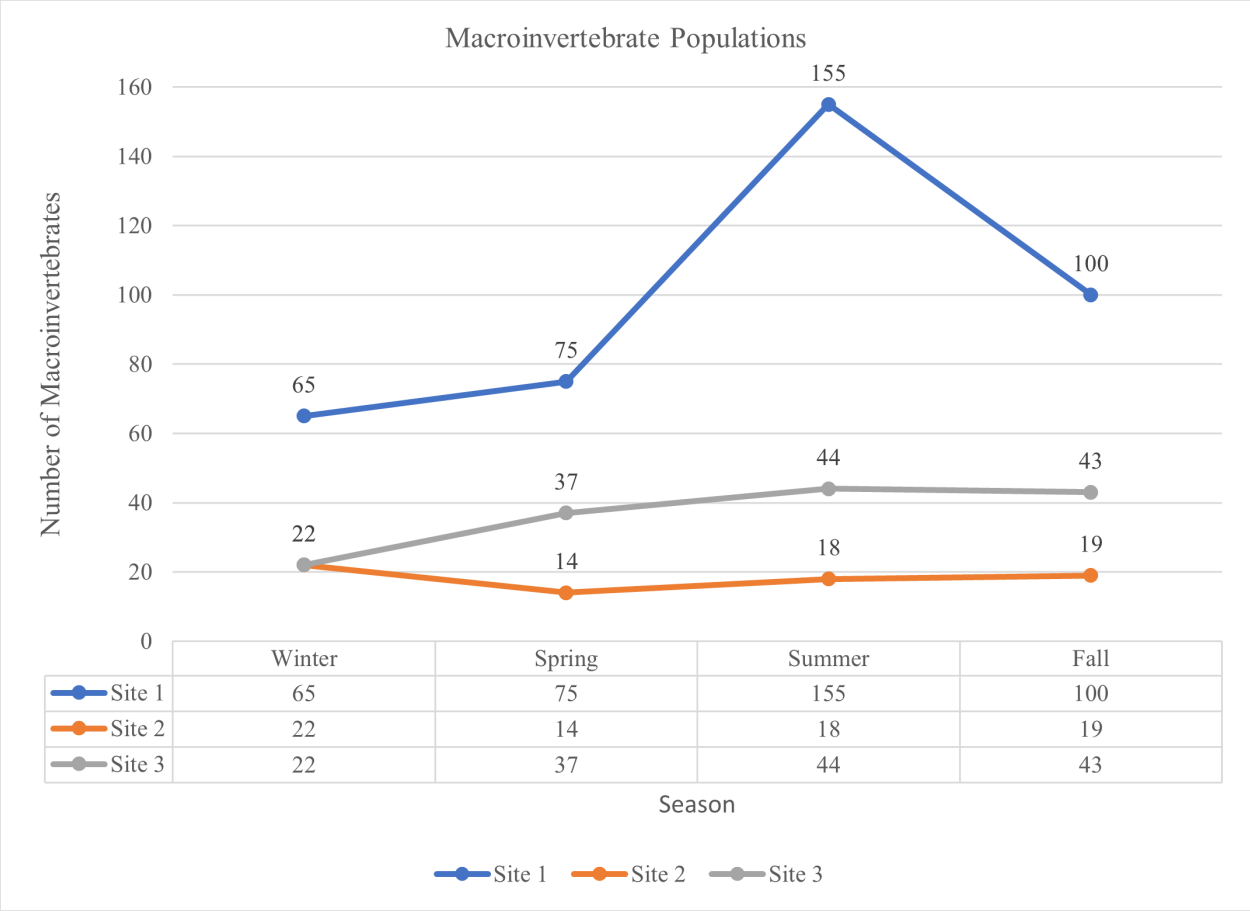


Figure 2: Seasonal Biological Sensitivity Score of Euchee Creek Population Samples

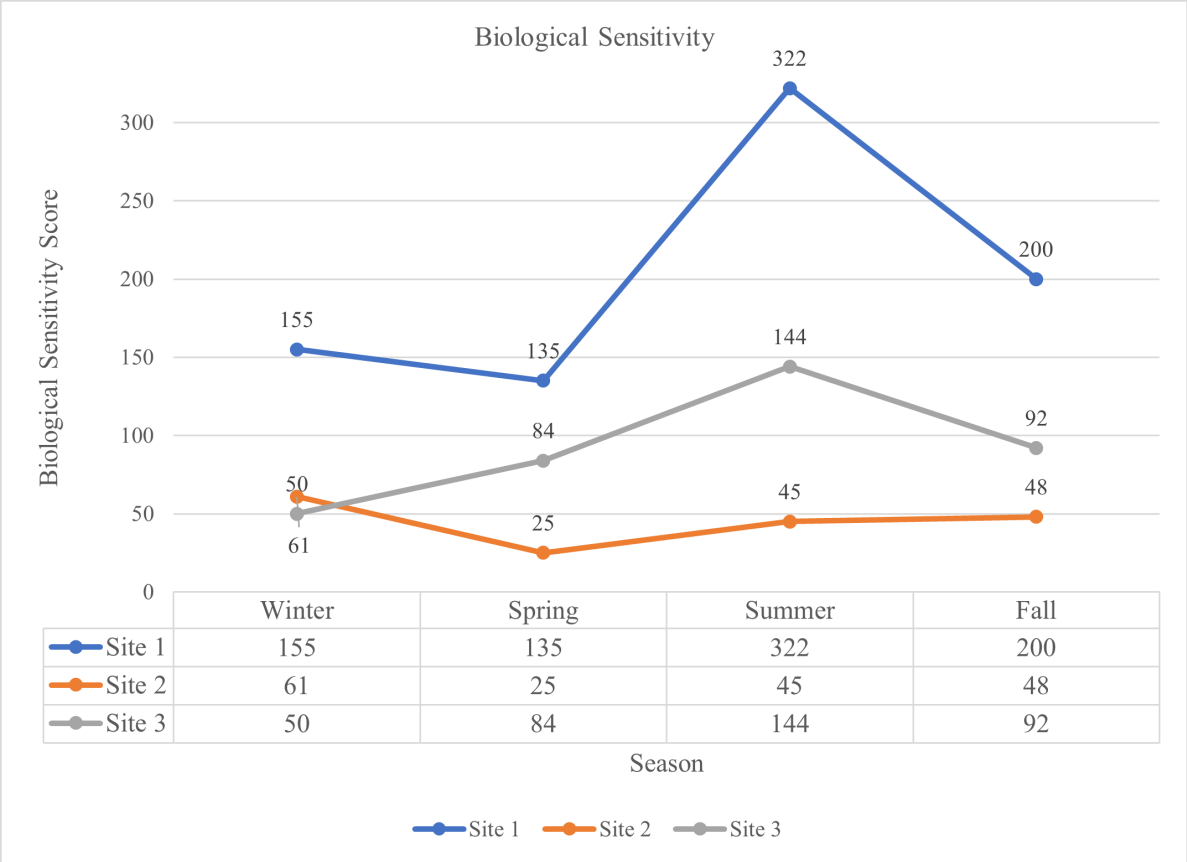


Figure 3: Macroinvertebrate Population Vs Sensitivity Comparision

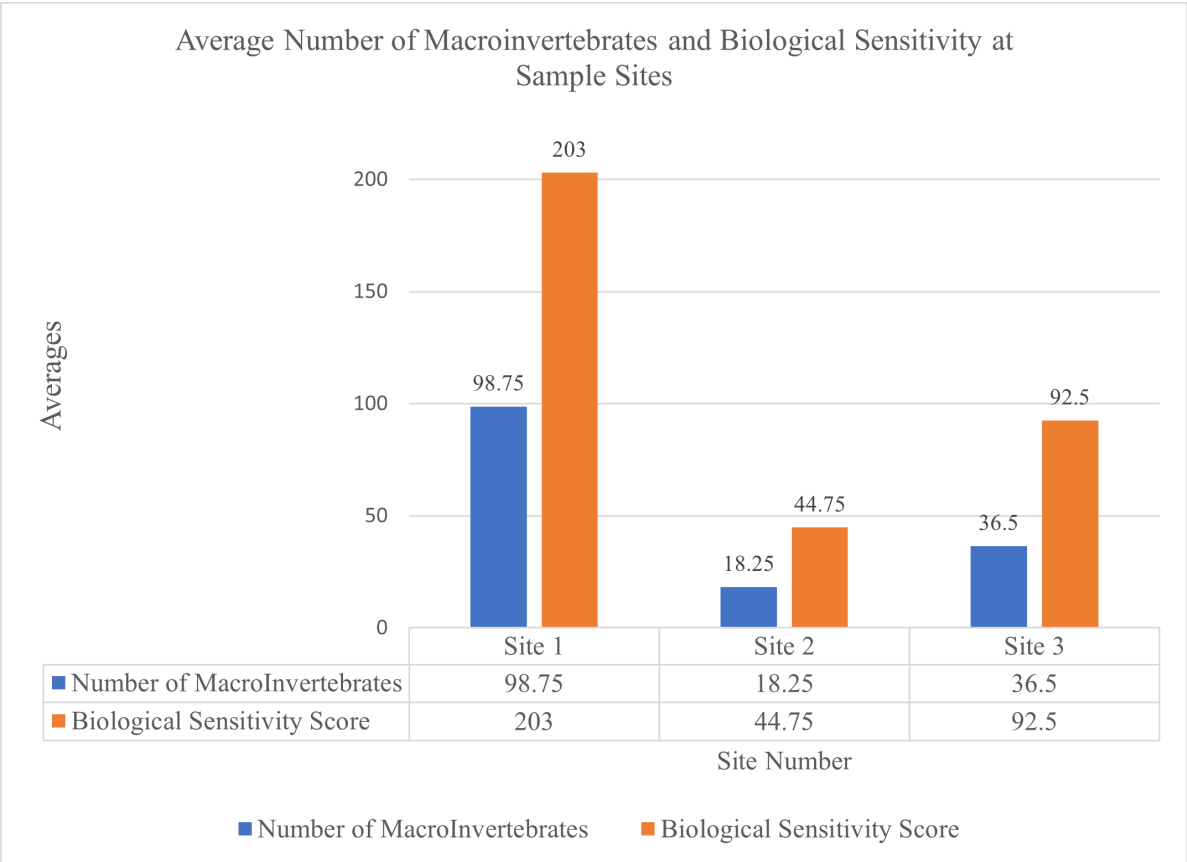


Figure 4: Percent Dissolved Oxygen by Season

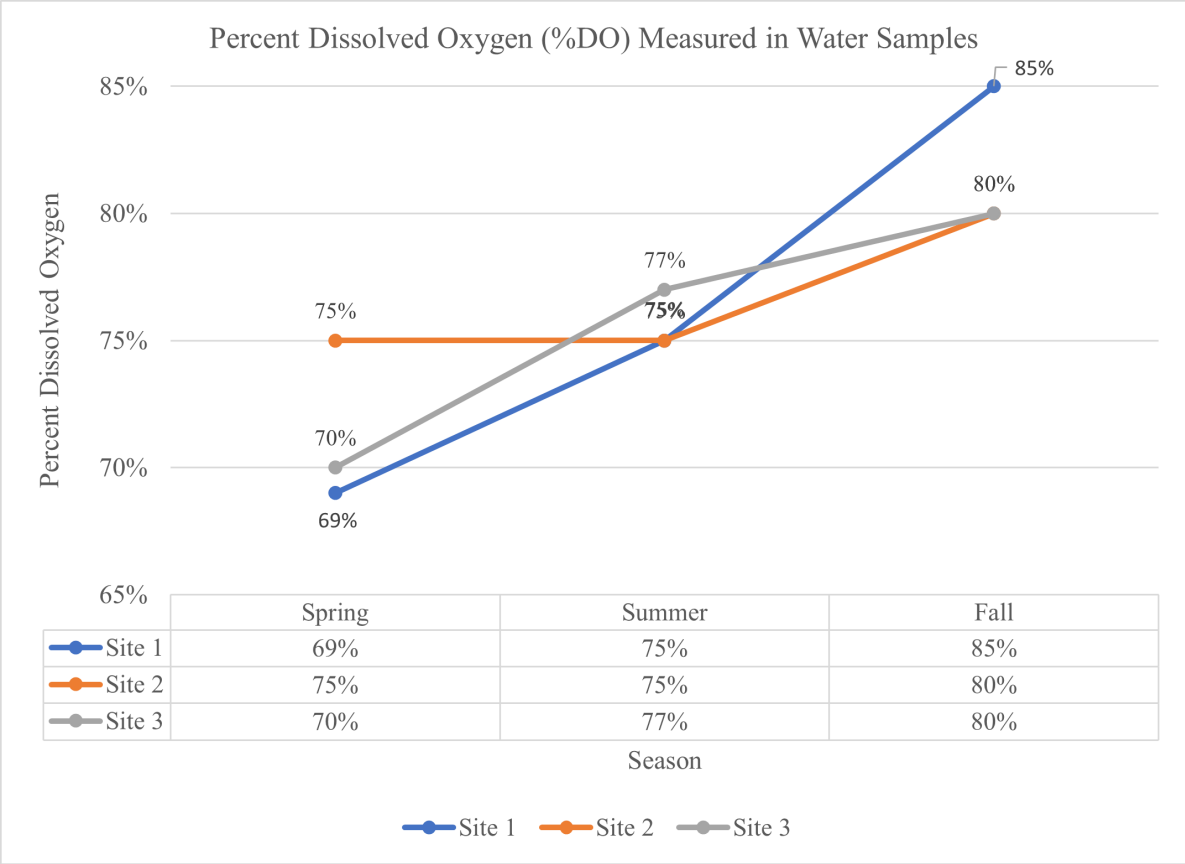


Figure 5: Nitrate/Nitrite by Seasons

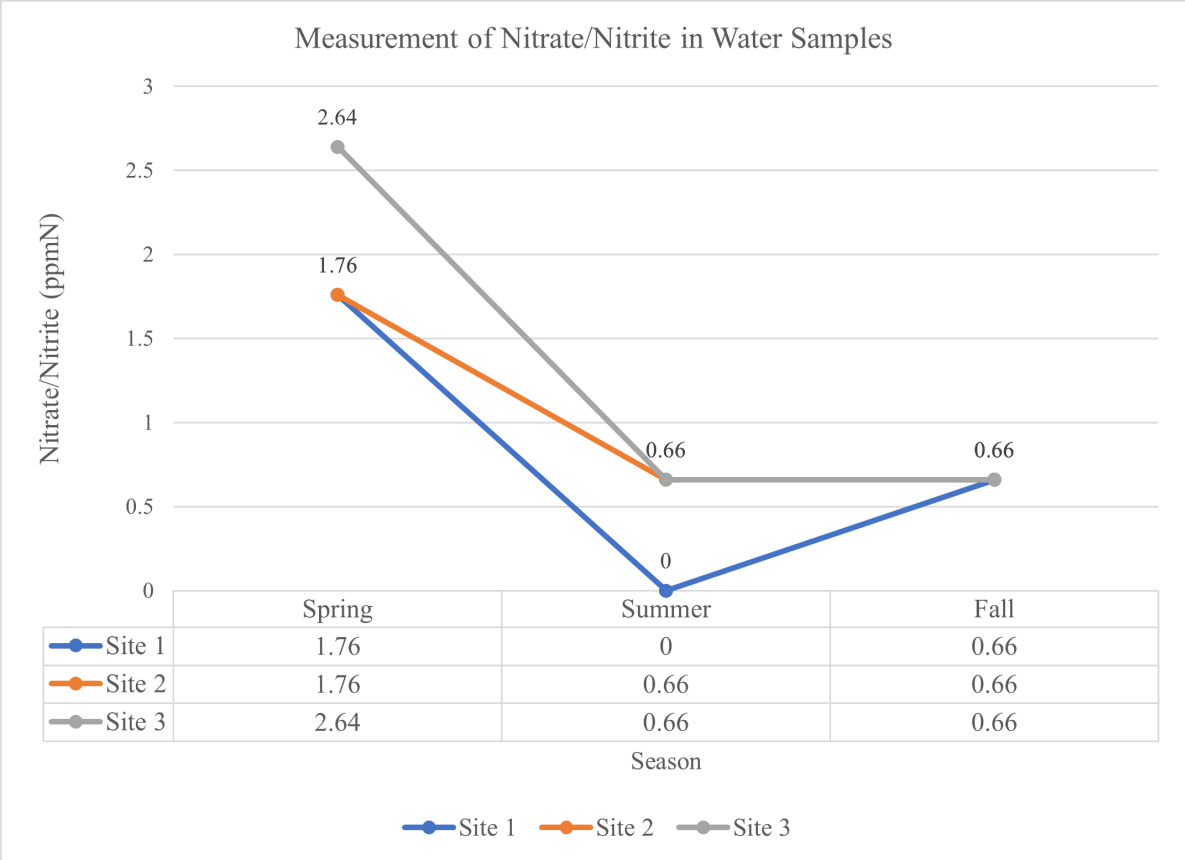
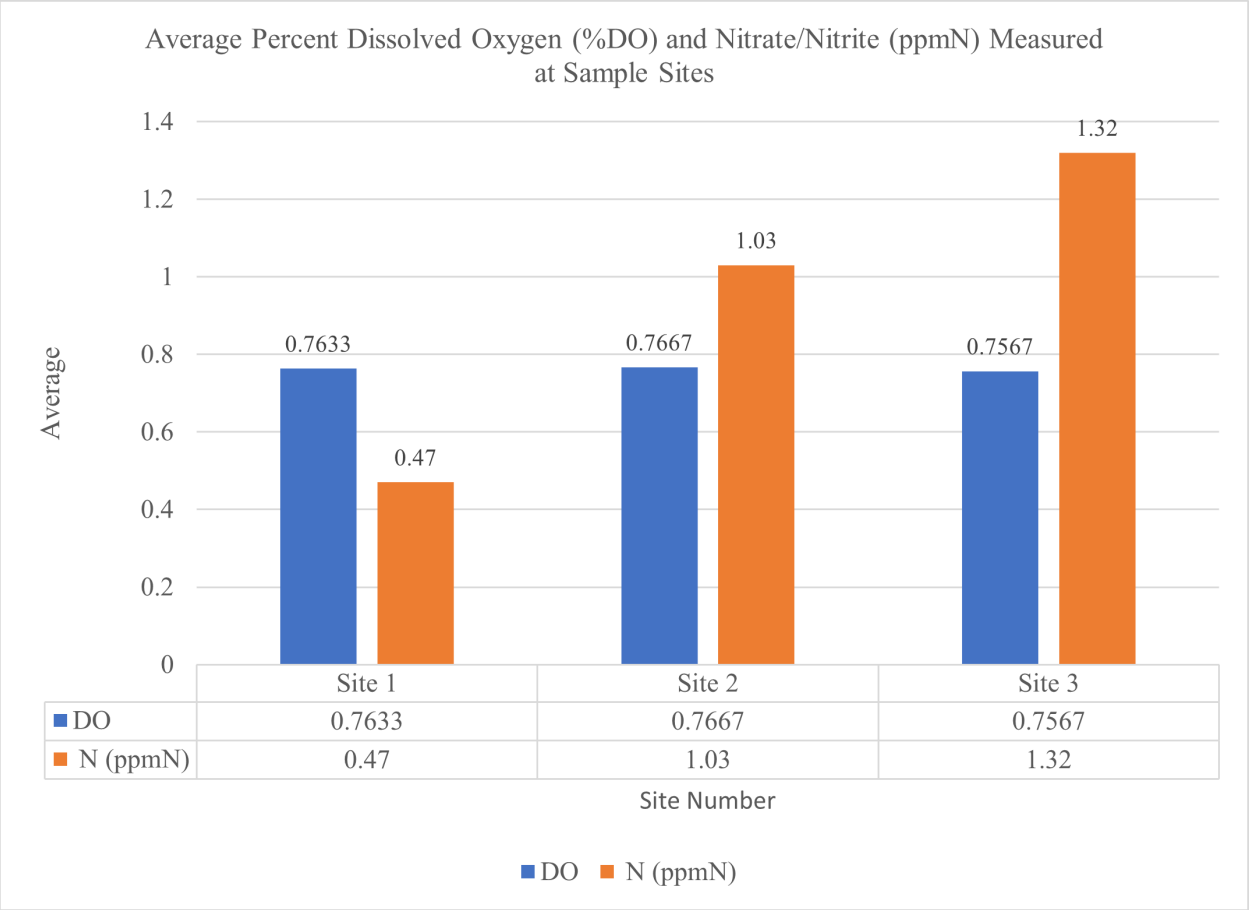


Figure 6: Average Water Quality Values by Sampling Site



REFERENCES

Allaire, M., Lall, U., & Wu, H. (2018, January 9). *National trends in drinking water quality violations*. https://www.pnas.org/content/pnas/115/9/2078.full.pdf

Battaglin, W. A., Smalling, K. L., Anderson, C., Calhon, D., Chestnut, T., & Muths, E. (2016). Potential interactions among disease, pesticides, water quality and adjacent land cover in amphibian habitats in the United States. *Science of the Total Environment, 566-567*, 320-332. https://doi.org/10.1016/j.scitotenv.2016.05.062

Betty's Branch Boat Ramp. *Swim guide*. (n.d.). https://www.theswimguide.org/beach/8752

Camargo, J. A., & Alonso, Á. (2006). Ecological and toxicological effects of inorganic nitrogen pollution in Aquatic Ecosystems: A global assessment. *Environment International*, *32*(6), 831–849. https://doi.org/10.1016/j.envint.2006.05.002

Grande, E., Beitz, P., Moran, J., & Visser, A. (2019). Examination of nutrient sources and transport in a catchment with an Audubon certified golf course. *Water*, *11*(9). https://doi.org/10.3390/w11091923

Izaak Walton League of America. (n.d.). *Resources for stream monitors*. https://www.iwla.org/water/resources-for-monitors

Johnson, D. (2020, July 8). Algal bloom causes water quality issues in Columbia County. WJBF. https://www.wjbf.com/news/columbia-county/algae-bloom-causes-water-quality-issues-in-columbia-county/

Meyer, J. L. (2009). Urban aquatic ecosystems. In G. E. Likens (Ed). *Encyclopedia of inland waters*. Science Direct.

Petersen, L., Heynen, M., & Pellicciotti, F. (2019). Freshwater resources: past, present, future. In D. Richardson (Ed.). *The international encyclopedia of Geography*. Doi:10.1002/9781118786352.wbieg0712.pub2

Public works monitoring euchee creek after manhole overflows; Avoid water on Euchee Creek Trails. Grovetown, GA. (n.d.). Retrieved January 18, 2022, from https://www.cityofgrovetown.com/AlertCenter.aspx?AID=Public-Works-monitoring-Euchee-Creek-aft-170

Raposeiro, P. M., Balibrea, A., Riva, J.-C., Ritter, C. J. F. R., & Gonçalves, V. (2022). Aquatic macroinvertebrates in Madeira Island (Portugal) streams: diversity and distribution. *Biodiversity Data Journal*, *10*. https://doi.org/10.3897/BDJ.10.e73909

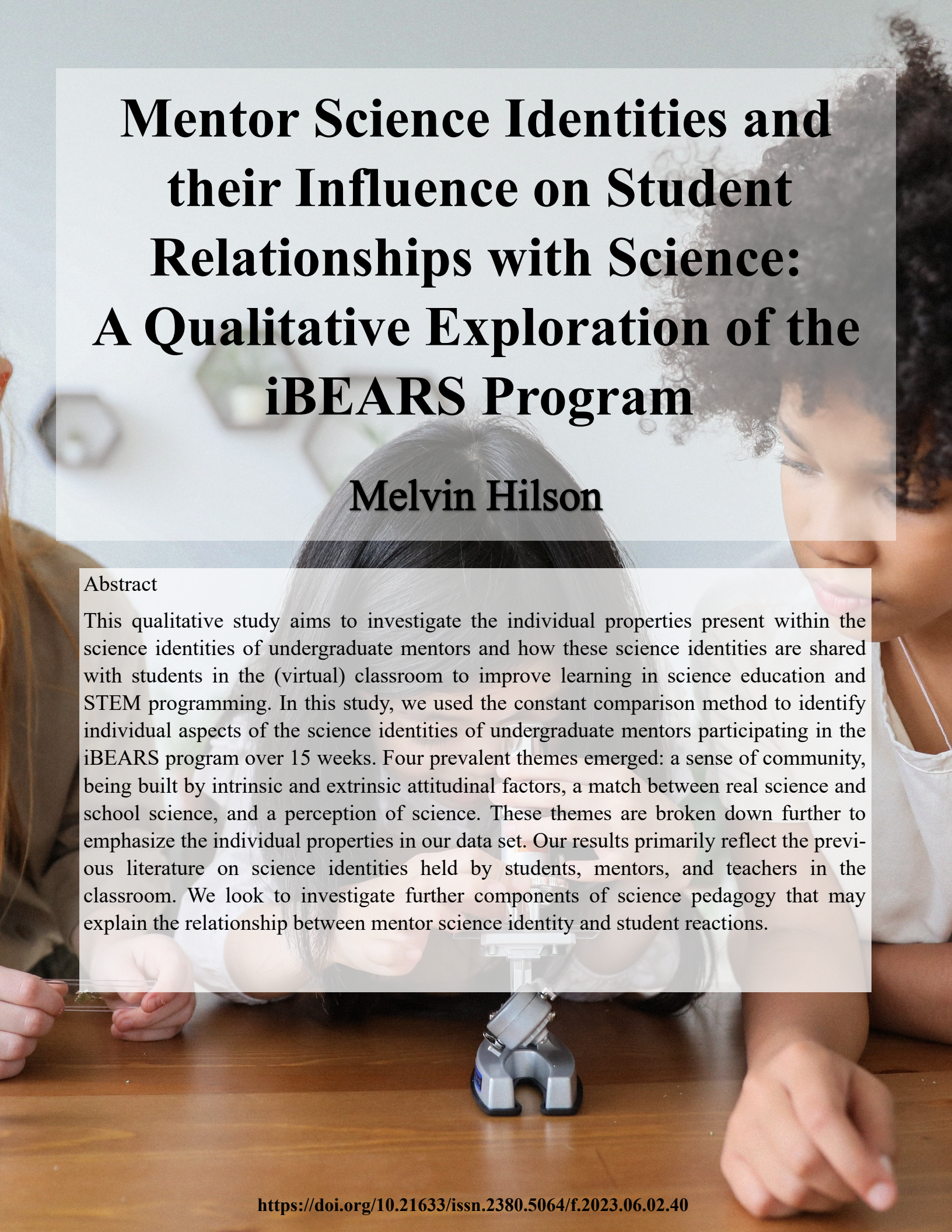
Strayer, D. L., & Dudgeon, D. (2010). Freshwater biodiversity conservation: recent progress and future challenges. *Journal of the North American Benthological Society, 29*(1), 344-358. https://doi.org/10.1899/08-171.1

Sumudumali, R. G. I., & Jayawardana, J. M. C. K. (2021). A review of biological monitoring of aquatic ecosystems approaches: with special reference to macroinvertebrates and pesticide pollution. *Environmental Management*, *67*(2), 263–276. https://doi.org/10.1007/s00267-020-01423-0

Thomas, M. A. (2007, June 8). The effect of residential development on ground-water quality near Detroit, Michigan. *Journal of the American Water Resources Association, 36*(5), 1023-1038. https://doi.org/10.1111/j.1752-1688.2000.tb05707.x

Liz Ortiz Contreras, Bori Ortega, Patricio Méndez, & Patricio Tierra. (2021). Evolution and identification of aquatic macroinvertebrates like bioindicators of water quality. *ESPOCH Congresses*, *1*(2), 1016–1023. https://doi.org/10.18502/espoch.v1i2.9527

Withanachchi , S. S. (2018). Sustainable water resource management for a safe food system in Georgia: A study of water quality governance, focusing the Mashavera River Basin [Doctoral dissertation, University of Kassel].



Mentor Science Identities and their Influence on Student Relationships with Science: A Qualitative Exploration of the iBEARS Program

Melvin Hilson

Abstract

This qualitative study aims to investigate the individual properties present within the science identities of undergraduate mentors and how these science identities are shared with students in the (virtual) classroom to improve learning in science education and STEM programming. In this study, we used the constant comparison method to identify individual aspects of the science identities of undergraduate mentors participating in the iBEARS program over 15 weeks. Four prevalent themes emerged: a sense of community, being built by intrinsic and extrinsic attitudinal factors, a match between real science and school science, and a perception of science. These themes are broken down further to emphasize the individual properties in our data set. Our results primarily reflect the previous literature on science identities held by students, mentors, and teachers in the classroom. We look to investigate further components of science pedagogy that may explain the relationship between mentor science identity and student reactions.

https://doi.org/10.21633/issn.2380.5064/f.2023.06.02.40

Student Author

Melvin Hilson

0009-0001-8074-6333

Melvin Hilson earned a bachelor of science degree in Psychology in 2023 from Augusta University. Hilson currently works at the Georgia Prevention Institute as a Research Assistant. His future plans include pursuing a doctorate degree in cognitive neuroscience and to research retaining and enhancing cognitive function in clinical populations affected by illnesses. A large portion of Hilson's research so far focuses on science education working under the guidance of Dr. Alex St. Louis. Most notably, Hilson was the featured student author at the 2023 AU Authors Reception.

Faculty Mentor

Alex T. St. Louis, PhD

0000-0002-1775-0276

Dr. St. Louis is an instructor in the College of Education and Human Development and also serves as coordinator for the Center for Undergraduate Research and Scholarship (CURS). Her research interests include mentorship, understanding the nature of science, and improving scientific relations within the greater community. She loves working with undergraduate students, advocates for inclusion in science education, and finds great value in helping students learn research skill to become the next generation of leaders and scholars.

INTRODUCTION

Science identities are a central entity in science education and STEM careers such as research and teaching (Nutall et al., 2018). In the realm of pedagogy, there are multiple factors that have an influence on the effectiveness and salience of identities and learning content. According to research done by Robinson et al. 2018, science identities can be destabilized and solidified given certain experiences and factors. This holds great importance because they affect the salience and effectiveness of certain programs and types of pedagogy. The strengthening of science identities through formal mentoring programs has been correlated with higher GPAs and an increased likelihood of persisting in the field of science (Piatt et al., 2019). Science identities are important in the field of science education, and more research placed into this field of study increases the likelihood of students pursuing careers in science (Carlone &Johnson, 2007). Our qualitative study focuses on conceptualizing science identity and its components within undergraduate mentors and K-12 students, with the goal of increasing the understanding of science identity to enhance the efficiency of classroom pedagogy and its outcomes.

LITERATURE REVIEW

Science Identities

The literature holds different definitions of a science identity; however, the consensus is that science identities are formed based on situational circumstances. Huvard & Talbot (2020) describe science identity as the combination of performance in a given role, expectations of the given role, amount and type of content knowledge, and verification and validation of their identities. Atkins & Dougan (2022) describe science identities as parallel to career paths. An example of this idea would be pre-medicine biology majors identifying as future doctors. They also describe science identities as similar across demographics, having shared values, coming with challenges in academic and research endeavors, and considering themselves a scientist.

Components of Identity

The exploration of science identities brings together science content and person-oriented developmental approaches to account for the heterogeneous patterns of science identity development (Nutall & Roseth, 2018). This lens aids in accounting for the internal and external factors that could play a role in the in-person and online learning environments. External support has been found to increase salience over time (Atkins & Dougan, 2022). This widens the lens through which science pedagogy can be viewed because mentorship and motivation can become factors of importance. Literature also states that working alongside more experienced scientists creates a greater sense of seeing oneself as a scientist (Robnett & Nelson, 2018). This creates a tether between science content and personal orientation in a way in which meaning can be derived. As the field of science identities is widened, there are a variety of analytic lenses to view them, which opens new ways of teaching and learning (Carlone & Johnson, 2007).

Undergraduate Science Identities

The population for the studies found in the science identity literature primarily focuses on professors and professional researchers serving as mentors and undergraduate science students serving as mentees. Our study builds on St. Louis et al. (2021) work where undergraduate science students serve as science mentors and K-12 students serve as mentees. While there is literature on the formation of science identities and strengthening these identities as students advance their knowledge, two gaps in the literature seem to appear. First, what specific aspects of the scientific endeavor create a science identity? Second, with the surge of the Coronavirus Pandemic and virtual learning, how are science identities being created and communicated in these new environments? This study aims to address these gaps in the literature by addressing the following research question: How do undergraduate science mentors share and describe their science identities to K-12 students in a primarily virtual learning setting?

PARTCIPANTS AND MATERIALS

The participants for this study are nine undergraduate science majors who served as mentors and three K-12 classrooms participating in the Inclusive Biologist Exploring Active Research with Students (iBEARS) program. The iBEARS program utilizes project-based learning for undergraduate students (St. Louis et al., 2021). Undergraduate mentors were tasked to develop a science experiment with fifth-grade students via online and in-person class sessions.

METHODS

For this study, we utilized data from the Fall 2021 cohort of the iBEARS program. 36 videos were analyzed in total (weeks 1-12) consisting of nine undergraduate mentors and three K- 12 classrooms, lead by teachers Mrs. Jones, Mr. Thomas, and Ms. Spikes (all pseudonyms), with three undergraduate mentors assigned to each classroom. Our research team used the constant comparison method (Glaser & Strauss, 1967) to analyze the data. Our research team used this grounded theory technique to sort and organize observed behaviors from the video recordings into categories based on their similarities. The data was organized using Microsoft Excel sheets. The team used in-vivo coding (Given, 2008) to develop themes that aligned with our research question: How do undergraduate science mentors share and describe their science identities to K-12 students in a primarily virtual learning setting? Each member of the research team coded the data individually. Before discussing any discrepancies, our level of agreement about our codes or inter-rater reliability was 84%. After discussing discrepancies and adjusting the codes, we were able to come to an inter-rater reliability of over 95%.

RESULTS

The results of the study are divided into two sections: the first session includes the results of observations from Mrs. Jones' and Mr. Thomas' classes, while the second session includes the results of observations from Ms. Spikes' classroom.

The researchers aimed to answer the research question: How do undergraduate science mentors share and describe their science identities to K-12 students in a primarily virtual learning setting?

The observations and codes developed from the data were grouped into four main categories, with several sub-categories to follow. The four main themes are: Building Upon Intrinsic and Extrinsic Attitudinal Factors, Creating A Match Between Real Science and School Science, Perception of Science, and A Sense of Community and Affiliation. Figures 1, 2, and 3 organize the themes of the data using descriptive statistics, displaying the prevalence of each theme and subtheme across the participating K-12 classrooms.

Building Upon Intrinsic and Extrinsic Attitudinal Factors

Building upon intrinsic and extrinsic attitudinal factors focuses on the interactions between undergraduate mentors and their K-12 students. Subthemes include positive feedback from mentors, negative feedback from mentors, positive presentation of science, negative presentation of science, and positive student engagement. In the first data analysis session, this theme made up 42 percent of observations; in the second session, this theme made up 28 percent of observations.

Positive Feedback from Mentors

Positive feedback from mentors is characterized when the mentors provide the students with direct, positive feedback. The mentors tell the K-12 students how well they are doing during the sessions (i.e., congratulating, encouraging, or applauding for correct answers). An example of this subtheme is as follows: the mentors talk about how they are extremely proud of the students for recording the observations in their data books during the experiment (Mrs. Jones, Week 8). This subtheme appears 17% in the first session and 15% in the second session.

Negative Feedback from Mentors

Negative feedback from mentors is characterized when mentors provide the students with negative or possibly discouraging feedback. An example of this subtheme is as follows: After showing the students a video about a task related to their experiment, one of the mentors says, “This video didn’t seem as interesting as we intended” (Mrs. Jones, week 3). This subtheme appears 2% in the first session and 1% in the second session.

Positive Presentation of Science

Positive presentation of science is characterized when science is presented in a positive way; as fun, exciting, and helpful. An example of this subtheme is as follows: “Sometimes in science, you don’t know how your contributions are going to affect the world. This scientist passed away before she knew how influential and impactful her work would be” (Mr. Thomas, week 9). This subtheme appears 9% in the first session and 4% in the second session.

Negative Presentation of Science

Negative presentation of science is characterized when science is presented in a negative way, as difficult, stressful, or harmful. An example of this subtheme is as follows: The mentors say, “None of us really started off loving science, but here we are” (Ms. Spikes, week 1). This subtheme appears 1% in the first session and 0% in the second session.

Positive Student Engagement

Positive student engagement is characterized by the K-12 students showing excitement when scientific topics are brought up, and they quickly engage with activities that relate to their experiment. An example of this subtheme is as follows: The K-12 students talk amongst themselves about how it would be really cool to measure how different languages affect daphnia growth (Mrs. Jones, week 4). This subtheme appears 13% in the first session and 8% in the second session.

Creating a Match Between Real Science and School Science

The theme creating a match between real science and school science focuses on the ability of mentors and students to relate instances of real-world science to science used in school and vice versa. The subthemes present include Real-World Application and Student Application. In the first data analysis session, this theme makes up 29% of observations; in the second session, this theme makes up 22% of observations.

Real-World Application

Real-world application is characterized by a mentor or student relating, connecting, or comparing real-world examples to their experiment or classroom activity. An example of this subtheme is as follows: The mentors talk about how the lights in this experiment will be cycling on and off in a 12-hour cycle to simulate real-world environments (Ms. Spikes, week 6). This subtheme appears 9% in the first session and 14% in the second session.

Student Application of Science

Student application of science is characterized as when students can use their previously or recently acquired knowledge of science and apply it to a question, situation, or task. An example of this subtheme is as follows: The students are able to point out potential problems that may arise while carrying out their experiment (Mr. Thomas, week 5). This subtheme appears 20% in the first session and 8% in the second session.

Perception of Science

The theme perception of science analyzed the different lenses that undergraduate mentors and K-12 students use to view and define science. The subthemes within this theme include Science as Empirical, Science as Inquiry, and Science as a Way of Life. In the first data analysis session, this theme appeared 20% of observations; in the second session, this theme made up 30% of observations.

Science as Empirical

Science as empirical is characterized when science is presented as a process that is all about using trial and error to create solutions. This process focuses on careful design and attention to detail to ensure accuracy and validity and displays information in graphs and other visual representations. It also includes the use of the scientific method as a scaffold in pursuing research. An example of this subtheme is as follows: The mentors talk about science as a meticulous process in which you should be creating a template for replication (Mrs. Jones, week 10). This subtheme appears 7% in the first session and 21% in the second session.

Science as Inquiry

Science as inquiry is characterized by the combination of science processes and traditional science content in terms of creativity and critical thinking to develop scientific knowledge. This is the process in which scientists produce their results, and scientific knowledge is generated and accepted (Lederman et al., 2014). The undergraduate science mentors present science as a process of gathering information and application. An example of this subtheme is as follows: “Throughout all of your observations, you should be taking pictures and recording these observations so we can go back and maybe find the scientific explanation for these things” (Ms. Spikes, week 7). This subtheme appears 6% in the first session and 8% in the second session.

Science as a Way of Life

Science as a way of life is characterized when science is presented as the principle that guides the order of everyday life. It is presented as a tool to help the students better interact with the world around them. An example of this subtheme is as follows: One of the mentors tells the students, “Science is more about finding your way than always being right” (Mrs. Jones, week 7). This subtheme appears 7% in the first session and 1% in the second session.

A Sense of Community and Affiliation

The theme a sense of community and affiliation encompasses examples that helped undergraduate mentors and K-12 students feel like a comprehensive community of scientists. This theme's subthemes include Anyone Can Be a Scientist and Mentorship from Mentors. During the first round of data analysis, Anyone Can Be a Scientist appeared 9%, followed by 7%. In the second analysis session, the subtheme of Mentorship from Mentors was added. In total, this theme makes up 28% of observations.

Anyone Can Be a Scientist

Anyone can be a scientist is characterized when the mentors present science as an inclusive and open field, presenting a scientist as someone who simply asks questions about the world and takes the necessary steps to hypothesize, collect data, and find answers. An example of this subtheme is as follows: The mentors say, "You don't have to come from a science background to be a scientist" (Mr. Thomas, week 2). This subtheme appears 9% in the first session and 7% in the second session.

Mentorship from Mentors

Mentorship from mentors is characterized when the mentors or teachers are assisting students or walking students through the experiment. The mentors provide guidance through experiences. An example of this subtheme is as follows: The mentors have an in-depth discussion with the class about why the class chose Planaria as a test subject, and they walk them through what responsibility they have to their subjects (Ms. Spikes, week 3). This subtheme appears in 13% of the second session. It was not included in the first session.

DISCUSSION

Building upon intrinsic and extrinsic attitudinal factors comprises 42% of codes in session one and 28% in session two. These factors are important because they focus on the ways in which mentors communicate their beliefs in terms of positive and negative presentations of science. We saw high rates of positive feedback to help encourage positive beliefs about science, with low levels of negative feedback, avoiding conversations that could be to the K-12 students. It also encapsulates the ways that the undergraduate mentors respond to the student's thoughts and feelings about science in terms of their feedback to the K-12 students. High rates of positive feedback were used to encourage the K-12 students and motivate them to continue using their inquiry skills. Another vital subtheme for this theme was Positive Student Engagement, and we use this subtheme to describe students' summative excitement and engagement in the lessons and with their mentors; further exemplifying that the students were building upon their intrinsic attitudes about the course material.

A sense of community and affiliation had a prevalence of 9% in our first session and 20% in our second session. This theme is important because the literature emphasizes that science identity depends on being able to see oneself as a scientist and feeling like one belongs to a community (of scientists) (Robnett & Nelson, 2018). The subtheme anyone can be a scientist is important because it describes the explicit nature in which the mentors present their field of science as an inclusive field open to anyone. The undergraduate mentors were inclusive in their display of science as a discipline and did not present science as a field full of barriers where you need certain skills or other attributes to enter (Piatt et al., 2019).

Mentorship from mentors encapsulated the process of the undergraduate mentors providing guidance through experience. According to the literature, mentorship increases the salience of science identities (Atkins et al., 2020), and in this study, the K-12 students are learning from the more experienced undergraduate mentor scientists. This subtheme was developed during the analysis of Ms. Spikes' class because the mentors worked hands-on with students and walked them through the experiment, even in online, virtual sessions.

Creating a match between real science and school science had a prevalence of 29% in the first session and 22% in the second session. This theme focuses

focuses on creating a connection between the science curriculum taught in classrooms and the actual work that scientists do in their labs and fields of study. The subthemes include real-world application of science, when a student compares their classroom curricula to that of real-world situations, and student application of science when students can take their previous knowledge about science content and add their discovery to their current scientific endeavors. This theme describes that students learn content and can apply and make connections across disciplines and contexts (Lucas & Spina, 2022).

Perception of science had a prevalence of 20% in the first session and 30% in the second session. This theme displays the mentors' and students' feelings about science and the ways they communicate with each other about science. The subthemes include science as a way of life, science as empirical, and science as inquiry.

The subtheme science as a way of life describes a view of science as the principles that guide everyday life, and scientists use these principles to better interact with the world around them. The subtheme science as inquiry describes when individuals combine science processes with traditional science content in terms of creativity, an important focus and component of the nature of science (St. Louis & Hokayem, 2023). The students also use critical thinking to develop scientific knowledge, and this subtheme describes how scientists produce their results and how scientific knowledge is generated and accepted (Lederman et al., 2014). The subtheme science as empirical encapsulates science being presented as a process that is about using trial and error to create solutions. This process focuses on careful design and attention to detail to ensure accuracy and validity while displaying information in graphs and other visual representations.

Figure 1: Themes from Session 1: Mrs. Jones and Mr. Thomas

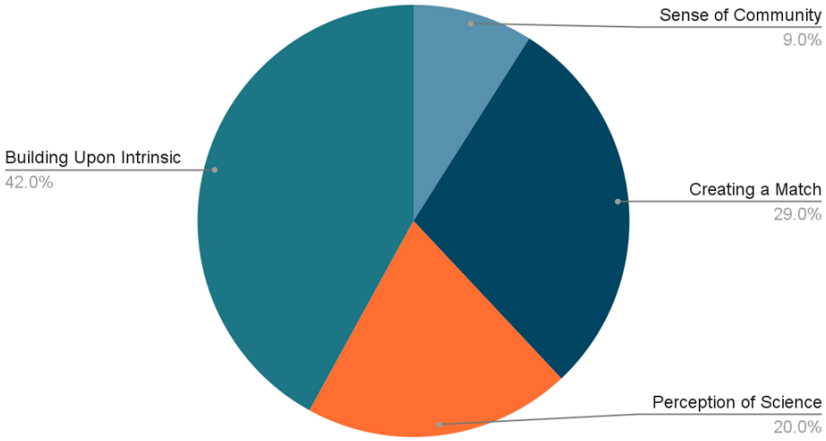


Figure 2: Themes from Session 2: Ms. Spikes

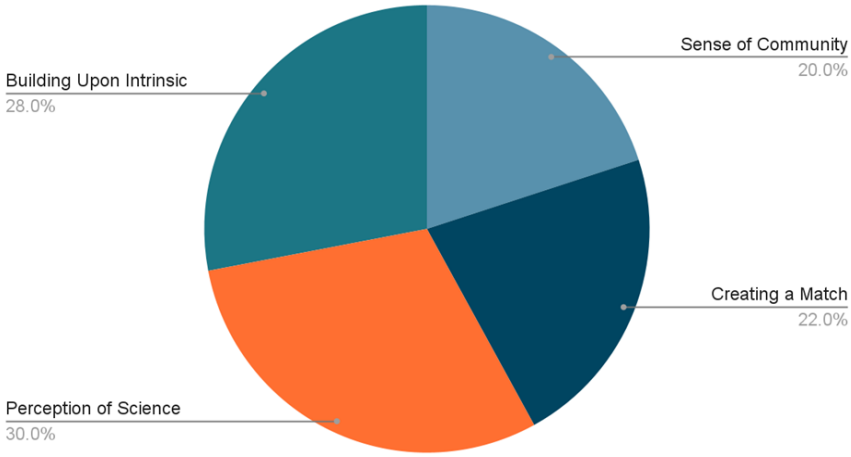
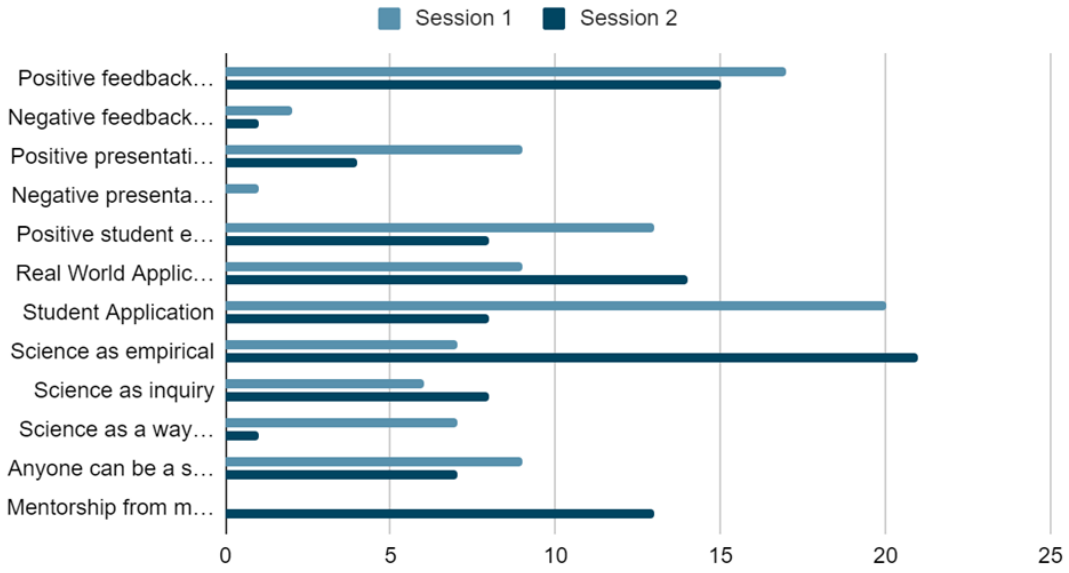


Figure 3: Prevalence of Themes Between Sessions 1 and 2



CONCLUSION

The themes displayed in this study reflect the previous literature surrounding science identities. However, previous studies have not endeavored to conceptualize science identity as a multifaceted concept with factors able to influence the stabilization or destabilization of identity. This study attempted to take steps in this direction with efforts to create a more complete picture of what science identities are and the external influences present in their development. It is important to continue to analyze how and why people relate to the science discipline. Our future research includes investigating correlations between race/ethnicity and the strengths or weaknesses of science identities within populations.

REFERENCES

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187–1218.

Given, L. (2008). Postpositivism. *The Sage Encyclopedia of Qualitative Research Methods*, 660- 665. http://dx.doi.org/10.4135/9781412963909.n332

Glauser, B. G. & Strauss, A. L. (1967). The discovery of grounded theory. *Strategies for Qualitative Research*. Chicago: Aldine.

Huvard, H., Talbot, R.M., Mason, H., Thompson, A.N., Ferrara, M., & Wee, B. (2020). Science identity and metacognitive development in undergraduate mentor-teachers. *International Journal of STEM Education*, *7*(1), 1–17. https://doi.org/10.1186/s40594-020-00231-6

Atkins, K., Dougan, B. M., Dromgold-Sermen, M. S., Potter, H., Viji Sathy, & Panter, A. T. (2020). "Looking at Myself in the Future": how mentoring shapes scientific identity for STEM students from underrepresented groups. *International Journal of STEM Education*, *7*(1), 1–15. https://doi.org/10.1186/s40594-020-00242-3

Lucas, K. L., & Spina, A. D. (2022). Science identity and its implications for STEM retention and career aspirations through a research-based first-year biology seminar. *Journal of College Science Teaching*, 63–71.

Piatt, E., Merolla, D., Pringle, E., & Serpe, R. T. (2019). The role of science identity salience in graduate school enrollment for first-generation, low-income, underrepresented students. *The Journal of Negro Education*, *88*(3), 269–280. https://doi.org/10.7709/jnegroeducation.88.3.0269

Robinson, K. A., Perez, T., Nuttall, A. K., Roseth, C. J., & Linnenbrink-Garcia, L. (2018). From science student to scientist: Predictors and outcomes of heterogeneous science identity trajectories in college. *Developmental Psychology*, *54*(10), 1977–1992. https://doi.org/10.1037/dev0000567

Robnett, R. D., Nelson, P. A., Zurbriggen, E. L., Crosby, F. J., & Chemers, M. M. (2018). Research mentoring and scientist identity: Insights from undergraduates and their Mentors. *International Journal of STEM Education*, *5*. https://doi.org/10.1186/s40594-018-0139-y

St. Louis, A. T., & Hokayem, H. (2023). Comparing undergraduate nature of science views in traditional vs. inquiry-taught science courses. *Journal of College Science Teaching*, *57*(2), 145-152.

St. Louis, A. T., Thompson, P., Sulak, T., Harvill, M. L., & Moore, M. E. (2021). Infusing 21st century skill development into the undergraduate curriculum: The formation of the iBEARS network. *Journal of Microbiology & Biology Education*, *22*:e00180-21. https://doi.org/10.1128/jmbe.00180-21