Increasing Student Confidence in Data Literacy Through Experiential Learning

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Abstract

Scholars have noted a dearth of experiential learning components in STEM. This study seeks to address that issue by assessing learning outcomes for students who participated in a class with an experiential learning element and those who did not. For the experiential learning component, students, in collaboration with a community organization, designed survey instruments that measured college students' mental health concerns, analyzed the results, wrote papers and presented posters of the findings. Students in the experiential learning class (ELC) had statistically increased confidence levels in comprehending scientific ideas, creating graphs, and discussing results, while their peers did not. Students reported that the experiential learning component helped them understand topics in their STEM class better. Given that many students in the ELC aspire to pursue healthcare professions, the increased confidence in understanding data through hands-on experience should help prepare them for the interpretation of clinical data and thus potentially benefit their future patients.

Introduction

STEM classes have a unique opportunity to engage with communities and/or community partners through projects that center on data collection and analysis. These projects require data literacy. Data literacy is commonly defined as the ability to understand and interpret real-world datasets and communicate the findings to others (Gibson and Mourad, 2018; Kjelvik and Schultheis, 2019). The necessity for data literacy has become ubiquitous across professions (Kjelvik and Schultheis, 2019; Schreiter et al., 2024). However, this is not a skill that is generally taught in K–12, and many college students struggle with the basics of making and interpreting graphs (Schreiter et al., 2024; Harsh and Schmitt-Harsh, 2016; Gibson and Mourad, 2018). Real-world problem sets can improve data literacy by enabling students to connect the lecture material with the appropriate dataset and analysis tools and can allow students to experience the process of analysis organically (Hicks and Irizarry, 2018; Langen et al., 2014; Kjelvik and Schultheis, 2019). The use of authentic data has also been shown to motivate students to understand and find answers to research questions, see how data literacy will be valuable in their future professions, and improve student learning outcomes (Langen et al., 2014; Harsh and Schmitt-Harsh, 2016). Experiential learning in STEM is one way that students can use authentic datasets to become data literate. Unfortunately, experiential learning is still relatively less common in STEM than in other academic fields. In a recent review of STEM projects, only a quarter had any form of experiential learning. Even then, when experiential learning was included, it tended to focus on specialized techniques rather than on general knowledge (Remington et al., 2023).

The first and third authors of this paper designed and taught the experiential learning class (ELC) that focused on teaching data literacy, an essential general knowledge skill in STEM. Students created a survey about the mental health needs and concerns of college students, distributed the survey and analyzed their results. The ELC collaborated with a community partner who shared their interest and expertise in assessing and improving college-age students' mental health. The ELC culminated in written reports and graphic posters that were presented to the partner and the campus community. To test the efficacy of the ELC, we used data from professor-led surveys that were collected at the beginning and end of the semester to assess students' perceptions of their data literacy skills. The data revealed that by the end of the semester, students in the ELC had statistically higher confidence in their scientific ability, while their peers in the control group did not. This study shows that using authentic data in experiential learning can improve students' confidence in key aspects of data literacy such as creating, reading, presenting, and graphing data. As we move into an increasingly data-driven medical system, experiential learning classes that work with data can help prepare aspiring healthcare professionals.

Methods

Institutional Setting and Class Format

The institution is a liberal arts college located in the United States. It is a primarily undergraduate institution, with approximately 1800 undergraduate and 500 graduate students. The college requires freshmen to participate in a first-year program (FYP) where they take two content courses taught by two different professors, and a third class co-taught by both of the professors. The third class is an interdisciplinary class where both professors incorporate their disciplines to create a writing- and reading-intensive course. In this course, as a requirement of the college, professors must assign primary literature in their fields as well as a research paper in their fields or with an interdisciplinary connection between their fields.

Student-Led Survey Topic

The professors of the ELC and community partner selected the topic of mental health for the student-led survey. The community partner runs an organization dedicated to understanding and improving the mental health of children and young adults in the area. Courses with community engagement generally focus on a problem that is in urgent need of attention (Rimm-Kaufman et al., 2021). According to a meta-analysis with over 20,000 student respondents, mental health among college students is an increasing concern, as rates of anxiety and mood disorders have risen in recent years (Buizza et al., 2022). The professors of the course selected mental health because of student interest in the topic. Students in previous iterations of the ELC had expressed the highest interest in mental health when choosing between that and topics of drug usage, alcohol usage, and anti-racism. These students ranked these 4 topics from their most desired survey topic to their least desired topic. All of the students ranked mental health as their most desired topic, except for one student, who ranked it as their second most desired topic.

Participants

Fourteen students in the ELC and 24 students who were not in the ELC (referred to in the text as the control group) completed both the pre- and post-surveys. The college requires that all first-year learning communities include formal research papers, as well as intensive

TABLE 1. Comparison of Course Content

Interdisciplinary Course	ELC	Control Class 1	Control Class 2
Intensive writing and reading	Required	Required	Required
One or more presentations	Required	Required	Required
Community engagement component	Semester-long (20+ hours)	None	None
Volunteering (not related to class content)	None	None	Four hours
Class size	*14	28	21
Response rate for professor-led survey	100%	43%	57%
Concurrent STEM course topic	Microbiology	Microbiology	Experimental psychology
Concurrent non-STEM course topic	Art	Literature	Philosophy

*Note: The class size in the ELC was capped at 14, a limit imposed by the arts course.

reading and writing. Both classes used as the control group were selected based on the inclusion of STEM content in the interdisciplinary course, so that all courses would contain intensive scientific reading and writing, making our data-driven experiential learning curriculum the distinguishing feature (Table 1; Figures 1, 2). In one interdisciplinary control group, students took an introductory microbiology course and an introductory course in literature. In the other control class, students took an introductory course in experimental psychology and an introductory course in philosophy. In the ELC students took a microbiology course and an art course. Thus all 38 students participated in a STEM content course, as well as in an interdisciplinary course that contained intensive reading and writing in STEM. However, only our course contained a semester-long experiential learning project. A comparison of the courses is provided for clarity (Table 1). STEM is defined in accordance with the National Science Foundation and the Department of Homeland Security and Immigration and Customs Enforcement and includes courses in the physical sciences as well as psychology (Li et al., 2020; Gonzalez and Kuenzi, 2012).

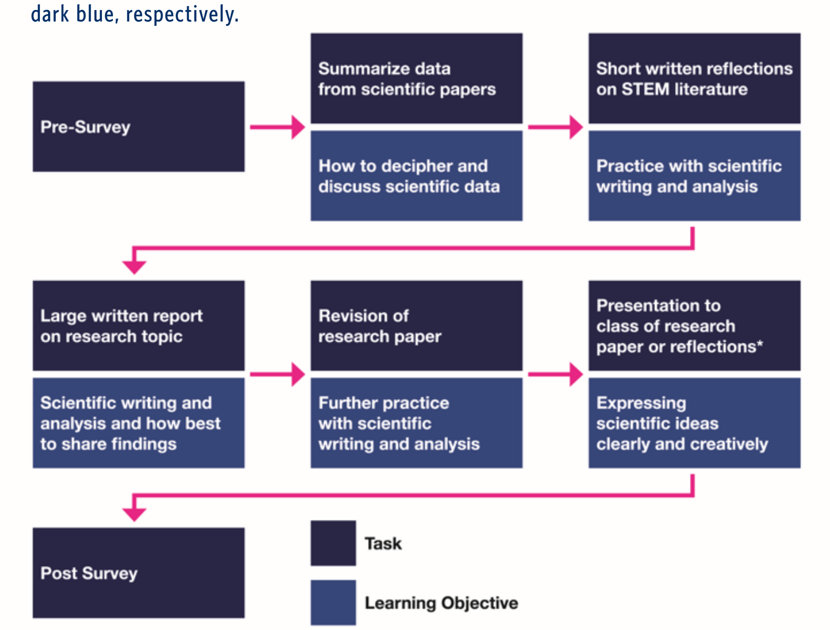
Experiential Learning Class

The two professors created an interdisciplinary course where students designed surveys regarding mental health among college students, distributed the surveys on campus, and analyzed the results graphically (Figure 1). Their required research report analyzed their student-led surveys, producing graphs and reflecting on the results, with particular emphasis on contextualizing the results and what they mean for the community partner. Students then made posters based on their survey findings, further forming their data analysis into concrete ideas. Throughout the class, the professors encouraged careful analysis of the results, highlighting the ways in which data is misconstrued.

Much like the control groups, the ELC started the semester with reading scientific literature and writing short assignments about it (Figures 1, 2; Table 1). The ELC also

FIGURE 1. Timeline of the course for the ELC during the semester. Main learning objectives in data literacy and the tasks that the students were assigned are shown in light and dark blue, respectively.

FIGURE 2. Timeline of the course for the control classes during the semester. Main learning objectives and the tasks that the students were assigned are shown in light and dark blue, respectively.



* Indicates that in one of the control classes the students presented their research papers and in the other control class students presented their reflections.

read multiple papers. Particular emphasis was placed on papers that had useful messages for data literacy. For example, the first paper we read as a class was a paper that was retracted (Wakefield et al., 1998). Students summarized that paper for homework, then engaged in group activities to identify flaws in the paper that caused it to be retracted. In this way, students were introduced to essential concepts of data analysis such as sample size. Each group examined specific figures, requiring students to focus on graphical interpretation. Other papers, such as Westphal et al. (2015), focused on analyzing survey results with student-accessible statistical tests such as ANOVAs and t-tests. Students were taught what a t-test is and how to interpret the p-value they received. Students were encouraged to utilize these when doing their surveys. Students were also taught how to calculate error rate based on their sample size. Interpretation of their error rate was a required component of their final report. The community partners also advised the students on how to design clear surveys and identify common flaws in survey design, such as double-barreled or leading questions. After the community partners finished their presentation, students were given time to look over their own surveys and apply their newfound knowledge to improve their survey questions.

When the time came for students to analyze their own survey results and generate figures, multiple classes were dedicated to students working in their survey groups. During the first class period students worked with data provided by the professors, to get used to graphing and analyzing data in Microsoft Excel. In multiple subsequent class sessions, students worked in their survey groups to analyze and identify patterns in their own student-led survey data. Students were required to graph the same data multiple ways in order to highlight how different graphs can reveal new interpretations of the same data. Problems with individual datasets came up organically, and the professors of the course would use these as teaching moments for the class. For example, one group struggled to interpret their survey results at first, but a discussion of how they administered the survey helped the group realize that they had biased their results by asking significantly more women to take the survey than men. A deeper discussion of how to identify bias in a survey followed and caused other groups to identify bias in their own survey results. When students wrote their final report, they were required to contextualize their results using primary and secondary research articles. Above all, students were encouraged to question the results in front of them, and to cultivate careful data analysis and interpretation.

Community Partner Benefits

Both the community partner and the participants should benefit from a shared project (Hayford et al., 2014). The class was structured so that the work the students did would be relevant and meaningful for the community partner. The students' research report was designed to give the community partner an accessible way to understand and utilize the results generated by the students and all data was presented to the community partner at the end of the semester. All material generated by the students was shared with the community partner in an organized fashion.

Informed Consent and Mixed Methods Analysis

This research was approved by the College's Human Experimental Review Board. The Likert response options of strongly disagree, disagree, neutral, agree, and strongly agree were converted to 1-5 respectively. Once converted, paired t-tests were used to compare the pre-and post-surveys (Sullivan and Artino, 2013). As multiple t-tests were performed, type one error was controlled using Benjamini-Hochberg (Benjamini and Hochberg, 1995).

Students in the ELC were asked to elaborate on their answers to the Likert scale questions in short response. If they answer mostly confident, they were asked to describe why they felt confident, if they answer mostly not confident, they were asked to describe why they felt not confident. Their responses to these questions can be seen in Table 3. To analyze the short responses, we first grouped the short responses by what each student responded on the likert scale questions in the pre-survey. If students responded to ≥ 5 of the 8 likert scale questions by selecting strongly agree or agree in the pre-survey, then their short responses were considered confident overall. If students responded to ≥ 5 of the 8 likert scale questions by selecting neutral, disagree or strongly disagree then their short responses were considered not confident. Further, each student's individual responses from the pre-survey were compared to the post-survey to investigate how individual students' responses changed throughout the semester (Table 3).

Results of the Professor-Led Survey

Improvement in Confidence in Reading Comprehension (Question A)

Question A examined students' overall confidence reading scientific papers and comprehending the main ideas (Figure 3A, Figure 4A, Table 2). The ELC increased significantly and the effect size was 0.79 (Figure 3A, p-value <0.01). Surprisingly, the students' confidence in reading scientific literature in the control group decreased during the semester, though the decrease was not statistically significant (Figure 3A). This was unexpected as students in the control group are required to read within their disciplines, and exposure to scientific material should increase confidence (Table 1, Grzyb et al., 2018). Further, this question did not relate to any specific requirement within the ELC, as all classes were required to have intensive reading within their disciplines. This finding suggests that experiential learning improved confidence in scientific literacy skills in general, not just those related directly to the student-led survey itself.

Continued Confidence in Graphing Comprehension (Question B)

Students in the ELC displayed continued confidence in interpreting graphs during the semester (Figure 3B, Figure 4B). Students did not increase in confidence because of the high number of students who selected strongly agree on the pre-survey (57 percent). All other questions

TABLE 2. Likert Survey questions for all classes for both the pre-and the post-survey. A-H questions correspond to A-H in Figures 3 and 4.

QUESTION
A. I feel confident in my ability to comprehend the main ideas in scientific papers.
B. I feel confident in my ability to comprehend what a pie or bar graph is showing in a scientific paper.
C. I feel confident in my ability to clearly share and discuss scientific results from survey data with scientists and/or professors.
D. I feel confident in my ability to clearly share and discuss scientific results from survey data with a layperson (a person without any specialized or professional knowledge).
E. I feel confident in my ability to create a graph from survey data that can be easily understood by a scientist/professor.
F. I feel confident in my ability to create a graph from survey data that can be easily understood by a layperson (a person without any specialized or professional knowledge).
G. I feel confident in my ability to design a scientific poster/ graphic based on survey data that can be easily understood by a scientist/professor.
H. I feel confident in my ability to design a scientific poster/ graphic based on survey data that can be easily understood by a layperson (a person without any specialized or professional knowledge).

ranged from 7 percent to 36 percent of participants selecting strongly agree on the pre-survey. Students in the control group decreased their confidence in interpreting these graphs but the decrease was not statistically significant (Figure 4B).

Improvement in Confidence When Discussing Scientific Results (Questions C and D)

Students in the ELC increased their confidence in their ability to share and discuss scientific results with both scientists/professors and laypeople (Figure 3C and D, p-value<0.05 for both). ELC students were required to present their posters twice, once to their peers and once to the community partner at the end of the course. They also wrote research reports on their survey results. Students' confidence in the control group did not increase significantly for either question (Figure 4C, D). This non-significant finding was not due to a lack of presentations. Students in the control group were required to have between one and three presentations (Table 1). However, their required presentations did not include their own generated data of any kind. These results suggest that using authentic data can increase confidence in presenting scientific material. However it should be noted that because the ELC presented twice, and some of the control group only presented once, that the difference we see could be due to the higher number of presentations within the ELC.

Improvement in Confidence When Creating a Graph (Questions E and F)

Students in the ELC significantly increased their confidence in creating graphs that can be understood by a professor/scientist but not by a layperson (Figure 3E, p-value<0.01, Figure 3F, p-value>0.05). Question E asked about creating a graph based on survey data for a scientist/professor. The effect size for this was large, 0.86, highlighting the significant increase from the pre-to post-survey. Question F asks about creating a graph that can be easily understood by a layperson. It is possible there is no significant difference between the pre- and post-survey because of the number of students who were already highly confident during the pre-survey (36 percent for strongly agree, 50 percent for agree) offering little opportunity for improvement. The control group decreased in their confidence in creating graphs for scientists, professors, and lay people, as the average change in response decreased for both questions, but the decrease was not statistically significant (Figure 4E, F).

Improvement in Confidence When Designing Scientific Posters (Questions G and H)

Students in the ELC increased significantly in their confidence in their ability to design a scientific poster or graphic for scientists, professors, and laypeople, with all students selecting neutral, agree, or strongly agree for

FIGURE 3. Results of the pre-and post-survey for the professor-led survey for the ELC using paired t-tests. All questions were ranked on the Likert scale from strongly disagree, disagree, neutral, agree and strongly agree from 1 to 5, respectively. Effect size rounded to the nearest hundredth for A-H respectively (d= 0.79, 0.45, 0.6, 0.8, 0.86, 0.42, 1.09, 1.24). Average change in response (post-survey subtracted by pre-survey) is rounded to the nearest tenth for A-H respectively (0.6, 0.4, 0.4, 0.6, 0.6, 0.3, 0.9, 1). *, **, and *** represent p-values less than 0.05, 0.01 and 0.001, respectively.

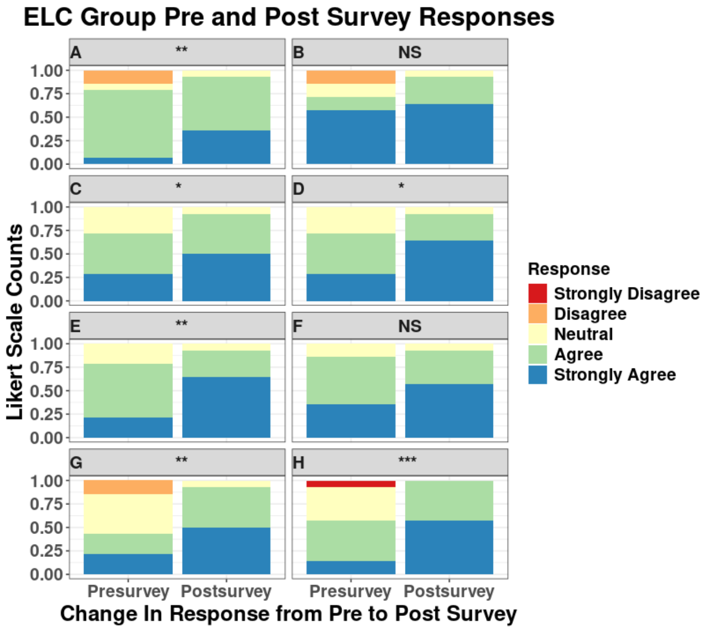
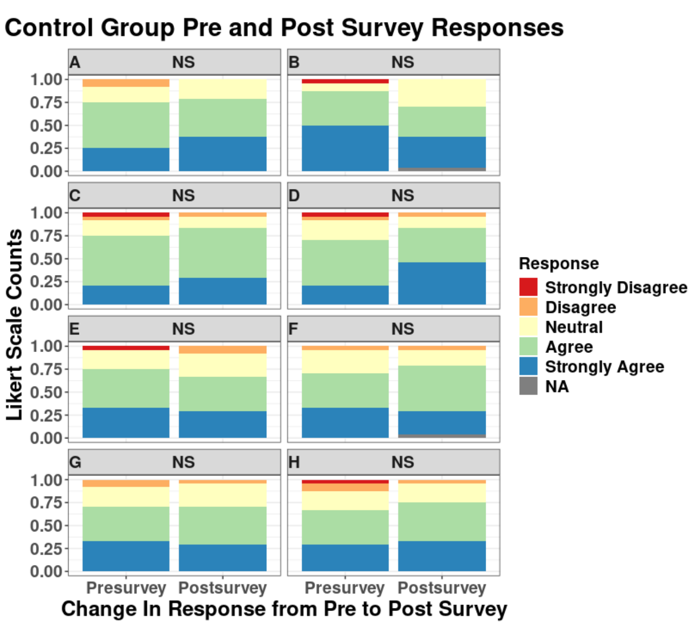


FIGURE 4. Results of pre-and post-survey responses for the professor-led survey for the control group using paired t-tests. All questions were ranked on the Likert scale from strongly disagree, disagree, neutral, agree and strongly agree from 1 to 5, respectively. Effect size rounded to the nearest hundredth for A-H respectively (d= 0.14, 0.15, 0.21, 0.14, 0.03, 0.10, 0.11, 0.25). Average change in response (post-survey subtracted by pre-survey) is rounded to the nearest tenth for A-H respectively (0.2, -0.4, 0.3, 0.5, -0.1, -0.2, 0, 0.3).



both questions in the post-survey (Figure 3G, p-value<0.01, Figure 3H, p-value<0.001). The students demonstrated the highest increase in confidence in their ability to make scientific posters and graphics. This might be because the scientific poster was the final assignment. As their confidence built during the semester in data literacy, the final task would potentially cause the biggest increase from pre-to post-survey. The control group did not increase significantly (Figure 4G, H).

Short Answer Responses

In addition to questions that asked students to rate their confidence level about scientific literature comprehension on a Likert scale (Figure 4), the professor-led survey featured open-ended questions that asked participants to elaborate on why they do or do not feel confident in their abilities surrounding data literacy (Table 3). Only students in the ELC completed this part of the survey. In the pre-survey 69% of all students surveyed felt confident (responding somewhat agree or strongly agree) about their abilities, while others felt less confident (responding with neutral, somewhat disagree, or strongly disagree) about being able to analyze and interpret data. In the post-survey, we found that some of the less confident respondents felt better equipped to discuss and analyze data. For instance, a student in the ELC who initially responded that they did not "have a lot of experience in graphing and understanding scientific papers" found that by the end of the semester they felt that they had been "well-prepared by my LC professors to visually and vocally conduct/display information from a survey."

Another student in the ELC, who responded to most of the questions by saying that they somewhat agreed that felt confident expressed that they felt "mostly neutral for most of these because I have not dealt with graphs enough to be confident about them." In the post-survey, this student responded to

TABLE 3. Likert Survey questions for all classes for both the pre-and the post-survey. A-H questions correspond to A-H in Figures 3 and 4.

PRE-SURVEY RESPONSE	POST-SURVEY RESPONSE
" Unlike some others, I feel very confident in conversations with people, whether it be family or complete strangers. I have always felt it essential to learn to communicate no matter what their	" I have been well-prepared by my LC professors to visually and vocally conducted/ display information from a survey."
"I feel confident that I am going to be able to design a scientific poster because my teachers seem like they can explain the programs well and clear. It also seems very hands on in this class	"I am confident after taking these classed i got the skills needed to complete the above taks."
No response recorded	"The LC taught me to do these"
"From my prior education i am somewhat confident that I would be able to do these things"	"i feel confident because we have went over a couple of scientific papers this semester"
"I am not good with art and posterd"	"Because I have been working with them this semester"
"I somewhat agree because I've seen examples of how data is collected and feel as if I have an idea of how to collect scientific data and present it"	"I feel we were informed in class on how to complete the tasks above"
"I don't feel confident because I don't have a lot of experience in graphing and understanding scientific papers."	"I feel neutral for most of them because I feel like I don't completely understand how to comprehend a graph, or make one."
No response recorded	"I feel confident because in this class we have made surveys, graphs and interpreted them multiple times."
"I did agreed for the majority because I know the general knowledge and basics of comprehending scientific research, but not to the point where I would be strongly confident enough discuss with someone who is more experienced in the area."	"I feel confident because I learned about it in highschool and we went over it in class."
"I feel confident because I have done most of these tasks before in another class in high school."	"I have learned how to and have done it before"
"I feel somewhat confident because I have done this before"	"Because my professors in my LC really taught us how to read scientific articles and make posters, surveys, and graphs."
"Simply because we were never taught how to do these things in highschool"	"I feel confident for the simple fact that it has been something we have been doing for the past few months"
"I feel mostly neutral for most of these because I have not dealt with graphs enough to be confident about them."	"My professors greatly explained to us how to read and write numerous kinds of scientific material. Whether it was charts or papers, they taught us exactly what is expected from them. This had made me confident enough to know i would be able to explain any scientific data to someone with or without the knowledge i have"

the same question: "my professors greatly explained to us how to read and write numerous kinds of scientific material. Whether it was charts or papers, they taught us exactly what is expected from them. This had made me confident enough to know I would be able to explain any scientific data to someone with or without the knowledge I have."

Even a student who had previous experience with data interpretation remarked on the post-survey, "I am confident after taking these classes I got the skills needed to complete the above tasks." While all students responding to the short answer in the ELC wrote about increasing confidence, not all increases were as substantial. One participant stated in the pre-survey that they didn't "feel confident because I don't have a lot of experience in graphing and understanding scientific papers." In the post-survey, they felt "neutral for most of them because I feel like I don't completely understand how to comprehend a graph, or make one." Overall, students' short responses concurred with those of the Likert questions, demonstrating that students felt increased confidence in performing tasks involving data analysis.

Student Assessments

In the ELC students submitted a written report and poster detailing their main findings. While there were no questions on the survey that tested their knowledge of the scientific material, we did observe improvement throughout the semester in students' ability to accurately graph and describe data. At the beginning of the semester, students were able to summarize scientific texts effectively, but were not able to go beyond that and question the results, identify flaws, or provide suggestions for future directions. Further, students struggled with the basics of graphing such as navigating Microsoft Excel and identifying the independent variable in their datasets. However, as students practiced examining their data and writing about their results, the professors of the course observed a change, particularly in the way that students were able to dissect their data. By the final report, the majority of students were able to identify flaws within their survey design, propose effective solutions for future surveys, and discuss scholarly literature that related to their results. Students were also able to successfully apply what they learned from their surveys to suggest possible solutions and ideas for the community partners.

Discussion

While experiential learning is more commonly found in social sciences and humanities, there are a growing number of STEM faculty who teach classes that have a community engagement component (Remington et al., 2023; Collins et al., 2020; Walser-Kuntz and Iroz, 2017; Daniel and Mirsha, 2017; Hayford et al., 2014). Our results suggest that when experiential learning is integrated into STEM classes, students' confidence in their ability to comprehend, discuss, and create data increases (Figure 3). In contrast, there were no significant increases in confidence for the control group for any of the eight questions (Figure 4). Both the control and the ELC were required to read and utilize scientific literature in their classes, but only the ELC increased significantly in their confidence in reading scientific papers (Figure 3A).

While not statistically significant, the survey results show that the control group did decrease in confidence in multiple categories, including reading scientific literature, interpreting graphs, and creating graphs (Figure 4). Reading scientifically was particularly surprising, because both control classes had research papers where students had to utilize scientific scholarly literature. This indicates that the practice that they received did not equate to increased confidence. One reason for this could be that they were required to read scientific scholarly articles and write scientifically without having any hands-on experience with graphing and analysis and thus had no benchmark to compare their research to. Experiential learning in the ELC gave students a concrete example that they could use to connect to the scientific articles they read. Experiential learning has also been shown to have higher engagement with scientific material (Langen et al., 2014). Perhaps students in the control class decreased in confidence because they felt more disengaged from the material, causing them to perceive that they understood less.

In the short responses, ELC students discussed having more scientific understanding and confidence by the end of the semester. Their responses were expansive, with some students noting that they felt they could now describe any type of scientific data to other people. This result further suggests that the increase in confidence goes beyond the survey data analysis performed in class. When combined, the short response and the professor-led survey results indicate that it is possible for experiential learning to increase confidence in scientific skills in general, beyond those directly associated with the experiential component of the course.

Data interpretation was identified as one of three essential skills STEM students should gain during college (Coil et al., 2010), and students report more interest in community engagement when projects provided career related skills (Caspersz and Olaru, 2015, p. 691; Coker et al., 2017). When combined with the fact that data literacy is a skill many students struggle with, programs that can combine data literacy and experiential learning can prepare students for their future professions (Harsh and Schmitt-Harsh, 2016; Gibson and Mourad, 2018). Our study provides evidence that when using experiential learning students' confidence in their ability to interpret data can increase significantly. Current research suggests that teaching data literacy analysis through the example of real-world datasets improves students' ability to understand these critical skills (Hicks and Irizarry, 2018; Langen et al., 2014; Kjelvik and Schultheis, 2019). This paper provides further support for this conclusion, as students in the ELC gained significantly more confidence. While studies with experiential learning that measured students' confidence in regard to designing their own research questions and protocols have had mixed results (Gormally et al., 2009; Rissing and Cogan, 2009), our ELC uniquely focused on a topic that students had reported interest in, and students worked closely with community partners using authentic data. Neither of the previous studies mentioned student interest in the experiential learning topic chosen (Gormally et al., 2009; Rissing and Cogan, 2009). It is possible that our students showed an increase because our student-led topic was selected based on student interest, and thus students were more motivated to excel, resulting in more confidence in their skills by the end of the semester. Our study suggests experiential learning can improve students' confidence in science in reading, creating, presenting, and interpreting data. We hypothesize that the ELC's practice of working directly with authentic data contributed to the students' increase in confidence in data literacy.

While we have demonstrated that students' confidence improved, we note that our study has limitations. We did not include survey questions that would test their knowledge of scientific material, and so we cannot conclusively say that our students have higher levels of knowledge in data literacy from pre- to post-survey. However, positive relationships between self-confidence and academic performance have been reported previously, suggesting that students who have more confidence in themselves may also excel academically at higher rates (Abdulghani et al., 2020). Further, the professors of the course observed an improvement in the way that students approached scientific data, from being able to summarize it at the beginning of the semester, to being able to question and critically analyze it by the end of the semester.

We note that many of our questions are specific to the type of data that students encountered in the ELC. We wanted our questions to focus on what the ELC was doing so that we could directly quantify whether they improved. There exist many ways of graphing and discussing results beyond survey data, and thus some of our questions are limited in their scope. However, both the short response and Figure 3A demonstrate that students in the ELC expanded their confidence beyond just survey data. Our study is done on a small sample size (Table 1). A larger future study could investigate whether students in an experiential model gain confidence across a broad range of scientific skills. Using a survey model, where the project changes but students still design, implement, and analyze a survey to learn the core components of data literacy, would test whether the results seen here could be generalized across disciplines. Despite its limitations, this study demonstrates the importance of experiential learning in STEM forboosting student confidence in a variety of essential scientific skills.

This study presents a successful format for educators who desire to teach data literacy. There are currently few examples of how to teach data literacy in the classroom and even fewer rigorous scientific articles that investigate the efficacy of teaching science literacy through community engagement (Hayford et al., 2014). Our paper employs multiple mechanisms to provide rigor to our experimental design. Using both pre- and post-surveys, as well as a control group, our paper contributes to the need for more rigorous studies. Further, few STEM projects contain experiential learning with general skills like data literacy (Remington et al., 2023). Since this survey model can be used with any topic, teaching data literacy through a student-led survey can be a useful tool for professors interested in fostering community engagement and increasing data literacy across a variety of disciplines and student populations.

Conflicts of Interest

The authors of this study declare no conflicts of interest.

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