

THE IMPACT OF BIWEEKLY READING ASSIGNMENTS ON STUDENT SCIENCE
LITERACY AND SELF-PERCEPTION OF COMPETENCE IN THE SCIENCE CLASSROOM

by

Tressa Lee Beauprez

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2024

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ABSTRACT

Students struggle with reading and comprehending science texts. This study involved giving 11th grade chemistry students biweekly (every other week) reading assignments with the goal of improving science literacy and student perception of their own competence in science. Students were given a pretest and a self-confidence survey. A smaller sample of students were interviewed about their attitudes about science learning and reading. Throughout the study students were given more posttests to gather data, and at the conclusion of the study the self-confidence surveys and interviews were repeated. This study found a statistically significant difference in student literacy scores after the treatment. There was not a statistically significant difference in student confidence.

INTRODUCTION & BACKGROUND

Context of the Study

This study focused on improving literacy in High School Juniors enrolled in chemistry classes at Lockwood High School (LHS) in Billings, Montana. Data collected from statewide testing of our students shows that literacy is an area in which our school needs to improve. The overall purpose of this study was to improve science literacy and confidence in reading science texts for my students at LHS. Our school serves approximately 600 students grades 9-12 and is a Title I school. At LHS, students struggle with literacy, and some have learned helplessness (they underestimate their abilities and wait until an adult assists them.) Often literacy initiatives focus on English classes, but literacy involves all subjects, and the ability to read, understand, and solve problems is essential in science. For college bound students, it is extremely important to build science literacy skills. Students must have baseline science literacy to get an acceptable score on the ACT, which is used in the state of Montana. Although educators are discouraged from “teaching to the test”, it is essential for students in our school’s economic demographic to score well on the ACT so that they can get accepted into college and do not have to pay for prerequisite courses. Additionally, many students who enroll in chemistry intend to study some kind of science while in college, and it is crucial for success at the college level in science programs that students can independently read and comprehend science texts. For students who are not college bound, it is also important to leave high school with a baseline of basic science literacy so that they can understand science well enough to make informed decisions in realms such as politics and making healthcare decisions. This research is relevant to educators directly working with students at LHS, and those involved in decision making for school leadership.

Sharing the results of this study may impact decision making for literacy initiatives and goal setting for how instructional time is used.

Support Team

Andrea Meiers is the curriculum director for Lockwood Public Schools. She was a professor of education at Rocky Mountain College at the time I attended, and I have invited her into my classroom many times in the past few years when I needed honest and constructive feedback. She is familiar with the operations of the district and is a great resource for curriculum design. Her undergraduate degree is in secondary English education and her graduate degree is in Educational Leadership. She has given me feedback throughout the process of designing and implementing my research.

Jake Bushnell is a science teacher who teaches next door to me at Lockwood High School. He has a Bachelor of Science in Exercise Science and his master's degree is in education. He teaches anatomy and physiology and sports science. I selected him because he works very closely with my students. Many students are enrolled in both chemistry and anatomy and physiology. Jake is also familiar with the skill progression of my students. He has taught a variety of subjects in science at Lockwood High School, including freshman earth and space science and sophomore biology. As a result, he has a unique perspective of student's capabilities and learning progressions over time.

I met with my support team separately to get the most variety in feedback.

Focus Question

My focus question was, what is the overall impact of biweekly (every other week) reading assignments on student literacy and confidence in science?

My sub questions include the following:

1. What is the impact of biweekly science reading assignments on student performance in science literacy?
2. What is the impact of biweekly reading assignments on student self-perception of competence in science?

CONCEPTUAL FRAMEWORK

The importance of literacy is difficult to overstate. Science literacy for all is especially important. All people in the modern world need some level of scientific literacy, as The National Research council (2022) shared, “personal and societal decisions in the 21st century increasingly require scientific and technological understanding. Whether about health, the environment, or technology, a certain level of scientific knowledge is vital to informed decision making” (p. 5). Science literacy for all is important, and this is one reason why the United States has set specific goals for improving science education. Other goals included expanding the number of minorities in the STEM field and increasing the number of people in the STEM workforce. (National Research Council, 2011). Science literacy is an essential component to success in STEM programs in college. One study conducted by authors Means et al. (2016) found that students who attended STEM inclusive high schools, which are schools that accept students into STEM courses based on interest rather than on testing or other measures of readiness were more likely than students in similar schools to earn a master’s degree later in life. Additionally, students with higher ACT and SAT scores, which impact college admission and cost, were found to have the commonality that they had taken courses that included at least 3 years of science (Anonymous, 2011). The article “Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine” used a variety of methods to interview students and found that students felt successful with science if they felt supported by important adults in their lives, even if the science courses in school were difficult (Aschbacher et al., 2010). Building science literacy in students now may lead them to support the literacy of their own children later in life. This idea of identifying the self as someone who is competent in science is important in my study. Developing students’ identity as someone who can understand science is echoed in

Jacquelynne Eccles's (2009) research on identity development, which posits that students need to think they can do well in a STEM field academically, and they need to see a post-secondary degree in such a field as valuable in order to pursue science learning in a meaningful way.

Literacy is a broad topic, and as a result there is lots of research done on literacy. It was a challenge to find studies like mine, but reviewing other studies gave me ideas for how to develop my treatment. One article (Wu et al., 2018) focused on academic literacy and science communication skills. Both areas are of interest to my study. The cohort was different than mine, as the study was done on undergraduate students that had received a high school diploma or the international equivalent, and all students involved were studying a science related field. The students completed a pre and post essay, and the treatment involved students reading popular science texts like Stephen Hawking's *A Brief History of Time*. The study involved a small sample but found that students' ability to communicate scientific ideas improved between the pre and post essay. This paper influenced my research because it helped me think about what kind of readings I would have my students do. I chose articles related to current learning topics, instead of something like textbook reading because this article mentions using popular science texts to improve student literacy. I selected articles that I felt were both relevant to the content I was teaching and that would draw students' interest. For example, students have a fascination with the Chernobyl nuclear disaster, so when learning about radioactive decay, students read about how the disaster unfolded from a scientific perspective. Another study that informed my conceptual framework was a study that involved 40 classrooms over a four-year period (Drew & Thomas, 2022). One part of their treatment that I adapted into my research was involving students in close reading. I modeled reading for students after reading this study, which the study claimed helped students with learning disabilities.

Another piece of my conceptual framework involved students learning vocabulary. It is important for students to work with science vocabulary in a meaningful way, and that they interact with science reading material the way a scientist would (Wisconsin Department of Public Instruction, 2015.) The paper, “Exploring the Relationship between Ability Grouping and Science Vocabulary Learning”, explored the differences between remedial and advanced students’ understanding of science vocabulary (Brown & Concannon, 2019.) One part of this study that I applied to my research was investigating students’ perception of their own literacy and content knowledge. The authors Brown and Concannon (2019) found that reading and vocabulary work improved student confidence in science. Instead of exclusively studying reading as a tool to improve science literacy, I also conducted interviews and gave self-confidence surveys to see if students’ self-perception changed in a meaningful way.

METHODOLOGY

Demographics

This study was conducted in my chemistry classes at Lockwood High School in Billings, Montana. Billings is the largest city in Montana, with approximately 120,000 people in the Billings area. Lockwood is an unincorporated community of about 8,000 people. It is the 16th fastest growing area in the State of Montana (United States Census Bureau, 2020).

Lockwood High School opened in the Fall of 2019 and graduated its first senior class in the spring of 2023. During the 2023-2024 school year when this study was conducted, there were 554 students enrolled in grades 9-12. 53.2% of students enrolled during the time of the study were male and 46.8% of students were female. 54.2% of students received free or reduced lunch, which qualifies Lockwood High School as a Title I school under the Elementary and Secondary Education act of 1965. Of the students enrolled nine percent receive special education services. Lockwood Schools are comparatively diverse at 28% compared to other schools in the state of Montana. The largest subgroup of minority students is Hispanic/Latino.

Lockwood High School has experienced significant levels of staff attrition, losing about 30% of the teaching faculty in the 2023-2024 school year. Most teachers hold only a bachelor's degree, and several teachers in the 2023-2024 school year had provisional teaching licenses and held less than a bachelor's degree (Lockwood School District, 2024).

The study included 69 students rostered in my classes. Thirty-two students were male, and 37 students were female. 64 students were in 11th grade and five students were in 12th grade.

Treatment

To improve student literacy, students were given short reading assignments in class every other week. These reading assignments were added to the current curriculum, and the existing curriculum was not altered in any way. The existing curriculum involved following the Next Generation Science Standards applicable to chemistry, and included guided notes and practice, as well as hands on activities with manipulatives and labs. The grading system was based on proficiency in the standard taught, so reading assignments were part of the learning process and completion of reading assignments and supplementary material was not graded. Initially, the science reading was modeled for students using a document camera. I held class discussions about which information was relevant. Students were given guidance on challenging words, and most of the time read the content with a partner. Reading samples came from a variety of online sources, but most came from the American Chemical Society. The reading assignments were always related to the content being taught. For example, when learning about radioactive decay, students read about the Chernobyl Nuclear Disaster (Dingle, 2020). When learning about light, students read about Einstein's development of the $E=mc^2$ equation (Tyson, 2005). A full student reading list can be found in Appendix A.

Data Collection and Analysis Strategies

Before the first reading assignment was given, I gave all students a pretest, which was a portion of the science ACT that students read and answered questions on. The section included reading on one single topic and the questions that went with the topic. The reading was given to students after the pretest was administered to get an idea of student baseline literacy. The pretest was given prior to the start of the treatment to see how each treatment impacted student literacy.

Throughout the fall semester, I readministered passages from the science ACT to see if student reading ability improved. At the same time as the initial pretest, I conducted student interviews. I asked for student volunteers and interviewed students that volunteered ($n=10$). The purpose of the interviews was to get an idea of student attitudes about science and their own competence in science (Appendix B). When the pretest was administered, I also gave students a self-confidence survey (Appendix C). All the students present the day the surveys were administered participated voluntarily. The data collected varied based on student attendance. Attendance is sporadic, with an average of 12 students rostered in chemistry class absent each day. Post tests were given every two to four weeks throughout the fall semester. The final interviews (Appendix B) and self-confidence surveys were given just before the end of the semester. Table 1 shows data collection tools and expected outcomes. This study was reviewed by the Institutional Review Board at Montana State University and was granted an exemption (Appendix D) due to the educational nature of the study and measures taken to ensure minimal student harm and the preservation of student privacy. Measures taken to ensure the reliability and validity of this study are discussed in Table 2.

Table 1. Data collection tools, research question, and expected student outcomes.

Research Question	Data Collection Tool and Student Outcome	Data Collection Tool and Student Outcome	Data Collection Tool and Student Outcome
	Pre-Assessment/Post Assessment (science ACT)	Student Self-Confidence Surveys	Student Interviews
What is the overall impact of biweekly (every other week) reading assignments on student literacy and confidence in science?	Student outcome: Measure changes in science literacy.	Student outcome: measure changes in student self-perception	Student outcome: measure changes in student self-perception

Table 2. Measures taken to ensure reliability and validity.

Research Question	Data Collection Tool	Data Collection Tool	Data Collection Tool
	Pre-Assessment/Post Assessment (science ACT)	Student Self-Confidence Surveys	Student Interviews
Strategy implemented to ensure validity	ACT science reading tests were used to ensure that there was no prior knowledge from the in-class learning of topics impacting the literacy scores. Members of my support team and other colleagues reviewed treatment plans.	Survey data was protected; students were made aware that surveys were optional and would not impact grading. Survey questions were reviewed by members of the support team.	Interview questions (initial and follow up) were kept consistent between interviewees to minimize interviewer bias.
Strategy implemented to ensure reliability	For pre and post assessments, I exclusively used science ACT tests to ensure that pre and post test difficulty was consistent.	Student survey questions were kept consistent when surveys were readministered. Support team reviewed surveys.	Interview questions were kept consistent when surveys were readministered.

DATA ANALYSIS

Results

Biweekly reading assignments do improve student literacy in science. Student scores improved over time following a science reading assignment and science reading lesson. There was a statistically significant difference in student scores between the pretest and final test.

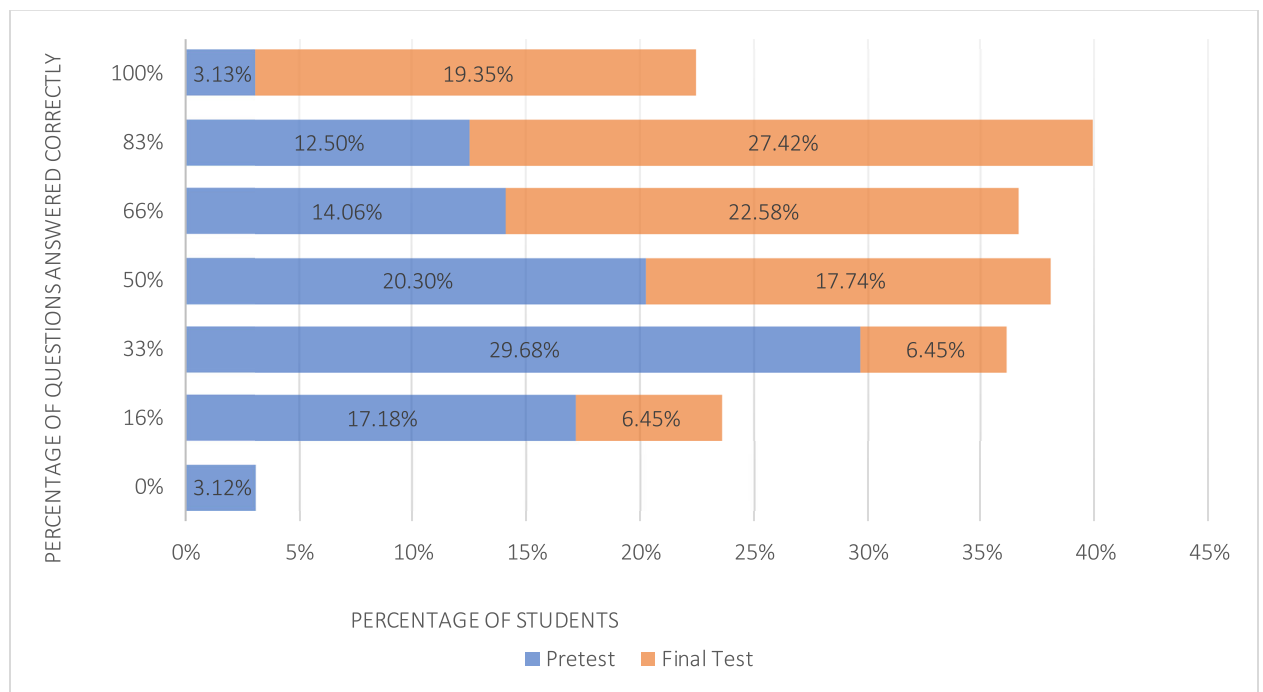


Figure 1. Pretest versus final test comparison, ($N=69$).

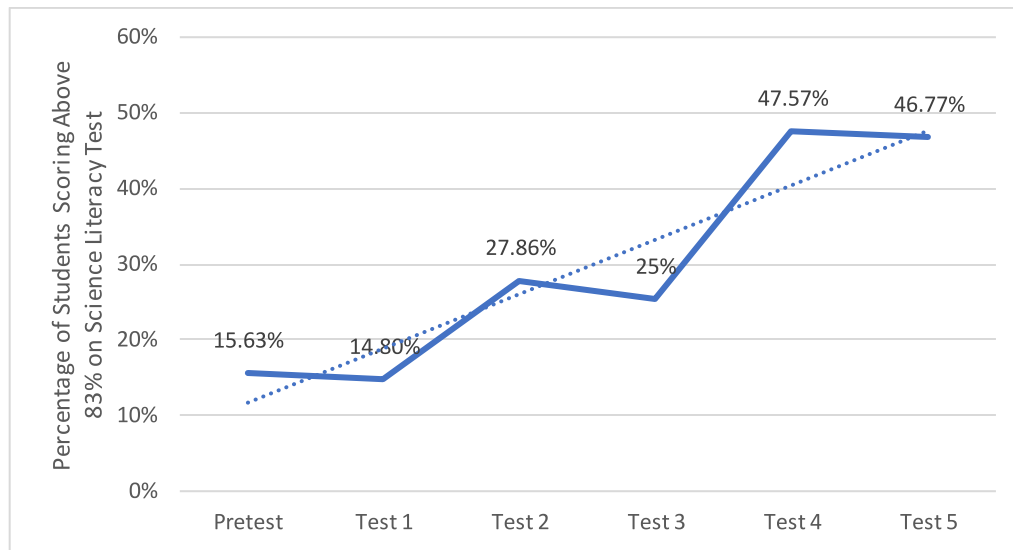


Figure 1. A graph of students scoring above 83% on science literacy tests, ($N=69$).

Figure 2 shows a general improvement in student scores over time. Students began scoring higher on literacy tests after administration of several reading assignments. The trend of improved student scores was observed over time, so a two-tailed, unpaired T test was performed to see if there was a statistically significant difference in scores between the pretest and the final test.

Comparative test scores for the pretest and final show improvement (Figure 3). A two-tailed T test was performed on the data to compare the initial test scores to the final test scores. The two-tailed P value is less than .05. This shows that there was a statistically significant difference between scores on the initial test and scores on the final test. The previous data that showed improvement over time is also evidence for improvement.

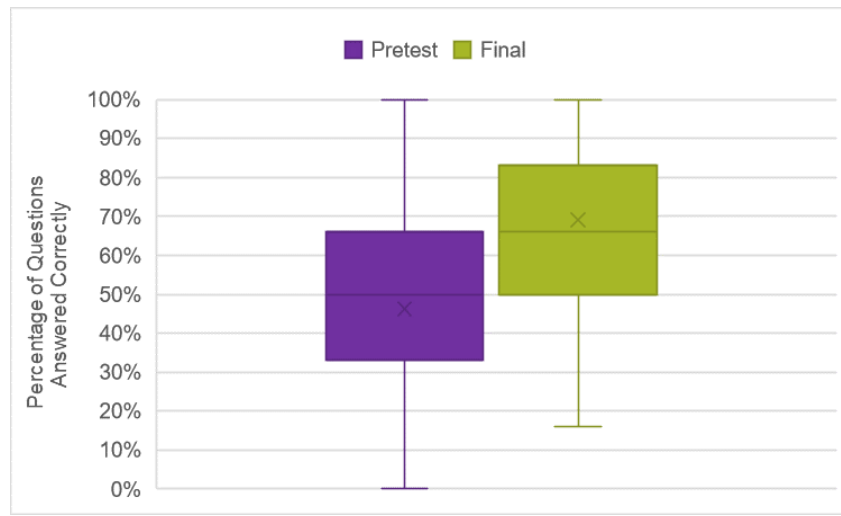


Figure 3. Box and whisker plot showing student literacy changes, ($N=69$).

Students' perception of their own competence did not improve in a significant way (Figures 4 and 5). Some interview questions were dropped because after collection they did not align with the overall theme of the study. A Chi-squared test was done on the survey data collected at the beginning of the study and at the conclusion of the study. The initial sample was 40 students and the final sample included 32 students. Students did not feel more confident reading in science class after the treatment, $p>.05$. Students did not feel more confident learning science vocabulary, $p>.05$. Students did not feel that they better understood science when reading outside of school, $p>.05$. The p values of all Chi-squared tests were greater than .05, with no statistically significant difference in student confidence at the beginning of the study versus at the end of the study. The initial data showed that many students surveyed were somewhat confident in their science reading abilities, and that when reading outside of school, they mostly understood science texts. The final data was mostly similar. There was no apparent correlation between science literacy confidence and students' test scores.

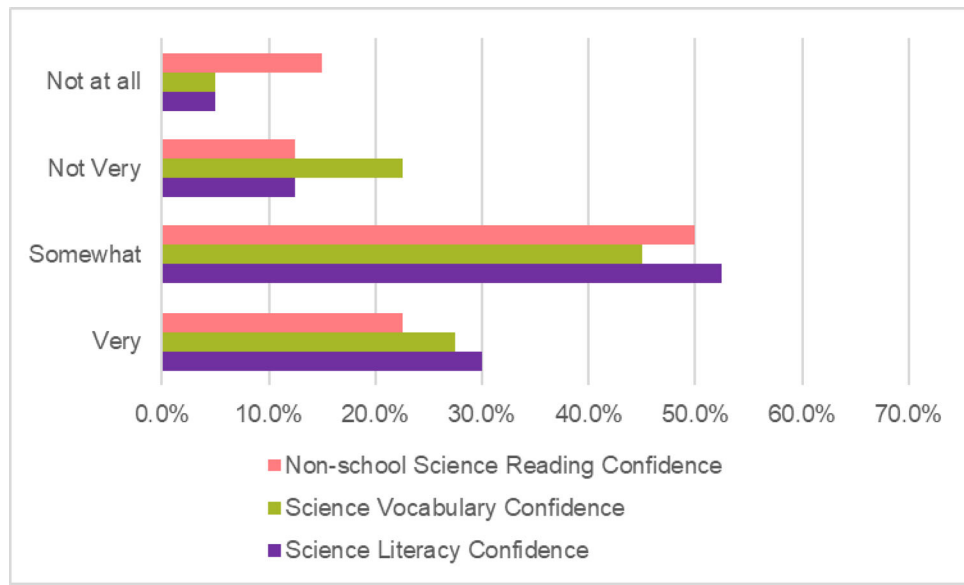


Figure 4. Initial student survey data, ($n=40$).

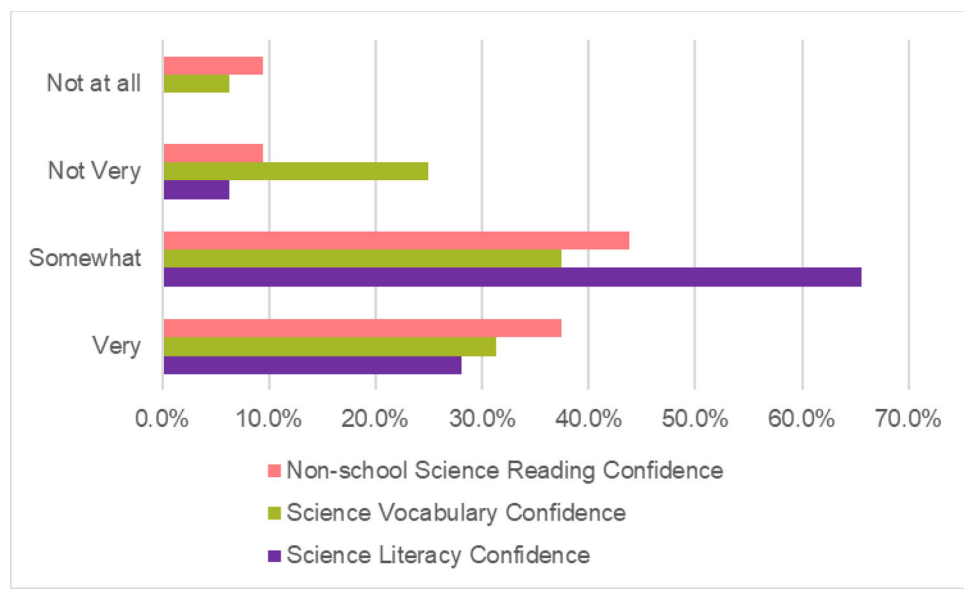


Figure 5. Final student survey data, ($n=32$).

Interviews were conducted and assessed for patterns. When asked what a student could teach me, many said something related to sports or hobbies. My follow up question asked how they learned that thing, and most students said someone else showed them how to do it, which relates to my survey question about how they preferred to learn, which was hands on. This is one

reason why partner reading continued to be a part of my treatment—learning from others is helpful to my students. Another reason I felt that partner reading was important was that students said in interviews that when they got stuck learning in chemistry class, they depended on their friends to help them. This was a theme identified in both pre interviews and post interviews, with students saying, “I ask [Student] for help and then if she doesn’t know, then I ask you.”. Themes were consistent between pre interviews and post interviews.

CLAIM EVIDENCE AND REASONING

Claims From the Study

The overall impact of biweekly (every other week) reading assignments on student literacy and self confidence in science was an improvement of literacy and no apparent improvement of student self-confidence. The impact of biweekly reading assignments on student performance in science literacy was higher scores on student literacy tests. Student scores improved over time. According to the literature as referenced in the conceptual framework, this improvement in science literacy has a far-reaching impact that increases the likelihood of taking additional high school science classes which in turn increases ACT and SAT scores (Anonymous, 2011). These improvements are also linked to a greater likelihood of earning a master's degree, increased participation in the STEM workforce, and more informed decision making later in life (Means et al., 2016).

The impact of biweekly reading assignments on student self-perception of competence in science was negligible. There was no apparent impact on students' self-perception of competence in science. This is evident when looking at the pre and post survey data and the lack of statistical difference between the pre and post survey data. This finding is not surprising, as many of my students tend to underestimate their capabilities. A reason for this could be a lack of science education in elementary school, as the district I work in just started offering science curriculum to students in elementary grades in recent years. Another reason for a lack of confidence could be that students come from disadvantaged backgrounds, and do not think of themselves as competent because academic confidence is not modeled for them. The data showed that there is value to taking time in science courses to devote to reading science-specific texts.

Value of the Study and Consideration for Future Research

This study leads science educators to consider that we should be teaching literacy as well. If I were to continue this study, I might try to also incorporate writing into my classroom in addition to regular reading. In the coming years, I would investigate the impact of reading science texts on a student's ability to communicate complex scientific ideas in written form. Incorporating more reading and writing in my classroom would limit the amount of time I have to cover the essential content in chemistry. It would be difficult to extend this study due to time limitations, but there is value in teaching science literacy in my classroom. This study is limited, as the study group was small and there was not a control group to compare to. If this study were to be repeated in a different context, educators may want to include a control group of students or control for factors like level of math classes students have taken.

Impact of Action Research on the Author

When I first started teaching, I rarely gave students reading assignments. If I did, I would give them little support and then found myself frustrated by their lack of ability to comprehend science texts. I made the excuse that I had too much content to cover, and that chemistry was more math focused than reading focused. The impact of this research on me as an educator is that it provides evidence that there *is* value in reading science text in science courses. Science texts differ from other literature in a few important ways. An article on the Wisconsin Department of Public Instruction (2015) sums up the differences well, "Typical science texts use less familiar vocabulary. They also present ideas through multiple modalities (such as graphs, diagrams, lab write-ups, paragraphs), requiring students to synthesize a range of information" (p.1). This study provides evidence that giving students regular opportunities and support to read science texts

enhances their ability to read science texts. I am hoping to continue to do biweekly reading assignments at a minimum. I also am going to look for other measures to take to improve student self-confidence in science, but since self-perception is such a vast topic, I would want to learn more about specific strategies that work to improve the confidence of High School students. Students' ability to read and comprehend information in science texts is very valuable, and it is a skill that can be extended to other subjects.

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APPENDICES

APPENDIX A

LIST OF SCIENCE READING RESOURCES GIVEN TO STUDENTS

Fission vs Fusion

Chernobyl's Legacy

The Legacy of Rachel Carson's Silent Spring

The Chemistry of Fireworks

Einstein's Big Idea

An Introduction to the Periodic Table

The Periodic Table and Transuranium Elements

Alkali metals and Alkaline Earth Metals

Chlorofluorocarbons and Ozone Depletion

The Silent Killer (Carbon Monoxide)

APPENDIX B

STUDENT INTERVIEW QUESTIONS

Research Question	Interview Question
Can biweekly reading assignments improve student self-perception of competence in science? (sub question)	1.What is something you could teach me?
	1a. Why did you choose this?
	1b. How did you learn it?
	2.Tell me about a time you felt confident learning science
	2a. Why do you think you felt this way?
	3.When you are learning, how do you know you're on the right track?
	4. Do you think you are good at science?
	4a. Why do you think this? (follow up to previous question)
	5.When you get stuck learning Chemistry, what do you do?
	5a. Where did you learn this from?
	6. Is there anything else you want me to know?

APPENDIX C

STUDENT SELF-CONFIDENCE SURVEY

1. How confident do you feel when reading in science class? Choose the statement that best describes your feelings.

Very Somewhat Not very Not at all

2. How do you learn best in science classes? Choose the statement that best describes how you learn.

Hands on learning,
like labs

Reading about
science

Watching science
videos

Notes- learning directly from
the teacher

3. How do you feel about learning science vocabulary? Choose the statement that best describes your feelings.

It is very
easy

It is neither easy nor
difficult

It is slightly
difficult

It is extremely
challenging

4. Do you understand science when you read about it outside of school (in the news, books, etc.). Choose the statement that best describes your feelings.

When I read about science in the news, I can understand what it means and form an opinion based on my knowledge

When I read about science in the news, I mostly understand it

I understand very little when I read about science-

I don't read about science

APPENDIX D

IRB EXEMPTION

Hello Beauprez, Tressa,

Your protocol was reviewed by the IRB and has been approved.

PI: Beauprez, Tressa

Approval Date: 10/16/2023

Title: Impact of Biweekly Reading Assignments on Student Literacy in the Science Classroom

Protocol #: 2023-1040-EXEMPT

Review Type: Exemption

Expiration Date: 10/16/2028

Work described under this protocol may now commence. The PI is responsible for ensuring that the protocol accurately describes research practices being conducted.

- > Review Category designation determined by the IRB can be found in the final section of your protocol.
- > IRB-stamped active Consent Forms are attached within your protocol where applicable.
- > Any changes must be submitted via Amendment prior to implementation.
- > Per the Common Rule, research only requires Interim (annual) Review by the IRB if 1) it was reviewed via Full Committee or 2) is regulated by the FDA.
- > All research is subject to post approval monitoring.

- > All protocol types must be renewed 5 years after approval.
- > Inform the IRB once your research is complete so that the protocol may be inactivated.

Please contact your IRB Program Manager with any questions or if you are in need of assistance.

Thank you for your diligence in the care of human subjects research participants.

Institutional Review Board for the Protection of Human Subjects | Office of Research
Compliance | Montana State University

Access your protocol anytime at

<https://montanaprod.topazti.net/Elements?emailLink=11%2c102%2c10440>.