Perceptions and Attitudes Toward Science Teaching of Preservice Elementary Teachers

by

Amanda D. Francis

B.S., West Liberty State College, 2005

M.A., West Liberty University, 2017

Submitted to the Graduate Faculty of the

School of Education in partial fulfillment

of the requirements for the degree of

Doctor of Education

University of Pittsburgh

2022

UNIVERSITY OF PITTSBURGH

SCHOOL OF EDUCATION

This dissertation was presented

by

Amanda D. Francis

It was defended on

June 22, 2022

and approved by

Dr. Emily Raney, Assistant Professor, Department of Teaching, Learning, and Leading

Dr. Karen Kettler, Dean and Assistant Professor of Biology, College of Sciences

Dissertation Director: Dr. Cassie Quigley, Associate Professor and Associate Department Chair, Department of Teaching, Learning, and Leading

Perceptions and Attitudes Toward Science Teaching of Preservice Elementary Teachers

Amanda D. Francis, Ed.D.

University of Pittsburgh, 2022

The implementation and teaching of science, technology, engineering, and mathematics (STEM) has improved at all field levels over the past 30 years. STEM education provides a skill set that governs the way we think and behave which helps us solve the challenges the world faces today (Norris, 2021). Therefore, the importance of students learning STEM effectively comes from providing valuable STEM learning opportunities. Consequently, vital STEM-related preservice teacher education is essential. The aim of this study was to examine what ways better prepare preservice teachers to implement science teaching providing a scaffolding science teaching approach to improve the students' perceptions, attitudes, and confident toward science and science teaching.

The study design incorporated an analysis of surveys and rubrics to determine the students' measured perceptions and attitudes toward science and their confidence in science teaching using in-classroom experiences, virtual observations, and classroom activities. Participants included 21 students enrolled in the Bio 340 Life Science course designed specifically for preservice teachers. Over the course of five weeks, the preservice teachers participated in three separate case study video observations, journal entries, and open discussions pertaining to the case study videos, with rubrics used to analyze student retainment and benefits. Additionally, preservice teachers participated in in-classroom teaching experiences, with rubrics used to measure the students' confidence in science teaching. The surveys were analyzed to determine the students' perceptions and attitudes toward science teaching and the effectiveness and improvements in student learning.

The analysis of the surveys established that how this group of preservice teachers had a positive effect on student attitudes and improved confidence for teaching science. The findings from this study support the addition of field hour assignments into the course content while also using the scaffolding teaching method to rejuvenate the science learning experience for the students.

Table of Contents

List of Tables

List of Figures

Preface

I would like to thank Dr. Cassie Quigley for guiding me through this doctoral experience and her knowledge in STEM education was greatly appreciated. Additionally, I would like to thank Dr. Emily Rainey for helping me become a better writer and guiding me through the daunting literature review process. Thank you to Dr. Karen Kettler for being on my committee and for being the example that drove me to pursue my doctorate. To my fellow cohort members, I appreciated all the texts, calls, and emails throughout the years. Finally, a huge thank you to my family for their continued support and encouragement during these years. They have never wavered in their belief in me, and I truly needed that at many times.

1.0 Naming & Framing the Problem of Practice

1.1 Broader Problem Area

Science education in early childhood is of great importance to the many aspects of a child's development because, by thinking and acting like a scientist, children develop deep understanding of important real-life phenomena. Therefore, researchers such as Eshach and Fried (2005) suggest that science education should begin in the early years of schooling. There are numerous reasons why children should begin learning science during their early elementary years. One such reason, as described by French (2004), is that young children are motivated to explore the world around them. Eshach and Fried (2005) state that engagement in science is vital to help a child understand the world, collect and organize information, apply and test ideas, and develop a positive attitude toward science. By building a solid foundation of scientific concepts at an early age, elementary students remain positive regarding science when encountering it throughout their academic lives.

The rise of the digital age has made science, technology, engineering, and mathematics (STEM) education even more critical for the future of the United States (Parker, 2020). The Smithsonian Science Education Center (2016) released data showing the importance of STEM and its imperativeness to students. For example, roughly 78% of high school graduates do not meet benchmark readiness for one or more college courses in mathematics, science, reading, or English (Smithsonian Science Education Center, 2016). According to the U.S. Department of Education, the skills that students develop in STEM will provide our nation's youth with the knowledge and skills to solve problems, make sense of information, and provide the know-how to gather and evaluate evidence to make a decision (Morrow, 2018). Therefore, the West Virginia Board of

Education (WVBE) and the West Virginia Department of Education (WVDE) placed Policy §126-44CC on July 1, 2016. This policy, also known as policy 2520.3C, defines the science content standards and objectives as required within WV (Tennant & Heinlein, 2016). The WVBE and WVDE introduced this policy to classroom teachers and special education teachers. They asked that teachers revise their content standards and objectives to those presented in the Next Generation Science Standards (Tennant & Heinlein, 2016). As a result, as stated in WV Policy §126-42, students receive a quality education, and the administration ensures the content standards are being implemented (Church, 2020).

The importance of students learning STEM places pressures on teachers to provide adequate STEM learning opportunities. According to popular media and educational research literature, children need to be better prepared in the STEM areas starting in elementary years to prepare them for careers in the future, both STEM and non-STEM related (Murphy, 2011; National Research Council, 2013). Therefore, my area of focus concerns how to prepare preservice teachers for effective life science teaching. In general, teacher preparation programs influence preservice teachers' attitudes toward teaching in the classroom (Feiman-Nemser, 2001). It is my job to prepare preservice elementary teachers to demonstrate numerous science activities in their classrooms one day.

Vital science-related preservice teacher education is essential. According to Bleicher (2007), if preservice teachers had deficient science teaching models, their confidence in teaching science to their students is less than average. Therefore, to support my students effectively, I need to guide their science education positively. Using my classroom experiences, the elementary preservice teachers have shown negative dispositions toward the pedagogy of science. For that reason, as a teacher educator, my practices need to change and evolve to rectify their outlook.

Additional research shows that primary teachers have had their own negative experiences with science in primary and secondary school, which often results in negative attitudes toward science after their preservice training (van Aalderen-Smeets et al., 2017). My goal is to change this perspective.

1.2 Organizational System

West Liberty University is a small liberal arts university in the northern panhandle of West Virginia. The school, established in 1837, provides higher educational opportunities west of the Appalachian Ridge. Today, West Liberty University has roughly 3000 students in approximately 70 different majors. The admissions site advertises West Liberty as one of the safest campuses in WV for students and employees and offers more than 60 student clubs and organizations. Mark Montgomery, the founder and CEO of Great College Advice, explains that the curriculum of a liberal arts university introduces students to a wide variety of academic subjects and materials and develop some expertise in a single field (Moody, 2018). Therefore, this allows students to be well-rounded individuals when they graduate with their degrees.

The College of Education has an extensive history with the identified problem of practice, better preparing preservice teachers for effective methods of instruction in life sciences. Of the seventy majors at West Liberty University, the College of Education program began during the West Liberty Academy and then Teachers College status. According to a retired professor and author, on March 4, 1931, the WV Legislature formally changed the school's name to West Liberty State Teachers College (Javersak, 2009). As education has evolved, the program and professors continue to evolve as well. For example, the College of Education begins its home page by stating, "Think…Move…Connect," and challenges its students to integrate the mind, body, and community (Moneroso, 2020). This statement shows that with the current situation of students, parents, and educators in virtual education, West Liberty University College of Education still emphasizes the correct values in their future and current education majoring students. The program offers a dedicated group of professors who teach varying content areas within the college. When evaluating the College of Education to the problem of practice, the department's support and diligence to its professors and students are vital in the program's success.

The identified problem of practice falls under the responsibility of the instructor of the course, who reports directly to the chair of their department. Most instructors, specifically the instructors for the science courses, are also members of the Education Unit. This committee comprises instructors from all the disciplines across campus; such courses designed for preservice teachers. We are given student pass/fail rates for the Praxis test or changes in the testing, state regulations, accreditation, student activities, and other education-related issues during meetings. In addition, the Education Unit is a chance for the instructors of the content area to voice their opinions and knowledge.

As West Liberty grew to university status in 2009, it also had growth in its diversity of student population. The Campus and Community Diversity Team (CCDT) is committed to serving the diverse student population while promoting an environment of open dialogue, cooperation, shared responsibility, and mutual respect. According to authors such as Nagda and Zúñiga (2003), intergroup dialogues are one effort that can actualize the multicultural mosaic and engage across differences (Nagda & Zúñiga, 2003, p. 121). While the use of Nagda and Zúñiga's framework at West Liberty University would be exceptional and an excellent concept, there has not been any show of this type of team on campus. Therefore, using the CCDT to advocate for equity and justice within the practice problem is still unknown. In education, another important topic to discuss during each content preparation is equity when teaching. Students must know and understand the meaning of equity. According to Bailey and Jakicic (2012), one such definition says that equity occurs when students learn the same essential learning targets no matter which teacher they have. Thus, diversity within the classroom settings is essential.

When assessing the fishbone, the organization affects the problem of practice in numerous ways. Firstly, providing capable faculty will deliver premium content and pedagogy instruction to the preservice teachers. These professors will leave a lasting impression on students. Secondly, the organization will afford the preservice teachers with learning content, believing that science is essential, and engaging students is fundamental. It is also crucial for preservice teachers to improve their attitudes toward science and increase their confidence in teaching science content. The experiences the preservice teachers receive in higher education should be positive and allow for numerous opportunities for elementary teaching and observations. They should also be mindful of equity, access, and diversity in their education. Finally, the fishbone demonstrates the guidance in preparing for student teaching within the organization, praxis preparation, and content instruction.

1.3 Positionality Statement

I grew up mostly educating and entertaining myself, in a white, middle-class home in a small town in West Virginia. I lived outside of the city limits, the country as we called it, in a two-story house with my mom, dad, and two sisters. I was the youngest daughter of three, with five years between my middle sister and me. Neither of my parents went to college; they struggled as students themselves. I vividly remember playing school with my dolls and asking my first-grade teacher for extra papers to give to my play students. Teaching was in my mind from an early age, and though I did not pursue it as a degree in college, I enjoyed teaching others how to perform lab skills or math problems. I can relate to my problem of practice as I began teaching preservice teachers three years ago and saw the students' distaste for learning and teaching science. This made me an insider to my problem of practice and became my passion for bringing joy to my class to make it memorable and educational for them. I think it is essential to get science into elementary schools. By having novice teachers interested and willing to teach science in an elementary school setting, an introduction to the subject occurs earlier than middle school.

1.4 Stakeholders

1.4.1 Elementary-aged students (K-5)

The goal at the end of this project was for elementary preservice teachers to have a more positive attitude toward science, be more confident in their science teachings, and be better versed in science content. The individuals affected by these teachers are the children in kindergarten through fifth grade. The preservice teachers are directly involved. Indirectly the project will eventually affect the future students of these preservice teachers. In the future, if a science lesson impacts a child that is taught by a preservice teacher who would not have initially had the confidence to do so until learning better science pedagogy, then my job has been done.

1.4.2 Student(s) without student teaching experience

The students currently enrolled as elementary and secondary education students at West Liberty University are essential to my problem of practice and therefore stakeholders for my study. Individuals enrolled in Biology 340: Life Sciences for Elementary Educators or EDU 100: Introduction to Education have not started student teaching. The courses taken during student teaching are four hundred level courses and cover instructional design and science methods.

The two students used for empathy interviews enrolled in my course of study. One student was an elementary education major, and the other was a secondary elementary major. It was vital to receive both perspectives, as the elementary education student is not as interested in science as a secondary student. I transcribed all the responses from each interview; however, the responses from the interview with S.S. were what I was most intrigued to transcribe, as they were a typical elementary preservice student who had no interest in teaching science. As S.S. was my student, I was aware of their personality and content knowledge. Therefore, I went into the interview with an open mind to answer questions honestly. Their feeling that learning more hands-on activities would help future demonstrations to elementary students was no surprise. They also wanted more help completing an entire unit plan before entering the previously discussed block time.

The other interviewee was a secondary education student interested in teaching science in a high school. I had T.C. in two separate courses geared toward future science teachers. Knowing the background of T.C., I was also not shocked by their responses. They felt more prepared by being around other secondary students and designing lessons or activities for older students. They also thought it was not easy to say how students engage until they are teaching and have more experience. I valued both students' opinions and felt that I learned a bit of information from their perspectives, which helped with my practice problem.

1.4.3 Student(s) with student teaching experience

The student had completed most of their education courses and was student teaching. The student used for the empathy interview, L.N., is one I had in Trends and Issues in Science Education the previous year. They had a willingness to go above and beyond to succeed. Additionally, they led a project creating and running an escape room for a middle school group that we brought to campus. They also showed their leadership skills, along with their knowledge of science. L.N. currently teaches in a seventh-grade science class at an Ohio County school in West Virginia. With L.N. in a school currently, they gave great responses on how students engage and learn science. I was also interested in learning what they felt prepared them the most to be confident in teaching science in the classroom and what we could be doing better as educators. As some of their responses were not surprising, I was surprised that they felt their technology classes were lacking at West Liberty. When prompted about student engagement, L.N. shared how they were engaging their current students and how their advisor stressed the importance of engagement in the classroom. Student engagement was referred to often in preparing the research and literature review for my problem of practice. Finn and Zimmer (2012) stated in their chapter in the *Handbook of Research on Student Engagement* that empirical research confirms the relationship between engagement behavior and academic performance. Therefore, interviewing L.N. as a stakeholder was vital for research purposes.

Additionally, a basic stakeholder analysis technique offered a quick way of identifying the stakeholder and comparing their interest or evaluation of the program. For example, Bryson (2011) describes how this technique was used to evaluate the performance of a state department of natural resources because it showed participants how existing strategies ignored important stakeholders and what might be done to satisfy the stakeholders. Figure 1 evaluates the student(s) with block/student teaching experience stakeholder.

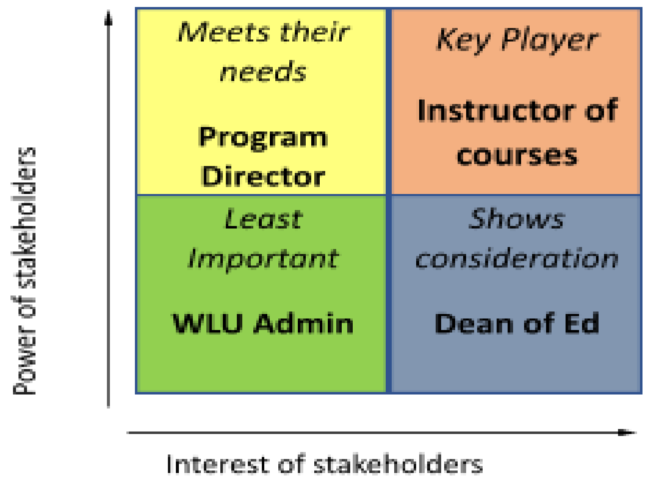

Figure 1. A Fundamental Stakeholder Analysis of Preservice Teachers

1.4.4 Novice teacher (1-2 years of experience)

A novice teacher is just beginning their teaching career, preferably in their first or second year of teaching. The novice teacher was a recent elementary education graduate of West Liberty University. I knew they had been substituting locally in Ohio and Marshall County West Virginia schools. Then in August 2020, they became a fifth-grade teacher at Woodsdale Elementary, an Ohio county school in West Virginia. Because of S.C.'s student teaching, substituting, and current teaching position, it was vital to use them for the interviews. S. C. provided a wealth of information on how students are engaging. Additionally, they clarified what we as educators could be doing better to prepare the students for when they become novice teachers. The setback of the empathy interview with S.C. was for their job to be more English-focused, but they did help by stating that children in elementary schools are engaged in numerous ways. They also expressed feelings of not being well prepared for the Praxis exams. Finally, they said that having more time in front of students, whether observing or doing activities, is highly beneficial for any student going into teaching. Using any information given by a novice teacher was the most helpful information for my practice problem, in my opinion.

1.4.5 Experienced teacher (10 plus years)

An experienced teacher has at least ten years of teaching experience, preferably in one location or grade. As a stakeholder, the experienced teacher was an elementary teacher who has been teaching in an elementary school in Bridgeport, Ohio, for over eighteen years. She spent fifteen years teaching kindergarten at Bridgeport Elementary in Bridgeport, Ohio. She decided to teach third grade at the same elementary school this year. Using experienced teachers as a stakeholder was essential because they have seen education trends over the years. For example, N.D. expressed a concern that many student teachers are not aware of state standards. This aspect of teaching is an integral part of creating a classroom curriculum, and in N.D.'s opinion, cross-curriculum is extremely useful in today's classrooms. Just as the student teacher and the novice teacher stated, the most beneficial aspect that helped was getting in front of students during student teaching. N.D. also spoke about their students' love of technology and how this is a great way to engage students in learning. I appreciate the information from the experience that N.D. brought to my problem of practice.

After conducting all interviews, it was apparent that all five interviewees held similar yet varying perceptions on what is essential to the education of preservice education students. By interviewing a student who is not in student teaching, a student teacher, a novice teacher, and an experienced teacher, I accessed the four teaching degrees. The process was like walking the beach while someone held your hand, put your feet in the water, and headed out. Next, you go out on your own, waist-deep, accepting your first job. Finally, once you have a few years under your belt and are more comfortable, it is like diving right into the water. Power distribution among my stakeholders is by the experience they have. I can tell that L.N. has more experience than my students, S.S. and T.C.; however, not as much as S.C. I could also feel the experience and knowledge that N.D. had by their talk of cross-curriculum and state standards. After conducting my interviews, I thought I was missing the perspective of those in the education administration department. One such contact that I use often is the program director, and I felt that she would be an exciting and informative interview. As my problem of practice focused on better preparing preservice teachers to implement science, the program director of education provided valuable tips and information on future classes the students will take. They also gave insight on practices other professors are trying.

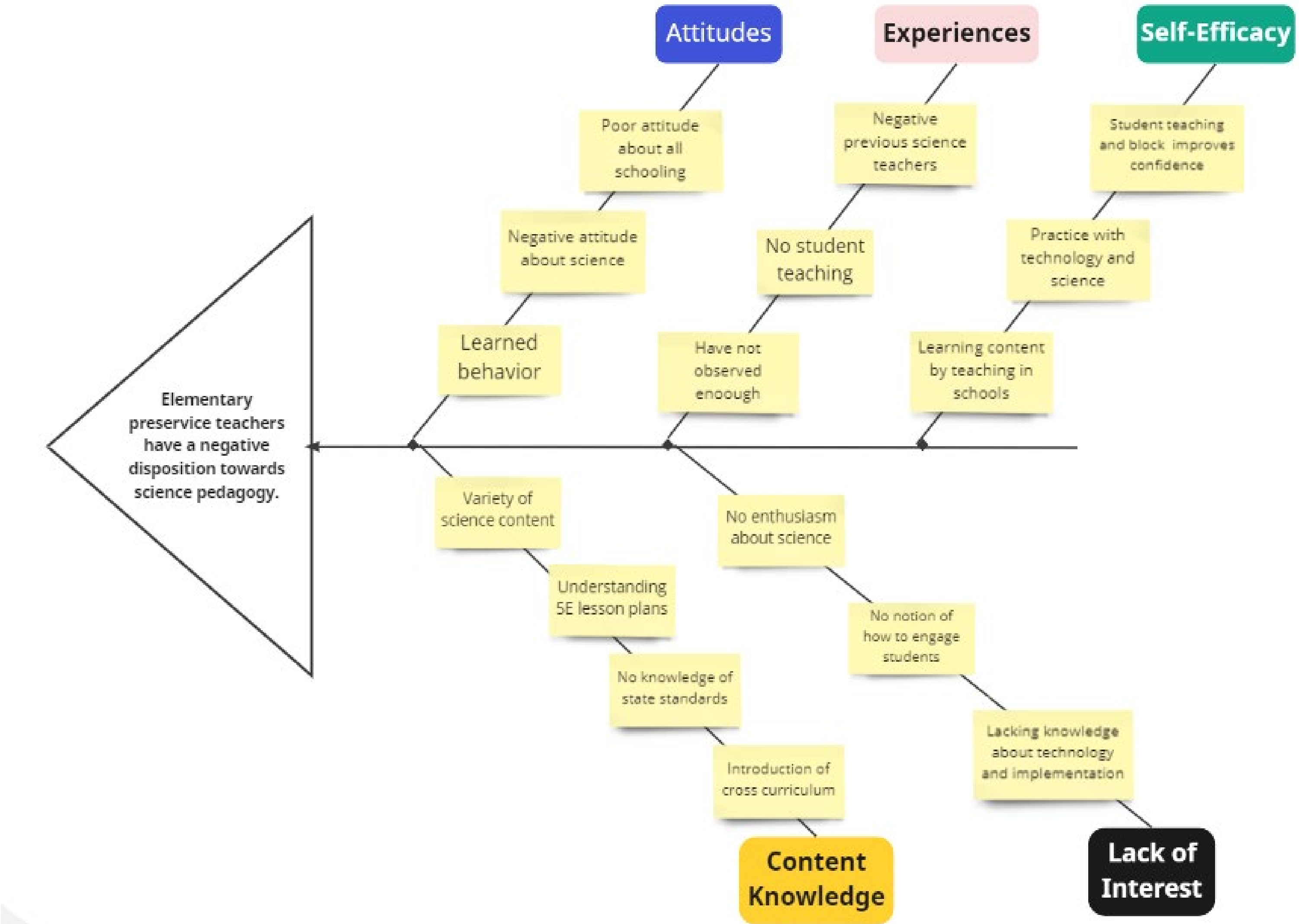

Figure 2. Problem of Practice Fishbone Diagram

After the completion of the empathy interviews, my fishbone needed to change. As seen in Figure 2, state standard instruction could be included in the curriculum to boast content knowledge. Learning content by teaching it within schools influences a student's self-efficacy. My problem of practice did not change as the issue continues to plague this area and the country. The problem is evident each semester to me as I begin with a new group of students who show a disregard for science. The same evidence reminds me when my son shows an interest in science but only receives handouts with no hands-on activities to show him how cool and exciting science is.

1.5 Statement of the Problem of Practice

The state of science teaching in primary and preschool classrooms has been a concern in recent years (Appleton, 1995). The concerns range from teachers' self-confidence in teaching science to teachers feeling that science is too hard for elementary students to understand. Due to these concerns, my problem of practice focuses on how we can rectify teacher reluctance in implementing more science activities in K-5 by better equipping the preservice teachers in higher education through scaffolded science teaching. "Scaffolding" refers to guiding strategies designed to help students develop a greater understanding of concepts along with skills to become more independent learners (Bigelow, 2017). Lind (1998) emphasizes that children spontaneously inquire, ask questions, and explore to understand the world. This questioning is critical to the child's development, which needs nurtured by teachers and parents.

Teacher preparation programs influence preservice teachers' attitudes toward teaching in the classroom (Feiman-Nemser, 2001). There must be consideration of the interrelationship between beliefs, attitude, and behavior when preparing future teachers. For example, suppose a preservice or in-service teacher has a low opinion on their ability to teach science (belief). In that case, this will result in a dislike for science teaching (attitude) that leads to the teacher avoiding teaching science (behavior) (Tosun, 2000). I have access to preservice teachers in my place of practice due to the courses I teach. The introductory biology course includes a two-hour lab each week, along with its three-hour lecture. My job is to prepare these preservice elementary teachers to demonstrate numerous science activities in their classrooms one day. According to van Aalderen-Smeets et al. (2011), various studies have shown a low level of scientific literacy among preservice primary school teachers, leading to a negative attitude toward science. The negative attitude often comes from their own negative experiences. There has been a lack of interest and enthusiasm in teaching science from many elementary education students in the past two years. Therefore, the question remains, how do we know if students are comfortable with the material and their understanding of science?

One method to improve preservice teachers' attitudes toward science teaching is by providing an opportunity for the students to teach the class. Options such as these allow the students to become relaxed in front of a classroom and with the content. For example, if the topic is about Mitosis, the students could use pipe cleaners to show the different stages of the chromosomes. The idea is for the material to be taught with discussions on how it relates to our everyday world and then an activity to reinforce the information with everyday items to spark interest. Studies by Bleicher and Lindgren (2005) state that to have relevance for preservice elementary teachers and affect their future teaching, time for reflection, discussion, and experimental learning must be included in the design of the course. Therefore, different subjects allow for a variety of teaching methods. Research has shown that when teachers gain confidence and a positive attitude through continued education efforts, they subsequently teach better

(Osborne & Dillon, 2008). With an overall positive attitude in their teaching, the preservice or in-service teacher will effectively improve their students' attitudes towards science as well.

A simple search finds many studies regarding teachers' attitudes in science teaching and other subjects (Palmer, 2001; Tosun, 2000; van Aalderen-Smeets et al., 2017). Attitude is not a unitary concept; it consists of multiple dimensions and subcomponents. Van Aalderen-Smeets et al. state that the overall construct of attitude divides into cognitive, affect, and behavior (2011). Using these three components, content testing and grading of other various activities can measure attitude. These miscellaneous gradings could include classroom presentations, written assignments, and different outside-classroom activity grades. The classroom presentations require a rubric to know how they are graded. Data collection using a rubric and other outside grading assistance evaluates the students' performances when teaching activities. The content testing and presentations allow instructors to understand students' scientific understanding and possible outcome expectancy when teaching. Martin-Dunlop and Fraser (2007) emphasized that with positive experiences in science courses designed for preservice elementary teachers, teachers would be more likely to teach science to their students. This study, along with others promoting teaching activities, enforces the need for my course to promote positive experiences with numerous teaching experiences.

Another issue discovered when researching the problem of practice was how preservice and in-service teachers conceptualize science. This discovery led to an alternative activity for the preservice teachers to do that also influences in-service teachers. During the semester, students can complete activity workshops at various elementary schools. The idea is for the primary education majors to get classroom experience with children doing the science they are learning in their biology course. Each week students arrive at the elementary school to teach a short biology lesson and a fun interactive activity. These workshops increase the self-efficacy and improve the attitudes toward science teaching of the current preservice teachers and the children involved in the activities. The in-service teachers also benefit from these days by learning future undertakings to do independently. There are many misconceptions about science in general. One misconception involves how to complete activities quickly; these activities show just that. There is a need to understand what educators think of science activities. When teachers feel it is "too hard" for children, it needs to be done conceptually and instructionally (Radloff & Guzey, 2016). Entering elementary schools and performing experiments help these pre-conceived notions.

Yet another driving issue is the need for elementary students' continued interested in science through middle and high school. As it currently stands, the department of natural sciences and mathematics is the largest department on West Liberty University's campus. Unfortunately, this department does not include nursing, dental hygiene, or PA majors. This situation may not be the case for every institution, but it is for the small university in Northern West Virginia. Our high enrollment is of great importance and pride for the school to generate numerous future science career-focused individuals. At one time, the United States was a leader in great scientists, engineers, and mathematics, but the US has not contributed to science as much as in years past. Due to our falling status, there has been a national movement to increase the number of individuals ready to enter the STEM workforce (Mohr-Schroeder et al., 2019). My hope is that this research study will help the education department generate capable and willing educators who will apply science with no trepidation.

1.6 Review of Supporting Knowledge

1.6.1 Purpose of review

My literature review focuses on answering the following questions: *What knowledge, stances, and beliefs do elementary preservice teachers need to teach STEM effectively, particularly science? What process in preparation of elementary preservice teachers would meet their needs in science education?*

Ultimately, I sought to gain insights about principles and promising approaches for teacher educators to use. I want to use these insights to support preservice elementary teachers to teach science effectively.

The review for this study accumulated from various sources, with most peer-reviewed sources no more than 15 to 20 years of age and newer. I searched many articles using keywords such as "attitudes toward science" and "scaffolding" for sources. I also used search terms such as elementary education, science, preservice and in-service teachers.

1.6.2 Roadmap

In what follows, I describe the main types of knowledge and skills necessary for preservice teachers teach elementary science.

1.6.3 Review of scholarship

What knowledge, stances, and beliefs do elementary preservice teachers need to teach science effectively? For preservice teachers to teach science effectively, they need familiarity of various approaches and in-depth content knowledge. Scaffolding, a strategic planning method, teaches these approaches and content. Additionally, teachers receive ways to engage their students, the national science standards, and an overall reason STEM education is essential. The knowledge, beliefs, and stances that these teachers gain improve their attitude towards science and build their confidence in the classroom.

1.6.3.1 Understanding of national science standards are vital in the development of the curriculum.

According to the National Science Teachers Association Position Statement (Crockett, 2016), teachers need a thorough understanding of the disciplinary core ideas and practices expected to teach, how students learn them, and the range of instructional strategies that can support their students' learning. In addition, many states are mandating that schools adopt the Next Generation Science Standards (NGSS) as their curriculum standards for education; therefore, it is essential to understand what the National Science Teacher Association (NSTA) will use. As it stands, there are numerous misconceptions on what the NGSS are or how they were created. However, the website for the NGSS states that there is no doubt that science education is central to all lives of Americans (Sarna, 2013), which is why so many states are mandating the standards offered by the NGSS. Furthermore, the standards allow students to develop more than just science investigation skills; they develop critical thinking and problem-solving abilities.

Having teachers, in-service or preservice, prepared to teach students science standards is of utmost importance. One key factor found in the literature was regularly providing professional development for our teachers (National Academies Press, 2015). With science being at the heart of our ability to innovate, lead, and create lucrative jobs in the future, our focus as educators should be to make the best students out there.

1.6.3.2 Deep science content knowledge is desirable for elementary teachers.

According to Bleicher and Lindgren (2005), if teachers lack understanding of core concepts, they probably will not feel comfortable teaching science to children, resulting in what we see so often today: an absence of science teaching at the elementary level. The deficiency of science education is becoming more evident in today's classrooms, as fewer teachers want to teach science due to fear or unfamiliarity with science content. Therefore, there must be a change to allow preservice teachers the chance to hone their science skills.

Another study began to connect teachers' knowledge with their students' learning. A study completed by Akerson and Donnelly (2009) showed that children of all grade levels generally held inadequate views of the nature of science (NOS) before instruction. The six-week K-2 program was known as "What is Science? Exploring the True Nature of Science." The study showed that students improved their views of NOS, the overall goal of why this age group should learn and enjoy science (Akerson & Donnelly, 2009). The literature stated that K-2 students could undoubtedly learn about NOS when addressed with the material and taught as part of their science lessons. Notably, for my purposes, the authors also recommended that by improving the teachers' views of the nature of science, their teaching could positively influence the children's understanding.

In one study of preservice STEM teachers, researchers found a clear divide on misconceptions of STEM (Radloff & Guzey, 2016). The preservice teachers' answers varied when asked to define STEM and when visually and textually representing what it meant to them in open-ended surveys. Many individuals incorrectly interconnected the disciplines with the most basic task of visual representation of what STEM is to the teacher. In contrast, others drew the "s," "t," and "e" inside a giant "m" (Radloff & Guzey, 2016). The authors concluded that many preservice teachers do not have the basic knowledge to teach STEM. Instead, they saw robots in drawings and responses that STEM is a government initiative or that science is "too hard" for children to understand. This study's findings suggest that one central area of focus for teacher learning may be teaching STEM content knowledge and richer conceptions of what "STEM" involves.

1.6.3.3 Elementary preservice teachers should believe that science is essential.

In addition to knowing STEM concepts, teachers also need to believe that teaching science is essential. One study by Thibaut et al. (2018) explained little information about the dynamics that influence teachers' attitudes toward teaching integrated STEM. However, a survey research method considered three factors: personal background characteristics, teachers' attitudes toward STEM, and school context variables. The study used 135 participant surveys and found three variables positively linked with a teachers' perspective: professional development, personal relevance of science, and social context. However, the researchers also found two negative variables: if a teacher had over twenty years of teaching experience or had any experience teaching mathematics (Thibaut et al., 2018).

When learning how to teach science, the approaches are numerous. Holding the necessary knowledge of science is a first step toward being ready to teach it, but teachers also need robust methods to teach children how science matters. For example, one study has shown whether teachers use correct scientific language with children or not has a significant impact on the eventual development of concepts (Eshach & Fried, 2005). As a result, children will understand a concept and feel like they achieved something that makes them proud and intelligent. Furthermore, the previous example indicates that exposing students to science and developing a constructive experience leads to a positive attitude towards science. Finally, the last two declarations state that exposure to science for young children benefits them because they can then understand scientific concepts, reason scientifically, and have an efficient means for developing their scientific thinking.

1.6.3.4 Engagement of students with science is essential.

Student engagement is a massive part of how and why teaching science is successful. Different teaching methods can be just as engaging to students as it is to the teacher. For example, inquiry-based instruction is an exciting way to engage students in the content and practices of science (Deaton & Johnson, 2016). This method allows teachers to invoke a child's true spirit of curiosity and take ownership in their science learning. The six strategies suggested by Deaton and Johnson (2016) provide preservice teachers with ideas on engaging their students in science. A simplified example used in today's curriculum is the 5E Instructional Model. Another great suggestion is to research common misconceptions in science. These tips will help preservice teachers engage their students in discussions, activities, and projects.

1.6.3.5 The development and improvement of attitude and confidence in teaching science increase success.

The attitude of a preservice or in-service teacher can come from a variety of places, whether it be from their attitude toward science or their professional attitude toward teaching science. Van Aalderen-Smeets et al. (2011) explained the difference between personal and professional attitude.

A personal attitude includes beliefs about science's historical or economic relevance for society or daily life and the general interest in or effects of staying informed through various means. In comparison, a teacher’s professional attitude toward science teaching in elementary school involves the beliefs and feelings regarding teaching these topics within their classroom content. Van Aalderen-Smeets et al. (2011) designed a new theoretical framework for the concept of primary teachers' attitudes toward science to improve the failure of methodological issues by other researchers. The resulting framework consisted of three components and seven underlying attributes. Van Aalderen-Smeets et al. (2011) focused on the components of cognitive beliefs, affective states, and perceived control that they felt would directly attribute to one's behavioral intention. Broadly, it is often difficult to change one's attitude, regarded as a stable personal belief; however, often discovered is improvement through training.

When preparing elementary teacher programs, consideration of the student and teacher belief systems is a factor. An apparent interrelationship among individuals' beliefs, attitudes, and behavior judges their ability to teach science. Confidence and self-efficacy to teach science can come from a teacher's experience from exposure to teaching the subject themselves or having science shown to them when young. Although, as Varma (2011) said through observations in the science field experience, preservice teachers will overcome their apprehensions about teaching science and understand the value of various pedagogy to instill interest and confidence in science regardless of whether they choose science as their career in the future. The preservice teachers also stated that having experience with science in their elementary schooling helped with their confidence and attitude toward teaching it themselves. Additionally, research in the early eighties concluded that courses with components such as student-centered approaches, practice teachings, and process approaches have the potential of positively influencing students' attitudes (Morrisey, 1981). Research also has shown that when a teacher gains greater confidence and a more positive attitude, they teach science better and improve their students' attitudes (Osborne & Dillon, 2008).

In addition to having a negative attitude and little confidence, most elementary teachers and preservice students find it challenging to teach scientific practices in the form of inquiry-based science (van Aalderen-Smeets et al., 2017). Inquiry learning, often used with hands-on activities in today's classrooms, include critically and creatively solving real-life issues. Researchers questioned how hands-on experiments and inquiry-based learning impact teachers during a study on preservice science and technology elementary teachers (Docherty-Skippen et al., 2020). A survey collected the data from the 27 preservice teachers. According to Docherty-Skippen et al. (2020), the research showed that the preservice teachers had a more positive attitude and greater confidence to teach science and technology when taught through hands-on experimentation during their elementary education. The data support the claim that continually having preservice teachers do hands-on activities will support their teaching and repetitive opportunities.

What process in preparation of elementary preservice teachers would meet their needs in science education? To prepare preservice teachers effectively, instilling strategies within the teachers' education programs and courses must change with the ever-changing educational landscape. Preservice teaching students no longer respond to content-driven techniques with little pedagogy sprinkled in. Therefore, a method of student learning, introduced in the late seventies, has been utilized to reinvigorate science teaching. This process will help prepare the preservice teachers and help meet more of their needs in science education.

1.6.3.6 Utilizing scaffolding in science teaching increases student understanding.

Wood et al. first introduced the idea of scaffolding (1976). They used the scaffolding metaphor to explain how adults can help support children during problem-solving activities.

Scaffolding refers to temporary support provided for completing a task those learners otherwise might not be able to achieve (van de Pol et al., 2010). This instructional technique can move students progressively toward more robust understanding and, ultimately, greater independence in their learning process.

According to the National Science Teacher Association (2017), one strategy to scaffold a student's skill learning is with an "I do," "we do," "you do" progression to an activity or lesson. This progression allows the students to connect to what they already know with focused demonstrations. Next, the students complete guided practices with monitoring by the teacher with feedback. Finally, the students have opportunities to choose and use their new skills independently. Numerous tools additionally guide scaffolding. Van der Valk and de Jong (2009) used concerns identified with teachers as a guide to formulate learning goals. The research found three teacher learning goals and related scaffolding tools utilized within open inquiry teaching. Upon reviewing the data, the tools developed included mini final open inquiries, focusing activities, go/no worksheets, and peer assessment forms (van der Valk & de Jong, 2009). In today's classrooms are the more common teaching tools such as instructional modeling and bridging. One well-known way to utilize bridging is by using a KWL chart (Couling, 2018). The KWL (i.e., Know-Want to know-Learn) chart enforces scientific knowledge in elementary classrooms today.

1.6.3.7 In sum

As the literature clearly showed, teachers' attitudes play an essential role in presenting science activities to children. Therefore, if a preservice teacher's attitude towards science is that science is not necessary, then this attitude will display while teaching. Preservice teachers must also understand the Next Generation Science Standards and implement them into their teaching. These standards involve a great deal of inquiry-based, project-based, visual, or textual learning approaches for the classroom. According to the literature, another valuable tool that preservice teachers need to learn is how to engage their students. It is also vital to mention that the research showed that preservice teachers must understand the content so that they have the confidence to teach the material to all the children in any situation. Finally, scaffold teaching within elementary schools effectively engages and progresses students' interests and science knowledge.

1.6.4 Synthesis

My literature review revealed the multiple types of learning and instructional strategies elementary preservice teachers need to be prepared for teaching elementary science. Learning content, believing that science is essential, and learning to engage students are significant. It is also vital for preservice teachers to increase their positivity toward science, confidence in teaching, and remember to consider scaffolding in their classrooms.

To support preservice teachers better, the review clarified that because the course I teach is the second installment of biology that the students will embark on, I must work with the other instructor to determine what topics utilize the NGSS in our curriculum. The importance of sequenced, coherent courses as the foundation of a teacher education program came through in the National Science Teachers Association Position Statement (Crockett, 2016).

My course requires a heavy pedagogical focus; therefore, as I typically relied on building my students up to completing one outside classroom learning experience, I now feel that they should meet more based on the study by Varma (2011). The more students practice science in classrooms with elementary children, the more prepared they will be when they become novice teachers and must implement science in their classrooms. The students must also understand that they will get better with practice, which is the whole idea behind going into the classes as preservice students.

Another takeaway from my literature review is that I need to model my enthusiasm for science. When I explain an activity or teaching method, I must have a positive, upbeat attitude. As a result, it is the priority of the preservice students to gain knowledge in science to teach it to future elementary children with excitement and confidence. After reading Thibaut et al. (2018), I realized that I should pay more attention to my teaching presence when in class.

While finding literature to review, I discovered that in-service teachers answered their surveys about science, their unwillingness to teach or implement science, or their distaste of science was the same as the preservice teachers. This research was very shocking even though I knew there was a shortage of science teachers; I did not realize the severity of how far in-service teachers would go not to implement science. The only good part of this is that preservice teachers could know that their feelings of discomfort with science are not unique. Both in-service and preservice teachers may have a distaste for science. However, by teaching students how to implement science correctly and confidently or even with the addition of professional development science activities for in-service teachers, ultimately, we must all do better to make our children better.

With the research literature I have done, I plan to implement some changes to my course. Using the Next Generation Science Standards and the policies mandated by West Virginia, I plan to change my course so that the preservice teachers learn the content within these standards. Before, I taught mainly about evolution in my class, but the students must understand the content and topics they will teach one day. In addition, I plan to incorporate more pedagogy to my course. Tosun (2000) stated that with frequent field experiences providing active participation from the students, preservice teacher preparation programs could enhance their outcome expectancy of science instruction in future elementary teachers. This research showed that my students would benefit from more teaching exercises and in-class experience. Practice makes perfect.

1.6.5 Refined statement of problem

The literature review caused me to view my instructional practices differently. I needed to dedicate my time with my preservice teachers to understand how to engage students, the importance of science, and to deepen their content knowledge while increasing their experiences with science practices. Before, I spent most of my time teaching about evolution and felt that I was boring the class. I learned from the review that if I thought the information was annoying, then my attitude affected the students' perception of the content. The literature taught me that my attitude towards science would directly affect how my students feel and see the subject. Therefore, I need to have positive, upbeat energy to teach the material.

Finally, my literature review showed me that there is no one set way to prepare preservice teachers to teach science. However, multiple techniques and methods can create a talented, capable novice teacher. With more research and practice, I am making sure I know the best ways of helping preservice teachers. The new problem of practice for this study involves the use of scaffolding science teaching. I plan to use online teaching observations, in-class activities, in-class teachings, and classroom teaching opportunities to better prepare preservice teachers to implement science.

2.0 Theory of Improvement and Implementation Plan

2.1 Theory of Improvement and the Change

Strong science-related preservice teacher education is essential. Bleicher (2007) stated that if preservice teachers had deficient science teaching models, their confidence in teaching science to their students is less than average. I have noticed a lack of interest and enthusiasm in teaching science from my numerous elementary education students in the past two years. My area of focus concerns how to prepare preservice teachers for effective science teaching by using scaffolding in science teaching. Therefore, with an increase in producing optimal science-related preservice education, my problem of practice centers on understanding why some preservice elementary teachers have a negative disposition to science pedagogy.

To combat this problem, I provided more hours of observation and in-class teaching outside of my classroom for the preservice teachers. Although the pandemic has caused issues and barriers, the university has provided the students with online observational opportunities. Access to a virtual observation site made by certified teachers and provided by the state board of education enlisted each student's email login, providing an account for each student. This site allowed students to observe classrooms without physically being present in the room. Therefore, students watched certified elementary teachers teaching science lessons while observing the teaching method, the students, and any other possible outcome. To enhance their science teaching skills, students experienced outside classroom teaching assignments. Finally, amending the current curriculum to include state standards, trends, and issues within science helped prepare students to become novice teachers. These changes improved participation in class discussions, the lesson designs' involvement, and enthusiasm when teaching elementary school children. I hope that my students leave my class with a positive attitude toward science and the confidence to teach science in the future without hesitation.

2.2 Driver Diagram

2.2.1 Aim statement

By May 2024, there will be an increase in student attitudes at West Liberty University in science lead activities for elementary children.

2.2.2 Primary drivers

For the project's success, the primary drivers revolved around the students and the course. The most important driver was improving the preservice student's attitude toward science. Just as Docherty-Skippen et al. (2020) found in their research, a preservice teacher could have a more positive attitude and greater confidence to teach science and technology if they were taught the subject's hands-on experimentation during their elementary education. This study supports the claim that continually having preservice teachers do hands-on activities supports their teaching and repetitive opportunities.

Another primary driver seen in Figure 3, focused on improving interactions between students and in-service teachers. This driver went hand in hand with adding observations and unit plans to the biology course. These two drivers allowed students to have more experience teaching elementary students in the content of science. The drivers also allowed students the chance to complete a unit plan. This task, typically not completed until the student enters the part of their degree path that focuses on being in an elementary classroom student teaching, provides encouragement and development as a future teacher.

The final two primary drivers were redesigning the course curriculum and introducing state standards. The curriculum for the Biology 340 class comes from on an older textbook that for numerous semesters has needed updated. By updating the curriculum and including the state standards in the course, students are better equipped when they become novice teachers in their state. This improvement also helps the students prepare for changes in their future classrooms.

2.2.3 Secondary drivers

The first secondary driver was the inclusion of the standards and any trends and issues in science—this driver supported three primary drivers. First, including the state standards supported the primary driver: introducing state standards. The secondary driver also supported the course curriculum redesign and improved the student self-efficacy by giving the student help in the future. Finally, the trends and issues portion of this driver supported the redesign and improved student self-efficacy, as they are open to new information on current science topics.

Two other secondary drivers that are important but only supported one or two primary drivers were class discussions, peer teaching, and content review activities using different teaching methods. The use of class discussions and peer teaching drivers supported self-efficacy by allowing students to speak out during class. This driver aimed to get students used to speaking in class and in front of their peers. The content review using various teaching methodological activities supported redesigning the course curriculum and improving students' self-efficacy. This driver supported the curriculum redesign because there are always more activities to create for preservice teachers to teach elementary school children. My job is to keep my curriculum current and excite the preservice educators with current technology and activities. By completing these activities, the preservice teachers understand and appreciate the elementary students' science content. These activities also improve their confidence in teaching the action themselves. According to Bleicher and Lindgren (2005), if teachers lack understanding of core concepts, they probably will not feel comfortable teaching science to children, resulting in what we see so often today: an absence of science teaching at the elementary level.

2.2.4 Change ideas

The most significant change idea implemented in spring 2022 was that students' ten hours of observational time was done in content courses. Therefore, in the Biology 340 science course, students had to complete ten hours of observation or in-class teaching in addition to their regular coursework. The program mentioned earlier and the virtual classroom teachings, although hefty, managed this change. This in-service practicum training enormously affected students' ability to teach and react in elementary school settings. It was my job to adapt my course to supply content, standards, and activities to allow the students to succeed while in their classroom assignments. Using scaffolding, students observed a particular subject, then complete related activities themselves in class, peer taught an activity or lesson, and eventually taught a science lesson to elementary students.

An additional change idea included science kits created for rural elementary schools in West Virginia using the state standards. This program allowed the students to use the content they have learned in the course and the state standards to develop a lesson for a specific grade.

Completed kits arrived at the schools, giving each child a science packet that did not require the internet to complete. This concept challenged the preservice teachers to think outside the box, imagine that the internet did not exist, and drop inhibitions.

Finally, another change idea, cross-curricular activities when peer teaching, prepared the preservice teachers for their observations/teaching assignments. Students were excited when shown that their activities did not have to be solely science or math but could include reading a book and tying the lesson to sciences. These cross-curricular activities worked best during the in-class teachings by presenting in front of the class and showing the activities they completed. Many students used their cross-curricular skills when student teaching.

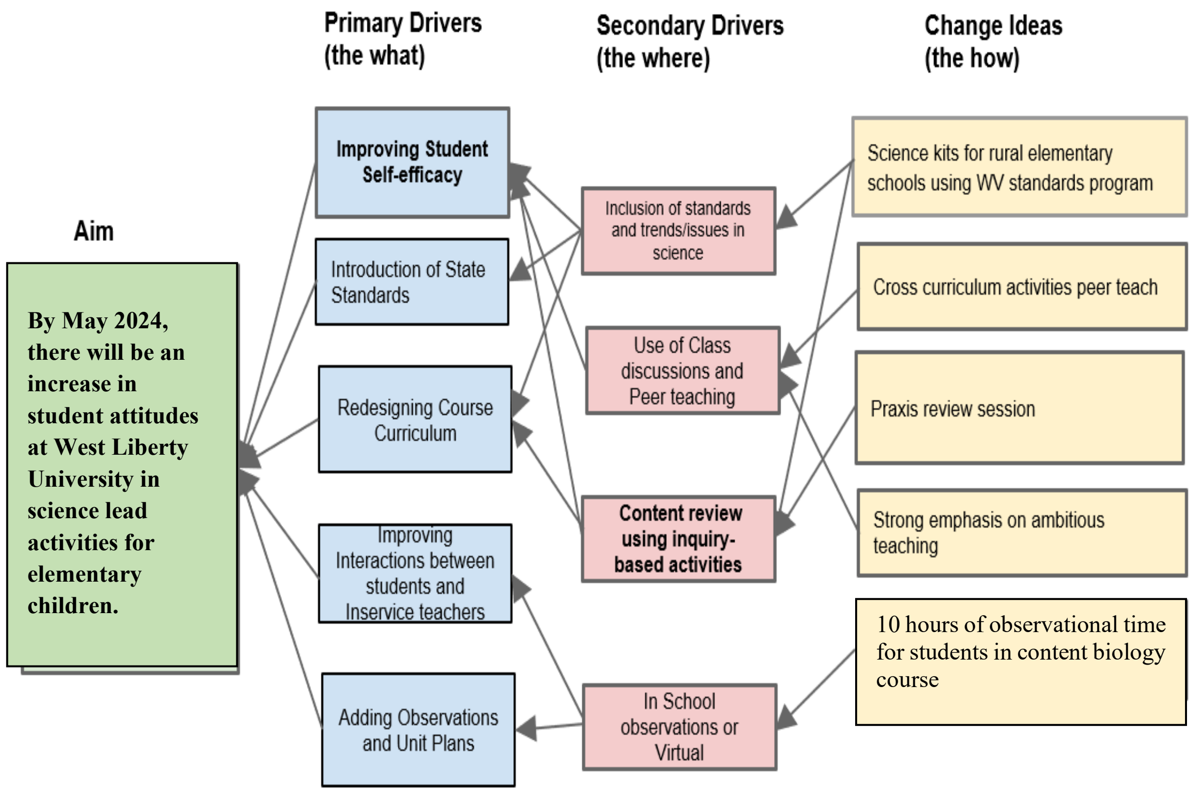

Figure 3. Theory of Improvement Diagram

2.2.5 PDSA cycle

Starting in the spring of 2022, the students in Biology 340: Life Science for Elementary Education were required to complete ten field hours for the course. The field hours consisted of online observations of teachings, open discussions, and outside-classroom teaching opportunities. The Biology 340 course hosts roughly 24-28 students each semester, and with these large classes, ample open discussions occurs.

Several of the field hour requirements pertained to the Accomplished Teaching Learning and Schools (ATLAS), an online library of video cases exhibiting National Board-Certified

Teachers delivering uninterrupted lessons to PreK-12 (Hougan et al., 2018). Video cases were roughly 12-15 minutes long and included descriptions of occurrences within the classroom. Therefore, each Monday, a link to the students provided the case within ATLAS to observe. Students posted a journal of their observations within West Liberty University's online management system, Sakai. A rubric evaluated the entry within Sakai. On Fridays, the class openly discussed their honest thoughts or observations of the lesson. If the students' conversations were not progressing, they were prompted with questions. My goal was to increase the students' field experience by engaging the students in discussions and improving their attitude toward science in.

Additionally, students participated in out-of-class teaching experiences to earn field placement hours. This assignment required the students to teach at local elementary schools set up by the Department of Education at West Liberty. As the students learned various methodologies used to conduct science activities, they practiced teaching their peers. Assignments of grade level, topic, and activity required my delegation and student cooperation. During this out-of-class teaching, I observed each student. In planning my PDSA cycle, I attempted to answer the following two inquiry questions:

1. What were the students' perceptions and attitudes toward the field hour assignments within the course?
2. As their teaching educator, how did I support a positive attitude of science teaching in the elementary classroom?

2.3 Methods and Measures

2.3.1 Intervention

The change idea implemented in the Biology 340 science course taught to elementary preservice teachers was adding ten hours of fieldwork for each student, including observation or in-class teaching. This change allowed the students to implement what content they had learned in their previous science courses and their teaching method courses and put them into action. As students were in actual elementary school settings, this opportunity gave them a feeling of what their future teaching classrooms could be like with the support of the in-service teacher to guide them. While the students were teaching, I hoped to answer the following questions:

1. Based on the intervention, in what ways did the student feel confident to teach the science content?
2. How or to what extent did the preservice teachers' attitudes toward science change?

Observation of the students' preparedness, confidence, and engagement helped me understand what needed focused on in the classroom. By asking if the student was prepared, I knew that they were not obtaining the content they needed to teach science in the classroom. If the students had confidence, were positive, and engaged, they knew the material and felt they could retell it to someone else. I predicted that this improved students' overall perception and attitude in teaching science in elementary schools. Overall, this informed preservice education on how to improve its content in preparing their students better.

2.3.2 Study population

During the intervention, the participants included the students enrolled in the BIO 340: Life Sciences II for Elementary course at West Liberty University. Twenty-one students participated in the study. Because of the laboratory hours built within the course, participants had ample time to participate in the study. This was the second science content course that elementary education students must take, therefore allowing them enough time to gain the information needed to teach within the schools. My focus was on better preparing preservice teachers to implement various methodological activities because numerous preservice teachers have a negative disposition to science pedagogy.

2.3.3 Data collection method

The implementation of the PDSA cycle and collection of data began in March 2022. As seen from Table 1, the two research questions utilized different survey and rubric data sources. The data sources included a survey on students' perception and attitude toward science and a survey on students' view of the field hour assignments. The analysis of the data sources, discussed in detail in later sections, provided a variety of reasoning and investigation from each preservice teacher. The first and most import step of the study was receiving student consent to participate. Therefore, notification alerted students of a consent form and survey through the online learning management system provided at West Liberty University. The link provided within the announcement sent students to Qualtrics, a web-based software that allows a user to create surveys and generate reports without having any previous programming knowledge (Smith, 2005). Once students clicked on the link, the consent form described the study and required the student's signature before being able to proceed with the survey that would start the research.

Table 1. Research Question and Data Source Breakdown

<table>
<tr><td colspan="2">Q1: What were the students' perceptions and attitudes toward the field hour assignments with the course?</td></tr>
<tr><th>Data Source</th><th>Analysis</th></tr>
<tr><td>Perceptions and Attitudes Survey</td><td>Anonymous survey via Qualtrics.
Measured students' enjoyment, anxiety, self-efficacy, and relevance toward science teaching with the following questions:
1. Teaching science makes me enthusiastic.
2. I enjoy teaching science very much.
3. I feel happy while teaching science.
4. I have enough knowledge of the content of science to teach these subjects well in an elementary school.
5. I am well able to deal with questions from students about science.
6. I know how to design and implement a science activity.
7. I think science education is essential in elementary education as early as possible.
8. I think that science education is essential for making elementary school students more involved in problems in society.
9. Science education is so important in elementary schools that inexperienced teachers should receive additional training in this area.
10. Teaching science makes me nervous.
11. I feel stressed when I have to teach science to a class.
12. I feel tense while teaching science in a class.</td></tr>
<tr><td>Rubric from journal entries and open discussions</td><td>Evaluations and submissions of the journal entries occurred in WLU's learning management system.
Open discussion notes allowed for scoring of students that led to scores entered into the learning management system.</td></tr>
</table>

Table 1 (continued)

Q2: How did I support a positive attitude of science teaching in the elementary classroom?	
Data Source	Analysis
Effectiveness and Improvements in Student Learning Survey	Anonymous survey via Qualtrics. Questioning on the field hour assignments included the following: • Rank the four types of assignments from most favorite to least favorite. Likert scale questions about ATLAS: 1. The science lesson observations made me more prepared to teach science. 2. Journal forum writing made me more prepared to teach science. 3. Open discussions made me more prepared to teach science. Likert scale questions about elementary classroom teaching: 1. Coursework prepared me for teaching science. 2. I was confident in teaching my science activity. 3. I am now more likely to teach science lessons in future classrooms. Open-ended questions: 1. During your teaching field hours, describe something that prepared you for teaching science. 2. During your teaching field hours, describe something you wish you had learned that would have prepared you to teach science.

To answer research question one, "What were the students' perceptions and attitudes toward the field hour assignments within the course?" implementation of the following data sources allowed for later analysis.

2.3.3.1 Perceptions and attitudes survey

An anonymous survey collected the quantitative data given to the preservice teachers to evaluate the students' perceptions and attitudes toward science that would help in the effectiveness and improvement needed for the program. The survey in Appendix A used parts of the Dimensions of Attitude toward Science (DAS) Instrument. Using a tripartite model (see Figure 4) as the initial frame, van Aalderen-Smeets et al. (2011) developed a new theoretical framework of relevant concepts that they believed when investigating primary teachers' attitudes toward science consideration is essential. Divided into three categories, cognition, affect, and behavior are the overall psychological notion of attitude. The authors used this definition as their starting point to make up their model. The cognition component covers the thoughts and beliefs, sometimes positive or negative, that a person has about the attitude object. The affect component involves the feelings or moods that someone experiences in relation to the object. Finally, the behavior component is the response or action a person takes when confronted with the object. Using these components in relation to my course, I selected specific context factors that related to my study.

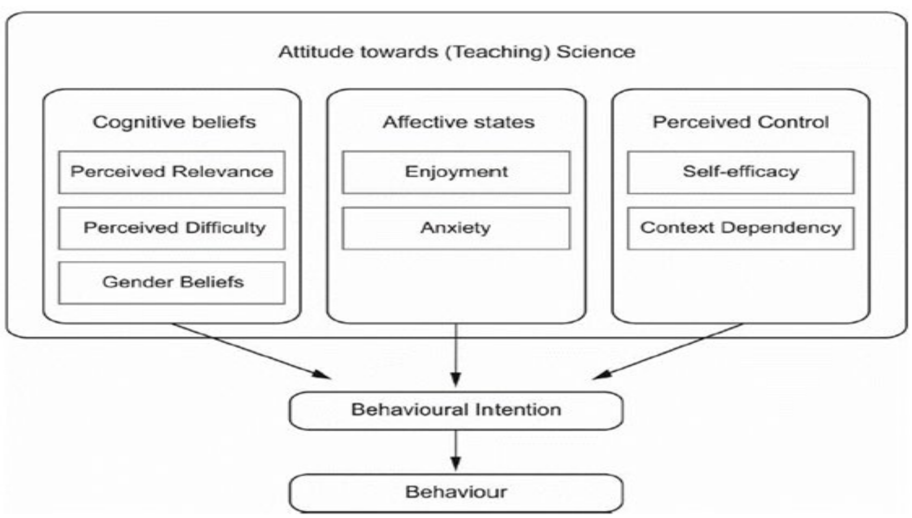

Figure 4. Theoretical Framework for DAS

The first context factor within the cognitive belief component that I looked at was relevance in teaching science. As stated in the literature review, preservice teachers must believe that science is important to teach. This factor is defined as the extent to which people consider science relevant or important for their personal lives, for society, for prosperity, or for health. The second context factor, perceived difficulty, is also in cognitive beliefs. This factor refers to the beliefs of individuals concerning the general difficulty of science relative to other fields. Elementary teachers must be willing to teach the children science and not feel it is too hard, as also referred to in the literature.

The next component considered was affect. The first subcategory within the component investigated was enjoyment. This category asked questions that referred to positive feeling of pleasure and joy related to science in an individual's daily life or for fun. The second category investigated was anxiety. This attribute comprises negative feelings of anxiety related to science in general or in daily life.

The final component of the tripartite model is that of perceived control. The only category within this component researched was self-efficacy. Self-efficacy refers to the perceived level of capability or one's confidence for performing a particular behavior. The Perceptions and Attitudes Towards Science Survey (Appendix A) was created using questions from portions of the validated DAS (van Aalderen-Smeet & van der Molen, 2013). The development and significance of the DAS was to measure attitude while investigating, guiding, monitoring, and evaluating teacher-training programs aimed at improving science education for elementary teachers therefore relating it to my study. My survey utilized twelve of the DAS's 28 set questions specific for my study. Some example questions are, "I enjoy teaching science very much," "Teaching science makes me nervous," "I am well able to deal with questions from students about science," and "I think that science education is essential for elementary school children's development."

2.3.3.2 ATLAS journal entry and open discussion rubric

A new scaffolding teaching strategy supported my students in their science teaching this semester. Following their content chapter lectures, ATLAS (Accomplished Teaching Learning and Schools, an online library of video cases exhibiting National Board-Certified Teachers delivering uninterrupted lessons to PreK-12) depicted an activity related to the current chapter. Students completed journal entry forums before our open discussions on Fridays.

For the first case study, after the lecture on evolution, the ATLAS case assigned was number 2018, exploring beak adaptations in birds. This video showed a second-grade class discovering how bird beaks adapt for eating specific types of foods. On Friday, the class participated in an open discussion about the ATLAS observation. A prompting of the students provoked discussions about the methods the teacher used, the classroom, and the overall lesson. At times, students indicated situations or concerns not mentioned in their journal entries. Additionally, open discussions provided opportunities to ask the preservice students on how to better the activities.

Upon completing the open discussion, the rubric seen in Figure 5 evaluated each Bio 340 student's journal entry and open discussion participation. The same procedures were completed for case study 590 (Identifying relationships in systems of living organisms) and case study 1378 (Developing understanding of ecosystems through discovery). After our lecture discussion about life cycles and food webs, students viewed ATLAS case 590. This video showed a teacher engaging a 1st grade class in learning all about frogs they had seen on a recent field experience. The students visited various stations and participated in activities such as writing and drawing. The following Friday the preservice teachers participated in an open discussion on their opinions of the case study.

You will be scored weekly concerning your journal entries and during the open discussion about the science lesson you observed.			
	Proficient *5 Points*	**Emerging** *3 Points*	**Beginning** *0 Points*
Preparation	The student viewed the lesson and wrote a 2-3 paragraph summary of observations and discussion points	The student viewed the lesson and wrote a 1 paragraph summary of observations and discussion points	The student failed to view the lesson or wrote summary of observations and discussion points
Speaking	The student made at least 2 or more thoughtful comments and fully participated in the discussion	The student made at least 1 thoughtful comment and participated in the discussion	The student made no comments or participated in the discussion

Figure 5. ATLAS Journal Entry and Open Discussion Rubric

Finally, following the content concerning ecosystems and biomes, the preservice teachers viewed ATLAS case 1378. This case demonstrated students dissecting owl pellets with the direction of their teacher. The third graders were observing, keeping track of their bones, and working with others. The preservice teachers submitted their journal entries and then discussed openly about this case the following Friday.

When scoring the rubric for students in many instances, a zero recorded during discussions and journals entries resulted from an absence from class or a failure to complete the forum. Some students were asked to respond during the open discussion therefore resulting in a lower than proficient score.

To answer research question two, "how did I, as the instructor, support a positive attitude of science teaching in the elementary classroom," evaluations of preservice students in elementary classrooms and an anonymous survey provided data.

2.3.3.3 Effectiveness and improvement in student learning survey

Finally, at the end of all the fieldwork assignments, each student answered a survey (see Appendix B) pertaining to their perceptions and attitude toward the addition of the field hours and its benefit to them. This anonymous survey generated quantifiable data showing if the use of scaffolding in my science teaching was beneficial.

Instructions of the survey began to rank the 4-field hour assignment of journal entries, open discussions, teaching in elementary school, and watching the ATLAS videos. The ranking was from most favorite to least favorite. Next, Likert scale questions pertaining to the ATLAS field hours and the elementary classroom-teaching field hours aimed to narrow which was more beneficial to preparing the students. In reference to the ATLAS questions, they specifically focused on if the videos, journaling, or open discussions prepared the students to teach science. The elementary classroom teaching questions focused on if coursework prepared the students, if they felt confident, and if they would teach science in the future.

Finally, two open-ended questions focused on final issues or thoughts on what prepared the preservice students to teach science. The first question asked for something that prepared them to teach science. The second question asked the preservice teachers what they wish they had learned to help prepare them. These responses helped focus on what worked within the course and what did not, along with possible future research.

2.3.4 Instruments/protocols

Analytical rubrics for observation journal entries and open discussion student observation made each student's scoring fair and consistent. To make the scoring consistent I used the rubric’s scoring to evaluate each student’s journal entry. Additionally, I observed the students during the open discussion, keeping notes. I used the rubric’s scoring scale to evaluate each student’s attitude and involvement in the open discussion. Furthermore, I created an anonymous survey using Qualtrics given to the students. Refer to Table 1 for clarification of instruments and protocols.

2.3.5 Process measures

The process measures were those that told me if the change ideas worked. The best way to see if the hours of observational or in-class teaching worked was by monitoring the students myself. Observations are an essential element in good teaching and program development (Taylor-Powel & Steele, 1996). Distribution that indicated their level of understanding, participation, attentiveness, and teaching ability, the students understood their level of preparedness with teaching science from their placement locations. This guided the student on elements to correct before their placement. Finally, the science kit's process measure was a survey sent to the schools accepting the kits. This survey asked their likeness of the activities and feedback.

2.3.6 Driver measures

The driver measures were those that let us know if the change worked to improve the system. For example, one way to know if including content activities enhanced student self-efficacy was by doing repetitive movements and watching the student's progress. Using video documentation showed a student how at the beginning of the semester their presentation skills were not as excellent as in the end. Another way of assessing understanding of content and state standard knowledge was by giving students summative assessments. Additionally, comparing the previous semester's unit plans from students to the new ones after the redesign measured how the change improved the course.

2.3.7 Outcome measures

The most apparent outcome measure was increased positive attitudes in science activities by the elementary education students. For example, seeing preservice elementary students happily volunteer for activities such as the Regional Science and Engineering fair held at West Liberty University. By volunteering, the students had first-hand experience with elementary and middle school students and experienced their imagination and enthusiasm for science. Additionally, preservice teachers could get involved with the grant for science kits for rural West Virginia schools or become ambassadors for the West Virginia Science Public Outreach Team (WVSPOT). According to the WVSPOT website (2013), this program recruits and trains West Virginia undergraduates to bring current West Virginia science, technology, and engineering presentations to West Virginia K-12 classrooms. Finally, numerous clubs on West Liberty University's campus are science-focused such as the biology club, STEAM club, and chemistry club that students could join. Any increases in the activities mentioned earlier indicates that I am preparing the preservice teachers to enjoy teaching science. They love to learn more for their classrooms in the future.

2.3.8 Balance measures

Data collected from the rubrics, surveys, and journal entries showed measurable balance within my system. Additionally, noting student behavior and attitudes during the observations contributed to the balance. Adding field hours to the preservice students' workload in the BIO 340 class helped collect data. However, if other class components (i.e., lecture) are neglected, the balance has shifted, and an adjustment would need to happen. There will need to be an evaluation of instructors' time taken away from other course time as they focus on their education students.

2.4 Analysis of Data

2.4.1 Data gathering

2.4.1.1 Journal entries

To answer the first inquiry question pertaining to any changes in the preservice teachers' attitudes, the journal responses from the ATLAS observations included the preservice teachers' opinions, views, and suggestions based off the board-certified teaching videos. These journals, due each Friday after our open discussions were expected to be two to three paragraphs in length and include all interpretations of the lesson taught and thoughts on the teacher and student interactions.

2.4.1.2 Open discussion rubric

In addition to journal entries, and again to answer inquiry question one, there was completion of the generated rubric during open discussions for each student. As seen from Figure 5, students earned up to ten points each week for their ATLAS assignment. The use of the rubric allowed me to observe my students and listen to what they took away from the classroom experiences. Open discussions allowed the preservice teachers to express what they liked and disliked within someone's lesson or classroom. Others agreed or disagreed with that view, and the discussions guided the students to see other pedagogical methods that are not what they may know or have seen before. Overall, by using the rubric, I assessed with the journal entries who was not watching the videos and if, during the open discussion, they did not discuss any relevant information. Comparisons of the quantitative data from the discussions and the student teaching data showed the effectiveness of each type of fieldwork assignment. Additionally, a comparison of the data to the Qualtrics survey on the field hours assignments was informative.

2.4.1.3 Student-teaching observation

To evaluate students' skills and confidence at teaching science activities, they completed at least one out-of-class teaching experience. This experience required students to teach a science activity at their assigned elementary school, Hilltop Elementary, located in Marshall County. Hence, students had numerous opportunities throughout the semester to practice different teaching methods in BIO 340. These methods included activities such as inquiry-based learning and project-based learning. The student then selected which form they are most comfortable teaching.

The instructor noted specific aspects for the preservice teachers while the student was teaching. These included the learning environment, teaching methods, subject matter knowledge, student appearance, and classroom management. Additionally, notable comments provided the student with positive reinforcement.

2.4.1.4 Questionnaire

Distribution of an anonymous survey link near the end of the semester to the students gathered additional data. This survey (Appendix B) through Qualtrics, evaluated the usefulness of the online ATLAS observations and out-of-classroom teaching as field hours, along with the use of open discussions in class. Bar graphs created by Qualtrics and quantifiable data, provided valuable information for this study.

3.0 PDSA Results

3.1 Question One: What Were the Students' Perceptions and Attitudes Toward the Field Hour Assignments Within the Course?

Question one focused on the field hour assignments and the students' perceptions and attitudes toward science. The goal aimed for and accomplished within the study was to see how and to what extent the students' attitudes toward science changed. The following data sources and results demonstrate how question one was answered.

3.1.1 Positive affect toward science teaching

The Perceptions and Attitude Survey analyzed student responses to evaluate whether students had a negative or positive disposition toward science. As seen in Figure 6, zero students disagreed or totally disagreed with the statements regarding enjoyment in teaching science, which is included in the affect component of the DAS. The graph shows that three of the twelve students felt neutral when asked if teaching science made them enthusiastic. However, seven of the twelve students responded that they felt happy while teaching science. This leads me to believe that the students had a general positive disposition towards science by looking solely at this graph.

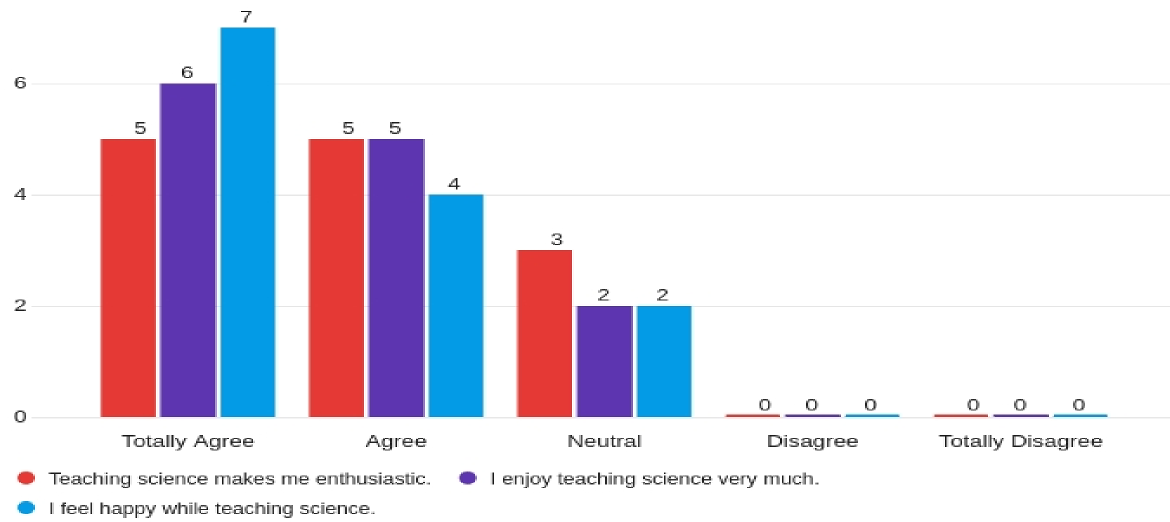

Figure 6. Perceptions and Attitudes Survey: Enjoyment Component Questions

Continuing with the affect component, the next subcategory measured was a student's anxiety toward teach science. When analyzing the anxiety of science teaching the values shifted a bit as seen in Figure 7. The data gathered from these questions show more trepidation in students to teach science than in the enjoyment category. For each of the three questions, two students totally agreed, and one student agreed that teaching science gives them anxiety. For the question stating that teaching science makes them nervous and teaching science to a class makes them feel tense, 41.67% of the students answered neutral. Then 41.67% of students responded they disagreed with the statement that they feel stressed when they had to teach science. I expected to see less students respond with neutral since only three responded with neutral in the enjoyment questions. The question remains whether the anxiety was influenced by being comfortable in front of a classroom or comfortable with the material.

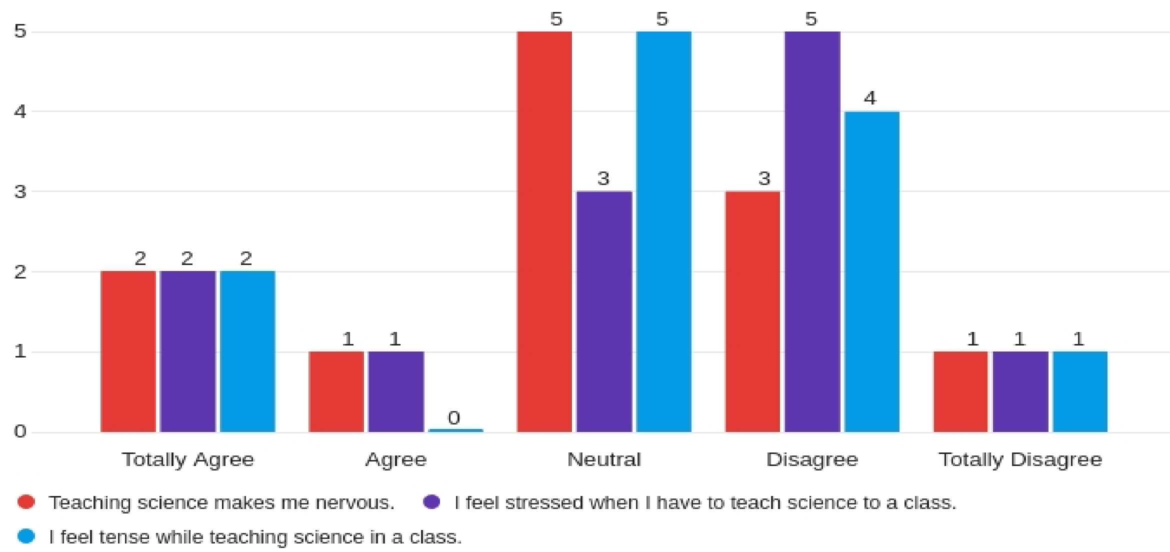

Figure 7. Perceptions and Attitudes Survey: Anxiety Component Questions

The next data source evaluated were the students' views on the relevance of teaching science. A student's cognitive belief is the extent to which they consider science relevant or important for their personal lives, for society, for prosperity, or for health. The data collected from Qualtrics showed that for all the questions asked about the relevance of science in elementary education and getting students involved, nine out of the twelve totally agreed and the remaining three agreed that science education is important as seen in Figure 8. This shows a push in the right direction in terms of making science meaningful and leaving students with a positive view on science education in elementary schools. Students can take with them this positivity and knowledge and use it in their future classrooms.

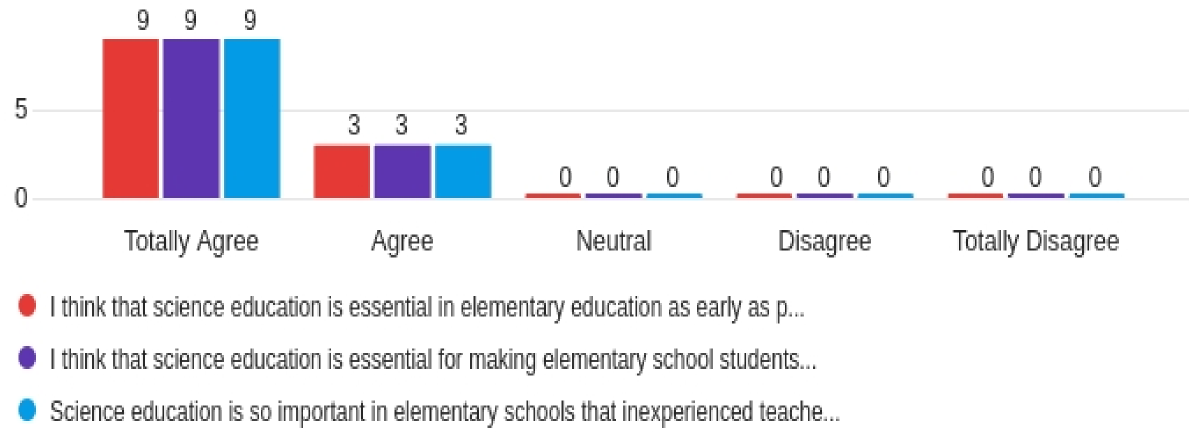

Figure 8. Perceptions and Attitudes Survey: Relevance in Teaching Science Question

After the conclusion of all field assignments students ranked the four field assignments of journaling, watching the ATLAS videos, having open discussions, and teaching in the elementary school from most favorite to least favorite. As Figure 9 shows, 85% of students listed their most favorite activity to be teaching in the elementary school. The equally valued second choice for students were the open discussions. However, over 50% of the students listed watching the ATLAS videos as their least favorite assignment. By analyzing the graph (Figure 9), journaling and watching the ATLAS videos were the two assignments ranked the lowest. Students had a positive disposition to teaching in an elementary classroom and the open discussions.

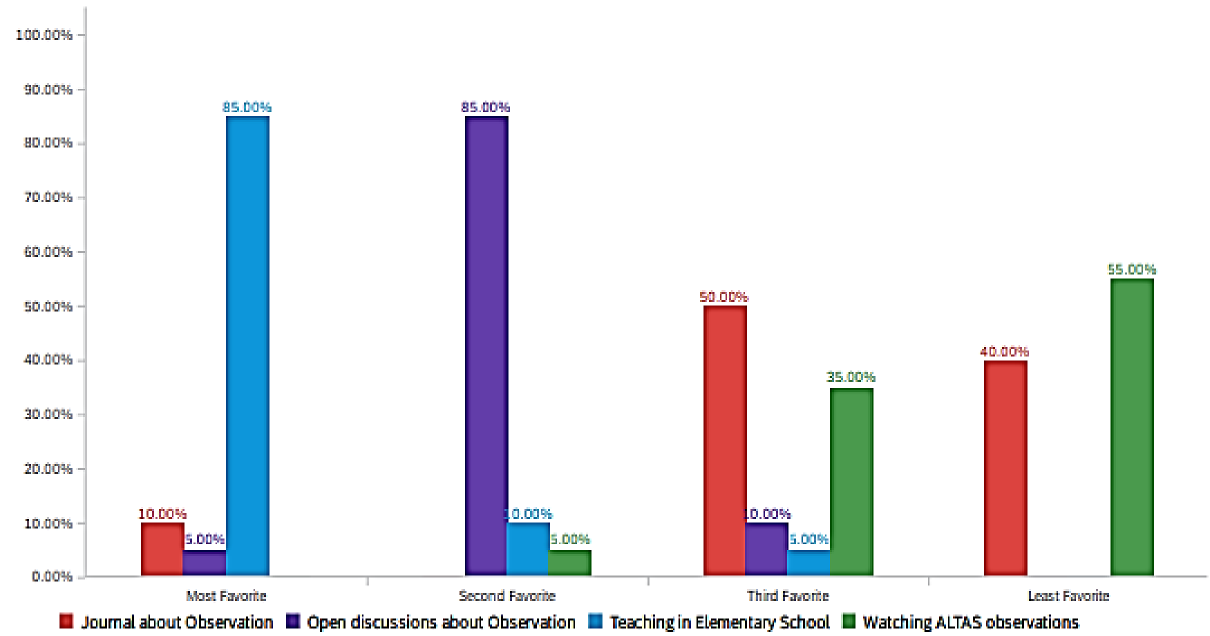

Figure 9. Ranking of Assignments Data

An open-ended question within the Effectiveness and Improvement in Student Learning Survey provided the final way results demonstrated that students had a positive affect toward science teaching. The question, "During your teaching field hours, describe something that prepared you for teaching science," responses were evenly distributed over six common themes (i.e., discussions, self-understanding, general observations, ATLAS videos, and presentations/activities) as seen in Table 2. Five students made responses coded under self-understanding. These answers focused on things like flexibility and class management. Four students responded in each of the topics related to discussions and ATLAS videos while three responded in each of the general observation and presentations topics. While these results show numerous positive effects for the students' science teaching, no one topic is dominant.

Table 2. Responses and Themes for Question: Something that Prepared You for Teaching Science

Themes	Student Answers
Discussions	**Student #1:** In the classroom we discussed our lessons before going into the classroom. This really helped me because I was able to gain other ideas and better my lesson before teaching it to students. **Student #3:** I found I gained the most from watching the videos then discussing them as a class. I gained so much information and knowledge about teaching by talking to my peers and professor about the dos and don'ts of teaching. **Student #5:** Having open discussions about our reservations about teaching science allowed me to work on the areas I needed to strengthen, thus better preparing me for teaching science. **Student #12:** Class discussions.
Self-understanding	**Student #7:** Knowing how to implement the content into an effective lesson. **Student #10:** I was prepared to be flexible and adjust the activities according to how they would best work in the classroom. **Student #13:** Knowing basic information that was necessary to understand. **Student #16:** During my field hours, I learned about classroom management and group activities to learn, teach, and explore science. **Student #17:** I learned how to not overwhelm myself and keep control of the lesson.
General observations	**Student #4:** During my teaching field hours, I was able to observe what worked well and what did not work well, which helped me differentiate and better my lesson for the future. **Student #18:** The observation of information **Student #19:** While observing real classrooms, I was able to see how instruction should go and some problems that I may run into. This gave me an idea of how to prepare instruction that would lead to the most learning possible.
ATLAS videos	**Student #6:** Observations from ATLAS and coursework done in class. **Student #11:** Something that prepared me for teaching science was watching the ATLAS videos, because they were all based off science experiments. **Student #14:** Something that prepared me for teaching science while completing my field hours were the different ATLAS observations we had to do. **Student #15:** The videos showed me some classroom that I do not want my classroom to look like, and others showed me how I would choose to run my classroom. These videos also showed me good teaching practices that I can model in the future.
Presentations/activities	**Student #2:** Presenting my lesson in front of the class really helped boost my self-esteem and knowledge for teaching. **Student #8:** Something that has prepared me for teaching science was using hands-on lessons and activities to keep the students engaged throughout. **Student #9:** Experiments and hands on activities hold students' attention the most.

3.1.2 No direct effect on student attitude toward science teaching

The journal entries on the case studies provided results of the students' opinions on the watched ATLAS videos. The open discussion that followed provided results in scores on the rubric that I notated. Neither assignment showed any effect on the students' attitudes toward their science teaching.

3.1.2.1 Case 2018

When evaluating Case 2018, students agreed they enjoyed the teacher's teaching methods and her use of open-ended questions. Journal entry notations stated the classroom was chaotic, they enjoyed the teacher going to each table, and some focused on the classroom décor. A point brought up in the open discussion but was not in the forum postings was concerning the students' tools during the activity. The preservice students found that with the chaos, the groups could be smaller and the activity more organized.

3.1.2.2 Case 590

The journal entries for Case 590 had a consensus on their views of the teacher and her teaching methods. The preservice teachers enjoyed how the teacher in the video moved about the room and asked open-ended questions to her students to be sure they all comprehended. The preservice teachers also noted that they enjoyed the setup of the different stations for the activity and having the students doing different activities was a clever idea. The one negative that showed in the journal entries was the elementary students getting off task with consistent lack of direction. During the open discussions, the preservice teacher reiterated the same comments; however, when asked how to better the activity, many felt that smaller group numbers would be a better idea.

3.1.2.3 Case 1378

The overall result from this case was that the students worked well together and on their own without the assistance from the teacher. The preservice teachers notated that the instructor was absent throughout most of the video, but this lesson was not chaotic. The students worked quietly and when asked a question could answer it easily. During the open-discussion, arguments for and against the teacher's teaching method allowed the preservice students to debate the video and their future methods.

The completion of the journal entries and the open discussions provided data using the rubric as seen Figure 5. Upon comparing the results from the three separate cases, there was no direct correlation between the journal entries and open discussion as seen in Figure 10. In answering question one, the results demonstrated from this data source showed no positive or negative effect on the students' attitudes or perspectives toward science teaching. However, I feel the addition of the teaching observations and open discussions is an asset to the course as part of the scaffolding science teaching method. Later results corroborate that statement.

Figure 10. Case Comparison of Journal Entries and Open Discussion Rubric Scores

3.2 Question Two: As Their Teacher Educator, How Did I Support a Positive Attitude of Science Teaching in the Elementary Classroom?

The second research question focused on how I supported a positive attitude toward science teaching for the preservice teachers when they enter the elementary classroom. My goal was to answer what ways the student felt confident to teach the science content. The following results provided by the data sources demonstrated a successfully achieved goal.

3.2.1 Expression of confidence in teaching science

The Perceptions and Attitudes Towards Science Teaching Survey addressed the students' perceived control by way of measuring self-efficacy. Self-efficacy questioned students on their perceived level of capability or confidence for teaching science. As seen in Figure 11, seven of the twelve students strongly agreed while the remaining five agreed that they were comfortable enough with teaching science that they could handle a classroom or science activity. When asked if they were able to answer a student's question about science, 67% agreed with that statement. When reviewing the graph, two of the twelve students feel neutral on whether they have enough knowledge of the content to teach science. Overall, the graph displays that the students have confidence in teaching science to do so in an elementary classroom.

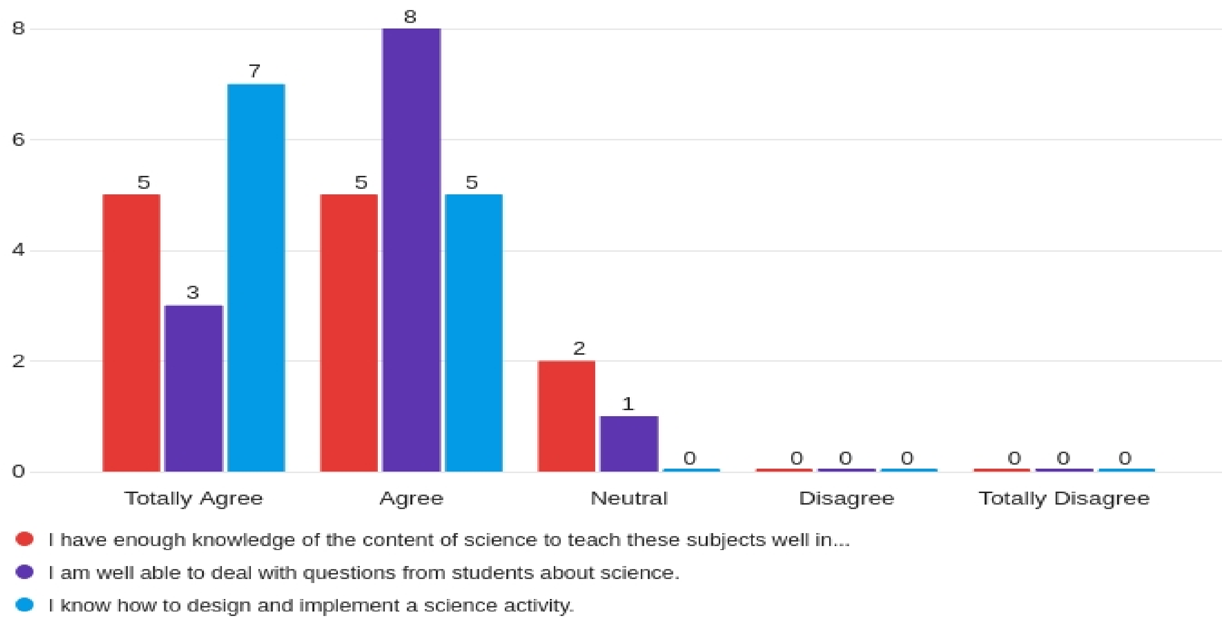

Figure 11. Perceptions and Attitudes Survey: Self-Efficacy Component Questions

Using a Likert scale from strongly agree to the response of strongly disagree found within the Effectiveness and Improvements in Student Learning Survey, data showed how teaching in the elementary classroom prepared the student to teach science. According to the graph in Figure 12, 84.2% of students answered that they strongly agreed that coursework prepared them to teach science while one outlier neither agreed nor disagreed. The same data results reflect the statement regarding if the student is more likely to teach science in their future classrooms. When asked if they were confident in teaching their science activity, 100% of the students answered either strongly or somewhat agree. This data represents a clear positive boost in confidence in the preservice teachers.

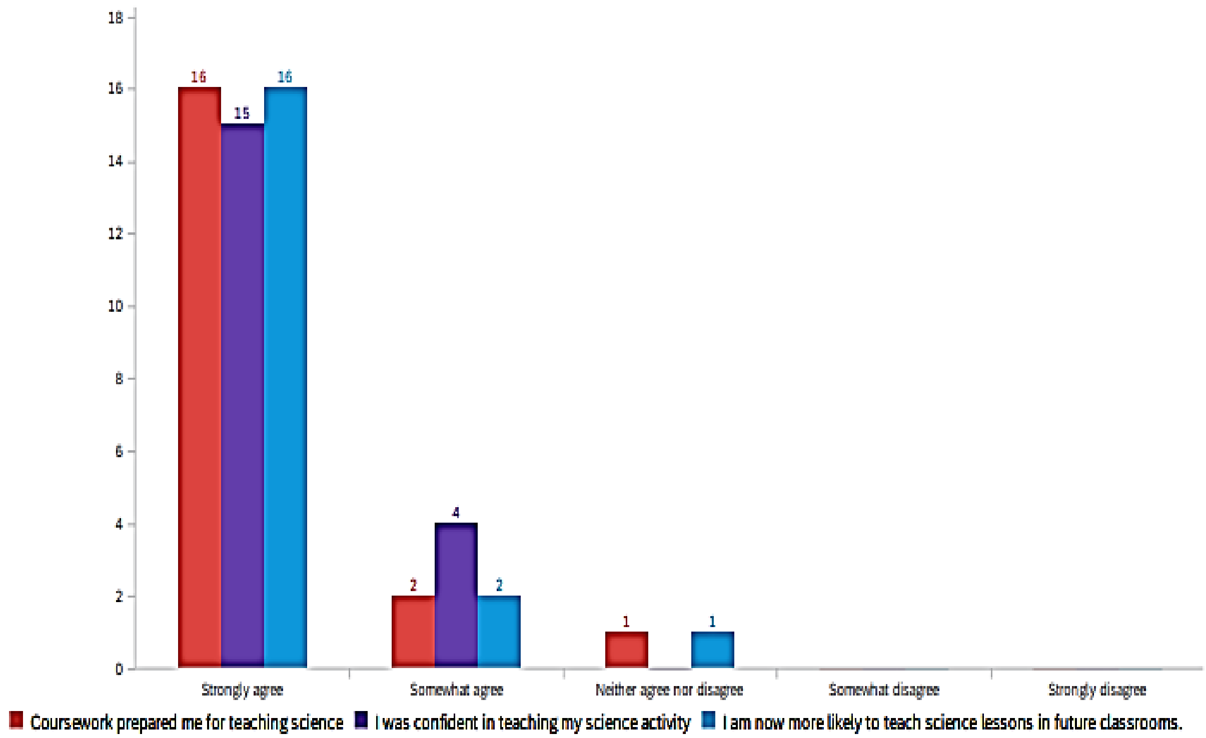

Figure 12. Elementary Classroom Teaching Questions Data

The next set of questions asked in a Likert scale from strongly agree to the response of strongly disagree focused specifically on the ATLAS field hour assignments. From the results seen in Figure 13, of the nineteen students who participated, 17 strongly agreed with that statement that the open discussions prepared them to teach science. Only 12 of the 19 strongly agree that the observations made them more prepared with one student outlier who somewhat disagrees with the statement. The journal forum writing had an even distribution of 47.4% who strongly agreed with them preparing them and 47.4% somewhat agreeing that they prepared them to teach science. This data shows that by participating in open discussions, the students are improving their confidence and preparedness for teaching science.

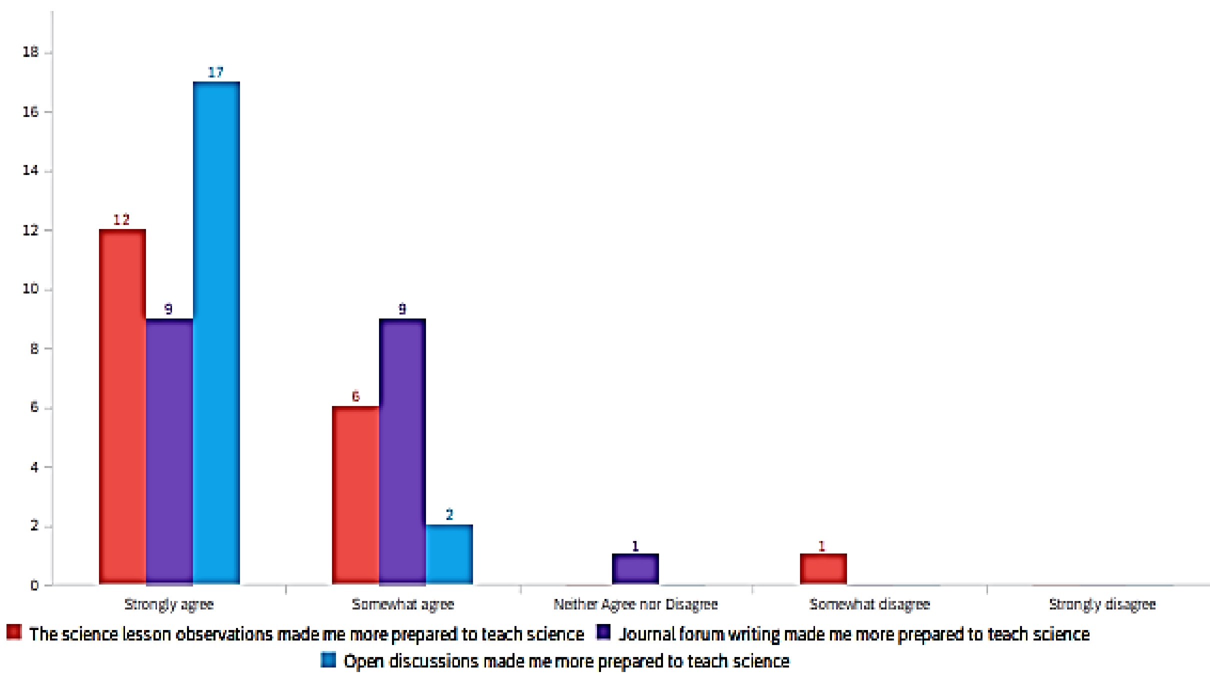

Figure 13. ATLAS Field Hour Assignment Question Data

3.2.2 Improvements needed to increase confidence

Data collected from the final open-ended question on the Effectiveness and Improvements in Student Learning Survey asked students to describe something they wish they had learned that would have prepared them to teach science. This question showed where there needs to be an increase in specific areas to allow students to improve their confidence or attitudes toward science. As seen in Table 3, five of the nineteen students responded with answers in relation to more information on the students and the grade level they were about to teach. Four students responded with requests on needing nothing more to be prepared. Additionally, the same number of students felt they needed more information on how to fill time. One outlier made a significant response about needing more technological skills. Referring to a preview empathy interview, they also referenced West Liberty's lack of technology education.

Table 3. Responses and Themes for Question: Something You Wish You had Learned That Would Have Prepared You to Teach Science

Theme	Student Answers
More info. on students/grade levels	**Student #1**: I wish I would have learned how to focus students. A few times during my lesson, I wasn't sure how to draw the students' attention back in after an activity.
	Student #2: I wish I would have known how smart the students were. There was a lot of information I left out because I thought it would be too hard for 1st grade.
	Student #5: One thing I wish I had learned was how to deal with teaching science specifically for state testing. I know it is an area that students often struggle with.
	Student #7: What the students already knew and had done before.
	Student #15: During my teaching field hours, I wish I would have learned about finding appropriate lessons to the correct grade level. When I teach science, I find it hard to find lessons.
Time filler/back up	**Student #6**: To always have back-up and/or changes because things can go faster than you think or maybe not work out how you think they will.
	Student #10: I wish I would have learned how to fill in time better whenever activities ran fast.
	Student #16: I wish I would know how to fill time if I have extra.
	Student #18: I wish that I had learned how much to prepare. I feel that I may not have enough material, but I also feel as if my activity is too long.
Nothing	**Student #4**: Student answered n/a
	Student #9: I felt very prepared when teaching my lesson.
	Student #12: I feel okay to teach science.
	Student #13: nothing!
What to do if something goes wrong	**Student #11**: Something I wish I had learned is maybe being more prepared if something goes wrong. Although this has not happened to me, it is still good to be prepared if it ever would.
	Student #14: Something I wish I had learned while completing my field hours is how to deal with unruly children, some of the ATLAS videos did show classrooms like that. However, I did not like the way some teachers handled it.
	Student #17: How to handle chaos.
More technological skills	**Student #8**: I wish I would have learned more technological skills to use in my lesson. For example, some of my classmates were able to put together amazing presentations with animations and pictures. I felt like I did not have enough knowledge to do so.
Other	**Student #3**: I wish the atlas videos had given more of an intro of what the lessons were about, sometimes it was hard to figure out what was going on in the video. Then when I figured out, I had missed a chunk of the lesson.

4.0 Learning & Actions

4.1 Discussion

My area of focus concerned how to prepare preservice teachers for effective science teaching using a scaffolding teaching approach. Over the past two years, I have seen preservice teachers have a negative disposition to science pedagogy, and my goal for this study was to improve the preservice students' attitudes about science. As Feiman-Nemser (2001) stated, teacher preparation programs influence preservice teachers' attitudes toward teaching in the classroom. Therefore, by having access to future elementary teachers, I had the ability to directly influence the preservice teachers' attitudes and perceptions of life science teaching.

To answer research question one, "What were the students' perceptions and attitudes toward the field hour assignments within the course," I used a variety of data sources to collect and analyze my study. Upon reviewing my data, I found that many of my data sources provided a positive affect toward science teaching for my students. Using the survey through Qualtrics and titled perceptions and attitudes toward science, data revealed an array of information that supported the positive disposition. One such evidence obtained showed that the students enjoyed learning and teaching science. Even though 42% of students felt neutral about their anxiety in teaching science this did not show a negative effect on the students. This makes the importance of teaching preservice teachers science even greater because, as van Aalderen-Smeets and van der Molen (2013) stated in their validation of the DAS instrument, scores on the subscale's enjoyment provide an indication of the likelihood and frequency that preservice teachers will teach science in the classroom.

Additionally, I felt it was highly important to evaluate the students' cognitive belief since my goal each semester is to make science relevant in a preservice teacher's life so that they do not fear or dislike teaching science. The results from that survey showed that all the students either strongly agreed or agreed that science was relevant. These results are important because as stated by the National Academies of Sciences, Engineering, and Medicine (2021) the average time devoted to teaching science in US elementary schools is 20 or so minutes per day, a few days a week. Many more hours are specified for reading, writing, and mathematics. With the results that my students find science relevant, my hope is that they will include science more often within their classroom including cross-curricular activities with reading, writing, and math.

Using the Effectiveness and Improvements in Student Learning Survey I evaluated the change ideas implemented within the course and their effect on the students. The change idea included the enactment of observational and in-class teachings for each student to benefit their skills in science teaching. As the results found, 85% of the preservice teachers indicated that their favorite supportive assignment was the elementary school teachings. This result was not surprising as the interviews with the student teacher, novice teacher, and experienced teacher all indicated having opportunities within classrooms is where students will learn their love for teaching and skills that they will need to help grow them to be better educators. In addition, research done by Strawitz and Malone (1986) indicated that field experiences could significantly improve a student's attitude toward science and science teaching. Therefore, these results strengthen my affirmation that this change is necessary.

A final way I found that the students had a positive affect toward science teaching was by evaluating one of two open-ended questions. The question that helped answer question one asked students to state something that helped prepare them to teach science. Although each answer varied, when coded by themes they all demonstrated how the students felt my course helped them in some way to teach science in the future. When examining the student responses individually, 12 of the 19 students hinted at a form of discussions or what was discussed preparing them to teach science. This revealed the positive mark that open discussions provided to my students.

The use of the ATLAS (Accomplished Teaching Learning and Schools) video observations and resulting journal entries and open discussions showed no effect on student attitude or perceptions of science teaching. The concepts and intentions behind the assignments were well-advised as indicated by current research on the ATLAS videos showing that teacher candidates could apply their new knowledge gained from interacting with ATLAS cases to their context and instructional decision-making (Hougan et al., 2018). However, after completing the journal entry and the open discussions rubrics, there was not much difference in the information relayed or gained. I did not see a benefit to the journal entries or how this provided an effect on a student's attitude toward science teaching. Although students found the open discussions valuable according to the Effectiveness and Improvement in Student Learning Survey, they did not care much for watching the videos, which go hand-in-hand.

Research question two asked, "As their teacher educator, how did I support a positive attitude of science teaching in the elementary classroom," and by using the change idea of in-class teaching opportunities and survey questions, question two was answered. The first way I noticed that students felt an improved confidence in teaching science was by the analysis of the data from the Effectiveness and Improvements in Student Learning Survey that concentrated on the student's preparedness to teach science by leading science lessons within an elementary school classroom. According to the answers students provided, the data showed that students felt confident that they could teach science. Results from this survey correlated with other data suggesting students viewed teaching within an elementary classroom setting as highly beneficial to their future.

Results of the Effectiveness and Improvement in Student Learning Survey specifically focusing on elementary classroom teaching provided me with data that, of the nineteen students questioned, all nineteen either strongly agreed or somewhat agreed that they were confident in teaching their science activity. The students were also strongly in favor of the coursework helping prepare them and teaching science in the future. These results are all beneficial to the overall goal of the study. In reference to the response results that narrowed on specifically the ATLAS field hours, students indicated a strong favoring for the open discussions and less so for the journal entries. These results coincide with other data results.

Finally, improvements needed to improve student confidence was answered in the second open-ended question in the Effectiveness and Improvement in Student Learning Survey. Looking at the responses, five of the eighteen students wished to be better prepared with their grade level students and content. Similarly, four of the nineteen students felt that being prepared to fill time or have back up information would be helpful. The same number of students did not need anything more to teach science in their opinions. These answers showed me what I need to focus on in the future. As Shapiro (1996) states, unless student teachers are assisted in developing confidence and competence in science, the cycle of avoiding and disliking science may repeat itself with new teachers, thereby providing the same limited encounter with science for students just as they experienced (1996, p. 536).

In conclusion, based on survey and rubric results a new driver diagram was constructed. As seen in Figure 14, an improvement in student attitudes was shown based on the addition of the ten field hours which included in-school teachings and virtual observations. Using these results, further research can be done on the type of content that is beneficial to the students. Based on the open-ended question survey responses, more time needs to be spent on activity and classroom time management.

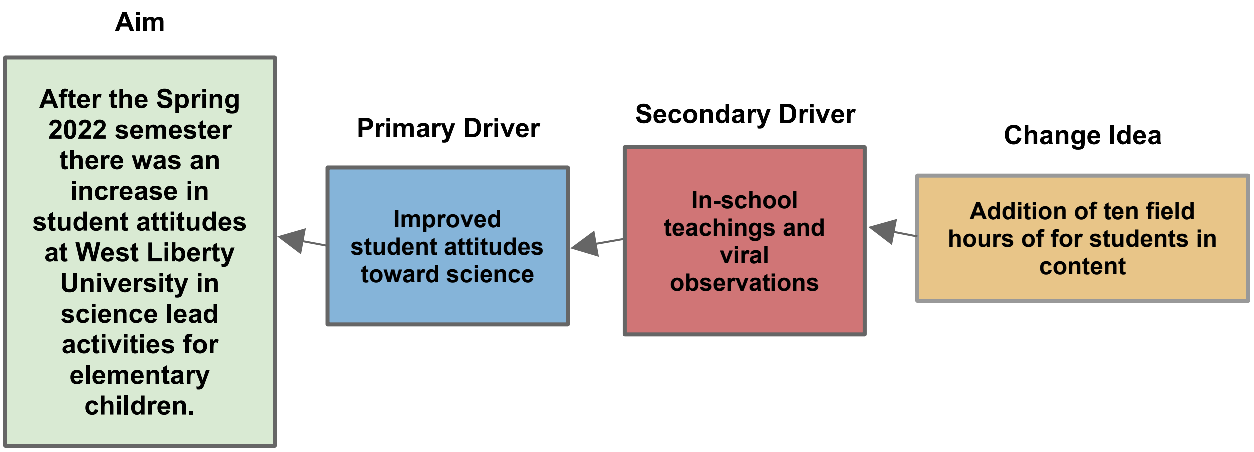

Figure 14. Revised Driver Diagram

4.2 Next Steps and Implications

As Zeichner (2002) stated, it is not enough simply to place a student teacher in a classroom setting; the quality of the setting, the supervision, and the support provided are critical to the development of an exceptional future teacher. Therefore, I do not feel my job as an educator to preservice students is complete even when my class ends for the semester. As this study was a trial that added ten field hours within the Biology 340 course, the data show that the students had positive learning and personal experiences due the addition. Additionally, changes from within the West Liberty University education department indicate a withdrawal from the ATLAS program starting in the spring 2023 semester. Hence, to allow students the opportunities to observe and have open discussions I must create a new change idea.

The new change, Figure 15, will still focus on observing classroom environments. The students will be required to complete these observations as a class arranged by me at local schools during the assigned lab hours of the course. This will allow the students to continue their participation in open discussions the following class time. I believe this experience will broaden the students' views, as they will see an actual classroom and not just a video. Additionally, by observing within classrooms around the county, students may make professional connections that may help them in their future in-class teachings or job searches.

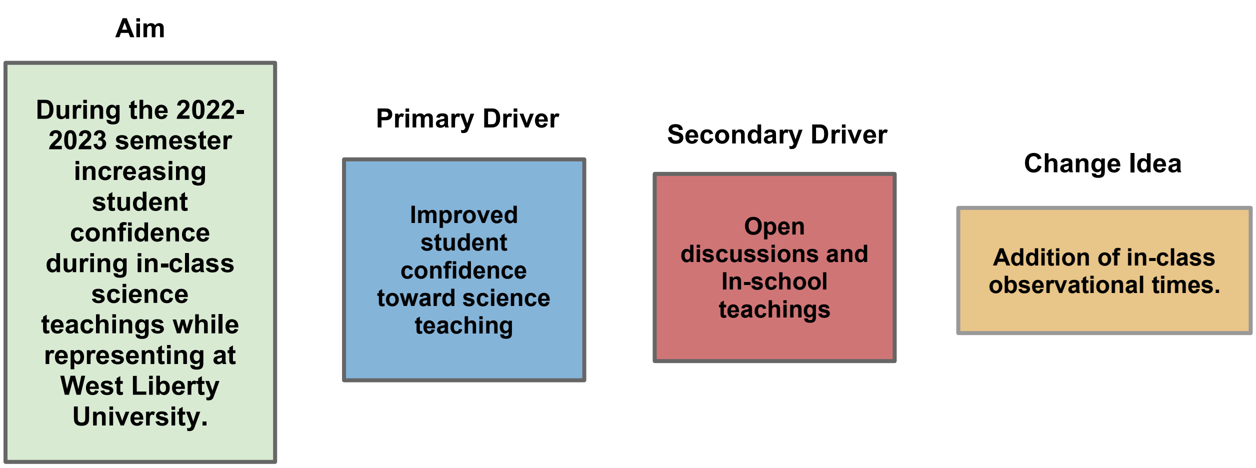

Figure 15. New Driver Diagram

The addition of field hours within the content course for preservice teachers is novel to the education program at West Liberty University. The use of the data will allow our education department to view how the assessments are advantageous for our students. In addition, as more content area courses are seeking recommendations for their field hour assignments, my biology course is a prime example of how the students were successful and enjoyed the experience.

Using the success of the survey data and the observations I completed of preservice teachers while they taught in the elementary classrooms, I concluded the change idea implemented into my course curriculum will continue in the future. The only alteration will be the removal of the journal entry forums. Removal of the journal entries stems from the data. Furthermore, the work seemed repetitive, and students had a more positive experience with the open discussion.

At the end of each semester, students evaluate their instructors. I use this feedback from my students as incentives to better my teaching abilities. From my PDSA I learned that not every idea I had was effective. I also found that what I suspected would be a great asset to my students, teaching in a classroom setting, was the best improvement within my course curriculum that I could have made and will continue for future semesters. I learned that building relationships with elementary school principals, teachers, and their staff is beneficial not only to my students but for any future science related activities that could occur at their locations. I learned that education is ever changing and as it changes so will our courses and the way we teach it. Each year I reevaluate how in a 16-week semester I can be more productive. I talk to my students about their wants and needs and I do my best to make science fun, entertaining, and the pedagogy of science memorable. Overall, I found that by increasing preservice teachers' introduction to science lessons and activities coupled with discussions and allowing them to teach said lessons to children, the future of science within elementary schools looks promising.

5.0 Reflections

Reflecting on the improvements made within my course for my study, I firstly reminded myself of the definition of improvement science. According to Hinnant-Crawford (2020), improvement science is a systematic approach to continuous improvement in complex organizations guided by three foundational questions. The questions ask what the problem is that needs fixed, what change can be used to solve it, and how the change will show improvement. Therefore, I can confidently say as both a leader and improver I feel I excelled at answering all three of the questions with my approach. To begin, I lead my class as a mentor and energetic instructor to accomplish the problem of students having negative dispositions toward science teaching. I strive each semester within the classroom to provide my students with a positive, enthusiastic experience learning science and how to effectively teach it to elementary students. I take time in my course to ask students to participate in their learning process and use their insights to adapt assignments and teaching methods.

To guide the second foundational question, I introduced change ideas that were functional and beneficial to my science course, which included state mandatory field hour increases. My research allowed me to focus on a curriculum for my students that would not only introduce more observations of science teachings, but the ATLAS videos would also give students numerous science activity examples. The open discussions gave opportunities for me to further the students' science teaching knowledge with suggestions and open dialogue on other options for activities. The addition of elementary classroom teachings was a change idea I wanted to include before this study; however, having no support from the education department, the idea never came to fruition until the state implemented the 120 additional field hours requirement. The use of a predetermined grading rubric during classroom teachings did not answer my inquiry question two, as I initially thought it would. Upon reflection of its use, the rubric would have been used more efficiently if evaluated during the Biology 340 classroom teachings and the in-class elementary teachings to compare pre and post confidence. Therefore, further research will need to be completed with preservice teachers to show an improved confidence in teaching science. In addition, having preservice students teach within elementary classrooms also had students planning science lessons fit for specific grades.

Finally, I answered the third question with data shown by rubrics and surveys. The preservice students were asked to voluntarily answer surveys based on their perspective and attitudes toward science. This survey allowed me to see their enjoyment, anxiety, confidence, and other feelings about teaching science. A rubric was used to measure students' observational journal entries and discussions of the ATLAS videos. Finally, a survey to measure the effectiveness and improvements in the field hour assignments was distributed to the students. These results allowed me to see what assignments supported my students' learning. All the results from each data collection method showed the change ideas were successful for the preservice teachers.

While completing the improvement science process I learned that there is always room for enhancement. Each semester a new set of preservice teachers enter the Biology 340 course; therefore, I found that improvement science taught me that I need to adjust, change, and evaluate each semester. The balance between content, activities, and teaching has always been an issue each semester. This study allowed me to reevaluate next steps for future semester curriculum. Scaffolding teaching utilized a unique method for students to learn science lessons, and future students will benefit from this addition. I have used journals and research studies to help improve myself as a scholar practitioner. Overall, I am the leader of life science education for the preservice teachers, and I need to lead by example.

Going further I do believe I will utilize improvement science when approached with issues in my courses. The approach will allow me to separate what the issue is and how I can resolve it. There are issues within the general science education course requirements that could benefit from a PDSA cycle. Additionally, a new course on science methods for secondary preservice teachers is being created for the spring of 2023. Using the knowledge gained from the study done with the elementary preservice students, I imagine using a form of the same improvement with these students as well. I think the general goal I want to accomplish is making great future teachers that are not afraid to teach science, which will allow elementary students to be exposed to science earlier in their education. As Du Plessis (2019) stated confident and well-prepared teachers influence effective improvement strategies, education reform and therefore the prosperous future of the United States.

Appendix A Perceptions and Attitudes Towards Science Survey

Enjoyment in Teaching Science

	Totally Agree	Agree	Neutral	Disagree	Totally Disagree
Teaching science makes me enthusiastic.	○	○	○	○	○
I enjoy teaching science very much.	○	○	○	○	○
I feel happy while teaching science.	○	○	○	○	○

Self-efficacy in Teaching Science

	Totally Agree	Agree	Neutral	Disagree	Totally Disagree
I have enough knowledge of the content of science to teach these subjects well in an elementary school.	○	○	○	○	○
I am well able to deal with questions from students about science.	○	○	○	○	○
I know how to design and implement a science activity.	○	○	○	○	○

Relevance in Teaching Science

	Totally Agree	Agree	Neutral	Disagree	Totally Disagree
I think that science education is essential in elementary education as early as possible.	○	○	○	○	○
I think that science education is essential for making elementary school students more involved in problems in society.	○	○	○	○	○
Science education is so important in elementary schools that inexperienced teachers should receive additional training in this area.	○	○	○	○	○

Anxiety in Teaching Science

	Totally Agree	Agree	Neutral	Disagree	Totally Disagree
Teaching science makes me nervous.	○	○	○	○	○
I feel stressed when I have to teach science to a class.	○	○	○	○	○
I feel tense while teaching science in a class.	○	○	○	○	○

Appendix B Effectiveness and Improvement in Student Learning Survey

Of the four assignments below, drag and rank from your most favorite to least favorite.

Journal about Observation

Open discussions about Observation

Teaching in Elementary School

Watching ALTAS observations

ATLAS Field Hour Assignments:

	Strongly agree	Somewhat agree	Neither Agree nor Disagree	Somewhat disagree	Strongly disagree
The science lesson observations made me more prepared to teach science	○	○	○	○	○
Journal forum writing made me more prepared to teach science	○	○	○	○	○
Open discussions made me more prepared to teach science	○	○	○	○	○

During your teaching field hours, describe something that prepared you for teaching science.

During your teaching field hours, describe something you wish you had learned that would have prepared you to teach science.

Elementary Classroom Teaching Field Hours:

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Coursework prepared me for teaching science	○	○	○	○	○
I was confident in teaching my science activity	○	○	○	○	○
I am now more likely to teach science lessons in future classrooms.	○	○	○	○	○

Bibliography

Akerson, V., & Donnelly, L. A. (2009). Teaching nature of science to K-2 students: What understandings can they attain? *International Journal of Science Education, 32*(1), 97–124. https://doi.org/10.1080/09500690902717283

Appleton, K. (1995). Student teachers' confidence to teach science: Is more science knowledge necessary to improve self-confidence? *International Journal of Science Education, 17*(3), 357–369. https://doi.org/10.1080/0950069950170307

Bailey, K., & Jakicic, C. (2012). *Common formative assessment: A toolkit for professional learning communities at work*. Hawker Brownlow.

Bigelow, M. (2017). *Scaffolding science skills*. NSTA. https://www.nsta.org/blog/scaffolding-science-skills

Bleicher, R. E. (2007). Nurturing confidence in preservice elementary science teachers. *Journal of Science Teacher Education, 18*(6), 841–860. https://doi.org/10.1007/s10972-007-9067-2

Bleicher, R. E., & Lindgren, J. (2005). Success in science learning and preservice science teaching self-efficacy. *Journal of Science Teacher Education, 16*(3), 205–225. https://doi.org/10.1007/s10972-005-4861-1

Church, W. (2020). *Educational program development: Policy 2510*. West Virginia Department of Education.

Couling, J. (2018). *Scaffolding for success: When high school science teachers scaffold their summative classroom assessments: Opportunities, observations, and outcomes* [Doctoral dissertation, UC Santa Cruz]. https://escholarship.org/uc/item/5zg93073

Crockett, C. (2016). *The next generation science standards*. NSTA. https://www.nsta.org/nstas-official-positions/next-generation-science-standards

Deaton, C., & Johnson, C. (2016). 6 tips for engaging students in science. *New Teacher Advocate, 24*(1), 16–17.

Docherty-Skippen, S. M., Karrow, D., & Ahmed, G. (2020). Doing science: Pre-service teachers' attitudes and confidence teaching elementary science and technology. *Brock Education: A Journal of Educational Research and Practice, 29*(1), 25–35.

Du Plessis, A. E. (2019). *Professional support beyond initial teacher education: Pedagogical discernment and the influence of out-of-field teaching practices.* Springer.

Eshach, H., & Fried, M. N. (2005). Should science be taught in early childhood? *Journal of Science Education and Technology, 14*(3), 315–336. https://doi.org/10.1007/s10956-005-7198-9

Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record, 103*(6), 1013–1055. https://doi.org/10.1111/0161-4681.00141

Finn, J. D., & Zimmer, K. S. (2012). Student engagement: What is it? Why does it matter? In S. L. Christenson, A. L. Reschly, & C. Wiley (Eds.), *Handbook of research on student engagement* (pp. 97–131). Springer.

French, L. (2004). Science as the center of a coherent, integrated early childhood curriculum. *Early Childhood Research Quarterly, 19*(1), 138–149. https://doi.org/10.1016/j.ecresq.2004.01.004

Hinnant-Crawford, B. (2020). *Improvement science in education*. Myers Education Press.

Hougan, E., Johnson, H., Novak, D., Foote, C., & Palmeri, A. (2018). Exploring the influence of accomplished teachers' video and commentary pairing on teacher candidates' noticing and thinking about practice. *Journal of Technology and Teacher Education, 26*(2), 217–248.

Javersak, D. (2009, February 19). *History - WLU college of education*. College of Education and Human Performance. https://westliberty.edu/education/about-us/history/

Lind, K. K. (1998). *Science in early childhood developing and acquiring fundamental concepts and skills*. ERIC Clearinghouse.

Martin-Dunlop, C., & Fraser, B. J. (2007). Learning environment and attitudes associated with an innovative science course designed for prospective elementary teachers. *International Journal of Science and Mathematics Education, 6*(1), 163–190. https://doi.org/10.1007/s10763-007-9070-2

Mohr-Schroeder, M., Jackson, C., Schroeder, C., & Wilhelm, J. (2019). *Developing a STEM education teacher preparation program to help increase STEM literacy among preservice teachers.https://onlinelibrary-wiley-com.pitt.idm.oclc.org/doi/full/10.1111/ssm.12079*

Moneroso, C. (2020, February 7). *Coehp homepage - WLU college of education*. College of Education and Human Performance. https://westliberty.edu/education/

Moody, J. (2018, December 7). *What a liberal arts college is and what students should.* US News. https://www.usnews.com/education/best-colleges/articles/2018-12-07/what-a-liberal-arts-college-is-and-what-students-should-know

Morrisey, J. T. (1981). An analysis of studies on changing the attitude of elementary student teachers toward science and science teaching. *Science Education, 65*(2), 157–177. https://doi.org/10.1002/sce.3730650207

Morrow, J. (2018). *Science, technology, engineering, and math, including computer science*. https://www.ed.gov/stem

Murphy, T. (2011, August 29). *STEM education--it's elementary*. U.S. News & World Report. https://www.usnews.com/news/articles/2011/08/29/stem-education--its-elementary

Nagda, B. R., & Zúñiga, X. (2003). Fostering meaningful racial engagement through intergroup dialogues. *Group Processes & Intergroup Relations, 6*(1), 111–128. https://doi.org/10.1177/1368430203006001015

National Academies Press. (2015). *Guide to implementing the next generation science standards*. https://doi.org/10.17226/18802

National Academies of Sciences, Engineering, and Medicine. (2021, October 7). *Science and engineering in preschool through elementary grades: The brilliance of children and the strengths of educators*. National Academies Press. https://doi.org/10.17226/26215

National Research Council. (2013). *Monitoring progress toward successful K-12 stem education: A nation advancing?* National Academies Press.

Norris, M. (2021, October 4). *Why is STEM important? The impact of STEM education on society*. StudyUSA. https://www.studyusa.com/en/a/2157/why-is-stem-important-the-impact-of-stem-education-on-society

Osborne, J., & Dillon, J. (2008). *Science education in Europe: Critical reflections*. The Nuffield Foundation.

Palmer, D. H. (2001). Factors contributing to attitude exchange amongst preservice elementary teachers. *Science Education, 86*(1), 122–138. https://doi.org/10.1002/sce.10007

Parker, C. (2020, July 9). *Why is STEM important in early childhood education? Understanding child development and learning*. American University. https://soeonline.american.edu/blog/stem-in-early-childhood-education

Radloff, J., & Guzey, S. (2016). Investigating preservice STEM teacher conceptions of STEM education. *Journal of Science Education and Technology, 25*(5), 759–774. https://doi.org/10.1007/s10956-016-9633-5

Sarna, J. (2013). *Understanding the standards*. Next Generation Science Standards. https://www.nextgenscience.org/understanding-standards/understanding-standards

Shapiro, B. L. (1996). A case study of change in elementary student teacher thinking during an independent investigation in science: Learning about the "face of science that does not yet know." *Science Education, 80*(5), 535–560. https://doi.org/10.1002/(sici)1098-237x(199609)80:5<535::aid-sce3>3.0.co;2-c

Smith, R. (2005). *Qualtrics*. https://www.qualtrics.com.

Smithsonian Science Education Center. (2016, March 25). *The STEM imperative.* https://ssec.si.edu/stem-imperative

Strawitz, B. M., & Malone, M. R. (1986). The influence of field experiences on stages of concern and attitudes of preservice teachers toward science and science teaching. *Journal of Research in Science Teaching, 23*(4), 311–320. https://doi.org/10.1002/tea.3660230405

Taylor-Powell, E., & Steele, S. (1996). *Collecting evaluation data: Direct observation*. University of Wisconsin-Extension. https://www.pages.drexel.edu/~rosenl/CollectingObservDataProgrEval.pdf

Tennant, N., & Heinlein, C. (2016). *WVBE content standards policies: Policy 2520.3C*. West Virginia Department of Education.

Thibaut, L., Knipprath, H., Dehaene, W., & Depaepe, F. (2017). How school context and personal factors relate to teachers' attitudes toward teaching integrated STEM. *International Journal of Technology and Design Education, 28*(3), 631–651. https://doi.org/10.1007/s10798-017-9416-1

Tosun, T. (2000). The beliefs of preservice elementary teachers toward science and science teaching. *School Science and Mathematics, 100*(7), 374–379. https://doi.org/10.1111/j.1949-8594.2000.tb18179.x

van Aalderen-Smeets, S. I., Walma van der Molen, J. H., & Asma, L. J. (2011). Primary teachers' attitudes toward science: A new theoretical framework. *Science Education, 96*(1), 158–182. https://doi.org/10.1002/sce.20467

van Aalderen-Smeets, S. I., Walma van der Molen, J. H., van Hest, E. G. W. C., & Poortman, C. (2017). Primary teachers conducting inquiry projects: Effects on attitudes towards teaching science and conducting inquiry. *International Journal of Science Education, 39*(2), 238–256. https://doi.org/10.1080/09500693.2016.1277280

van Aalderen-Smeets, S., & Walma van der Molen, J. (2013). Measuring primary teachers' attitudes toward teaching science: Development of the dimensions of attitude toward science (DAS) instrument. *International Journal of Science Education, 35*(4), 577–600. https://doi.org/10.1080/09500693.2012.755576

van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher–student interaction: A decade of research. *Educational Psychology Review, 22*(3), 271–296. https://doi.org/10.1007/s10648-010-9127-6

van der Valk, T., & de Jong, O. (2009). Scaffolding science teachers in open-inquiry teaching. *International Journal of Science Education, 31*(6), 829–850. https://doi.org/10.1080/09500690802287155

Varma, T. (2011). Preservice elementary teachers' perceptions of their understanding of scientific inquiry-based pedagogy and their confidence to teach science: Influence of elementary science education methods course and science field experience. *Global Education Journal, 2*, 76–106. https://doi.org/10.32469/10355/4763

Wang, F., Kinzie, M. B., McGuire, P., & Pan, E. (2009). Applying technology to inquiry-based learning in early childhood education. *Early Childhood Education Journal, 37*(5), 381–389. https://doi.org/10.1007/s10643-009-0364-6

West Virginia Science Public Outreach Team. (2013). *Home.* https://sites.google.com/view/wvspot

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry, 17*(2), 89–100. https://doi.org/10.1111/j.1469-7610.1976.tb00381.x

Zeichner, K. (2002). Beyond traditional structures of student teaching. *Teacher Education Quarterly, 29*(2), 59–64.