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Bridging the Gap Between Beliefs and Practice: Preservice Science Teachers' Orientation Shifts through Experiential Place-based Instruction

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ABSTRACT

This study examined the impact of hands-on, inquiry-based learning experiences in an informal setting on developing preservice teachers' science teaching orientations. Effective science instruction requires educators to adopt adaptive, inquiry-oriented beliefs that guide how they plan, implement, and assess their teaching, extending beyond mere content knowledge. By engaging in authentic, place-based educational activities that offered unique opportunities for experiential learning, participants in this study connected with scientific concepts in real-world contexts. The study explored how outdoor, inquiry-based experiences shaped preservice teachers' orientations and revealed patterns in their orientations toward place-based education as practical instructional teaching models. The findings showed observable and significant shifts as participants expanded their views, favoring more interactive informal or outdoor teaching and learning. The results also showcased the value of hands-on engagement, scientific relevance through localized contextual learning, and peer collaboration. These findings suggest that teacher education programs should include contextually relevant experiential learning strategies to foster students' development of effective, inquiry-driven teaching beliefs. These beliefs promote increased innovative science practices that connect learning to local communities.

Keywords: Place-based education, informal science education, teacher beliefs and orientations, science teacher education, experiential instructional practices.

Introduction

Effective science teaching involves mastering content knowledge and instructional skills (Gess-Newsome, 2013, 2015; Shulman, 1986) and developing appropriate teaching orientations and beliefs. Given the current teacher shortages, preparing effective science teachers is critical for advancing science education that aligns with contemporary educational goals, prioritizing more innovative approaches to teaching and learning. Teacher orientations, including educators' assumptions and attitudes about teaching and learning, significantly shape how they plan, implement, and assess instruction. Research has shown that teacher beliefs and orientations greatly influence their Pedagogical Content Knowledge (PCK), affecting how they translate their knowledge into classroom practice (Gess-Newsome, 2013, 2015; Pajares, 1992; Shulman, 1986). Therefore, it is essential to foster adaptive and inquiry-oriented teaching beliefs in teacher education programs (Loughran, 2013; Nilsson & Loughran, 2012).

One promising strategy for influencing preservice teachers' (PSTs) orientations is experiential learning, where hands-on, inquiry-based activities enable them to engage directly with meaningful teaching practices in authentic contexts (Kolb, 2014). Place-based education (Smith, 2017; Sobel, 2004) enhances these experiences by situating learning within the local environment and community, helping teachers connect scientific concepts to real-world contexts.

This study investigated how an immersive experience at Outdoor School, an outdoor education center, impacted PSTs' orientations toward inquiry teaching. Furthermore, it aims to identify patterns in how PSTs perceive and plan to integrate experiential and place-based education into their emerging teaching practices. By focusing on experiential learning, this research provides an in-depth understanding of how real-world teaching experiences might shape PCK development by influencing the beliefs that underpin effective science instruction. The following research questions guided the study:

a) How does an outdoor place-based experience influence preservice teachers' science teaching orientations?

b) What patterns emerge in preservice teachers' perceptions of science teaching through their engagement in place-based education activities?

Theoretical Framework

This study is grounded in Kolb's (1984) Experiential Learning Theory and Sobel's (2004) Place-Based Education conceptual framework. These frameworks offer a robust lens to understand the development of PSTs' science teaching practices during an informal, immersive learning experience.

Experiential Learning Theory

Experiential learning theory (Kolb, 1984) describes that learning occurs through a cyclical process involving four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. In this model, learners engage directly with a subject, reflect on their experiences, conceptualize what they have learned, and apply that understanding in new contexts. This iterative cycle allows learners to develop deeper insights and apply knowledge to real-world scenarios. Experiential learning enriches teachers' pedagogical content knowledge and skills, enhancing their professional competence across various disciplines and contexts. According to research, these active experiences in teacher development lead to meaningful changes in classroom practice and shape teachers' beliefs, resulting in significant curriculum innovations (Girvan et al., 2016; Lee, 2019a). In the context of this study, Kolb's experiential learning provides a critical foundation for understanding how PSTs benefit from place-based experiences. The PSTs experienced an inquiry-based learning field trip at a local outdoor school. They reflected on the experience, conceptualized it by including the experience as part of a 5E lesson plan, and then used the lesson plan to represent and apply their teaching philosophy in a final paper.

Place-Based Education

Place-based education (Sobel, 2004) expands on Kolb's (1984) experiential learning approach by grounding learning experiences in the local environment and community. This teaching approach emphasizes connecting scientific concepts to students' immediate surroundings, making learning more relevant and impactful (Lund & Stains, 2015; Semken et al., 2017). It fosters a deeper understanding of scientific phenomena by contextualizing abstract ideas within real-world settings. The outdoor school chosen as the setting for the experience is regarded as a valued part of the community, and many participants had previously visited it in elementary school. Due to the rural setting of the university and the fact that many students matriculated from nearby areas, the outdoor school exemplified the definition of the "local environment." This study's integration of experiential learning theory and place-based education provided a robust theoretical foundation for understanding how PSTs' beliefs and orientations were reshaped through immersive, hands-on experiences. By examining how these experiential and place-based approaches interact to influence preservice teacher development, this study provided a lens through which teacher preparation programs can effectively foster inquiry-oriented and contextually relevant teaching practices.

Literature Review

Teacher Beliefs and Orientations

Teacher beliefs and orientations are foundational to effective science teaching. Orientations shape educators' development and dictate their ability to implement innovative instructional practices (Buehl & Beck, 2014; Gess-Newsome, 2015). Addressing and re-shaping traditional beliefs through reflection and experiential learning is essential for preparing teachers to implement inquiry-driven, student-centered instructional strategies that align with contemporary educational goals (Buehl & Beck, 2014; Lebak, 2015; Loughran, 2013). Although it may seem complex, changing teachers' beliefs can lead to significant shifts in instructional practices, particularly when supported by professional development, reflective practices, and collaborative environments.

Definition and Significance

Teacher beliefs are the fundamental assumptions and values shaping how they think about teaching, learning, and science education. Teachers' beliefs about education meaningfully contribute to their curricular and instructional orientations, yet orientations characterize a more actionable position that can conceivably prevail over individual beliefs (Kind, 2016). These beliefs and orientations are evident in how teachers perceive the goals of science education, their instructional practices, and the dynamic interactions between teachers and students. As a multidimensional construct, science teaching orientations guide how teachers interpret and enact their instructional practices. They play a crucial role in teacher knowledge, influencing how educators combine content knowledge with pedagogy to make science learning meaningful and accessible for students (Buehl & Beck, 2014; Demirdöğen & Uzuntiryaki-Kondakçı, 2016).

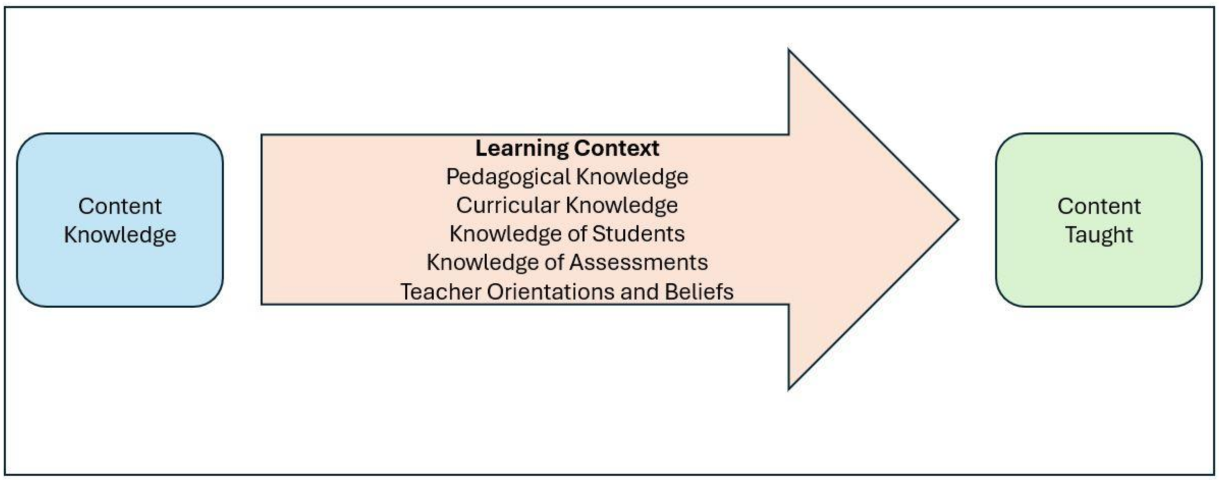
Teacher orientations act as lenses through which instructional decisions are made and determine what teachers prioritize, including their perceptions of student learning and assessment outcomes (Friedrichsen et al., 2011; Gess-Newsome, 2015). For example, a teacher who values inquiry and exploration will likely utilize student-centered, inquiry-based methods, while a teacher who views science as a set of facts to memorize may favor more traditional, lecture-based approaches (Campbell et al., 2017; Demirdöğen, 2016). Thus, a teacher's beliefs and orientation can enhance or hinder their development, depending on how they align with best practices in science education.

Teacher Beliefs, Orientations, and PCK

Teacher beliefs and orientations are pivotal in shaping PCK, influencing how teachers design and deliver instruction. First conceptualized by Shulman (1986), PCK refers to a teacher's ability to translate subject matter into teachable content that is understandable for students. See the model operationalized in Figure 1. Thus, PCK intersects with knowing what to teach (the content) and how to teach it (pedagogy). What teachers bring to practice determines the interactions between the content they know and the practices they implement.

Figure 1.

Pedagogical Content Knowledge in Action



Teacher Beliefs and PCK

Research indicates that teacher beliefs serve as both "amplifiers" and "filters" of PCK (Gess-Newsome, 2015). As amplifiers, beliefs drive teachers to adopt and refine instructional strategies that align with their educational goals. For instance, a teacher dedicated to fostering inquiry actively seeks professional learning opportunities to enhance their inquiry-based teaching skills, thereby expanding their PCK. Conversely, as filters, beliefs can limit PCK development when a teacher holds a rigid view of science as a static body of knowledge. This perspective leads to resistance against new pedagogical approaches, restricting their instructional growth. Addressing teacher beliefs is essential for shaping teaching practices; failing to do so may result in less productive teacher induction or ineffective professional development to improve PCK.

Aligning teacher beliefs with modern educational goals requires reflective and experiential approaches in teacher education. Research has demonstrated that programs encouraging reflective practice through experiential learning or mentorship/coaching yield promising positive outcomes in re-shaping teacher orientations (Demirdöğen & Uzuntiryaki-Kondakçı, 2016; Lee, 2019a; Lee, 2019b; Morris & Ogodo, 2024). Additionally, structured opportunities for reflection, feedback, and hands-on practice enable teachers to examine and critically refine their beliefs, fostering the development of adaptable and robust PCK suited to diverse classroom contexts.

Jones and Jones's (2013) study on the impact of science teacher beliefs on their instructional practices regarding reform-based, inquiry-oriented teaching methods found that teachers' beliefs played a critical role in interpreting and implementing professional development initiatives. Teachers with strong inquiry-oriented beliefs engaged more with reform-based practices, integrating questioning and exploratory activities into their classrooms. However, when misalignment exists between their beliefs and the recommended instructional strategies, implementing reform practices is often fragmented, which diminishes the efficacy of these approaches.

Another study by Lee (2019a) looked specifically at preservice teacher development. Results showed that participating in experiential learning activities transformed PSTs' beliefs from traditional, teacher-centered instruction to facilitating more inquiry-based, student-centered methods. Through hands-on practice, reflection, and adaptation, they developed critical thinking, lesson planning, and problem-solving skills essential for effective inquiry-based teaching. Thus, research reinforces that immersive experiences and reflective practice are key to developing educators who can adapt to innovative instructional practices and respond to student needs (Girvan et al., 2016; Jones & Jones, 2013; Lee, 2019a, 2019b).

Teacher Orientation and PCK

Teacher orientations and views on instructional goals and the nature of science itself can impede the connections they make between the content and the practice. Research suggests that understanding these nuances is critical for teacher education programs (Campbell et al., 2017; Demirdöğen & Uzuntiryaki-Kondakçı, 2016). Incorporating reflective practices can modify teacher orientations to align more with reformed-based practices, such as inquiry-based, student-centered approaches, leading to positive learning outcomes.

Kind's (2016) investigation of PSTs' science teaching orientations and beliefs about the nature of science revealed that about half of the 237 PSTs in the study preferred teacher-centered, content-focused approaches over student-centered learning, with limited evidence of reform-based practices. This highlights a disconnect between current educational reforms and PSTs' instinctive methods. Many participants held naïve or partially informed views of the nature of science as a static body of facts rather than a dynamic, evolving field, which correlated with their preference for didactic instruction.

The interplay between teacher beliefs, orientations, and PCK is demonstrated in studies on how they interact with various PCK components that affect their science teaching expertise, instructional strategies, curriculum knowledge, and assessment methods (Demirdöğen, 2016; Kind, 2016). Consequently, teachers with clear, purpose-driven orientations can integrate PCK components more effectively and cohesively. Where there is misalignment between teacher beliefs, orientations, and PCK, their practice defaults to a teacher-centered pedagogical approach. While understanding teacher orientations and the development of PCK is crucial for effective science teaching practices, it is equally important to consider how the local context impacts teacher beliefs. This focus is central to place-based education.

Place-Based Education

Place-based education is an instructional approach that utilizes the local environment, community, and culture as the primary context for learning. Rather than relying solely on textbooks, place-based education encourages students to engage with their learning contexts' physical, social, and environmental aspects, making learning more tangible and relevant. This approach to learning emphasizes real-world connections, allowing students to investigate and solve problems directly tied to their community (Sobel, 2004; Webber, 2021; Yemini et al., 2023). By bringing local contexts into the curriculum, place-based education fosters a sense of place and belonging, which can deepen students' understanding of content across various subjects, particularly in science. Through outdoor or community-based activities, students can observe natural phenomena, engage in fieldwork, and explore ecological and cultural issues significant to their region (Webber, 2021; Yemini et al., 2023). This approach makes learning more meaningful because it connects classroom concepts to the world outside and encourages students to see themselves as active participants in their community's ecosystem and cultural heritage.

Benefits of Place-Based Science Education

Place-based education offers several benefits in science teaching and learning. One of its most significant advantages is the increased engagement it fosters among students (Yemini et al., 2023). When learners can see the direct relevance of scientific concepts to their local environment, they are more likely to be motivated and invested in the learning process. For example, studying water quality becomes more engaging when students collect and analyze samples from a nearby stream, rather than merely reading about it in a textbook. This hands-on, context-driven approach helps science students develop a deeper and more intuitive understanding of scientific principles (Dori et al. 2018).

Place-based education enhances content retention by reinforcing abstract concepts through direct experience, allowing students to apply their knowledge in real-world contexts. Furthermore, it fosters critical thinking and problem-solving skills, as students analyze data, make observations, and draw conclusions based on their local investigations (Smith, 2017). By focusing on local issues and ecosystems, place-based education also encourages learners to cultivate a sense of responsibility for their community and the environment, which aligns well with the goals of science education, promoting scientific literacy and environmental stewardship.

Influence of Place-Based Approach on Teacher Beliefs and Practice

Engaging PSTs in place-based educational experiences can have a transformative impact on their beliefs and teaching orientations. Such experiences expose them to inquiry-based, student-centered approaches that reshape their understanding of how science can be taught effectively within a local context (Lowenstein et al., 2018). Additionally, when PSTs participate in place-based learning activities, they experience firsthand the benefits of engaging with their environment. This shifts their orientation from a more traditional, didactic approach to a dynamic, inquiry-driven perspective. Studies have demonstrated that PSTs who engage in place-based education are more likely to adopt practices that encourage exploration, questioning, and hands-on learning because they see the benefits of connecting curriculum content to the real world (Webber, 2021; Yemini et al., 2023). This shift enhances their PCK and aligns their teaching practices with reform-based science education, which advocates for active learning and critical thinking over passive information transmission.

These extant literatures show the correlation between integrating experiential and place-based education approaches in supporting PSTs' preparation. They are crucial in developing PSTs' confidence and competence in teaching science. Experiential learning encourages active participation and reflection (Kolb, 2014), while place-based education provides a concrete, real-world context for these experiences (Sobel, 2004). Together they enable PSTs to recognize the connection between theoretical concepts and instructional strategies in authentic settings. By participating in place-based learning and utilizing experiential activities, PSTs gain a better understanding of how to use PCK components—content knowledge, pedagogy, and assessment—to promote inquiry and engagement (Chinn, 2012; Lowenstein et al., 2018; Yemini et al., 2023). These methods can provide a foundation which PSTs use to design informative, interactive lessons adapted to the students' local environments and educational needs.

Methods

This study utilized a qualitative case study research design approach (Creswell & Poth, 2016; Yin, 2017) to explore how an inquiry-based outdoor experience influenced PSTs' science teaching orientations and to identify the patterns that emerge in their perceptions of science teaching following the experience.

Context/Participants

The case was bound by the location of the study and the participants involved. The study took place at Outdoor School, located in a 385-acre section of land along the local lake in a southwestern part of the United States. The participants included 38 (37 female/1 male) pre-service elementary education students enrolled in a science methods course at a university in the community. The course was designed to prepare the PSTs for elementary science in grades EC-6.

Following a course module on place-based learning, the PSTs went on a three-hour field trip to Outdoor School and an exploration of two ponds. The onsite outdoor instructor provided boots and safety instructions before they began the investigation by first hypothesizing "which pond is healthier" through mere observation. They took pictures and discussed what they believed were characteristics of a healthy pond. Next, they received instructions on the best method for using the nets provided to scoop specimens from the pond and how to keep the organisms healthy in the "swimming pool" until they were returned to the pond. The outdoor instructor also helped the PSTs remove their catch from the net if they were uncomfortable doing it themselves.

After collecting and separating the specimens, they brought them to the pavilion for microscopic examination. They also took pictures with their cell phones, allowing them to see tiny features when enlarged. They documented their observations and identifications in their journal entries, using a key supplied by the Outdoor School Instructor. After completing the data entry process, which involved identifying and counting the organisms, they discussed their findings. They shared the characteristics that define a healthy pond with the Outdoor School Instructor and compared the results with their initial hypothesis. Finally, they discussed adaptations of the activities for different age groups and possible extensions including testing water pH and turbidity.

Before the PSTs returned to the university campus the following week, they wrote or recorded a reflection on their experience at Outdoor School. During the next class meeting on campus, the PSTs worked on creating a 5E lesson plan utilizing the Outdoor School experience in one of the Es of the lesson. In a follow-up discussion, PSTs brainstormed other local sites (including those on elementary campuses) that might be used for similar types of lessons. For their final paper of the course, they developed their philosophy of science teaching and used the Outdoor School lesson plan to demonstrate their philosophy in action.

Data Collection

Qualitative data were collected from three key sources: the pre-assessment, which was the PSTs' Personal Science and STEM Beliefs Assignment, and two post-assessments, including the written or video reflections and their final philosophy essays. Participants were assigned numbers to replace their names, and all assignment documents and transcripts were numbered to align pre- and post-data.

Personal Science and STEM Beliefs Assignment (Pre-assessment). Before the Outdoor School experience, participants completed a written assignment to articulate the PSTs' existing beliefs about science teaching and learning and how they planned to incorporate various approaches. This pre-assessment provided a baseline for understanding participants' initial perceptions. Figure 2 illustrates the prompt for the pre-assessment.

Written or Video Reflections (Post-assessment). Immediately following the Outdoor School activity, participants were given two options: a) a written reflection or b) a video reflection. These reflections captured the PSTs' immediate reactions and insights about how the experience influenced their perceptions of science education and highlighted key takeaways. These reflections assessed how participants' views on teaching approaches and place-based education had evolved during the outdoor activities. This assignment played a key role in their experiential learning, fulfilling the reflection portion of the cycle. See Figure 3 for the reflection prompt.

Final Science Teaching Philosophy Essays (Post-assessment). At the end of the course, participants submitted a comprehensive essay outlining their science teaching philosophy. They incorporated their understanding of science teaching, inquiry-based methods, and the integration of place-based learning, particularly from their experiences at Outdoor School. These essays were crucial for understanding their teaching orientations and how they intended to apply the skills and knowledge from the outdoor learning experience to their broader science teaching practices. This assignment prompt is included as Appendix A.

Figure 2

Personal Science and STEM Beliefs Assignment Prompt.

Personal Science and STEM Beliefs Assignment

This assignment is designed to explore the factors impacting your views of science and science education. Share your experiences and address the following:

1. What do you recognize as the beliefs, ideas, and attitudes about science that you bring into this course and that you will potentially bring into your elementary classroom?

2. What were your previous science courses? How did you choose those courses? How did you feel about those courses? How did the courses influence your beliefs, ideas, and attitudes? How do you feel the courses prepared you to teach science to elementary students?

3. How have other experiences (other than science courses and teachers) impacted your beliefs, ideas, and attitudes about science and STEM?

4. Did your family impact your beliefs about science? Explain.

1-2 pages, double-spaced, size 12 font, 1" margins

Figure 3

Outdoor School Reflection Prompt

Outdoor School Reflection Please reflect on your experience visiting Outdoor School. You may type or record your reflection as a video. However, make sure to address each question fully. 1. What did you learn that you didn't know before? 2. How could this impact the way you would teach science? 3. What were the benefits of visiting Outdoor School? 4. How could the instructor improve the experience in the future?

Data Analysis Procedure

Part 1

Inductive Analysis. The data analysis followed a multi-step process, first utilizing an inductive approach to understand how the immersive, place-based experience shaped participants' beliefs and orientations toward science teaching. The analysis began with a detailed review of the Personal Science and STEM Beliefs Assignment. A line-by-line open coding process was employed, highlighting key phrases related to science teaching practices and place-based education (Saldaña, 2015). Initial codes were developed to capture the essence of the participants' statements. The codes were grouped to form initial themes based on their commonalities. The themes were further refined to better represent the data. Similar themes were merged while overarching patterns were identified (Clarke et al., 2015). It is important to note that real-world, informal, and place-based approaches were included in the initial themes but later categorized within the final theme of inquiry-based approach because each was originally mentioned in conjunction with inquiry-type methods. Table 1 shows examples of initial codes from the "pre" assignment along with the themes that developed for initial beliefs and orientations toward science teaching.

Table 1

Initial Beliefs/Orientations Codes and Themes

Example Codes	Initial Themes	Final Themes
Hands-on, experiments, real life, investigate, explore, inquiry, observations, explanations, ask questions, discuss, test hypotheses, collect data, field trips, real-life examples, science all around us, museums, planetarium, observational projects, curious about the world	Hands-on, place-based, inquiry, informal learning, exploration, experimentation	Inquiry-based approach

Facts, know content, focus on content, standards, objectives, knowledge, given facts, experiments frighten and deter me, explain, facts and equations, science knowledge, concerned about how to implement experiments, not enough time to teach science, cost of materials, I will show interest, ask questions and find answers	Fact-based, teacher-guided, science concepts, limitations to inquiry, standards and objectives	Traditional approach

Part 2

Deductive and Inductive Analyses. This analysis section began with a detailed review of the written and video reflections and final philosophy essays (post-experience data). Using a line-by-line open coding process (Saldaña, 2015), key expressions and statements related to science teaching practices and place-based education were highlighted. This part of the analysis served a two-fold purpose. First, the codes were deductively grouped according to the themes derived from the inductive analysis in Part 1 (Traditional or Inquiry-based). The second step involved an inductive analysis process to identify patterns in participants' perceptions of science teaching after engaging in immersive inquiry and place-based science activities. This portion of the analysis provided insights into developing additional themes which were merged into three overarching themes.

Categorizing Participants' Changes. Each participant's pre-assessment, Outdoor School reflections, and final essays were compared to determine any changes in their orientations and beliefs. The themes from the inductive analysis were used for this deductive step in the process. This portion of the analysis involved identifying instances where participants explicitly expressed support for or reservations about inquiry- or place-based learning after their Outdoor School experience. Instances of support for more traditional, fact-based or objective-based methods were also identified. To better understand how the experience influenced their beliefs, the following categories were used to characterize changes:

- Reinforced Beliefs: Participants whose beliefs about science teaching remained consistent following the Outdoor School experience, regardless of the approach they favored.
- Expanded Beliefs: Participants whose initial beliefs grew or expanded to encompass a broader understanding of the preferred science teaching approach following the Outdoor School experience.
- Shifted Beliefs: Participants whose initial beliefs about science teaching changed following the Outdoor School experience.

Within each category, two subcategories were defined:

- *Valued Inquiry Learning*: Participants whose beliefs were reinforced, expanded, or shifted in a positive manner towards inquiry learning.
- *Did Not Value Inquiry*: Participants whose beliefs were reinforced, expanded, or shifted in a negative manner towards inquiry learning.

Frequencies were utilized to quantify changes in the PSTs' beliefs and orientations toward science teaching methods. The number of participants in each category and subcategory was determined and used to better demonstrate the impact of the experience across the groups.

Emerging Patterns of Participants' Perceptions. The inductive portion of the "Part 2" analysis began with the pre-coded post assessment data. As in the "Part 1" analysis, the codes were grouped to form initial themes based on their commonalities, and similar themes were merged while overarching patterns were identified (Clarke et al., 2015). Table 2 shows examples of initial codes from the "post" assignments along with the themes that developed for participants' perceptions of science teaching after engaging in immersive inquiry and place-based science activities. To ensure trustworthiness in the study, researchers utilized triangulation and member checking. Multiple data sources were used to verify findings including two narrative documents for post data. Additionally, preliminary findings were shared among all researchers for their feedback and verification.

Table 2

Final Beliefs/Orientations Codes and Themes

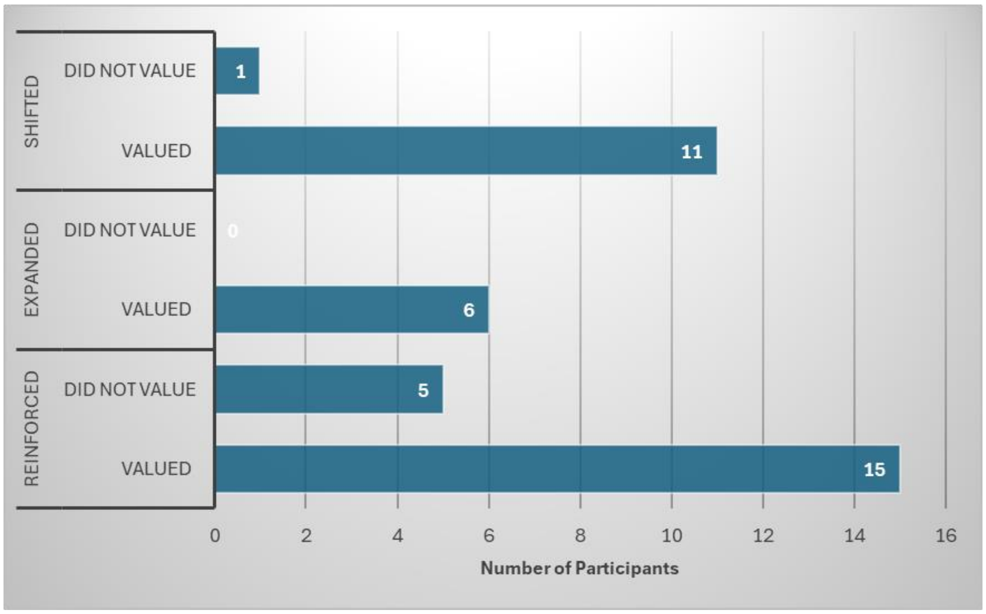
Example Codes	**Initial Themes**	**Final Themes**
Hands on exploring, 5e lesson, student-driven learning, experience, do the work, inquiry-based learning, inquiry-based lessons, authentic hands-on experiences, experiments, test hypothesis, student-led, make discoveries, hands-on activities	Hands-on learning, active learning, scientific practices	Hands-On Engagement
Caring for the environment, enjoy nature's beauty, local activities, outside the classroom, teach science anywhere, real-world observations and investigations, out in the wilderness, immersing them in nature, a different environment, a personal connection, real-life scenarios	Real-world connection, meaningful learning experiences, environmental literacy	Contextual Relevance
Collaborating with my peers, group work, seeing classmates engaged, seeing classmates' interactions and different things that they learned, collaborating with everybody, roles can be important, collaborating, seeing classmates curious, communication, sharing observations, discussing outcomes with classmates, fostering a sense of community, shared discovery	Collaboration, social learning, peer-supported learning	Integrating Collaboration in Learning

Results

Significant insights were offered into how the Outdoor School experience shaped PSTs' perceptions of inquiry learning. The data findings regarding the first question, "How does an inquiry-based outdoor experience influence PSTs' science teaching orientations?" were organized into three categories: reinforced beliefs, expanded beliefs, and shifted beliefs. These categories were further divided into subcategories based on whether participants valued or did not value inquiry-based learning. Figure 4 illustrates the frequencies for the categories.

Figure 4

Changes in Beliefs and Orientations toward Inquiry Learning



Reinforced Beliefs. The largest group of 15 participants held positive views on inquiry-based learning before the Outdoor School experience, and their beliefs were reinforced. These participants saw the outdoor learning experience as confirmation of their existing belief that hands-on, real-world interactions are vital for effective science teaching. They often mentioned how observing science in a natural context strengthened their understanding of its relevance and engagement. For example, one participant noted, "Seeing science happen in a real-world setting, like the pond study, validated my approach to making learning hands-on for my students."

A smaller group of five participants maintained their prior skepticism or indifference towards inquiry and/or place-based learning. Even after the immersive experience, they did not demonstrate an observable change in their preference for more traditional, classroom-based teaching methods. Though, their reflections often highlighted logistical concerns or doubts about how outdoor learning could be seamlessly integrated into the curriculum. For example, one participant stated, "I think I would modify the activity and have the bugs picked out and let the students observe them in the classroom. That would be a better way to let them interact with nature but get through the curriculum."

Expanded Beliefs. A group of six participants held positive views of inquiry and/or place-based learning before the field experience, and their beliefs were subsequently deepened and expanded. They gained new insights into how they could apply inquiry approaches to various aspects of science teaching. They expressed increased confidence in facilitating inquiry-based activities and emphasized the benefits of integrating local environmental contexts into their teaching. For example, a participant reflected, "The Outdoor School experience showed me how to teach complex topics like ecosystems through local, hands-on activities, which I hadn't fully considered before. I think being outdoors and experiencing nature and seeing firsthand exactly what we were talking about will change the way I teach science." It is essential to note that no participants initially fell under the subcategory of not valuing inquiry learning, then expanding their beliefs in a negative direction.

Shifted Beliefs A substantial group of 11 participants experienced a shift in their orientations, moving from uncertainty or skepticism to a strong appreciation for inquiry learning. These participants had prior reservations but found the outdoor activities to be eye-opening. They recognized the impact of engaging with hands-on, inquiry-based activities and were inspired to adopt similar methods in their teaching practices. For example, one participant stated, "Initially, I wasn't sure how effective outdoor learning could be but seeing my classmates so engaged and curious during the pond study completely changed my perspective." One participant indicated a slight shift but did not fully embrace the idea of inquiry learning in an outdoor setting. They acknowledged some benefits of the approach but remained hesitant due to the perceived barriers. This participant fell under the subcategory of "did not value." Table 3 shows examples of quotes and the represented orientations of participants following the experience at Outdoor School.

Table 3

Participant Orientation Quotes Following Outdoor School Experience

Initial Belief and Orientation	**Change**	**Quote (Post)**
Inquiry-Based	Reinforced	This experience just reinforced the importance of hands-on activities or engaging activities to support learning. It didn't feel like I was learning, but I was.
Inquiry-Based	Expanded	I always like hands-on exploring whenever I do science lessons, but I really like the way we learned. It put into perspective how a 5e lesson could fully be used.
Inquiry-Based	Expanded	It raises the value of a 5E lesson. I do believe that I now have a better understanding of how to not only teach students scientific concepts but also help develop important skills that will serve them well beyond the classroom.
Traditional	Shifted	I realized being at Outdoor School that being able to observe allowed me to see more of the organism's habitat and be able to describe it in detail. The way I will teach science will be having students do a lot of hands-on activities
Traditional	Shifted	I really enjoyed it because it got us out of the classroom, and I learned better out of the classroom
Traditional	Shifted	I learned that you could use the outdoors while teaching curriculum. I never knew how well that it would connect the students to the real world of science until we attended Outdoor School.

Traditional	Reinforced	I did not want to touch anything at all. Some students might feel the same way. I would modify the activity.

Three themes emerged from the inductive analysis of the data responding to the second question, "What patterns emerge in PSTs' perceptions of science teaching through their engagement in place-based education activities?" This experience underscored the value of hands-on engagement, contextual relevance, and integrating collaboration into learning.

Hands-On Engagement. This theme centers on students' engagement in hands-on activities and how these experiences deepen their understanding of scientific concepts, such as observing ecosystems~~,~~ identifying organisms~~,~~ ~~and~~ recognizing the benefits of tangible, interactive experiences in enhancing student engagement. Additionally, this theme emphasizes the significance of hands-on interaction with scientific phenomena. Participants valued how these activities sparked excitement and curiosity, which they saw crucial to introduce into their classrooms. One participant highlighted the difference that hands-on, sensory experiences make for students, suggesting that seeing and touching scientific concepts in action made the learning more impactful, "It's different when they can see and touch it themselves."

Contextual Relevance. This theme connects science to students' local environments and everyday experiences. Participants believed that science instruction becomes more powerful when students see how it applies to their lives, communities, and surroundings. Many highlighted that science is more than just abstract knowledge; it's something students can relate to and engage with in their communities. One participant suggested that teaching in local settings can make scientific concepts feel more real and relevant to students, thereby fostering a stronger connection to the content. "I want to teach my students about ecosystems using places they know, like local parks or lakes, because it makes the learning feel real."

Integrating Collaboration in Learning. The collaborative nature of the outdoor activities stood out prominently for many pre-service teachers. They noted the desire to adopt similar approaches in their classrooms, enabling students to work together during activities. The experience highlighted the benefits of teamwork, problem-solving, and collective learning, which participants plan to incorporate into their instructional strategies. One participant stressed the value of working with others and how that can extend from the classroom to the community: "The collaborative aspect of sharing observations and discussing outcomes with classmates added depth to the learning process, fostering a sense of community and shared discovery."

The three themes illustrate how the experience at Outdoor School reshaped pre-service teachers' perspectives on place-based inquiry science education. The instructional approach underscored the value of hands-on engagement, made science relevant through local contexts, and integrated collaboration into learning. Table 4 shows examples of quotes and the represented patterns emerging in PST's orientations following the experience at Outdoor School. These findings reveal that pre-service teachers view place-based inquiry learning as a powerful method for making science education more engaging, relatable, and effective.

Table 4

Patterns Emerging in PST's Orientations Following Outdoor School Experience

Theme	Example Quotes (Post)
Hands-On Engagement	I always like hands-on exploring whenever I do science lessons, but I really like the way we learned. It put into perspective how a 5e lesson could fully be used. Being there and doing the assignment firsthand brought it to life and I was allowed to use all senses to understand the content of the assignment better. Because this is a student-led activity, I must allow students the chance to make their own discoveries first. We got to really get dirty and do the work ourselves and not just look at data that we've seen on the screen or a paper that we got passed out.
Contextual Relevance	The Outdoor School experience showed me how I can teach complex topics like ecosystems through local, hands-on activities, which is something I hadn't fully considered before. I feel like it's better to teach kids with real-life scenarios and show them things that in real life they would see. I loved how we got to learn in a different environment than a classroom. Gaining that experience, I now have a personal connection.
Integrating Collaboration in Learning	Collaborating with my peers during the pond study made me think about how I can use group work to teach science concepts more effectively. I also got to see my classmates' interactions and different things that they learned and things that they saw. The collaborative aspect of sharing observations and discussing outcomes with classmates added depth to the learning process, fostering a sense of community and shared discovery. I think that was really cool, just being able to collaborate with everybody.

Discussion

Findings in this study suggest that the inquiry- and place-based science learning experience reshaped the PSTs' teaching orientations and perceptions of science instructional practices. Most participants valued the tangible experiences and knowledge gained. Their interactions with outdoor learning and the activities provided an in-depth understanding of the scientific concepts and enhanced their passion for science teaching. Frequency data showed that the experience at Outdoor School greatly impacted the PSTs' teaching beliefs and orientations with many participants expanding or shifting their views in favor of more inquiry-based teaching methods. Although many began with positive attitudes toward inquiry, they deepened their understanding and appreciation for the approach through this process, and their reflections highlighted their beliefs, which they applied to their lesson plans. These findings support the previous research that traditional beliefs are reshaped through experiential learning methods and prepare teachers to implement innovative active learning strategies (Buehl & Beck, 2014; Lebak, 2015; Loughran, 2013).

For those participants who remained unmoved towards more inquiry methods, the outdoor location may have been a deterring factor. One participant stated, "But I don't know if I would take a group of second graders out into a pond, because that would be scary." Another participant shared, "I am not really an outdoor person. It was fun being there with my classmates, but I did not want to touch anything at all." Thus, a different type of outdoor setting for an immersive experience could have been more effective in shifting their orientations. Preference for and comfort level with the content and context may have played a role in their lack of enthusiasm for the experience. These results support existing literature findings that dynamic experiences during teacher preparation encourage significant innovations in curriculum and practice (Girvan et al., 2016; Lee, 2019a). Using a familiar location, such as Outdoor School, the PSTs appreciated how science can be engaging in a meaningful and relevant way and provide accessibility to all students, thereby promoting a more profound sense of connection.

Additionally, the findings showed the effectiveness of place-based education and its benefits for bridging the gap between school science and local environments and communities along with increasing the engagement of students in the learning process. Several participants emphasized the importance of the local environment and community resulting from the pond study activity. They used phrases such as "environmental stewardship," "informed citizenship," and the "beauty of nature." Several more participants highlighted increased engagement during the outdoor experience. For example, they included the phrases "engage in real-world observations and investigations," and "engage with what they are learning." These findings mirror previous research suggesting the most significant benefit of place-based education is the engagement fostered among students (Yemini et al., 2023).

While many participants shifted towards more inquiry and place-based orientations, a few expressed hesitancies due to perceived barriers such as classroom control or curriculum demands. Their reflections highlighted logistical concerns about how integrating outdoor learning could hamper structured curriculum. Some voiced safety concerns for younger students, while others discussed time constraints and the lack of opportunities in various districts. These worries are not new to science educators. Many veteran teachers in science classrooms have voiced similar reservations about implementing these types of innovative practices (Fitzgerald et al., 2017). To begin addressing these issues, teacher education programs must offer appropriate guidelines for managing and aligning outdoor activities with curriculum standards and provide proper tools for developing PSTs' confidence and self-efficacy with inquiry strategies.

Implications and Limitations

Despite the benefits of inquiry-based approaches, traditional beliefs can be deeply rooted and difficult to change. Many PSTs have pre-formed notions and established beliefs about teaching and learning before entering teacher preparation programs. These beliefs are shaped by their educational experiences and limit their openness to adopting new ideas or reform-based practices (Buehl & Beck, 2014). The findings in this study suggest that teacher education programs should incorporate experiential learning opportunities that expose future educators to hands-on, collaborative, and contextually relevant teaching strategies, which can transform their instructional philosophies and enable them to create more dynamic, inquiry-driven, and student-centered learning environments. Although prior studies have shown that PSTs are more likely to shift from traditional to inquiry-based orientations when they engage in experiential learning and innovative instructional methods (Demirdöğen & Uzuntiryaki-Kondakçı, 2016), this study takes a novel approach by examining these shifts through a lens of "place." Furthermore, these researchers suggest that teacher education programs must move beyond traditional brick-and-mortar settings to create more relevant contexts and environments that broaden PSTs' existing beliefs and encourage conceptual change. Doing so will prepare future educators to design and implement innovative instructional activities in formal and informal settings.

Traditional beliefs may also be engrained in early-career and veteran science teachers who are resistant to inquiry methods of instruction. These teachers might experience systematic barriers and misunderstandings about the nature of inquiry itself (Morris, 2024, 2025). Educational researchers should investigate how these kinds of programs could be structured and implemented to benefit teachers and ultimately, the learning outcomes for students. School districts might then seek experiential learning opportunities that expose science educators to similar hands-on, collaborative, and contextually relevant professional development and induction programs. These platforms could promote more inquiry-based and student-led settings for future K-12 science instruction.

Although the results indicated the experience at Outdoor School impacted PSTs' orientations toward more innovative teaching approaches, some limitations existed in the study. First, with only 38 preservice teachers, the sample size may not be representative of the larger population of future science teachers. The study size and the qualitative nature of the data do not support generalizing the findings to all preservice science teachers. Second, the scope of the place-based experience was limited to ponds in one rural community. These findings may not fully capture the scope of potential benefits and challenges of place-based learning in a broader context or be applicable to place-based learning in other settings. Third, many of the participants described shifted, expanded, or reinforced orientations toward more hands-on and inquiry-based learning; however, the data do not necessarily indicate their level of scientific inquiry literacy. More research is needed to determine if the changes in orientations lend themselves to actual increases in inquiry practices.

Conclusion

As science education reform continues to advocate for more active and authentic learning experiences, this research affirms that equipping future teachers with tools to integrate hands-on, collaborative, and locally relevant activities can lead to more dynamic and effective science instruction. This study illustrates how informal learning can profoundly shape PSTs' perceptions and orientations to teaching science. The immersive and contextual learning experiences used in this course gave participants the ability to engage directly with scientific concepts. Many of the PSTs who participated in this course found the experience more impactful than traditional, classroom-based approaches which enabled them to shift from their previously held notions. The study showed how using such a template, teacher education programs can purposefully incorporate and present learning opportunities that embrace the duality of integrating formal and informal learning.

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Appendix A

<u>Personal Science Education Philosophy</u>

An educational philosophy offers a basis for clarifying the purpose(s) of education, and, specific to science, a science education philosophy clarifies the purpose(s) of science education. Zinn (1991) determined that all those involved in the business of education, including teachers, administrators, and college professors, should not address any educational issue "without some underlying purposes, even if the purpose is not explicitly articulated" (p. 39). While many major decisions about the purposes and direction of education are made at the national, state, or school district level, there is still an element of choice for individual teachers when it comes to such things as what to emphasize when teaching, what to downplay or avoid, what materials to use, and how to assess learning. Many determinations of these factors can be resolved, in part, through a teacher's personal philosophy of education, and, when making determinations specific to science content, science materials, and science assessment, determinations can be made through a teacher's personal science education philosophy. Therefore, the purpose of this assignment is to allow you the time and parameters for articulating your personal science education philosophy so that you may use this philosophy as a basis for making well-founded decisions in your science classroom.

Utilizing all the knowledge you have gleaned through your science course discussions, activities, readings, assignments, and experiences, you need to address and answer the following questions within your personal science education philosophy:

- What is the purpose of science education?
- What content should be addressed in a science classroom?
- What instructional practices/approaches should be utilized in a science classroom?

- What is the teacher's role in a science classroom?
- What is the role of students in a science classroom?
- What types of materials should be utilized in a science classroom?
- How should science understanding be assessed?
- How does a teaching for understanding perspective influence your science education philosophy?

To represent your views on science instruction in the classroom, use the Outdoor School activity as the basis for an example of how you could use that type of activity in your classroom to teach according to your philosophy.

- What TEKS would be appropriate for this activity? Explain
- How could you incorporate it within the 5E structure of inquiry? Provide details.
- Reflect on your experience and the content you learned as you describe your activity.

Your philosophy should be at least **3** double spaced pages in length and no more than **5** double spaced pages, and you are to give explanation in support of your philosophical beliefs and ideas. The Outdoor School portion may include diagrams, tables, lists, or other visuals and should be between 1 and 2 pages. **<u>Thus, your total project/paper should be between 4 and 7 pages.</u>**

Upload your paper on Canvas by the date/time of the final. If you have any questions, please don't hesitate to contact me.

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