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An examination of educators' approaches and strategies when facilitating field study science observations

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ABSTRACT

The untapped potential of field study science is not being fully recognized or explored within the United States despite the recorded benefits of outdoor learning within K-12 settings. This research study contributes to the broader understanding of the affordances of field study science as an essential component of science education by investigating the approaches teachers adopt when facilitating scientific observations in an outdoor setting as well as specific strategies that support implementation. Engaging in qualitative content analysis allowed us to consider the descriptive concepts represented within K-12 teachers' narratives as we determined patterns within the transcript documents. Seven themes were developed from the analysis of participants' interviews, highlighting teachers' approaches and specific strategies for supporting students as they participated in field study science observations. Understanding these effective practices can shed light on both the theoretical and practical ways that teachers can implement outdoor science observations within a formal school setting.

Keywords: field study science, outdoor learning, nature observations, NGSS, nature journaling

INTRODUCTION

The current generation of children and youth is lacking regular and meaningful experiences in outdoor environments, resulting in an absence of kinship with nature as well as a depleting sense of care towards the natural world (Chawla, 2020; DeVille et al., 2021; Louv, 2005).

In order for students to be ready to counter the global problems facing us today, they must have a strong understanding of the natural world and their more-than-human neighbors (Pyle, 2008). The dearth of nature-based experiences and the lagging biological literacy within the United States is caused, in part, by the overall scarcity of field study science opportunities available to K-12 students (Entress, 2022).

School settings, particularly science classrooms, can provide avenues for children and youth to have regular outdoor engagements centered around inquiry. Nature-based observations are a powerful way to support students as scientists while simultaneously affording the much-needed outdoor time that students need (Bollich, 2023). This has the potential to be mutually beneficial, as educators can facilitate genuine, student-driven observations within the framework of field study science.

Educators face an existing tension between following the next generation science standards (NGSS) while simultaneously maximizing opportunities for student scientists to have sustained time in nature (Merritt & Bowers, 2020). This untapped potential of field study science is not being fully recognized or explored within the United States' current science education approach (Entress, 2022). If we desire for science education to be inclusive, then we must broaden our conceptualization of school science and begin to incorporate student funds of knowledge relating to the outdoors and ecology (Stapleton & Reif, 2022). Within a place-based framework, empowering and accessing student funds of knowledge pertaining to an area's natural resources can effectively complement field study science (Entress, 2022).

NGSS framework for science often undervalues the emotive and relegates students to the role of compliant technicians (Stroupe & Carlone, 2022). In order to empower a generation of young scientists who skillfully approach science learning with joy and wonder, let us consider not only *what* and *how* we're teaching, but also *where* we're providing science learning opportunities (Stapleton & Reif, 2022). This research study seeks to contribute to broader understanding of affordances of field study science as an essential component of science education by investigating the approaches teachers adopt when facilitating scientific observations in an outdoor setting as well as specific strategies that support implementation.

LITERATURE REVIEW

In reviewing the existing literature, we considered the greater framework into which we situate this study, including prior knowledge related to field study science and its rich history grounded in the nature study movement. We also describe the literature on observation skills, paying close attention to nature journaling as one pedagogical approach. Finally, we make connections to NGSS, embracing the current discourse within the science education community that critiques NGSS as missing opportunities to offer field study experiences or nature-based observations in general.

Field Study Science

Field science involves the collection and investigation of ecological data outside of the traditional laboratory setting (Boumans, 2015). At the turn of the 20th century, field science was prevalent within the American education system since the science curriculum consisted of anything that could be observed and questioned within the natural world (Eick, 2012; McComas, 2008). Commonly referred to as *nature study,* this movement blended science with spirit, approaching learning from a holistic perspective in a way that closely aligned with the progressive education movement (Johnson, 2013). Nature study played an essential role in pushing science learning into the public-school classroom (Kohlstedt, 2010) as it became apparent that even young children could methodically study the natural world around them, including flora, fauna, and nonliving components of an ecosystem (Kass, 2018). The idea that students might participate in scientific exploration by studying the natural environment fostered an understanding of the aesthetic aspect of observing nature and the inherent beauty of field science observations (Kass, 2018). In today's literature, the term *field study* or *field study science* is commonly used to refer to the discipline of field science and its accompanying common practice of nature study. For this reason, we will continue to use *field study* or *field study science* interchangeably but implore the reader to keep in mind this construct is inclusive of the historical field science and nature study movements.

As time progressed, field study within the United States ebbed and flowed alongside historical events on a global level. There was declining interest during the two world wars, and then a resurgence alongside Rachel Carson, her emphasis on wonder, and the subsequent environmental movement (op de Beeck, 2018). In 2005, Richard Louv's (Louv, 2005) book *Last child in the woods* renewed awareness about the significance of children spending time outdoors and the necessity for outdoor experiences to become a routine part of daily life. Research from the past twenty years highlights the myriad of benefits connected with outdoor learning and playing, including positive physical, cognitive, social, and emotional outcomes (Children & Nature Network, 2020; Kuo et al., 2019; Tillman et al., 2018). Since COVID-19, academic articles, practitioner magazines and blogs, and popular media indicate a newfound awareness for outdoor classrooms and nature-based learning (see for example Green Schoolyards America, 2023).

Although it goes by many names–outdoor learning, environmental education, nature study–there is a general consensus that it is good for students to have opportunities to learn outdoors, and that science can often be a suitable home for this type of learning. Historically, however, field scientists had to convince society that practicing science in the field was just as legitimate and valuable as science practiced in a laboratory (Stroupe & Carlone, 2022). Today, advocates of using field study science within K-12 education point out its ability to actively engage students and build observation skills from regular, sustained practice attending to a natural phenomenon (Bensusen, 2020; Bollich, 2023; Hu, 2022).

Observation Skills

The ability to observe natural phenomena accurately, thoroughly, and with detail is an essential skill for scientists (Ahtee et al., 2009). One could even argue that the act of observing is inherently foundational to science; it awakens student wonder to real-world phenomena and supports student-as-scientists as they make sense of the world (Merritt & Bowers, 2020). Opportunities to observe within a field science context provide students with foundational knowledge and skills when explicitly taught and connected to disciplinary concepts (Merritt & Bowers, 2020). Furthermore, observations can result in rich, authentic data to be analyzed, investigated, and incorporated into science learning.

In searching the literature for scholarly work involving field science observations, we found that most of the articles foregrounded the act of nature journaling. Nature journaling is not a new idea and has its roots in the historical field science movement previously mentioned. Interestingly, there is a greater number of articles in practitioner journals related to observation vis-à-vis nature journaling compared to empirical studies published in peer-reviewed academic journals (e.g., see Baird & Coy, 2020; Hobart, 2005; Rogers & Steele, 2014; Weekes, 2005).

Nature journaling requires paying close attention to detail and can develop student observation skills when explicitly incorporated into science instruction (Laws & Lygend, 2020; Shipp, 2017). Rogers and Steele (2014) suggest that nature journaling can serve as a potential method to support observations by employing teacher demonstration, group-wide exercises, the integration of diverse tools, and subsequent follow-up after observations. Because nature journaling encompasses both artistic and scientific aspects (McMillan & Willhelm, 2007), its holistic qualities–sensorial, cognitive, affective–play a key part in a student's development within the context of ecological systems (Hu, 2022).

While nature journaling represents just one possible support structure for conducting nature-based observations in field science, it holds a significant and enduring role in the history of the United States' education system and continues to be widely employed today. There is a lack of research that examines the affordances of other avenues to field study observations that teachers might employ. While there is still more to examine regarding the ideas, theory, and practice of nature journaling as a pedagogical method (Tsevreni, 2021), we acknowledge the need for empirical work that analyzes other approaches and strategies. This study aims to fill in this gap within the literature on facilitating student scientific observations within a field study setting.

Next Generation Science Standards Connection & Critique

Before NGSS were released in 2013, "making observations" was emphasized as part of the science processes the national science education standards included as a key part of scientific inquiry contextualized within content knowledge (National Research Council, 2000, p. 23). Prior to NGSS, Eick's (2012) proposed in his 2012 study that the outdoor environment offered a suitable backdrop for making observations in science learning because engaging in nature study contributes to meaningful science education experiences.

When NGSS emerged with the construct of three-dimensional learning, observation was (and still is not) explicitly included within the dimensions since it is perceived as an inherent part of doing science and understanding science (Laws & Lygren, 2020). Observation can be considered a component of *analyzing and interpreting data,* one of the science practices, since students use various tools to gather data about the natural world (see NGSS Lead States, 2013a). Observations can arise from some type of experience, and the associated data collection is a key component towards NGSS integration (Baird & Coy, 2020). Aside from the analysis and interpretation of data, there is also evidence that student observation can lead to wonder, curiosity questions, and scientific investigations when scaffolded appropriately by teachers (Dean & Gilbert, 2021).

Laws and Lygren's (2020) nature journaling text, intended as a guide for educators, makes many NGSS connections across all three dimensions of science learning and even includes possible phenomena on which to center observations grounded in nature journaling. The authors describe specific ways to scaffold nature journaling in the form of activities, which are referenced in the appendix in matrix form, connected to each of the individual disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs).

> We think that journaling can be an effective and simple way to achieve the core goals of NGSS–namely, engaging students directly with discovering knowledge themselves–and as naturalists, educators, and nature journalers, we find this development in mainstream education really exciting (Laws & Lygren, 2020, p. 238)

In stark contrast, a study by Merritt and Bowers (2020) critiques NGSS for missing an opportunity to incorporate observation-based ecology within the standards. They analyzed the extent to which students are encouraged to explore and investigate the natural world on their own, searching for evidence within the DCIs, SEPs, and CCCs. "Therefore, we must critically examine curricular frameworks to evaluate whether they explicitly require, or at least make space and time for students to hone their observation skills in the natural world as part of their learning process" (p. 620).

What Merritt and Bowers (2020) found was that there were minimal opportunities for students to use observation in a field science context as they participated in three-dimensional NGSS learning. For example, the performance expectation 1-LS1-2 states "read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive" (NGSS Lead States, 2013b). Although reading texts and media within science is an important skill, this particular performance expectation is rife with possibility for real-world authentic observation in a field science context. Merritt and Bower's (2020) study showed that only three out of 64 of the NGSS performance expectations in life sciences explicitly include observation; the authors concluded that observation-based ecology is not valued within the NGSS and thus hinders the development of observation skills in students.

The missed opportunity for the NGSS to include observation can be seen particularly at the secondary level in which concrete nature studies have been usurped by more abstract concepts at the molecular/cellular level or by constructs related to broad ecological knowledge (Bollich, 2023; Entress, 2022; Stapleton & Reif, 2022). Bollich (2023) criticizes the NGSS for removing the emphasis on individual organisms unless it relates to evolution, commenting on how secondary science students are missing the important in-between as they consider micro and macro systems. If students "are looking at the parts without seeing the whole or looking at the group without seeing the individual," they are not getting the full picture of the species, how it functions, and its role in the ecosystem (Bollich, 2023, p. 187).

Stroupe and Carlone (2022) echo the above concerns regarding the way the NGSS privileges laboratory science over field science and thus reinforces the idea that lab science carries more epistemic weight while simultaneously decontextualizing science knowledge and skills. Teaching science in the field can adopt a funds of knowledge approach that honors student ecological expertise (Stapleton & Reif, 2022). Placing equal prestige on field study science within the NGSS would "disrupt science teaching and learning" (Stroupe & Carlone, 2022, p. 898) rather than marginalizing students who do not fit into the NGSS' traditional lab-based standards (Stapleton & Reif, 2022). Recent reforms have stripped away opportunities for local, contextualized knowledge in favor of universal learning, therefore marginalizing observation-based approaches (Merritt & Bowers, 2020).

Despite the negative trends mentioned earlier, a growing number of teachers are becoming aware of the opportunities associated with place-based education. Place, as a "living laboratory" supports authentic learning about the students' own locale while providing opportunities for both meaningful learning and affective connections (Goodlad & Leonard, 2018, p. 150). Due to this fact, field study observations can be seen as a component of place-based education, as it combines observation of local natural phenomena with meaningful learning. Semken and García (2021) posit that, although the NGSS is overly generic and decontextualized, it can be compatible with place-based learning since educators have autonomy in how they implement NGSS and could potentially bundle using a place-based approach. Recent reforms have sought to engage students as capable and interested scientists, but perhaps the field of science education needs to reimagine what field science can offer in terms of knowledge production alongside joy, wonder, and discovery (Carsten-Conner et al., 2018; Stroupe & Carlone, 2022). Field study science pushes against the privileged view of laboratory science and offers an alternative way of knowledge production due to its situated nature (Stroupe & Carlone, 2022). Although field study science

appears to currently be an untapped field within NGSS, nature journaling and other nature-based observations offer promising possibilities for science educators to promote contextualized learning, environmental affinity, and holistic wellbeing.

METHODOLOGY

We approach this inquiry from an interpretivist paradigm, recognizing that there are multiple ways of understanding the world and that interpretations of reality are always context-bound (see Butler-Kisber, 2010; Merriam & Tisdell, 2016). The purpose of this study was not to generalize to the greater population, but to describe and make meaning from phenomena situated within our participants' experiences. The following research questions reflect our interpretivist paradigm as does the rest of our design specifics.

1. *What approaches do teachers use when facilitating field study observations?*
2. *What specific strategies do teachers employ when facilitating field study observations?*

Engaging in qualitative content analysis allowed us to consider the themes and concepts represented within the empirical material through an interpretivist approach, paying consideration to the underlying contexts (Hsieh & Shannon, 2005). Content analysis involves a systematic condensing of textual data into categories and is useful for determining patterns within a document (Mayring, 2010; Stemler, 2001)–in our case, the interview transcripts. We chose to utilize conventional content analysis with the aim of providing a qualitative description of the phenomena (Hsieh & Shannon, 2005). This involved delving into the nature of the data using words and examples, as recommended by Merriam and Tisdell (2016). Even though there are commonalities shared with grounded theory, the analysis differs as it does not seek to generate theory but relies more on descriptive outcomes (Drisko & Maschi, 2015). The goal of inquiry for this study was to describe the patterns seen within teacher facilitation of field science observations, which aligns with both the purposes of conventional qualitative content analysis as well as our interpretivist paradigm (see Drisko & Maschi, 2015).

Through content analysis, researchers interpret both the manifest–apparent and observable–qualities alongside contextual latent content (Saldaña & Omasta, 2018). It is an inductive approach that incorporates a variety of analytical techniques as written or visual data are condensed into categories for ease of analysis (Harwood & Garry, 2003), and then expanded upon during thematic interpretation (Saldaña & Omasta, 2018). Although it has its roots in quantitative inquiry, qualitative analysis is different from its (post)positivist counterpart that values measures and numbers over the words themselves (Merriam & Tisdell, 2016). Qualitative content analysis can be conducted within an interpretivist framework (see Drisko & Maschi, 2015), thus complementing our perception of reality as socially constructed and qualitative inquiry as the practice of making sense of phenomena with its associated constructed meanings (see Denzin et al., 2024).

Table 1. Study participants & grade

Participant pseudonym	Grade
Finn	11th & 12th
Melaina	9th
Danae	Kindergarten
Brita	Middle school
Esther	5th
Andrea	Kindergarten

Participants & Data Collection

Participants were selected through snowball sampling; we reached within our networks of friends and colleagues to find individuals who met the criteria of our study and who were available to participate (Coleman, 1958). Specifically, we were looking for teachers who were currently engaging in field study science within a US K-12 school to some capacity. Field study was conceptualized as doing science outdoors, collecting and analyzing ecological data in some shape or form (see Boumans, 2015). Although we could have continued soliciting participants through the snowball effect, we decided to focus on six teachers as part of our bounded case. This smaller sample size enabled us to narrow our field of concentration and ultimately gather a deeper knowledge of the manifest and latent meanings within the interview data.

Our purpose for the inquiry was not to generalize or create theory; it was to describe and understand the ways in which educators might structure observation within a field study context and how their students respond to these scaffolds. For this reason, we did not need a large sample size, merely a bounded case that included participants from a variety of settings. Patton (1990) used the term *information rich* to describe qualitative samples such as ours that are able to thoroughly explore the research question. The participants represented a range of school settings, geographical locations, and years of experience in field study science. **Table 1** displays the participants' pseudonyms and the grades they taught during the interview data collection.

In line with conventional content analysis, we conducted open-ended interviews in a semi-structured format. This approach was chosen because we did not come into the inquiry with any pre-existing theories, as highlighted by Hsieh and Shannon (2005). Using the online Zoom platform, we received verbal consent from our participants before recording the conversations, and then began using a *live interview* approach so we could change the direction of the interview as needed (see Saldaña & Omasta, 2018). The interview questions solicited descriptions of participant lived experiences so that we could explore both the manifest and latent content. Most of these questions centered around how our teacher participants structured outdoor learning experiences and how they perceived this to impact their students.

Design Specifics

Although we relied heavily on Drisko and Maschi (2016) in conceptualizing qualitative content analysis within our study, Saldaña and Omasta (2018) provided concrete analysis guides that were helpful in considering the actual step-by-step processes. We engaged in data analysis in two parts:

(1) condensing and
(2) expanding.

This aligns with other content analysis approaches evidenced in the literature (see Graneheim et al., 2017; Hsieh & Shannon, 2005).

Part one involved condensing the interview transcripts, which resulted in the textual content we analyzed. This process of condensation entailed thoroughly examining the data and enhancing its quality through the systematic organization, elimination, and refinement of information. This was done in order to highlight the key aspects of the subject matter, which predominantly revolved around the observations derived from field study, aligning with the primary focus of our research (see Huberman et al., 2020). We removed redundancies within the transcript as well as components that did not directly relate to the research questions (Saldaña & Omasta, 2018). We did not change participants' words, but merely reduced the text so that each interview focused solely on the phenomena of field study science and accompanying observations. The next step in part one involved identifying patterns in the data through codes. We engaged in *in vivo* coding, symbolizing and compacting data into salient words or phrases that captured the essence of that piece of data (see Saldaña & Omasta, 2018). The research team discussed these codes and placed them into categories. Throughout the entirety of part one, we embraced the messiness and complexity of the phenomenon, regularly engaging in reflexivity both personally and collaboratively.

Part two allowed us to expand upon the codes and reach for broader meanings beyond the participants' contexts. According to Saldaña and Omasta (2018), "a theme is an extended phrase or sentence that identifies and functions as a way to categorize a set of data into a topic that emerges from a pattern of ideas" (p. 230). Generating themes enabled us to expand our understanding of the individual categories into conceptual summations. To do so, we dialogued on the connections between categories and sought to transcend the individual transcribed narratives into broader meanings. We considered predictive statements–propositions–as well as influences and effects of observations within a field study context (see Saldaña & Omasta, 2018). These inferences ultimately led us towards transference as we reflected on broad theoretical constructs that holistically extended our themes while still capturing essence of the original transcript content.

Trustworthiness

When considering the trustworthiness of the findings, Elo et al. (2014) posit specific factors directly related to qualitative content analysis for researchers to consider. They suggest that scholars pay attention to issues of trustworthiness throughout each part of the research process, including preparation, data analysis, and the reporting of results (Elo et al., 2014). This matches up with Creswell and Miller's (2000) suggested approach to validity procedures based on our interpretivist paradigm; we spent sufficient time working with the empirical data, looking for disconfirming evidence, and presenting findings using thick and descriptive details. The responsibility is on *us*, the authors, in establishing that our study is trustworthy rather than merely on the reader (Cian, 2021). Specifically, we were aware that a common challenge of conventional content analysis is that researchers can often fail to develop key categories grounded on the understanding of the context (see Hsieh & Shannon, 2005). To mitigate this, we regularly returned to the full narratives to become immersed in the situated phenomenon as suggested by Drisko and Maschi (2015). Throughout the analysis process, we also reached out to participants via email with contextual follow-up questions or inquiries that sought to disconfirm our findings as suggested by numerous scholars as a component of trustworthiness in qualitative research (Cian, 2021; Creswell & Miller, 2000; Drisko & Maschi, 2015).

Table 2. Seven themes from content analysis of participant interviews

Theme no	Theme
Theme 1	Embracing their role as facilitator and advisor
Theme 2	Curating student agency
Theme 3	Prioritizing the whole student
Theme 4	Fostering a safe and supportive environment
Theme 5	Nurturing a learning community
Theme 6	Creating space for diverse learners
Theme 7	Aligning curriculum with real-world experiences

FINDINGS

There were seven key themes that emerged during the data analysis process after we coded, categorized, and then found broader meanings within the participants' interviews. Content analysis allowed us, as researchers, to interpret the manifest and latent content to generate these themes from the data (Saldaña & Omasta, 2018). **Table 2** displays the seven themes that answer our research questions, reposted below for reader reference:

1. *What approaches do teachers use when facilitating field science observations?*
2. *What specific strategies do teachers employ when facilitating field science observations?*

Embracing Their Role as Facilitator and Advisor

The most salient theme that emerged from the interview data was the idea that teachers embrace their role as both a facilitator of learning and an advisor of student scientists. This theme serves as an anchor for the following themes, grounding the ways in which our participants perceive field science observations within their approach. One of our semi-structured interview questions was *what is your role as a teacher during outdoor lessons?* Participants responded emphatically by describing their role as facilitator (Danae, Esther, and Andrea), guide-on-the-side (Finn), or as someone who helps students make connections (Brita). Melaina explained that she sees herself as a project manager who aids student scientists as they need it, which includes procuring necessary materials that they require to do their field science work.

Amongst our participants, a key component of teacher approaches to field study observations involves a perception of who they are as teachers and the part they play within science learning process. Although this manifests in different ways pertaining to grade level, learning objectives, and individual characteristics, participants facilitate scientific observations from an approach that embraces their role as one who coordinates learning experiences rather than controls them.

Specific Strategies

There were many specific strategies that our participants shared that correlate to this theme of a teacher's role, so we chose to highlight the most recurrent ones that our participants communicated. First and foremost, participants intentionally let students take the lead on field study investigations. They offer support throughout the initial launching of the project or experience, and then remain present as a resource-provider or advisor. As mentioned above, teachers incrementally take a step back throughout the year or the unit as students grow in self-confidence and overall skills. In his interview, Finn described how he structures the semester to support student field study observations.

> I'm still watching them even though they have that freedom. And I hate to be cliché, but it's like the guide on the side, you know, or sometimes not even on the side, but this slow release. It starts off with me talking and then by the end of the semester, I'm asking them what they want to do. Rather than me having any idea they're the ones that are taking ownership and advocating for what direction they'd like to go.

Finn begins with a more teacher-directed approach to field study science and then slowly hands over more agency to his students. Finn also explained how he provides feedback within student journals to support this gradual release process. As a facilitator and advisor, Finn sees his role as one to help students learn course material as well as other important social-emotional skills.

As a kindergarten teacher, Andrea's gradual release process looks a little different, but she uses similar strategies as our other participants when facilitating field science observations.

> We started with just observation and doing a lot of oral language as journaling. I would be writing or drawing things for them that they told me from observations. We then started adding some other things in, like symbolic drawings and even ways to show sound. They're different senses were represented. And now we've built up to the actual notebook that they take out. We'll start off with putting the date, the location, the weather, and the time. They know the kind of information to record before we head out to the nature study property, and then they'll sit and put in their discoveries, whatever it is that we're talking about. We share them and then later the students draw and write on their own.

This detailed description highlights the ways in which Andrea facilitates observation within a field science context. A key component of the success she has experienced with nature journaling with kindergarten students rests on this gradual release strategy grounded in Andrea's perception of her role as facilitator. Other participants described comparable teacher moves in which they begin the year with much more modeling and whole-group practice before gradually releasing students to be independent scientist-observers.

Curating Student Agency

Our participants worked towards empowering students as agents of their own learning experience. This was seen throughout the data as it relates to students as epistemic agents within the science knowledge production process (see Cavagnetto et al., 2020). Additionally, we found evidence that teachers encourage student voice and choice within their class community. Curating student agency is a key component of our participants' approach when considering field science observations.

The teachers within our study spoke of student agency within field science as manifested within the NGSS SEPs; in other words, students *doing what scientists do* as they investigate the world around them (Cherbow et al., 2020; Dean & Gilbert, 2021). According to Melaina, students-as-scientists is "the whole goal" throughout the year, and she hopes that her students take ownership within the ecological knowledge-building process. This component of Melaina's approach is echoed by other participants who shared ways in which they support students as leaders of scientific knowledge production. Oftentimes this is reflected in the ways that our participants created opportunities for students to authentically *do* science, using observations as a launching point for data collection, analysis, and communication.

When describing the role of her students, Esther explained that she expected them to "be curious, ask questions, contribute to the conversation, and make observations." Esther then went on to describe how these relate to successful science in the outdoors. In a similar vein, Danae stated, "I think that [students] should feel empowered to learn and to be a leader." These highlights from participant interviews point towards the approach that our science teachers use when facilitating observations within a field study context.

Specific strategies

Esther's specific strategy for empowering student agency was to create plenty of opportunities for her fifth-grade students to engage in authentic science. One investigation started with students observing goldenrod galls in the outdoor area surrounding the school and then brainstorming questions their observations had raised. Esther provided guidance in helping her students select a feasible question that they could pursue as a class using the scientific method.

> We can actually do something with it and investigate a question and get to the answer. We decided on: *Do birds prefer to eat the galls closer to bushes versus further away from bushes?* So some students counted the galls near the bushes and other students went far away from the bushes and counted the galls that had been pecked. As a teacher it was really fun to be able to do because I did not know what the answer would be!

Esther goes on to describe the ways in which her students were involved in the discovery process, which involved them taking ownership throughout the experimentation activity. The scientific question itself arose out of student observations of the goldenrod galls and then culminated in data analysis.

As a kindergarten teacher, Danae likes to give students specific choices regarding the ways in which they wanted to meet specific state standards. One of the NGSS performance expectations for kindergarten students is understanding building and engineering design. "And I said to them, we could do this with popsicle sticks and things like that in the classroom, or we could go outside. Which one would you prefer to do?" This simple question that Danae posed to her class highlights a key strategy that supports curating student agency: offering students-as-scientists the opportunity to contribute to the learning experience. Danae wanted her students to have a say in how they could approach an NGSS standard. Other participants used similar strategies by providing their students with plenty of choice as well as crafting opportunities for students to authentically collect data as scientists and enact science with agency.

Prioritizing the Whole Student

Within the interview transcripts, there is evidence to support the idea that educators perceive students as whole people and value them holistically beyond merely the cognitive domain. This finding reflects the ways in which our teachers approach field study science and the strategies they employ when implementing observation.

This component of our participants' approach to field study science was explicitly mentioned throughout the interviews, shedding light on the ways in which teachers consider the value of a holistic perspective. For example, in Finn's narrative, he shared about the social-emotional growth he witnessed within his students throughout the course of his semester-long field ecology class. "There was one student who was struggling with a lot of mental health stuff, especially anxiety towards school, and she noticed the absolute change in her perspective." Andrea also described the value of holistic skills in conjunction with field science observations, speaking to the ways in which outdoor learning supports the whole child: "You cannot measure that stuff with academics, but they've learned to help each other. And overcoming fears is definitely a big piece of it." In Brita's interview, she emphasized the importance of showing her students that being outside can make them feel better, acknowledging that middle schoolers need opportunities to discover how to support their own mental health.

Specific strategies

There is implicit evidence regarding the ways in which teachers enact their value of the whole student in concrete ways, particularly in the strategies that reflect their prioritization of a students' social, emotional, physical, and spiritual well-being. Our participants recognize the natural environment as more than just a location for field study science; they have firsthand experience of the positive outcomes nature has on their students. In addition, participants strive to incorporate outdoor learning experiences that go beyond academic achievement goals.

Danae's particular strategy involved embedding *critical skills* within their time spent outdoors.

> Coming off of the pandemic, I was noticing more than ever that students were having a hard time working cooperatively and functioning with those hard skills– which we used to call soft skills. And so one of the things that I started to do with the students early in the year was take them outside and give them different challenges to work on as a group.

Although not directly related to observations within a field study context, Danae's strategy of teaching critical skills outdoors supported her science learning and reflected the way in which she prioritized the whole student. These critical skill opportunities impacted student confidence and led towards a holistic development that positively impacted their role as scientists.

Another example is reflected in Melaina's description of how she connects social emotional principles with science standards, finding ways to incorporate a more holistic approach towards learning that positively impacts her students' science observation opportunities.

> I've taken from the social-emotional curriculum because I think it plays really nicely with science skills and some of the engineering practices in the NGSS. Like the senses one. I ask them to all be quiet, and we sit in a location, and I ask them to identify five different colors that they see, four different things they can hear, three things they can touch, two things they can smell. Then I just do one thing that you've never seen before. I was exposed to that through social-emotional awareness, and emotional regulation.

This strategy of Melaina's reflects her view of students as whole people and the way in which she incorporates a holistic approach into her field study science observations.

Fostering a Safe & Supportive Environment

Individuals throughout this study spoke to the importance and significance of fostering a safe and supportive environment within a field study setting. This included promoting a sense of comfort, trust, openness, resilience, and security within their classroom communities. When considering a safe and supportive environment, our participants were highly attuned to both the outdoor space itself - the physical place - as well as other components that constitute a learning environment, such as relationships, physical well-being, and psychological comfort. In order for students to be able to fully participate in field study observations, they need to feel safe in multiple dimensions and feel supported by their teachers and peers. Thus, a crucial aspect of fostering a safe and supportive learning environment is the notion of trust, closely connected to vulnerability, both which play a significant role in bringing students and teachers together. Our participants, such as Danae, often encouraged mistakes and created a safe space to do so. Finn also emphasizes cultivating trust as a way to foster a sense of safety and create a supportive environment for field study observations.

> I remember [a] student. She's like, "I'm not going in the woods." She did refuse, she wanted to refuse to leave the mowed grass. So she was open to being outside, but she had her boundary. But by the end of that semester,

> that same girl was barefoot and had mice run across her feet. I think it's that willingness to embrace discomfort. I think this is where trust comes in. If you do not have trust, kids are going to put up a wall, and it's going to be impossible to get through that wall. Also, I'm leading by example, I'm not asking the kids to do anything that I'm not doing so that I'm there with them, they know that I'm there being supported. You have to start by trusting your kids when taking them out. Building those relationships. That's the foundation of how you can make outdoor learning successful is empowering kids by building trust and relationships.

The willingness to embrace discomfort, as illustrated by the student initially reluctant to venture into the woods, underscores the transformative potential of trust in facilitating experiential learning. Our teachers worked to leverage trust in regard to personal relationships as well as the physical environment as a powerful tool in their efforts to foster a safe and supportive field study environment.

Specific strategies

When facilitating observations in a field study setting, educators use gradual release as a specific strategy to support students' feelings of holistic safety. "These [field science] experiences for them are new and you cannot expect them to know what to do. I wait until they're more comfortable." Brita articulates this idea of fostering safety and security with and for her students, going on to explain how she takes a gradual release approach to ensure that the class is comfortable and ready for greater field study experiences. Melaina also explained how she starts with a "low stakes" first lesson, letting her students acclimate and feel safe in the outdoor space.

> So I do have some students that are usually kind of hesitant, and I tell them like, "Hey, you can even just walk in, around the prairie. You do not even have to go into where the plots are." Some students, I think it's pushing their comfort zone a little bit, and I purposely do that lesson before - I have lots of lessons in the prairie - but I purposely do that one first as a really, really low stakes, just getting them kind of used to being out there.

Melaina sees the value in fostering a sense of safety and community in the outdoor environment before diving into field study experiences. Our participants understand that some students will be hesitant, and some will wholeheartedly engage from the beginning. Supporting students so they feel comfortable engaging in field study observations is an ongoing process that takes a nuanced approach and a sense of trust.

Nurturing a Learning Community

Teachers approach the facilitation of field study observations by nurturing community among students, teachers, and place. Our participants value the relational moments that occur during field study science, and regularly spoke of these during the interviews. Danae referred to "those shared experiences of creating community" when describing how her students truly bonded throughout the year during field study science and other outdoor learning activities. There is evidence of intentionality within our interview data, particularly as it relates to how our teachers nurture a learning community in conjunction to a sense of place. A sense of place involves the relationship between people and places (Sedawi, 2021) and was a key part of the formation of a cohesive learning community in field study science. The significance of personal interactions and experiences in place adds meaning to those locations for our participants and their students.

These learning communities that teachers nurture during field study science are often inclusive in nature, inspiring *all* students to participate with their peers. Brita described one specific student she worked with who struggled in a traditional school environment and was often placed in special programs. "In this case [of field study science], he can be part of community that he's not normally part of," Brita explained. She went on to describe how important it was to develop these field study science communities that are centered on relationships. "The kids bonded during that [extended] time outdoors even though it was not that different. They were doing something special outside together."

Specific strategies

To aid in nurturing a learning community, our teachers employ specific strategies related to field study observations as outlined in the data. One such strategy involved pivoting from individualized nature observations into shared experiences, allowing students to enter into others' perspectives. Esther starts her time with an opening circle, where she tells a story and grounds the outdoor learning experience as one whole group. After students have individual time to observe, either through Sit Spots, nature journaling, or a quiet reflection, they come back together as a class and "do a share out from the things they noticed." Esther also pointed out how she always closes outdoor time with a circle and usually a song.

Finn, who works with high school students, also nurtures a learning community by using shared experiences after field study science observations.

> We do a quick share out of experiences or observations, so kids are recognizing like, 'Oh, I heard a woodpecker' or, 'Oh, I heard that woodpecker too.' It gives them that opportunity to recognize that there might be something they missed.

Similar strategies were weaved throughout the collected transcribed interviews, some of which included purposeful exercises that emphasized *place* as part of the shared experience and learning community as well. By designing meaningful interactions and encounters within the field study science experiences, teachers were able to facilitate observations within a learning community, which included students, teachers, and place.

Creating Space for Diverse Learners

Our participants recognize that each of their students are unique individuals who come from a variety of backgrounds and experiences. As part of their approach, they see the value in creating space for diverse learners, not only within a field science context, but throughout the entire school day.

Throughout participant interviews, it was clear that these teachers understand the importance of the skills, knowledge, and life experiences that their students bring to the science classroom from cultural and familial backgrounds, a construct commonly referred to as funds of knowledge (Hogg, 2011). By incorporating a funds of knowledge mindset, our participants desettle the deficit mindset that has long been prevalent within today's educational system (Llopart & Esteban-Guitart, 2018).

The reflection of this theme was commonly woven through the participants' narratives when they were discussing how a field science approach supports students who might struggle with the traditional academics. "It allowed them to shine," Danae shared in reference to the opportunity for her diverse learners to practice a new set of skills in an outdoor setting. She explained that many of the students who excelled outdoors were ones who had lots of energy and needed to "let that out." Similarly, Brita acknowledged that her middle school students had specific needs that were supported by learning in an outdoor environment. At first glance, this particular theme appears further removed from our investigation into field science since it focuses more fully on the whole student, similar to theme 3. We see the value in highlighting this particular teacher approach, however, in that it incorporates student funds of knowledge into the learning process in a way that honors the person as a human being. Facilitating student observations within a field science context starts with the individual learner and creating space for their diverse backgrounds and skills.

Specific strategies

Although there were specific strategies evident in each of our participant interviews, it was Melaina who was explicit in the way that she intentionally solicits student knowledge or skills as it relates to field science observations. When pointing out specific plants for her students to notice, Melaina often provides opportunities for her students to teach their peers using their funds of knowledge. She explains how enjoyable this is to her, as a teacher, and recounts a recent occurrence involving milkweed and monarchs.

> I had a student this year whose family works for Monarch Watch, which is a monarch butterfly advocacy organization. So she knows - sometimes I have kids that are like, "Oh, yeah, this is milkweed, and this is like–." They can identify some of the plants. It's really cool to have that moment to share with them, where we can kind of identify something together. I can be like, "Oh, I'm so glad you know that. Where did you learn to identify that plant?"

This specific strategy that Melaina uses foregrounds student knowledge and creates space for unique cultural or familial experiences that students in her class have experienced. Brita also spoke of a particular student she worked with who had some significant behavioral challenges, particularly in a traditional school setting. Brita made connecting with this student a priority and took an asset-based approach.

> He knew quite a bit because he spent a lot of time outside. That was another good thing - it gave him a chance to share what he knew. He knew things from hunting and from just being in the forest, you know. He had a chance to feel successful in knowing things.

Brita, like our other participants, used specific strategies that reflect her overall approach as it relates to meeting the needs of and supporting a class full of diverse learners. She found ways to incorporate the funds of knowledge her student had related to the outdoor environment.

Aligning Curriculum with Real-World Experiences

Throughout the study, participants emphasized the advantages of aligning curriculum within real-world field study experiences. Our teachers approached field study by finding ways to incorporate everyday phenomena, sometimes through a single lesson grounded in observation and other times through a series of lesson bundled within a project format. The evidence suggests that educators consider field study observations as part of a broader conceptualization of learning that is relevant and applicable. Finn explained how important this application component is to the learning experiences he designs for his students. "Students are applying something from class, taking what we're learning in traditional class, and we're looking at it now in the real world in real time."

As teachers align curriculum with real-world experiences, they often included an interdisciplinary approach to observations that incorporated subject matter beyond science. Place-based phenomena were frequently included during real-world observations as student scientists engaged in field study. Esther explains: "I like to take the science, the content and process that I want to do, and do it while we're outside, in a real-world setting. The kids are really curious. They're seeing these phenomena outside that it's very visceral."

This quote illustrates Esther's approach to curricular alignment, which was similar to our other participants; they utilized the schoolyard, community, public lands, and other special places as valuable resources as they taught state-mandated standards in a way that was relevant for their students.

Specific strategies

One specific strategy that our teachers employed was the way in which they used their schools' outdoor spaces while engaging students with real-world field study experiences. Melaina described how the prairie ecosystem in her Midwest state formed the starting point from which she could design meaningful field study lessons that cultivated real world observations and other learning. "So [the prairie] is a really rich place to pull in lots of those topics that we teach in the classroom, but then they can actually see out in real life."

Andrea describes a similar strategy in which she uses a Land Trust parcel that is within walking distance from her school. This easily accessible outdoor space becomes the laboratory for field study science and other interdisciplinary learning that aligns with the kindergarten curriculum.

> And I'm doing a lot of nature study–pure nature study there, which is great. There's things that we bring back and work that we do in the classroom. This past week we've been doing things on signs of spring. We went last week to actually do some mapping skills, so we went, and we took some mental pictures of the site, and they did some counting, stepping, and walking, getting some idea of space in place. And then we drew maps, they drew maps of the place. It really brought together a lot of different things besides our nature study work that we were doing. It had all of the mapping skills and geography and social study skills that we were working on. They were reading from the directions that I gave them for the treasure map. They were doing a lot of math with the counting and all kinds of numeric work with that as well. Spatial relationships. Lots of things together. Now they're writing their own treasure maps of the school field for their friends of the school field and our campus property that we have.

Esther's narrative points out how interdisciplinary learning can occur in a way that is relevant to students' day-to-day lives. Furthermore, Esther's specific strategy uses nature study (observations) as a starting point, and then builds upon this in a variety of ways that related to learning standards.

These strategies demonstrate the importance of aligning curriculum with real world experiences, with a focus on practical application towards field study science objectives. Teachers effectively utilize educational settings and local surroundings to promote student observation, integrate science practices, and make connections to the real world.

DISCUSSION

The goal of this research study was to investigate the approaches teachers adopt when facilitating field study science observations in an outdoor setting as well as specific strategies that support this implementation. By interviewing K-12 teachers who enact student science learning in a field study setting, we were able to shed light on both the theoretical and practical ways that teachers go about implementing observations in the field.

Reflecting back upon our research questions, we have effectively responded to both, acknowledging that the answers are complex and nuanced as evidenced through our presentation of seven themes. The themes described in the Findings were intentionally shared within a specific order, the interconnectedness of which is illustrated in **Figure 1**. *What approaches do teachers use when facilitating field science observations?* Our teachers' approach to facilitating field science observations is primarily rooted in their perception of themselves as facilitators and advisors (theme 1). Theme 1 serves as an anchor for the other themes, as educators who embrace their role during outdoor field study science contribute towards successful student observations. Theme 1 overlaps with theme 2 and theme 3, which are inextricably linked and provide additional considerations for our first research question. **Figure 1** highlights the connections

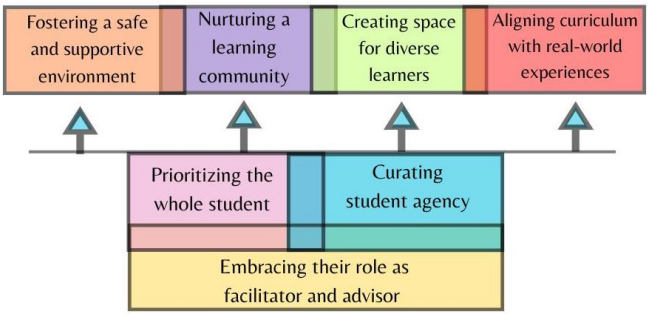

Figure 1. Themes representing key findings (Source: Authors' own elaboration)

between theme 1 through theme 3 through the overlap inherent within our findings. Curating student agency and prioritizing the whole student go hand-in-hand and lead towards transformative learning experiences on behalf of individual students as well as the whole learning community. This coincides with Pugh's (2020) suggestion to create opportunities for transformative experiences to facilitate meaningful school biology learning. Encounters with nature in a field study setting can "enable and encourage students to appreciate their world through the lens of science content, even outside of school" (Entress, 2022, p. 1740). Theme 2 and theme 3 in our findings agree with the idea that transformative experiences do not arise out of memorizing scientific facts, but from student-driven inquiry experiences with local flora and fauna within a field study context (Entress, 2022).

Theme 4 through theme 7 emerge out of the prior themes, as indicated by the arrows in **Figure 1**. This cluster of themes is more action-specific, surfacing out of the values that are so inherent to our participant's approach to field study science. Our findings agree with other literature that emphasizes the importance for students to feel safe within their learning environment (Thompson & Wheeler, 2008) as well as comfortable within a physical educational setting, such as the outdoors (Puteh et al., 2015). When students are part of a vibrant and safe learning community highlighted by trust, they are more likely to actively engage in the learning experiences. A key component of this trust involves mutual respect and minimized hierarchy between teacher and students' interpersonal relationships (Corrigan & Chapman, 2008). Furthermore, our participants intentionally create space for diverse learners, recognizing the funds of knowledge that their students possess. Incorporating student funds of knowledge relating to nature, ecology, and the outdoors can expand notions of school science (Stapleton & Reif, 2022). This can particularly be seen regarding the ways a place-based framework can value the diverse natural knowledge and experiences students have and what they can offer the learning community (Entress, 2022). By aligning curriculum with real-world experiences, participants connect NGSS with place-based, interdisciplinary, and relevant phenomena (see Reed & Klassen, 2020).

Laws and Lygren (2020) hint at the ways that the NGSS connect to nature journaling specifically, but our teachers demonstrated the ways they made even more connections. Whether it was Melaina's habit of embedding observation practices into both social emotional learning *and* science instruction or Andrea's approach of including symbols with

her kindergarten class, teachers demonstrated genuine creativity in how they aligned curriculum. This leads to our second research question–*What specific strategies do teachers employ when facilitating field science observations?* Describing all the strategies that our teacher participants used to implement field study observations is beyond the scope of this paper. We find it imperative to note that our teachers surprised and impressed us with their innovative approaches as they incorporated the NGSS, observations, and meaningful field study science into their daily lessons. Some of their specific strategies followed a place-based approach (Goodlad & Leonard, 2018), whereas others were grounded in phenomenon-based learning (Wakil et al., 2019).

These seven themes and their interconnections could be considered in different contexts other than field study science. We posit that our participants' approach to field study observations was grounded in their understanding of educational effective practices in general. Yes, these themes can perhaps be transferable to other disciplines or even laboratory science, but their specific connection to outdoor learning is inherent within the teacher narratives we collected. Applying these themes to field study science can provide valuable insight for scholars or educators seeking to foreground nature literacy and scientific observations within an outdoor setting.

Our research comes at an opportune time as we consider the role of field study observations within K-12 learning environments. Nature literacy used to be a desirable trait within the United States' K-12 system, but now it has been mostly forgotten, pushed aside in the face of other curricular concerns (Pyle, 2008). This is reflected in the marginalization of nature study and the overall lack of appreciation for place-based knowledge (Pyle, 2008). Field study should be planned and structured in such a way that maximizes effective practices. "Fieldwork, properly conceived, adequately planned, well taught and effectively followed up, offers learners opportunities to develop their knowledge and skills in ways that add value to their everyday experiences in the classroom" (Dillon et al., 2006, p. 1). Given the overall benefit of field study science and its associated components - nature literacy, place-based knowledge, etc. - we hope to contribute to the conversation regarding scientific observations, NGSS, and outdoor science experiences.

CONSIDERATIONS

The goal of this research study was to consider the approaches and specific strategies that teachers enact when engaging students with field study observations using detailed, rich depictions of our participants' experiences. The findings from a qualitative content analysis, particularly the conventional approach, can contribute to a conceptual understanding of a phenomenon but are limited in that they do not generate theory (see Hsieh & Shannon, 2005). Therefore, we suggest that other scholars build upon this work to develop a more nuanced understanding of observations within a field science context that can be applied to other situations. Our study included only six teachers, but their similar backgrounds coupled with our study's clearly defined objectives can increase our confidence in the data quantity and quality (see Hennink & Kaiser, 2022). Still, we recommend that future work include a greater number of participants' approaches and strategies when implementing field study science.

FINAL THOUGHTS

The lack of biological literacy within the United States is partly due to the shift of school biology classes away from field study science that centers around local living organisms (Entress, 2022). This study fills the gaps in empirical research by investigating the ways that certain teachers *do* foreground observations in a field study context, their approaches, and their specific strategies. It is unfortunate that school science is typically happening indoors, leading towards less real-world relevancy or authenticity connected to everyday scientific phenomena (Ayotte-Beaudet et al., 2017). School grounds have an untapped potential for contextualized science learning when considering their accessibility (Ayotte-Beaudet et al., 2017); understanding teachers' approaches and strategies can shed light on the ways that field study science can serve as an avenue for meaningful outdoor engagements centered around real-world observations.

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