MOUNT RAINIER INSTITUTE FIELD STUDY GUIDE

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ABSTRACT

Mount Rainier Institute (MRI) in Eatonville, Washington (WA) provides nature-based programming with a focus on science. These four-day three-night programs are delivered primarily to middle school students in the Mount Rainier region. However, due to the recent total implementation of Next Generation Science Standards (NGSS) MRI found themselves without a formally aligned curriculum for field studies. This along with requests from staff and perceived gaps in science education created a need for a Field Study Guide to be developed using a theoretical framework containing a learning cycle, NGSS, and best practices found in the current literature. The purpose of this project was to create a Field Study Guide with this theoretical framework to inform an experiential training for MRI staff.

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From where I started
to where I am today
to all those that helped me
along the way.

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CHAPTER 1.

INTRODUCTION

Mount Rainier Institute (MRI) is a residential environmental education center, a program of the University of Washington in partnership with Mount Rainier National Park (MORA). MRI's mission is to "provide outstanding nature-based education experiences that are rooted in science and nurture the next generation of environmental stewards and leaders" (Hayes & Wilson, 2016, p. 3). MRI is located at Pack Forest, a 3,400-acre working forest owned by the University of Washington in Eatonville, Washington. Pack Forest is a multi-use facility as it houses not just MRI, but also active research, timber harvests, and a retreat center. The ability to house students in historic cabins, provides access to the forest, and offers opportunities to observe active research which makes Pack Forest an ideal place to base MRI.

This paper describes how the field study guide was developed for use in a residential environmental education (EE) program aimed at middle school students residing in the Mount Rainier region. The foundation for this curriculum is rooted in the literature, exemplifies current EE best practices, and aligned to the Next Generation Science Standards (NGSS). The aim of the literature review (Chapter 2) is to provide a clear window through which to view best practices as they relate to the development of the field study guide and to provide an understanding of the theoretical framework that shaped this curriculum. Chapter 3 outlines the methodology for creating the curriculum, starting with a review of NGSS, an overview of the foundations of the organization, then progressing onward to the curricular framework. Additionally, the methodology section contains discussion on the feedback obtained on the field study curriculum from the expert panel.

Statement of Need for Field Study Guide

A review of MRI's curriculum revealed a lack of resources for instructional staff and lack of curricular alignment with the current educational standards. Additionally, MRI staff identified a need for MRI programming to provide authentic science experiences for underfunded science programs that may be lacking in relevant instructional material and access to scientific equipment.

Created in 2014, the MRI curriculum was just a framework to guide education staff in their lesson planning. The curriculum being delivered predominately orally and experientially during staff training, has proven difficult in creating continuity in programming. One possible reason for this, is there is no written foundation for instructors to reflect upon after the experiential training. Education staff also come to MRI with differing backgrounds and the staff training changes slightly each season according to those various needs. This often comes in the form of allowing more time for one concept versus another, if a staff member indicates they are unfamiliar. In the hopes of creating continuity, education staff at MRI have voiced a desire for a written, in depth, theory-grounded curriculum surrounding MRI's field study piece (R. Bishop, S. Francis, N. Frymier, A. Patia, & R. Weisberg, personal communication, November 7, 2013; A. Bavier & K. Ewen, personal communication, October 27, 2016).

Failure to formally align MRI's framework with the emerging NGSS has outdated the current curriculum. Weis (2013) states curriculum and resources that are not aligned to current educational standards are vastly underused, thus, creating the possibility that MRI has lost valuable programming opportunities with schools. The alignment of the field study curriculum to NGSS also allows participating teachers the opportunity to increase learning transfer and extend the MRI experience by linking from, and back to, their classroom studies (James & Williams, 2017).

The breadth of curriculum in schools is constantly being narrowed and becoming hyper-focused on product-driven outcomes due to standardized testing (Berliner, 2011; Cawelti, 2006; Faulkner & Cook, 2006). This is exemplified by the findings of a 2012 survey that reported primary school students between third and fifth grade receive just 23 minutes of science instruction a day (Trygstad, Smith, Banilower, & Nelson, 2013) thus making it conceivable that within the 179-day school year in Washington state, a student could receive the equivalent of just 11 days of science instruction (U.S. Department of Education & National Center for Educational Statistics, 2008). This finding is in sharp contrast to reading and math instruction, which registered 85 and 61 minutes per day respectively (Trygstad et al., 2013). The lack of science exposure in primary school perpetuates a tenuous foundation for students to build upon later in life. This creates a need for science education to be applied in relevant and real-world situations so that students can gain a better understanding and progress towards scientific literacy (Reid & Yang, 2002; Zion & Mendelovici, 2012). Additionally, a collection of middle school science teachers was surveyed about the adequacy of equipment, consumable supplies, and instructional technologies. More than half stated they had inadequate access in all areas and were omitting parts of their curriculum materials due to misalignment with current educational standards (Weis, 2013). Many EE programs are uniquely situated to provide the relevant science application and the equipment that underfunded schools seek.

The underfunding of science education, current education standards in the form of NGSS, and MRI staff demand a field study guide be created with EE best practices, NGSS, and proven theoretical framework in mind. The theoretical framework unified with the key principle of understanding includes NGSS, KELT, and Understanding by Design (UBD) (Kolb, 2015; National Research Council, 2012; Wiggins & McTighe, 2005).

Operational Definitions

Active Participation – A best practice that requires learners to be actively engaged in the education experience (Stern, Powell, & Hill, 2013).

Place-Based Education – Educational approach used to connect students to their local communities and ecosystems by using those areas as a starting point to teach interdisciplinary concepts in the curriculum (Sobel, 2004).

Cooperative Learning – A best practice that demands all participants work together for a common goal (Stern et al., 2013).

Cognitive Load Theory – Cognitive load needed during a lesson can be evenly dispersed among students during intense instruction so fatigue does not occur within the student group (Sweller, 1994).

Environmental Education – A pedagogy that aids students in gaining knowledge about the environment, developing skills, and creating understanding in how to address local and global challenges (NAAEE, 2016).

Experiential Education –A pedagogy where students learn through direct experiences (Dewey, 1997).

Immersive Field Investigation – A best practice that incorporates data collection and analysis into the experience (Stern et al., 2013).

Kolb's Experiential Learning Cycle – A four stage learning cycle that can be entered at any point but then must be followed in sequence thereafter. The stages of the learning cycle are, abstract conceptualization, active experimentation, concrete experience, and reflective observation (Kolb, 2015).

Middle School – As defined by this project, sixth, seventh, and eighth graders.

Pure Inquiry – Learners develop, refine, and conduct investigations with little to no help from the educator overseeing the experience (Stern et al., 2013).

Reflection – Allowing students time to look back on personal experiences or to think on a recent experience to make connections to the current objective (Stern et al., 2013).

CHAPTER 2.

LITERATURE REVIEW

This literature review will cover current best practices, proven techniques, and emerging research within the fields of environmental education (EE), science education, psychology, and sociology. These sources were drawn upon in the selection of best practices which ultimately shaped the development of the field study guide. Throughout the examination of literature for best practices in EE, the umbrella term "experiential education" stood out as shown by its breadth in the academic journals (Ballantyne, Fien, & Packer, 2001; Ballantyne & Packer, 2009; Knapp & Poff, 2001). Due to the vast amount of literature on experiential education pedagogy in EE, many authors have chosen to identify and establish subcomponents or specific characteristics of experiential education for continuity in research (Jacobson, McDuff, & Monroe, 2006; Stern et al., 2013). The subcomponents of active participation, immersive field investigation, and reflection identified by Jacobson et al. (2006) aided in the creation of this guide by providing more specific best practices to implement.

During the review of literature, six best practices emerged from the EE field: (1) active participation, (2) cooperative learning, (3) immersive field investigation, (4) place-based education (5) pure inquiry, and (6) reflection. These best practices were selected due to the prevalence of implementation in EE programs found among the literature (Ballantyne & Packer, 2009; Basile, 2000; James & Williams, 2017; Knapp & Poff, 2001). These are the best practices that will heavily influence the development of the field study guide for MRI.

Active Participation

During the meta-analysis of empirical data found in a systematic literature review covering 66 articles from peer-reviewed journals, Stern et al. (2013) found that active participation had the greatest positive impact in the area of student enjoyment. Three studies included by Stern et al. (2013) also suggested that the use of active participation is better equipped to foster attitude and behavior changes within students than a traditional didactic method (Ballantyne & Packer, 2009; Knapp & Poff, 2001; Kusmawan, O'Toole, Reynolds, & Bourke, 2009).

The qualitative research of Knapp and Poff (2001) found that recall of an interpretive experience was more successful in programs utilizing active participation over more passive methods of teaching. The idea of recollection in EE while using the best practice of active participation is well documented in the literature with participants' vivid descriptions of the lived experience several months and in some cases even years afterwards (Farmer, Knapp, & Benton, 2007; Knapp & Poff, 2001; Liddicoat & Krasny, 2014). The recall and retelling of stories also can bring about enjoyment and an elevated level of engagement (Ballantyne & Packer, 2009). These recollections of EE experiences are important in building the mental foundation for future connections (Knapp & Poff, 2001).

A positive concrete impact on attitude towards science can be seen in several quantitative studies where the use of active participation with students furthered their interest in science (Fancovicova, & Prokop, 2011; Prokop, Tuncer, & Kvasnicak, 2007; Zoldosova & Prokop, 2006). Each study exposed upper elementary school students to science experiences where active participation was a keystone characteristic, of the programs in which students participated (Fancovicova & Prokop, 2011; Prokop et al., 2007). The statistical analysis of multiple studies revealed students demonstrated an increased interest in science (Fancovicova & Prokop, 2011; Prokop et al., 2007; Zoldosova & Prokop, 2006).

Active participation can also reach students that typically do not excel within a traditional classroom setting due to differing abilities, apathy, or behavioral issues (James & Williams, 2017). This is an important fact, as one of the most common differing abilities, ADHD is on the rise (Visser et al., 2014). Approximately 6.4 million children between the ages of 4 – 17 have been diagnosed with ADHD as of the year 2011 (Visser et al., 2014). Active participation can give space for those students to excel and demonstrate critical thinking skills beyond what is known of them within four walls. The most recent evidence of this can be seen in a mixed methods qualitative study conducted with 56 seventh and eighth graders (James & Williams, 2017). While the overall study found that students valued the opportunity to learn science through hands-on experiential activities, James and Williams (2017) were also able to add depth to their study with individual student observations. These observations over the course of a two-day experiential outdoor education camp added a richness to the information gained due to prior teacher-student relationship within a traditional classroom (James & Williams, 2017). In these observations, it was noted that a student with a second-grade reading and writing level demonstrated critical thinking skills far beyond what he demonstrated in the classroom (James & Williams, 2017). These observations continue, to further describe another student with differing abilities commanding a leadership role and leading his team to success during an activity (James & Williams, 2017). These two observations are a small sample of the great possibilities students with differing abilities can achieve in residential EE programs.

The use of active participation as a best practice can rekindle an enjoyment of learning, foster behavior changes (Stern et al., 2013), increase recollection of the experience (Knapp & Poff, 2001), and create a more inclusive environment for students (James & Williams, 2017).

Furthermore, creating an inclusive environment for students to coalesce within, allows for cooperative learning to more naturally occur.

Cooperative Learning

Many EE programs utilize team, cooperative, or small group learning best practices as a part of their curriculum (Knapp, 1986). Cooperative learning is recognized as a best practice most often utilized to complement or strengthen other best practices in EE. One example of this can be seen in the final suggestions by Ballantyne et al. (2001) investigating program effectiveness. Ballantyne et al. (2001) suggest that cooperative learning techniques such as group discussion should be used alongside field investigations and place based experience for a more complete view of the topic at hand (Ballantyne et al., 2001). This complete view can only come when many voices within the learning community are shared in a collaborative manner.

Prokop et al. (2007) note that even when students were not explicitly instructed to form small groups after a full day field experience, they did so freely. The students within these subgroups carried on unprompted, detailed conversation about their day creating a richer dialog within the group than was originally planned per the curriculum (Prokop et al., 2007). However, several authors warn that meaningful group collaboration does not just simply occur nor is it always appropriate to use cooperative learning (Kirshner, Paas, & Kirshner, 2009; Schmitz & Winskel, 2008). A growing body of literature states that cooperative learning is best used for positive outcomes in a more structured environment (Dillenbourg, 2002). If the goals, directions, and boundaries of the project are not clearly stated educators may risk an activity full of student detractors. These negative impacts from students come in the form of social loafing, sunk cost effect, and production blocking (Diehl, Stroebe, & Reis, 1987; Latane, Williams, &

Harkins, 1979; Smith, Tindale, & Steiner 1998). Kirshner et al. (2009) relate cooperative learning to cognitive load theory and further elaborates that cooperative learning is only efficient when the task is complex and would benefit from the use of multiple minds. Therefore, if the task at hand is not complex enough the use of cooperative learning becomes cumbersome and reduces the students' positive experience (Kirshner et al., 2009).

Cooperative learning can create well-rounded learning opportunities, feelings of accomplishment, and communication skills among the students, if implemented correctly (Ballantyne et al., 2001; Kirshner et al., 2009). It is clear from the literature that in order for cooperative learning to be beneficial, there must be high expectations and firm boundaries associated with this best practice (Dillenbourg, 2002).

Immersive Field Investigation

Sauve (2005) identified 15 differing approaches within EE. While science has long been a part of EE, with the rise of STEM this approach has been gaining traction in the EE literature and most often presents itself as authentic field investigations. Field investigation has a reputation in many circles as an enjoyable best practice to reach the desired outcomes of skill acquisition or refinement (Stern et al., 2013). This best practice has also been reported to have the highest positive relationship to change in environmental attitude (Stern et al., 2013).

A study completed in Australia with a wide spectrum of ages stated that students reported the largest contributor to their learning or changes occurring within were due to their involvement with data collection and presentation (Ballantyne, Fien, & Packer, 2001). This study noted that both group and individual data collection and presentations happened, as did active participation in other's presentations (Ballantyne et al., 2001). The focus of this study was to identify outcomes of the six EE programs and relate them back to best practices to be employed in EE (Ballantyne et al., 2001). In a case study conducted with 152 students that completed an EE program, a subset of 73 secondary school students reported positive changes that occurred due to programming, 22% reported knowledge gain, 17% stated attitudinal change, and 45% relayed positive behavioral change relating to the environment (Ballantyne et al., 2001). These students went on to further identify the largest proponent of these changes was data collection and presentation, which are the hallmarks of an immersive field investigation (Ballantyne et al., 2001).

In Carole Basile's (2000) quantitative mixed methods study, learning transfer was examined through the lens of scientific process. A control group was taught curriculum through a series of more traditional classroom practices such as art, discussion, reading, worksheets, occasional walks in the school yard, and one field trip (Basile, 2000). The treatment group experienced the same curriculum in a hands-on, skills based way that was rooted in the scientific process (Basile, 2000). The results of this study showed that students in the treatment group could perform tasks distantly related to the learned curriculum whereas the control group was unable to complete those same tasks (Basile, 2000). The research of Milà & Sanmartí (1999) states that while the aim of EE is to create a citizenry of environmentally literate people, the list of environmental problems and the many unforeseen facets of each demand learning transfer be a goal of EE. Intentionally including activities that increase learning transfer in EE experiences allow students to adapt the information to new situations and settings. Ultimately this aids in students' understanding in relation to unforeseen environmental issues in years to come.

Ballantyne and Packer (2009) investigated how students' feelings during EE programming impacted their attitude and behavior. The researchers conducted a quantitative mixed method study that combined observations and self-reports of student's feelings and levels of engagement during EE programming (Ballantyne and Packer, 2009). They reported that field investigations stood out as being one of the most engaging types of learning activities (Ballantyne & Packer, 2009). In the student interviews conducted three months' post programming Ballantyne and Packer (2009) found attitude and behavior changes to be more likely associated with happy or calm emotions rather than sad or angry emotions. Students most often reported their field investigation experience as being associated with the lower positive emotions, such as calm or happy (Ballantyne & Packer, 2009).

The rise in STEM education has rekindled the immersive field investigation for many EE programs. This best practice has the ability to foster attitude and behavior changes (Ballantyne & Packer, 2009), skill acquisition (Stern et al., 2013), and increase learning transfer (Basile, 2000). Immersive field investigation also typically draws from place-based education (PBE) as PBE involves using the local area as a starting point for further understanding (Sobel, 2004).

Place-based Education

PBE can positively impact students in the areas of acquisition of skills, awareness, and community-place attachment (Cincera, Johnson, & Kovacikova, 2015; Gruenewald, 2003; Powers, 2004, Sobel, 2004). The ideas of awareness and skill acquisition are closely linked through inquiry and critical thinking in the EE literature (Gruenewald, 2003; Knapp, 1985; Sobel, 2004). For students to have an intentional and positive impact on our ecological, economic, and cultural systems, they must first become aware these systems exist. In PBE students become aware of these systems by direct interaction (Gruenewald, 2003). Powers (2004) found, in an evaluation of four PBE programs, that the majority of the 85 students interviewed reported an increase in skill and knowledge retention when learning through PBE. Gruenewald (2003) creates a stark contrast between PBE and traditional classroom learning when he states, "In place of actual experience with the phenomenal world, educators are handed, and largely accept, the mandates of a standardized, "placeless" curriculum…" (p. 8). This infers that if only textbooks and traditional pedagogies are used in education settings, teachers risk never making a connection to the local environment—unlike PBE, which creates community-place attachment by using students' community or local ecosystem as their research space (Woodhouse & Knapp, 2000). Duffin, Powers, and Tremblay (2004) completed an evaluation collaborative across four differing PBE programs. The 1,875 student surveys obtained from fourth – twelfth graders showed the largest significant positive impacts to students' attachment to place were: time spent outdoors, participation in stewardship projects, and learning through local resources (Duffin et al., 2004).

PBE creates awareness of the systems at play within the local ecosystem and students become enlightened through investigation, to the ways their lives are inextricably linked to their environment (Theobald, 1997). Understanding this link encourages admiration for the local environment and a consciousness of the current challenges within it (Sobel, 2004). A best practice used alongside PBE is that of pure inquiry. PBE creates awareness, while pure inquiry fosters the generation of questions.

Pure Inquiry

Pure inquiry is but one level (see Figure 1) in a subset within the utilization of the best practice of immersive field investigation. To embark upon an immersive field investigation, students must apply the scientific process. According to several studies, the scientific process is most often taught as the scientific method in a series of discrete steps (Carey & Smith, 1993; Tang, Coffey, Elby, & Levin, 2010; Windschitl, 2004). This practice can run counterproductive to students pursuing authentic scientific inquiry (Tang et al., 2010). The way in which structured inquiry is often used parallels the scientific method, as structured inquiry is portrayed almost solely as a linear approach (Zion & Mendelovici, 2012). It remains unseen if the linear approach in structured inquiry has the same possible negative effects as the rigid use of the scientific method.

Figure 1 Levels of Inquiry and Gradual Release of Responsibility

Teacher **Student**

	Structured Inquiry	Guided Inquiry	Open Inquiry	Pure Inquiry
Topic	Teacher	Teacher	Teacher	Teacher/Student
Question	Teacher	Teacher	Teacher/Student	Student
Materials	Teacher	Teacher	Student	Student
Procedure	Teacher	Teacher/Student	Student	Student
Results	Teacher/Student	Student	Student	Student
Conclusions	Student	Student	Student	Student

Figure 1. Levels of Inquiry with corresponding student teacher involvement (Adapted from Bonnstetter, 1998)

There is great debate in the science education community about various forms of inquiry (Zion & Mendelovici, 2012). Questions such as, should students' progress from structured inquiry to guided and then onward towards open inquiry, remain to be answered adequately because of this debate. Each inquiry process has its own set of strengths and limitations. For instance, structured inquiry is easily managed from a classroom standpoint but does very little to advance the learners past a basic level of inquiry (Zion & Mendelovici, 2012). Guided inquiry requires the educator to be ready for multiple outcomes in order to reflect with students on the experience. Guided inquiry also gives students slightly more autonomy over the inquiry process than structured inquiry due to the only teacher input being the questions and procedures of the investigation (Zion & Mendelovici, 2012). Lastly, there is the spectrum between open and pure inquiry which gives students the most ownership over their investigation and requires constant decision making along the way thus relying heavily upon critical thinking skills (Zion & Mendelovici, 2012). These two methods often find favor with cognitively adept groups as they are the most authentic to science practice (Reid & Yang, 2002; Zion & Mendelovici, 2012).

Two studies on open inquiry focused on the learning process and changes in student approach while utilizing open or pure inquiry (Krystyniak & Heikkinen, 2007; Zion, Shapira, Bashan, Nussinowitz, & Mendelovici, 2004). The Zion et al. (2004) study focused on tracking 135 high school students' perceptions of open inquiry by issuing questionnaires and gathering reflection in written and verbal formats throughout the use of an open inquiry curriculum. The study showed that throughout the use of a specific open inquiry curriculum, students began to see science practice as more dynamic than static (Zion et al., 2004). This finding is in line with that of Chinn and Malhotra (2002) who found that the use of structured inquiry only promotes inaccurate beliefs held by students that science is simple and certain. Krystyniak and Heikkinen (2007) found in their qualitative study that the use of open inquiry within a chemistry lab in a university setting promoted cooperation among the experimental group. This shifted the classroom environment away from a more traditional instructional approach (Krystyniak & Heikkinen, 2007).

The explicit use of open inquiry can transform a student's perception of science, strengthen critical thinking skills, and expose students to the most authentic type of science (Reid & Yang, 2002; Zion & Mendelovici, 2012; Zion et al., 2004). These benefits are important to consider in light of Chinn and Malhotra's (2002) finding that science textbooks capture very few of the cognitive processes associated with authentic science practice. One of those rarely captured cognitive processes within textbooks is that of intentional reflection for the *sole purpose* of reflection, rather than as an assessment.

Reflection

Stern et al. (2013), summarize the outcomes of EE programs associated with observed best practices. In the summary of programs, the best practice of reflection ranks in the top five best practices to have a positive impact on the measured outcome of attitude (Stern et al., 2013). While a literature review has some limitations such as consistency in quality of research and unreported details from the original study, these findings point to a deeper investigation of reflection as a best practice (Stern et al., 2013).

One study, included in Stern et al. (2013) empirical review was a quantitative mixed methods study investigating the best strategies to facilitate students learning in natural spaces (Ballantyne & Packer, 2009). This study using observation, post and 3 month-post interviews for students and teachers alike, found that the use of experience based learning is longer lasting than that of a more didactic teacher-directed approach (Ballantyne & Packer, 2009). One finding that stands out among the results of this study is that reflective response had the highest effectiveness (Ballantyne & Packer, 2009). Ballantyne and Packer (2009) go on to state that incorporating reflective response into the EE programming had a real impact on students and it facilitated positive attitude change.

These findings were also supported by two studies that suggested that exposing students to authentic experiences and asking them to think critically and reflectively brings about change (Giron, Vasquez-Martinez, Sánchez-López, & Ayón-Bañuelos, 2012; Tooth & Renshaw, 2009). Tooth and Renshaw (2009) take this idea further by stating reflection on authentic EE experiences force students away from only activating the knowledge gained in an experience. A reflection on a previous learning experience in an EE setting can access the emotional and sensory aspects of the experience that would be much less effective in a classroom (Tooth & Renshaw, 2009). Intentional reflection is also incorporated into KELC (Kolb, 2015).

Kolb's Experiential Learning Cycle

David Kolb influenced by the works of Follett, Vygotsky, Piaget, Lewin, and Dewey, has dedicated his scholarly career to creating and refining the experiential learning cycle (Kolb, 2015). This learning cycle was originally published in 1984 however, Kolb started testing the underpinnings for this model in 1966 (Kolb, 2015). Kolb's Experiential Learning Cycle (KELC) is among many learning style models, however, few are as influential in education as KELC (Bergsteiner, Avery, & Neumann, 2010). The versatility of KELC can be seen across the spectrum of education from career trainings in management and internal medicine to use in formal and non-formal classrooms (Kolb, 2015).

The reason KELC is so versatile across disciplines is due to its roots in the very foundations of the cycle. David Kolb built from the fundamentals others had laid before him. Several of those scholars, particularly John Dewey believed in educating the whole person and acknowledging the dichotomies the education system or society had placed in conflict with this idea (Dewey, 1906). Kolb set about creating and testing his model and eventually settled on the model on the following page (see Figure 2).

Figure 2 Kolb Experiential Learning Cycle

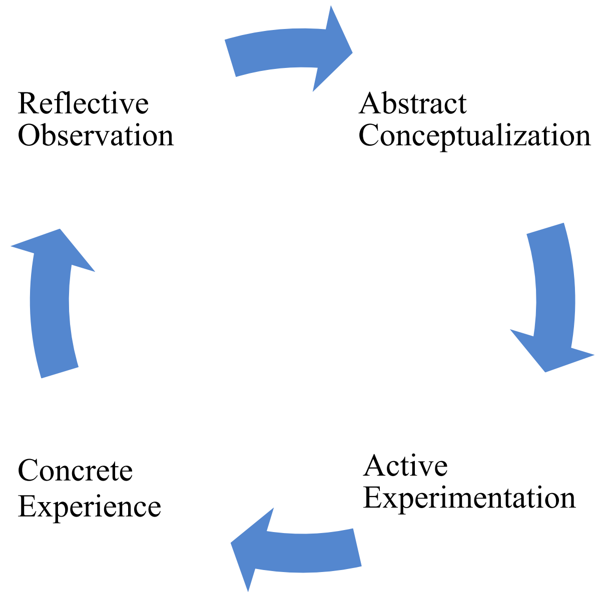

Figure 2. David Kolb's Experiential Learning Cycle (Kolb, 1984)

In this model, there are four stages of learning, abstract conceptualization, active experimentation, concrete experience, and reflective observation (Kolb, 2015). Educators can initially engage in KELC in any stage of the learning cycle so long as the subsequent stages are followed in sequence. An example of this would be if an instructor began in the stage of abstract conceptualization the students might be given or asked to conceptualize an idea, theory, or model that is to be observed (Healey & Jenkins, 2000). Then the educator would progress onward with the students towards active experimentation. In the active experimentation stage an educator would guide students in forming a plan for the upcoming concrete experience (Healey & Jenkins, 2000). The concrete experience would then demand that learners actively experience the activity in which they had previously planned (Healey & Jenkins, 2000). Lastly, learners would be encouraged to reflect on the experience by writing, engaging in discussion, or any number of other reflective techniques (Cowan, 2007). Cowan (2007) comments on the idea of repeating the steps of the cycle to make changes in the experience such as further conceptualization, further experimentation, etc. This is not a novel ideal but one that originates in Kolb's ultimate interpretation of Figure 2. In two-dimension Figure 2 lies flat as a circle, however, Kolb (2015) suggests a more accurate depiction of the cycle would be a never-ending spiral. This statement from David Kolb echoes much of John Dewey's work, as Dewey believed in continuous lifelong learning (Kolb, 2015). This also seamlessly aligns with the practice of science in the way that answering one question typically leads to asking more questions.

Summary

EE when implemented is inherently multidisciplinary and requires the use of not just one but many of the best practices above. The best practices of active participation, immersive field investigation, place base education, and pure inquiry also exemplify MRI's mission and values. While cooperative learning is a popular characteristic of curriculum, Wilson and Gerber (2008) suggest it should be an integral part of curriculum to reach the current generation of students. Lastly, reflection was chosen as an explicit attempt to add to and perpetuate its place in MRI's programming and root the practice in experiential education theory. Taken together as a whole, these best practices, when implemented alongside MRI's mission and vision, and aligned with NGSS, have produced a field study guide responsive to the needs of all parties involved. The following section will describe how these best practices have informed the design of the field guide. It will also outline a review and feedback process of the curriculum by the expert panel.

CHAPTER 3.

METHODS

The statement of need and the literature review have described the need for best practices and current standards important to the creation and implementation of the field study guide. Other considerations covered within this methodology section include NGSS, MRI's mission and values, and Kolb's Experiential Learning Cycle. The methodology will also outline the implementation of feedback on the field study guide from the expert panel who consisted of past MRI staff and EE professionals with experience in many different parts of the United States.

Next Generation Science Standards

The National Academy of Sciences, a branch within the National Research Council (NRC), gathered 18 individuals well versed in science and education to create the *Framework of K-12 Science Education* (National Research Council, 2012). The creation of this document, derived from cutting-edge research, was identified by the NRC, American Association for the Advancement of Science, the National Science Teachers Association, and Achieve Inc. as the first step within a larger process of creating national standards for the K-12 education system (National Research Council, 2012). The recommendations of this committee created a tangible scaffolding for state partners to eventually build upon. The committee recommended the scope of the curriculum be contained in one of three dimensions, scientific and engineering practices, crosscutting concepts, and core ideas (National Research Council, 2012). Each dimension also contains clarifying information on what practices, concepts, and ideas should be the focus of each dimension (see Figure 3). The dimensions, clarifying information, and accompanying research were then passed on to the states for further refinement.

Figure 3 Dimensions of NGSS

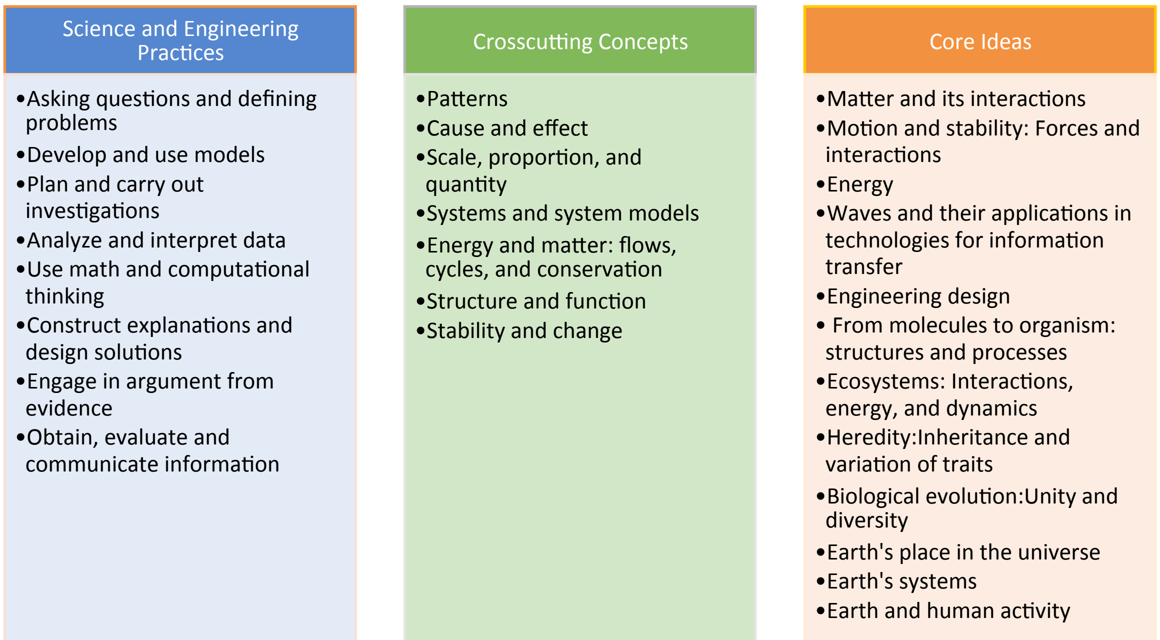

Figure 3. Framework of the Three Dimensions of NGSS (National Research Council, 2012)

A committee of forty representatives, curriculum development professionals, science teachers, and special interest groups was assembled in 2011 to represent twenty-six states (Next Generation Science Standards). These individuals ultimately created the deliverable standards seen today. While Washington State was one of twenty-six lead state partners in the NGSS development process, only eight states and the District of Columbia formally adopted the standards by the first year’s end (Heitin, 2014). Today, as it stands, 18 states have formally adopted NGSS and Washington State is among them (National Association of State Boards of Education, 2016). Governor Jay Inslee and former state Superintendent Randy Dorn welcomed the adoption of the NGSS to Washington with a public announcement on October 4, 2013 (Office of Superintendent of Public Instruction, 2016). Former Superintendent Dorn shared his beliefs in this statement, “Having all our students’ literate in science is the key to our success in the future. The Next Generation Science Standards will make our students successful, whether they are college- or career-bound” (Office of Superintendent of Public Instruction, 2016). The 2017 -2018 school year marks the total implementation of NGSS in Washington State with the last addition in the process being, a NGSS aligned science test (Dorn, 2014). The last step in this process will hold public school teachers across the state accountable for fully integrating the NGSS into their curriculum.

The Field Study Guide depends upon the science and engineering practices, as each practice represented in Figure 3 will be touched upon through the process of completing the whole Field Study Guide. The core idea of earth’s systems will be the unifying concept of the Field Study Guide, as students will be encouraged to use the natural space around them to create, conduct, and conclude their field study. Lastly, the crosscutting concepts that are drawn upon most often are those of patterns, cause and effect, scale, proportion, and quantity, and systems and system models. Each dimension of the NGSS will reinforce the very fabric of EE. Just as NGSS strives for knowledge gain, skill acquisition, and the creation of understanding, so too does EE. It would then come as no surprise that NGSS echoes much of the North American Association of Environmental Education’s (NAAEE) *Excellence in Environmental Education: Guidelines for Learning K-12* (North American Association of Environmental Education, 2010).

Mount Rainier Institute

MRI began four-day, three-night residential environmental education programming aimed at middle school students in the Fall of 2014. According to Hayes and Wilson (2016) the mission of MRI is to “…provide outstanding nature-based education experiences that are rooted in science and nurture the next generation of environmental stewards and leaders” (p. 3). This mission statement links science and traditional EE outcomes, and is the guiding principle in program development at MRI. The Field Study Guide covers approximately 42% of programming during the four-day, three-night experience, due to the scope of the study.

The overarching MRI values of community, education, excellence, place, and inspiration also narrowed the scope of how to further the development of programming (Hayes, 2013). The explicit use of cooperative learning as a best practice incorporated into the Field Study Guide is supported by the institutional value of community. Hayes (2013) elaboration of community reads, “It is essential to foster a sense of community among students, staff, and our partners. Meaningful collaboration with one another will create an enduring conservation ethic” (para. 3). The use of active participation within the guide is supported by the value of education, more specifically in a clarifying statement that says, “we provide hands-on authentic learning experiences” (Hayes, 2013, para. 4). The value of place demands that PBE be integral to the program. Hayes (2013) states, “we encourage students to form strong attachments to the Mount Rainier region and their home” (para. 6). The guide furthers the value of inspiration, when a pure inquiry approach to field investigations is used (Hayes, 2013). Lastly, the creation of this guide has helped to solidify another MRI value, that of excellence. The clarifying statement associated with this is, “we incorporate the most accurate, up-to-date and best-known science and information into the topics we teach” (Hayes, 2013, para. 5). This is the aim of the Field Study Guide, to incorporate the most current best practices and standards along with a dynamic use of the scientific process.

Curricular Framework

When constructing the Field Study Guide, each activity was designed according to the process outlined in Understanding by Design (UBD). The UBD design process was chosen for its wide use within the EE field. This curriculum design approach also focuses on creating understanding among students, which closely aligns with the goal of NGSS: to create over time an understanding of science (National Research Council, 2012). Additionally, the holistic style, versatility, and proven record as a learning cycle, makes KELC an ideal candidate for use in the creation of MRI's Field Study Guide. The guiding design and theoretical framework provided by UBD and KELC had profound influence on the field study guide in layout, approach to topics, and final delivery.

Field Study Guide Feedback

A well-documented phenomenon in education is the unused curriculum (McKeown, 2003; Weis, 2013). In a survey of nearly 1,000 middle and high school teachers, Weis (2013), summarized that 65 percent of the participating teachers reported omitting curriculum and sections in their text books due to misalignment with current educational standards. To avoid teachers omitting MRI's programming due to misalignment, key stakeholders were asked to give written and verbal feedback on the Field Study Guide prior to adoption. The researcher initially sought three stakeholder groups of three individuals each. These stakeholder groups were participating teachers, current and previous MRI staff, and a collection of other EE professionals. These stakeholder groups are referred to collectively as the expert panel. The expert panel was made up of entirely self-selected participants.

Due to unforeseen policy changes within many school districts of MRI's participating teachers, this stakeholder group was not immediately available for inclusion in the feedback process. However, verbal feedback will be gathered during the Fall 2017 pilot programming of the Field Study Curriculum. Feedback from this stakeholder group is important because MRI's participating teachers have a unique voice in this process as they themselves are not responsible for delivering the end-product directly to students. Yet, they are participating alongside their students and reaping the benefits of the knowledge and skills gained at MRI for the rest of the school year. These teachers also actively create opportunities in their own classrooms for learning transfer both before and after their students' experience. Therefore, it is important for this field study guide to be practical in that application as well. All teachers participating in giving verbal feedback will be from within Washington State and have experience teaching middle school science. These teachers will most immediately reap the benefits of the newly created curriculum, as it will be piloted in the Fall 2017.

Past and present MRI staff were asked to review the guide as well. These reporting staff members gave insight to the realities and possibilities of the Field Study Guide. Their voices were invaluable in this process as ultimately it will be upon the staff to deliver the curriculum to the participating students. One former MRI instructor, who now works in an indoor museum setting, relayed halfway through reading the Field Study Guide, "So far it's making me wish I was teaching in the forest" (Personal Communication, August 7, 2017).

Another former instructor stated, "Overall this is a great guide, very helpful for instructors" (Personal Communication, August 19, 2017). This instructor provided a great deal of feedback on all activities, however, one quote from the Exploration activity stands out.

She stated:

> I like the exploration as an introduction to getting acquainted with the forest. I sometimes found explorations to be a bit scattered, and I love that this still allows for exploration freedom, with a bit more added structure. I also like the focus on ecological connections. (Personal Communication, August 19, 2017)

The third former MRI instructor who also read and commented on the whole guide immediately after reading it said, "I can see the intentionality in each activity" (Personal Communication, August 3, 2017). They went on to say:

> The activities in this Field Study Guide follow well researched best practices for environmental education. They use existing framework developed by Kolb and others to effectively teach EE concepts within a 4-day residential program. Reading through the curriculum, I kept wishing I would have a chance to try out these lessons with students! (Personal Communication, August 3, 2017)

Lastly, the third group of stakeholders were comprised of EE professionals throughout the country. Differing techniques, trends, and approaches over time find favor in one location or another. Pulling from this depth of knowledge across a wide expanse can only add richness to the field study guide. Furthermore, the need for a Field Study Guide based on best practices, current standards, and entrenched in research also goes beyond MRI (T. Beachy & D. Gardner, personal communication, January 12, 2017). This stakeholder group contained an EE Center Director, Education Director, and a curriculum writer and trip leader. This group has a combined educational experience in 18 states and 2 countries. They were asked to review the Field Study Guide as this stakeholder group likely has the most considerable amount of knowledge surrounding curriculum, NGSS, and differing field techniques. The following comments are from the EE professionals' stakeholder group.

An EE Center Director said, "I think it sounds awesome! You have done a really good job of bringing to life some other field study components that can feel a little forced" (Personal Communication, August 20, 2017). Another EE professional stated, "This Field Study Guide adds a very cool structure to Mount Rainier Institute's program, overall, I think it is great" (Personal Communication, August 20, 2017)!

All feedback received during the review period from former MRI instructors and EE professionals was considered and used when revising the final draft of the Field Study Guide. The participating teacher stakeholder group will be asked to give verbal feedback in Fall 2017 upon their students' participation in the Field Study Guide activities.

Conclusions

The Field Study Guide was developed based on a need for written curriculum rooted in EE best practices as well as aligned to the NGSS, which echoes many of the key understandings within the NAAEE *Excellence in Environmental Education: Guidelines for Learning (K-12)*. A survey of the literature revealed many best practices in EE, yet, six specific best practices were used in this project as they reinforce the very underpinnings of MRI's mission. The best practice of dosage was also considered and ultimately left in favor of the scope of the current project and the vital role it will play in upcoming organization- driven projects. The decision to target the NGSS science and engineering practices and crosscutting concepts instead of the specifics of core ideas was ultimately made in favor of the proposed best practice of open inquiry.

The complete Field Study Guide contains nine activities, each individual activity was designed with the UBD framework in mind. UBD provides constants such as goals, understandings, skill acquisition and assessment to each activity. Knowledge and learning transfer are also present, only, it is presented in the form of NGSS dimensions core ideas and crosscutting concepts. What is referred to in UBD as the learning plan is titled facilitation within the Field Study Guide, this facilitation is structured with KELC in mind. The overall guide centers around NGSS science practices and ultimately leads students through activities to make space for those practices and encourage the further development of environmental stewards.

The best practices reviewed within this paper also heavily informed how activities were implemented within the Field Study Guide. The desired outcome of completing the activities in the Field Study Guide is that students will experience an authentic student-centered field study.

References

Ballantyne, R., Fien, J., & Packer, J. (2001). Program effectiveness in facilitating intergenerational influence in environmental education: Lessons from the field. *The Journal of Environmental Education, 32*(4), 8-15. doi:10.1080/00958960109598657

Ballantyne, R., & Packer, J. (2009). Introducing a fifth pedagogy: Experience□based strategies for facilitating learning in natural environments. *Environmental Education Research, 15*(2), 243-262. doi:10.1080/13504620802711282

Basile, C. (2000). Environmental education as a catalyst for transfer of learning in young children. *The Journal of Environmental Education, 32*(1), 21-27.

Bergsteiner, H., Avery, G., & Neumann, R. (2010). Kolb's experiential learning model: Critique from a modelling perspective. *Studies in Continuing Education*, *32*(1), 29-46. doi:10.1080/01580370903534355

Berliner, D. (2011). Rational responses to high stakes testing: The case of curriculum narrowing and the harm that follows. *Cambridge Journal of Education, 41*(3), 287-302.

Bonnstetter, J. (1998). Inquiry: Learning from the past with an eye on the future. *Electronic Journal of Science Education, 3*(1). Retrieved July 7, 2017, from https://wolfweb.unr.edu/homepage/jcannon/ejse/bonnstetter.html

Carey, S., & Smith, C. (1993). On understanding the nature of scientific knowledge. *Educational Psychologist, 28*(3), 235-251.

Cawelti, G. (2006). The side effects of NCLB. *Educational Leadership, 64*(3), 64-68.

Chinn, C., & Malhotra, B. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Science Education, 86*(2), 175-218.

Cincera, J., Johnson, B., & Kovacikova, S. (2015). Evaluation of a place-based environmental education program: From there to here. A*pplied Environmental Education and Communication, 14*(3), 178-186.

Cowan, J. (2007). *On becoming an innovative university teacher* (2nd ed.). Maidenhead: McGraw-Hill Education.

Dewey, J. (1906). *The school and society: And, the child and the curriculum*. Chicago: University of Chicago Press.

Dewey, J. (1997). *Experience and education* (1st Touchstone ed., Kappa Delta Pi lecture series). New York: Simon & Schuster. (Original work published 1938)

Diehl, M., Stroebe, W., & Reis, H. (1987). Productivity loss in brainstorming groups: Toward the solution of a riddle. *Journal of Personality and Social Psychology, 53*(3), 497-509.

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three worlds of CSCL: Can we support CSCL?* (pp. 61-91). Heerlen, The Netherlands: Open University of The Netherlands.

Dorn, R. (2014, August 14). Office of Superintendent of Public Instruction. Retrieved from http://www.k12.wa.us/Science/NGSS/NGSS-AssessmentDescriptionTimeline.pdf

Duffin, M, Powers, A., & Tremblay, G. (2004). Place-based education evaluation collaborative report on cross-program research & other program evaluation activities 2003-2004. Program evaluation & educational research (PEER). Retrieved from http://www.seer.org/pages/research/PEEC%202004.pdf

Farmer, J., Knapp, D., & Benton, G. M. (2007). An elementary school environmental education field trip: Long-term effects on ecological and environmental knowledge and attitude development. *The Journal of Environmental Education, 38*(3), 33-42.

Faulkner, S., & Cook, C. (2006). Testing vs. teaching: The perceived impact of assessment/ demands on middle grades instructional practices. *RMLE Online, 29*(7), 1-13. doi: 10.1080/19404476.2006.11462030

Fancovicova, J., & Prokop, P. (2011). Plants have a chance: Outdoor educational programmes alter students' knowledge and attitudes towards plants. *Environmental Education Research, 17*(4), 537-551.

Giron, G., Vasquez-Martinez, C., Sánchez-López, J., & Ayón-Bañuelos, A. (2012). *Environmental education: From the perspective of scientific knowledge for constructivist learning*. Speech presented at Annual Meeting of the Bulgarian Comparative Education Society in Bulgaria, Kyustendil..

Gruenewald, D. (2003). The best of both worlds: A critical pedagogy of place. *Educational Researcher, 32*(4), 3-12.

Hayes, J. (2013). Overview. Retrieved from http://rainierinstitute.org/overview.html

Hayes, J., & Wilson, A. (2016, August 8). *Teacher Planning Guide*.

Healey, M., & Jenkins, A. (2000). Kolb's experiential learning theory and its application in geography in higher education. *Journal of Geography, 99*(5), 185-195.

Heitin, L. (2014, January 28). Common science standards slow to catch on in states. *Education Week*. Retrieved from http://www.edweek.org/ew/articles/2014/01/29/19 science_ep.h33.html

Jacobson, S., McDuff, M., & Monroe, M. (2006). *Conservation education and outreach techniques* (Techniques in ecology and conservation series). Oxford; New York: Oxford University Press.

James, J., & Williams, T. (2017). School-based experiential outdoor education. *Journal of Experiential Education, 40*(1), 58-71. doi:10.1177/1053825916676190

Kirschner, F., Paas, F., & Kirschner, P. (2009). A cognitive load approach to collaborative learning: United Brains for Complex Tasks. *Educational Psychology Review, 21*(1), 31-42.

Knapp, C. (1985). *Using Valuing and Inquiry Skills in Environmental Education*. [Washington, D.C.]: Distributed by ERIC Clearinghouse, http://www.eric.ed.gov/contentdelivery/Servlet/ERICServlet?accno=ED263003

Knapp, C. (Ed.). (1986, July). Cooperative learning and outdoor/environmental education. *The International Association for the Study of Cooperation in Education*, *7*, 3-6.

Knapp, D., & Poff, R. (2001). A qualitative analysis of the immediate and short-term impact of an environmental interpretive program. *Environmental Education Research, 7*(1), 55-65. doi:10.1080/13504620124393

Kolb, D. A. (2015). *Experiential learning: Experience as the source of learning and development* (2nd ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Kirschner, F., Paas, F., & Kirschner, P. (2009). A cognitive load approach to collaborative learning: United brains for complex tasks. *Educational Psychology Review, 21*(1), 31-42.

Krystyniak, R., & Heikkinen, H. (2007). Analysis of verbal interactions during an extended, open-inquiry general chemistry laboratory investigation. *Journal of Research in Science Teaching, 44*(8), 1160-1186.

Kusmawan, U., O'Toole, J., Reynolds, R., & Bourke, S. (2009). Beliefs, attitudes, intentions and locality: The impact of different teaching approaches on the ecological affinity of indonesian secondary school students. *International Research in Geographical and Environmental Education, 18*(3), 157-169.

Latane, B., Williams, K., & Harkins, S. (1979). Many hands make light the work: The causes and consequences of social loafing. Journal of Personality and Social Psychologv, 37, 822-832. doi: 10.1037/0022-3514.37.6.822

Liddicoat, K., & Krasny, M. (2014). Memories as useful outcomes of residential outdoor environmental education. *Journal of Environmental Education, 45*(3), 178-193.

McKeown, R. (2003). Working with K-12 schools: Insights for scientists. *BioScience, 53*(9), 870-875.

Milà, C., & Sanmartí, N. (1999). A model for fostering the transfer of learning in environmental education. *Environmental Education Research, 5*(3), 237-266.

National Association of State Boards of Education. (n.d.). Next generation science standards. Retrieved from http://www.nasbe.org/project/next-generation-science-standards/

National Research Council. Standards committee on conceptual framework for the new k-12 science education. (2012). *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington: National Academy Press.

Next Generation Science Standards. (n.d.). Writing Team. Retrieved from https:// www.nextgenscience.org/writing-team

North American Association of Environmental Education. (2016, August 09). About EE and Why It Matters. Retrieved from https://naaee.org/about-us/about-ee-and-why-it-matters

Office of Superintendent of Public Instruction. (2016, September 8). Science. Retrieved from http://www.k12.wa.us/science/NGSS.aspx?printable=true

Powers, A. (2004). An Evaluation of Four Place-Based Education Programs. *Journal of Environmental Education, 35*(4), 17-32.

Prokop, P., Tuncer, G., & Kvasnicak, R. (2007). Short-Term Effects of Field Programme on Students' Knowledge and Attitude toward Biology: A Slovak Experience. *Journal of Science Education and Technology, 16*(3), 247-255.

Reid, N., & Yang, M. (2002). The Solving of Problems in Chemistry: The more open-ended problems. *Research in Science & Technological Education, 20*(1), 83-98.

Sauve, L. (2005). Currents in Environmental Education: Mapping a Complex and Evolving Pedagogical Field. *Canadian Journal of Environmental Education, 10*(1), 11-37.

Schmitz, M., & Winskel, H. (2008). Towards effective partnerships in a collaborative problem solving task. *British Journal of Educational Psychology, 78*(4), 581-596.

Smith, C. M., Tindale, R. S., & Steiner, L. (1998). Investment decisions by individuals and groups in 'sunk cost' situations: The potential impact of shared representations. *Group Processes & Intergroup Relations*, 1, 175-189. doi: 10.1177/1368430298012005

Sobel, D. (2004). *Place-based education: connecting classrooms & communities* Nature Literacy Series Vol. 4. New Patriotism Series 4. Great Barrington, MA: Orion Society.

Stern, M. J., Powell, R. B., & Hill, D. (2013). Environmental education program evaluation in the new millennium: What do we measure and what have we learned? *Environmental Education Research, 20*(5), 581-611. doi:10.1080/13504622.2013.838749

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction, 4*(4), 295-312.

Tang, X., Coffey, J., Elby, A., & Levin, D. (2010). The scientific method and scientific inquiry: Tensions in teaching and learning. *Science Education, 94*(1), 29-47.

Theobald, P. (1997). *Teaching the commons: Place, pride, and the renewal of community*. Boulder, CO.: Westview Press.

Tooth, R., & Renshaw, P. (2009). Reflections on pedagogy and place: A journey into learning for sustainability through environmental narrative and deep attentive reflection. *Australian Journal of Environmental Education, 25*, 95-104.

Trygstad, J., Smith, S., Banilower, R., & Nelson, M. M. (2013, April). *The Status of Elementary Science Education: Are We Ready for the Next Generation Science Standards?* (Rep.). Retrieved http://www.horizon-research.com/2012nssme/wp-content/uploads/2013/06/ The-Status-of-Elementary-Science-Education_paper.pdf (ERIC Document Reproduction Service No. ED548249)

U.S. Department of Education, & National Center for Educational Statistics. (2008). Average number of hours in the school day and average number of days in the school year for public schools, by state: 2007–08. Retrieved March 7, 2017, from https://nces.ed.gov/ surveys/sass/tables/sass0708_035_s1s.asp

Visser, S. N., Danielson, M. L., Bitsko, R. H., Holbrook, J. R., Kogan, M. D., Ghandour, R. M., & Blumberg, S. J. (2014). Trends in the parent-report of health care provider-diagnosed and medicated attention-deficit/hyperactivity disorder: United States, 2003–2011. *Journal of the American Academy of Child & Adolescent Psychiatry, 53*(1). doi:10.1016/j.jaac.2013.09.001

Weis, A. M. (2013, September). *2012 National Survey of Science and Mathematics Education: Status of Middle School Science* (Rep.). Retrieved http://www.horizon-research.com/2012nssme/wp-content/uploads/2013/09/2012-NSSME-Status-of-Middle-School-Science.pdf (ERIC Document Reproduction Service No. ED548253)

Wiggins, G., & McTighe, J. (2005). *Understanding by design* (Expanded 2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Wilson, M., & Gerber, L. (2008). How generational theory can improve teaching: Strategies for working with the "millennials". *Currents in Teaching and Learning, 1*(1), 29-44. Retrieved March 5, 2017, from https://tigerweb.towson.edu/garcia/past%20semesters%20of%20intro/intro/2011%20fall%20intro/wilson%20and%20gerber.pdf.

Windschitl, M. (2004). Folk theories of "inquiry:" how preservice teachers reproduce the discourse and practices of an atheoretical scientific method. *Journal of Research in Science Teaching, 41*(5), 481-512.

Woodhouse, J., & Knapp, C. (2000). *Place-based curriculum and instruction: Outdoor and environmental education approaches* (ERIC digest) Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools, Appalachia Educational Laboratory.

Zion, M., & Mendelovici, R. (2012). Moving from structured to open inquiry: Challenges and limits. *Science Education International, 23*(4), 383-399.

Zion, S., Shapira, L., Bashan, B., Nussinowitz, A., & Mendelovici, V. (2004). Dynamic, open inquiry in biology learning. *Science Education, 88*(5), 728-753.

Zoldosova, K., & Prokop, P. (2006). Education in the field influences children's ideas and interest toward science. *Journal of Science Education and Technology, 15*, 304-313.

Field Study Guide

A Guide for Mount Rainier Institute
Developed by Amy Wilson

2017

Acknowledgements

From where I started

to where I am today

to all those that helped me

along the way.

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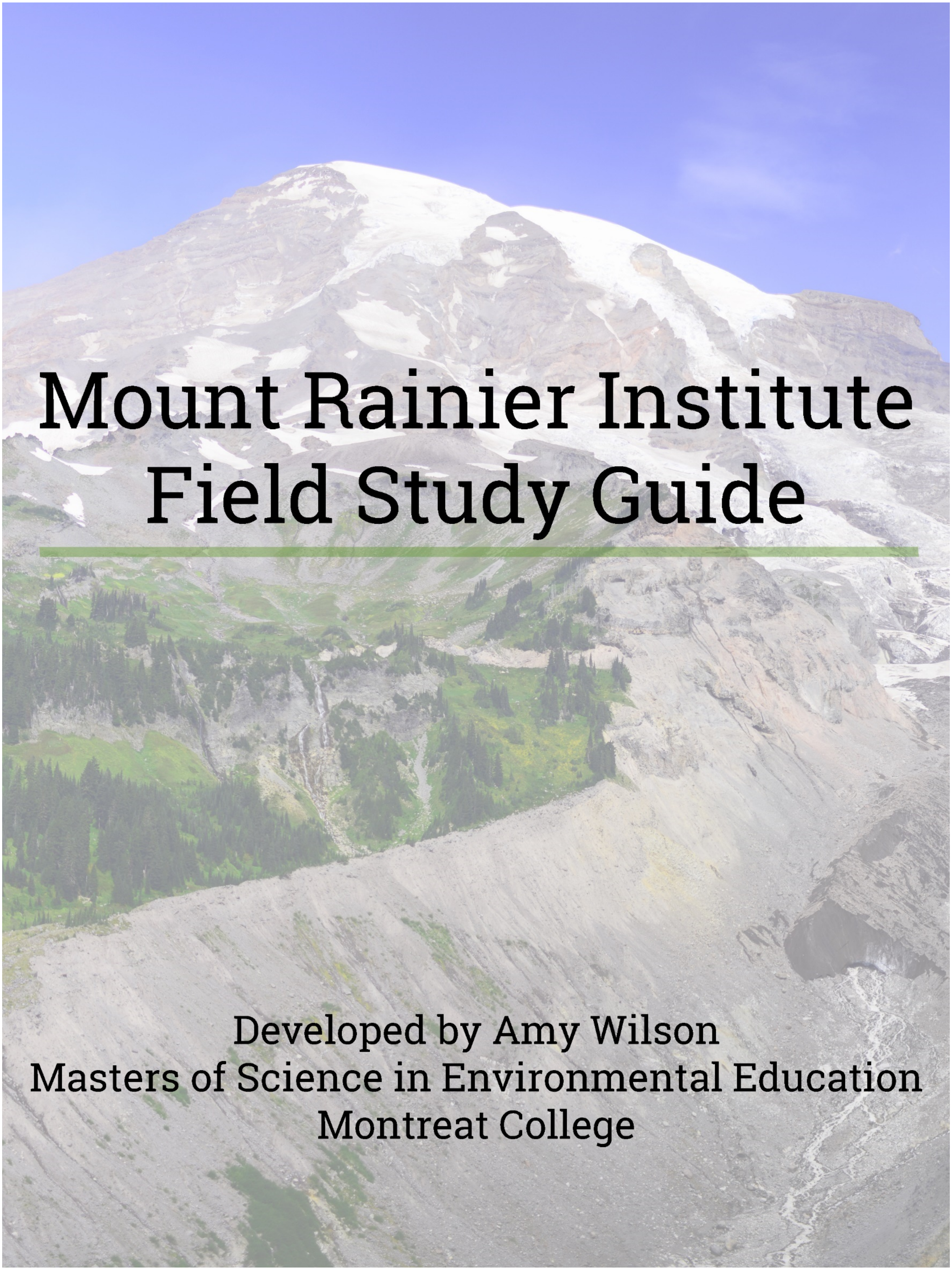

Mount Rainier Institute Field Study Guide

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Masters of Science in Environmental Education
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Table of Contents

Introduction

Introduction

This Field Study Guide was created in support of Mount Rainier Institute's mission, which states, "Mount Rainier Institute provides outstanding nature-based education experiences that are rooted in science and nurture the next generation of environmental stewards and leaders" (Hayes & Wilson, 2016, p.3). The guide was also created with learning transfer in mind and is therefore aligned with many Next Generation Science Standards (NGSS) for middle school students. Using a NGSS alignment aids students in making connections from the classroom to Mount Rainier Institute and back to the classroom again.

Created for use during Mount Rainier Institute's four-day three -night programing, this guide was designed with middle school students in mind. The bulk of these activities were created to fit within an 8 hour and 30 minute day. This day begins at 8:30 am and ends at 5 pm. During the day, instructors will lead students through the first seven activities. This schedule allows for transportation to and from the site, two trailside snacks, lunch, teachable moments and these seven activities to be completed with some flexibility on activity timing. Symposium Preparation will be completed later as an evening program and the Field Science Symposium will be completed on the morning of the student's departure. Mount Rainier Institute uses the Field Science Symposium as a reflective tool, as well as, a way to demonstrate and gain practice in communicating scientific information.

Although this guide was created for use at Mount Rainier Institute, the curriculum design is heavily process-based, which allows for adaptability. This adaptability can happen within Mount Rainier Institute, schools, and other environmental education centers. As a facilitator, it is important to maximize students' experience, which often means adapting activities to meet students where they are and guide them towards educational and community growth. You will find that it is often necessary to adapt these activities to meet the specific needs of students. These adaptations can be as simple or as large as deemed appropriate by the instructor so long as they are in the students' best interest. During the creation of this Field Study Guide it became increasingly important each activity be student centered. Therefore, each activity is written with open inquiry practices in mind. It is likely one of the more common adaptations that will occur with this Field Study Guide is one of a more guided inquiry approach. This will most often happen if the instructor finds the students struggling with cooperative learning or self-motivation. The difference between a guided inquiry approach and an open inquiry approach can be as little as one sentence. Therefore, it is recommended that instructors using this guide have a strong understanding of the differing levels of inquiry and how to move between them if required for the benefit of the students. An instructor not familiar with inquiry may find it difficult to find success with in field adaptation of this Field Study Guide.

Theoretical Framework

The theoretical framework for this field study guide is made up of three separate pieces, all unified within the theme of understanding. The structure of each activity comes from *Understanding by Design* by Wiggins & McTighe (2005). This structure was selected due to its prominence in environmental education curriculum. The creation of activities with this structure also demands intentionality, as this design process starts with the end goal in mind. In an effort to create easy-to-use curriculum with intentionality, the *Understanding by Design* model was adopted. The second piece of the theoretical framework comes from NGSS. In order to develop scientifically literate students, Mount Rainier Institute partners with participating schools. This ensures Mount Rainier Institute is using the correct bridge for learning transfer. The state of Washington has adopted, and is currently using, NGSS to guide science instruction in schools. The last piece of the framework comes from David Kolb's Experiential Learning Cycle (see Figure 1). In this model, there are four stages of learning: Abstract Conceptualization, Active Experimentation, Concrete Experience, and Reflective Observation (Kolb, 2015). Educators can initially engage in Kolb's Experiential Learning Cycle (KELC) at any stage of the learning cycle, so long as the subsequent stages are followed in sequence. For example, if an instructor began in the stage of Abstract Conceptualization, the students might be given or asked to conceptualize an idea, theory, or model that they will be observing (Healey & Jenkins, 2000). The educator would progress onward with the students towards Active Experimentation. In the Active Experimentation stage, an educator would guide students in forming a plan for the upcoming Concrete Experience (Healey & Jenkins, 2000). The Concrete Experience would then demand that learners actively experience the activity they had previously planned (Healey & Jenkins, 2000). Lastly, learners would be encouraged to reflect on the experience by writing, engaging in discussion, or any number of other reflective techniques (Cowan, 2007). Cowan (2007) comments on the idea of repeating the steps of the cycle to make changes in the experience, such as further conceptualization, further experimentation, etc. Repeating steps is not a novel ideal but one that originates in Kolb's ultimate interpretation of Figure 1. When examined as two-dimensional, Figure 1 lies flat as a circle; however, Kolb (2015) suggests a more accurate depiction of the cycle would be a never-ending spiral. This statement from David Kolb echoes much of John Dewey's work, as Dewey believed in continuous lifelong learning (Kolb, 2015). This also seamlessly aligns with the practice of science in the way that answering one question typically leads to asking more questions.

Figure 1. Kolb Experiential Learning Cycle

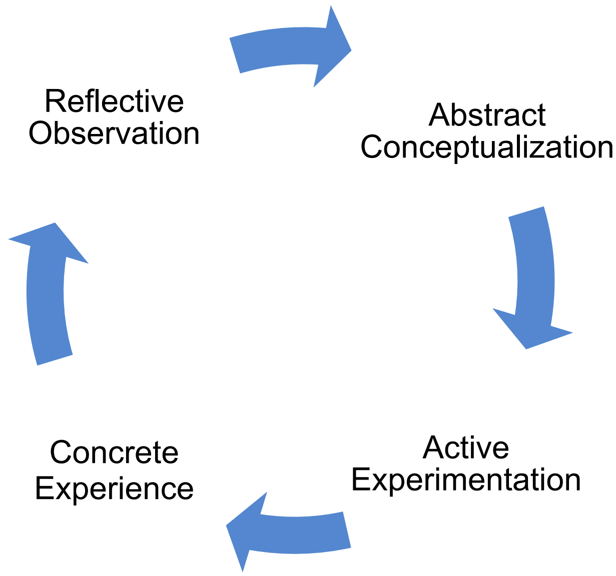

Figure 1. David Kolb's Experiential Learning Cycle (Kolb, 1984)

Curriculum Layout

As you proceed to the delivery portion of the activities you will notice graphics within the directions. Each graphic corresponds to a stage of David Kolb's Experiential Learning Cycle (see figure 2). These provide visual cues of the transition between the four stages of the learning cycle. It is also worth noting that these activities are presented linearly for ease of use. Several of these activities may be used in a different order than they are presented to reach the end goal of a completed field study. There are also materials referenced that can be found in the resource section of this Guide for your use.

Figure 2. Graphics Key

Figure 2. Graphics representing each stage of David Kolb's Experiential Learning Cycle in this Field Study Guide.

01/ Everyday Science

"Equipped with his five senses, man explores the universe around him and calls the adventure science"

- Edwin Powell Hubble

Everyday Science

Goal: Students will begin to think about how we use science practices every day.

Time: 20-30 minutes

Materials:

1 White Board and dry erase marker

4 Sticks

Skill Acquisition:

Demonstrate the ability to incorporate information gained through trial and error to create new and viable solutions.

NGSS Connections:

Practices

Asking questions and defining problems

Planning and carrying out investigations

Core Ideas

Engineering Design: Developing Possible Solutions

Crosscutting Concept

Cause and Effect

Credit:

Magic Sticks is a well-known camp game that has been spliced with an adapted activity idea shared at the 2017 ANCA RELC Conference by Denali Education Center's Youth Programs Manager, Patrick Kelly.

Understandings:

Science practices are relevant and usable in everyday life.

Reinforcing Key Concepts:

Applies science practices to solve a mystery.

Background:

This activity will likely be the instructor's introductory activity for the field study day. The purpose of this activity is to engage students and make science relatable.

Activity Prep:

This activity requires the instructor to plan ahead and gain help from the adult chaperone with the group. The instructions the instructor should give to the chaperone are as follows: "We are going to do an activity around ____ time that I will need help with. Your cue will be everyone sitting in a circle with four sticks placed in the middle. I will give the instructions to the students and walk away. At that point, the students will be responsible for choosing one person to touch one of the sticks. After that person touches the chosen stick and rejoins the circle your job will be to place your hands in a certain position. If the student touched the outermost stick on the right then you will place your right hand on the outside of your leg. If the student touched the inner right stick you will place your right hand on the top of your right leg. The same happens for the two sticks on the left." Specify if the chaperone will mirror the instructors' position or display the stick touched from their point of view. The students will then call the instructor back into the circle and the instructor will start to guess which stick was touched. This will continue for several more rounds.

Assessment:

You will know if students understand the content of this lesson by observing if:

Students modify this activity at least once to reflect knowledge gained in a previous round.

Students' conclusions about what happened during the activity are supported by at least one piece of concrete evidence.

Call the group over and have them sit in a circle.

Ask the students if they are curious and ask them to raise their hand if they like to solve mysteries. Have them think back to the last mystery they solved.

Now ask what things they tried that worked and what things didn't work. Have they created their own formula for solving mysteries? What is this model they have created?

Explain that there is a mystery for the students to solve. Place those sticks parallel to each other in a line in the center of the circle.

Tell the students "I found four magic sticks in the woods one day last week. I don't know how this happens exactly but I know if one of these sticks were touched and I can tell which stick has been touched!" Do not explain anymore to the students about the connection between the instructor and the sticks.

Ask the students if they would like a demonstration.

Tell the students that you are going to walk away from the circle and the students will need to pick one person to get up and touch only one stick.

After that student touches the stick and returns to their spot in the circle the students should call the instructor back into the circle.

When the instructor returns to the circle, they will inspect the sticks to see which one has been touched. What the instructor is really doing is inconspicuously taking note of where the chaperones hands are. Then the instructor will declare to the group which stick was touched.

Ask the students if they have any questions. They will most likely ask, "how did you do that?"

Write that question at the top of the white board, then ask the students if they have any prior knowledge about these sticks from the explanation earlier. Record the prior knowledge on the white board and then explain that the students they will have three more rounds to figure out how the instructor completed this task.

They may change anything about the game except the sticks must stay in their location and they may not touch multiple sticks in one round. They are also only allowed to change one thing, or variable, per round.

Give them a moment to decide if any changes will be made then proceed with round one.

After the round is complete record the change the group made on the white board in the "if… then… because…" hypothesis sentence frame. Also indicate if the instructor could identify the stick that was touched.

Continue this for two more rounds.

Review all changes to the game with students and ask for their conclusion on how the instructor completed the task of identifying the stick.

Now complete one last round with their final conclusion.

Lead a discussion with the students about the fact that they may or may not have succeeded in interrupting the instructors' ability to identify the stick. If they succeeded, were they correct in their conclusion or did they identify another variable at play? Students may need to be reminded that a variable is a feature that may vary or change. If they identified an additional variable then what was that variable?

If the students succeeded in interrupting the instructors' ability to identify the stick but their conclusion of how the instructor was guessing the stick is incorrect, this is a great time to explain why we use the words *supported* and *unsupported* when talking about our hypothesis. We use this language because we did not, and could not, positively say we tested every possible variable. This is where the instructor may or may not decide to reveal the mystery.

This is also a great place to draw the students' attention to the fact that engaging in scientific practice is not a linear process. Many people have confused the way we practice science and formally present science research. Let the students know they will be practicing science as well as organizing their field study for presentation so they will be gaining experience in how the sequence of field study and the sequence of scientific presentation can be vastly different.

Transition Statement and Question:

Tell the students, "In just a moment we will be heading into the forest where we will create and conduct a field study, then form conclusions based on our data and analysis. The skills we will be using are not unlike the skills you use to solve mysteries every day or the skills you used in this game. The largest difference is instead of an experiment like in this game, we will be completing a field study. Tell the students that the scientific skills used in both are mostly the same then, ask the students to think about the difference between an experiment and a field study during their travel to the next site."

When students arrive at the next site before the group begins the next activity, ask them the difference between a field study and an experiment. The answer to this is that an experiment requires the scientist to introduce a treatment and then records what happens to the study subject. An example of this would be applying fertilizer (the treatment) to 1 stand of trees but not to another stand of trees with similar age, size, and soil nutrients. The scientist would then measure both stands of trees for growth and record the impact the fertilizer had on tree growth. A field study or observational study is defined by a treatment that is out of the scientist's area of control. An example of this might be posing the question if the soil in the old growth forest had a higher pH than the soil in a 25-year-old stand? We as scientists cannot just simply make old growth or a 25-year-old stand of trees. These stands would be an example of a treatment out of the scientist's area of control.

02/ Exploration

"In wisdom gathered over time I have found that
every experience is a form of exploration"

- Ansel Adams

Nature Scope

Goal: Introduce the day with a safe and structured way to explore an unfamiliar natural area.

Time: 30 - 45 minutes

Materials:

1 White Board and dry erase marker + *1 per group*

Kaleidoscopes
1 per group

Journal and Pencil
1 per student

Skill Acquisition:

Demonstrate teamwork

Model energy flow between chosen items.

NGSS Connections:

Practices

Develop a model

Core Ideas

Ecosystems: Interactions, Energy, and Dynamics - Cycle of matter and energy transfer in ecosystems. Ex. Old growth forest.

Crosscutting Concept

Energy and Matter

Stability and Change

Understandings:

Students can work together to investigate the world around them, construct models, and build greater understandings of the connections in the ecosystem they are exploring

Reinforcing Key Concepts:

Identify chosen items

Trace energy flow through the old growth forest

Background:

Often, students come to Mount Rainier Institute feeling uneasy and sometimes fearful of being in a forest. This activity places students in small groups for a structured exploration. Using this type of exploration allows instructors to safely engage students that have been showing signs of being wary in nature. This activity can serve as a springboard to introduce the day, provoke questions, and identify connections within an ecosystem.

Activity Prep:

Nature Scope is best completed in an area without stinging nettle, poison hemlock, cow parsnip, or giant hogweed. Remember, a goal of this activity is to safely engage students who are wary of nature. This can be impossible if the activity comes with a lengthy list of biotic factors that could potentially hurt the students. While it is important for students to be aware of all environmental dangers present in any area where programming takes place, it is recommended that environmental dangers be reduced by the instructor, in site selected for this activity.

Assessment:

You will know if students understand the content of this lesson by observing if:

Students use evidence and reasoning in small and large group discussions to support their claims about energy transfer in the ecosystem.

Students model of the forest ecosystem includes at least four examples of energy flow within the system.

Gather the students, after arriving in a new section of the forest.

Ask the group if they have any observations about the area in which they are standing.

Tell students that they will have 15 minutes to explore within the boundaries the instructor has set. Please describe any environmental hazards at this time.

Have students divide into groups of 3-4 and give each group one nature kaleidoscope.

Explain to the students that these kaleidoscopes are special in the way the bottom plastic piece (cup) is removable. They may place small natural items in the cup and look through the kaleidoscope. If students desire an item in the cup to turn they should roll the whole kaleidoscope in their hands (instead of twisting the cup). The instructor should demonstrate.

Instruct the students to explore this new area. Give boundaries. Each student should find one natural item they find interesting that they could contribute to the kaleidoscope.

Before sending the students off, it is important to remind them of their impact on an area. Ask students to refrain from placing picked flowers and arthropods in the cup of the kaleidoscope.

Tell students to observe each item individually in the kaleidoscope before putting all items in the cup together. After each small group has collected and observed their own kaleidoscope, have them present to the larger group.

Release students to explore and be available to aid with teamwork or share in the wonders of the area.

Pull students back together in a circle and pass each kaleidoscope around the circle so that each person has a chance to enjoy the pieces created.

Distribute to each small group a white board and dry erase marker.

Instruct students to carefully place their natural items on the dry erase board and encourage them to circle and label the items they can identify. If they cannot identify the items on their board then encourage them to write descriptions next to them.

Ask a few students to share with the large group why they chose the natural item they did. What did they want to investigate closer?

Now ask students to turn and talk in their individual groups about how each item they chose may be connected in the ecosystem.

Request that they only talk about their chosen natural items for now.

Instruct students to draw arrows on their dry erase board to show those ecological relationships.

Bring students back into one large sitting circle with each dry erase board touching in the center.

Ask the students if they felt like they were missing any key ingredients in order to record those ecosystem connections. Some examples of this may be the sun, water, or animals.

Select a volunteer to draw the student-identified missing links in the ecosystem. As each missing piece is added, reevaluate all other pieces to see if there are any connections to the new piece.

Ask students if there are any surprising ecosystem connections on the boards.

Direct students to grab their pencils and journals and turn to a blank page.

Ask students to walk quietly in the area defined earlier and have them identify any other possible ecological relationships. Ask them to jot down a few ideas to share with the group when they reassemble.

Call the group back for sharing, ask students to state their claims about ecosystem relationships. Then ask for their evidence and reasoning.

Transition Statement:

Tell the students, "Take a moment to reflect on all of the natural items chosen in the beginning of this activity." Find the most common item picked up among the small groups and draw the students' attention to that item. Tell the students, "Just as they worked together to create something they were proud to show off in this activity, they will be doing the same with a field study they create as a large group. I noticed in this activity many of you found the same item interesting and wanted to place it in your kaleidoscope. Finding one thing we are all interested in and excited to share will be our goal the rest of the day."

03/ Asking Questions

"I have no special talent. I am only passionately curious."

- Albert Einstein

Asking Questions

Goal: Students will brainstorm, create, and refine a question that leads their field study.

Time: 30- 40 minutes

Materials:

Scrap paper

Journal and Pencil
1 per student

Skill Acquisition:

Create an answerable question that is time-bound.

NGSS Connections:

Practices

Asking questions and defining problems

Core Ideas

None Specified

Due to the open inquiry process completed with each field group during the field study, core ideas will be student-led and emerge during this activity

Crosscutting Concept

Cause and Effect

Understandings:

The question chosen by the students will guide the whole field study, as the purpose is to find the answer to that question through field research.

Reinforcing Key Concepts:

Compile a student-generated bank of answerable questions

Choose a question from the bank of questions and refine it for use in the field study

Background:

The hardest, and arguably most important, tone-setting activity for the field study, is that of creating, choosing, and refining a question for use during the field study. If the group starts with a vague question, the data will reflect it, so it is important that after a viable time-bound question is chosen, the instructor takes time to help the group refine the question to be as specific as possible. This activity can be completed before or after the Scope of Study activity.

Activity Prep:

This activity requires very little preparation, as lined journal pages and pencils are all the instructor will need. This activity will require students to partner up and collaborate on ideas that are eventually written down in one student's journal. Remind the students to write all group members names at the top of the journal page. This helps the students' teacher when reviewing journals to see where certain work was recorded.

Assessment:

You will know if students understand the content of this lesson by observing if:

Students present one achievable, time-bound field study question.

Asking Questions Facilitation

In the Exploration activity, students ended with a claim about possible relationships in the ecosystem. They also stated their evidence and reasoning for this claim.

Now, tell the students that they are responsible for coming up with a question that will guide the rest of their field study. This question must be answerable in the span of just a few hours and must be centered on realistic and likely possibilities.

Give the students an example of an unrealistic and unlikely field study topic, such as observing mountain lion behavior.

Ask the students what wildlife species they have observed since being at Mount Rainier Institute. Ask them why they think that is—why those species, and why so few individuals. The explanation is that it is hard to observe any type of wildlife when 12 people are walking together on the trail. The animals tend to smell and hear people long before they see them.

Instruct the students to recall the item they chose for the Nature Scope activity. Ask them what was interesting about that item? Tell the students even though it was a small item it had a greater impact to the larger ecosystem.

Have students partner up and grab a journal and a pencil.

Tell students they will have five minutes to brainstorm and come up with at least 10 realistic, time sensitive, and answerable questions about the forest. The question they are excited about the most, or the one they think is the best, all pairs will share with the rest of the group when everyone comes back together.

Tell students when their five minutes starts. During this time, the instructor should walk around to each group of students and get an idea of the broader topics present in the questions. This allows for the instructor to prepare mentally before the group discussion. This also allows students to ask for help in a casual environment, rather than with the whole group present.

After the five minutes are up, explain to the students they have another five minutes to talk about their questions, choose the best one, and refine the question into a useable field study question.

After the last session is complete, ask the students to come back together and share the question they chose.

This is where the instructor will need to listen very carefully. If students have simple questions, and several students have the same topic, is there a way to combine them? Can this be done without losing the integrity of the questions?

The students may also share the questions they created and they may be perfect for the time and topics available to the group that day. If this is so, and there is more than one question that is in favor, have students vote on the question they are most excited to research.

Note: If there is a popularity dynamic playing out in the group, ask students to write down their questions on a scrap piece of paper and turn them in. The instructor may then draw the questions out of a hat or bag one by one and share them with the group. The instructor may also have students make a blind vote. This is where students close their eyes and raise their hands when the question they want to investigate further is read out loud by the instructor.

After the question is chosen, is there any need to clarify, or add anything to the question? If so, pose this to the group and let them take over the process. If not, then the group has their field study question.

04/ Scope of Study

"Deciding what not to do is as important as deciding what to do"

- Steve Jobs

Scope of Study

Goal: Students will choose the most appropriate equipment to complete their field study.

Time: 30-45 minutes

Materials:

1 Field Tape
1 DBH Tape
1 Landscape Flag
1 Calculator
1 Densitometer
1 Compass
1 Clinometer
1 Increment Borer
1 Leaf Litter Box
1 Bug Box
1 Pack Forest Map
1 Sibley Bird Guide
1 Pojar Plant Guide
1 Quadrat
1 Thermometer
1 Tarp
Journal and Pencil
1 per student

Skill Acquisition:

Demonstrate appropriate choice and use of field equipment

NGSS Connections:

Practices

Planning and carrying out investigations

Core Ideas

Engineering Design-Developing possible solutions

Crosscutting Concept

None identified

Understandings:

The scope of the study is not just what equipment is available and appropriate to use. It is also about the time available, cooperation of the team, objectives of the study, and methods of data collection.

Reinforcing Key Concepts:

Identify available equipment and its various uses

Summarize the individual pieces of S.C.O.P.E (Schedule, Cooperation of the team, Objectives of the study, Protocol, and Equipment)

Background:

Rarely do students come to Mount Rainier Institute with experience in full-day field studies. Because of this, students often don't understand the importance of the scope of the study.

Activity Prep:

This activity is very materials heavy, as students will be deciding their question and hypothesis in the field, and therefore it is almost impossible to know exactly what to pack. If students showed an interest in one topic over another on the previous day, the instructor may be able to scale back on the materials taken out into the forest. Otherwise, have a plan to introduce these materials before the group gets too far from the forest road. The materials should all be laid on half of the tarp and covered with the other half before students engage in the area. A good time to set this up is while students are completing their structured exploration of the area during the nature scope activity.

Assessment:

You will know if students understand the content of this lesson by observing if:

Without prompting from instructor, students choose the appropriate equipment to complete their field study.

Scope of Study Facilitation

Call students together around the tarp that has been set up.

Tell the students they will have 20 seconds to view what is under the tarp. They should try to remember everything on the tarp. Have students take note of their body placement so that everyone is able to see during the 20 seconds and remind them not to touch anything on the tarp because that could also obstruct someone's view.

Uncover the materials for 20 seconds, then recover them with the tarp.

Ask students how many items were under the tarp and what their names are.

At this point uncover the items and review each item as students list them off. An example of this would be the students naming the field tape and then the instructor asking students how they could use it in a field study.

Invite the students to sit, and explain to them that this is the equipment they have access to today to answer the research question they decided upon earlier in the day.

Then explain that the available equipment falls into the extent, or scope, of this field study.

Tell students: "One thing we need to be careful of as we complete this field study is being aware of the scope of our study. SCOPE stands for schedule, communication, organization, protocol, and equipment. We must take all these things into account to finish our field study on time. We also think about these pieces to make sure we are on track with our field study. Today, we have until 5 pm to finish our field study—that is our *schedule*. *Communication* is up to each and every person in this field group. This means leaving time to double check data and communicate if you need help with a task. When you get further along in the field of science you may be communicating with an expert on an unknown species, so you must leave time for appropriate communication depending on your circumstances. If you are *organized* in your movements and tasks, then data collection will be easy. If you are not organized and in communication with the rest of your team, data collection will take much longer. The *protocol* is something we will be creating a little later and we will be following the directions we write like a recipe. This protocol needs to reflect our *schedule* so it must be time-bound. Lastly, the *equipment* available for our use is part of the scope of our study."

Ask the students what equipment in front of them would help them collect data to answer their question.

Then as a group, ask the students to make their final decisions about their equipment. As the final decision is reached, have students list in their journals the materials and how they will be used. This is information the group will come back to during the creation of their protocols.

Note: The materials listed in the section above are materials that Mount Rainier Institute has and frequently uses for field studies. This material list often changes with the addition of equipment.

05/ Protocol

“Every great design begins with an even better story”

- Lorinda Mamo

Practicing Protocol

Goal: Create awareness of field study protocols and how they should be conveyed.

Time: 90 - 150 minutes

Materials:

1 6-Sided Die

1 White Board and dry erase marker

Item to Hide
1 per group

Landscape Flags
1 per group

Journal and Pencil
1 per student

Skill Acquisition:

Provide precise instruction

NGSS Connections:

Practices

Asking questions and defining problems

Planning and carrying out investigations

Core Ideas

Engineering Design - Defining and delimiting engineering problems.

Crosscutting Concept

Scale, proportion and quantity

Understandings:

Students will work together to create sound field study protocols. These protocols are important to follow so that replication studies can be conducted and precise data gathered.

Reinforcing Key Concepts:

Break down a complex task into smaller parts

Recognize a precise way to measure distance

Background:

Students come to Mount Rainier Institute knowing how to give and take simple step-by-step directions. However, we often find that students struggle in creating precise instructions for a field study. This activity will allow students to gain practice through trial and error before creating their final field study protocol as a group.

Activity Prep:

Select a site where students are safe going off trail and can easily hide a small item on the ground. Site selection, as described, adds a level of difficulty and authenticity to the activity. There should also be an area nearby that is large enough to sit everyone down for a group discussion.

Adaptation: The instructor may also provide field tapes as an optional piece of equipment so students can measure precise distances rather than counting their steps.

Assessment:

You will know if students understand the content of this lesson by observing if:

Students adjust the second active experimentation stage to provide more precise instructions than the first active experimentation stage.

Students break complex directions into at least 3 smaller parts.

Ask students to help generate a list of what makes good, easy to follow directions. Ask them to focus on their own past experiences and what helps them individually.

Write that list down on a white board. The instructor may ask students to be more specific or generalizations may be used.

Summarize the list with the preface: “We believe good, easy to follow directions consist of …” then read off the list.

Now tell students they will be hiding an item in the forest and creating directions for someone else to follow, so they can find the hidden item. The goal is for the finders to follow the step-by-step instructions to locate and retrieve the item within 5 minutes.

The catch is the finders may not make any moves not written down on the direction card and the directions must direct the finders to walk around Sword Ferns as these are shelter for many small mammals and birds.

Have students grab a partner, a flag for their starting point, an item to be hidden, journals, and pencils.

Students will have 10-15 minutes to hide their item and create directions to find the item. Remind students of the list generated by the group earlier, and that the finders should be able to locate the item in 5 minutes without stepping on Sword Ferns.

After the pair has created adequate directions to their hidden item they should find another pair that has completed the task.

The group that created the directions should show the finder group the starting flag and hand them the directions. They will also time the finder group and tell them when time is up. There should be no other interaction between the pairs.

The groups should then switch, with the same rules applying to the new finder group.

Have the students note if they found the item or how close they were to the item when the directions ended.

Gather the students in a circle and have a seat.

Ask them how many of the students found and retrieved their item? How many did not find the item they were given directions to? How many students found but could not retrieve their item? Ask the students how far away they were from their item, then ask them if the area they had to cover was doubled would they be further away or closer to retrieving their item?

Pull out the die and explain that each number has a corresponding sentence frame. Each student will roll the die and complete the sentence frame to share a thought or observation with the group.

1 - If I were to write my directions again I would….

2 – I found this activity difficult because….

3 – I liked ______ about the directions I was given.

4 – I was (successful/unsuccessful) in this activity because…

5 – I found that the 5-minute time to find the item was (enough/not enough) because ...

6 – I found that the 15-minute time to create the directions was (enough/not enough) time because …

At this point, bring out the list generated at the beginning of the activity and add to it the larger themes brought to light by the die reflection.

Ask the group if they see any areas in the list that should be more specific. Explain to them the group will be comparing their created protocols to this checklist to ensure the protocols for their field study are sound.

Ask several students to grab the equipment identified earlier for use in the field study and have them place it in the middle of the circle. This is a quick and easy task to break up sitting for those students that find sitting for longer than five minutes difficult.

Have students' double check that all equipment chosen for the field study is written in their journals.

Have students turn and talk to another person about how they would set up this study and why. Students should be able to describe the number of plots sampled, how equipment will be used, and in what order this will happen.

Ask each pair or small group to share with the larger group some of the ideas they came up with and how they approached any problems they identified.

While students are sharing their ideas, the instructor should be compiling ideas into step-by-step directions to be used for the field study protocol. The ideas complied here should represent the ideas with the most group support or the ones shared by multiple students.

Expect for the ideas shared to need some refining before use. The instructor should then guide students through their previously created list of what makes directions easy to follow. Use these as a check list and encourage everyone to not only state the revision needed but why it is needed.

Lastly, the instructor should ask the students how they should record their data. As the students describe the data table draw it on a whiteboard, then have all students copy this table into their journals.

Seeing as this will be many of the students' first field study, the protocol nor the data table will be perfect. This is OK. It is important to resist the urge to continue sitting in the same location to make the protocol perfect.

Ask students to stand and self-assemble. They should now be instructed to complete the protocol.

Students may need help assembling effectively and they may need reminders to record their data as they collect it.

After the students have completed one plot ask them if they should change anything.

Record any changes made by the group to the protocol for use on Plot 1. Also check in with everyone to ensure that all jobs are actively being worked on. If an area is lacking in attention, assignments may become necessary. Remember: each group will be different in maturity, self-motivation, and their ability to work together effectively. The group should then continue to complete the fieldwork as specified within the protocol until all data has been collected.

06/ Analyzing Data

"It is a capital mistake to theorize before one has data."

- Arthur Conan Doyle

Analyzing Data

Goal: Students will make a conclusion from the data collected and analyzed.

Time: 30 minutes

Materials:

1 White Board and dry erase marker + *1 per group*

Graph Resource Sheet
1 per group

Journal and Pencil
1 per student

Skill Acquisition:

Select the appropriate graph for the data represented

NGSS Connections:

Practices

Analyzing and interpreting data

Core Ideas

None Specified

Due to the open inquiry process completed with each field group during the field study, core ideas will be student-led

Crosscutting Concept

Patterns

Understandings:

Data analysis and representation is key in creating a solid conclusion to any field study.

Reinforcing Key Concepts:

Create a graph illustrating the data collected from the field study

Develop a conclusion based on the graph students create

Background:

Data analysis can be overwhelming to students. It is important that this activity is broken up into smaller pieces so the students are not trying to synthesize everything all at once. When met with data, graph choice, and design to communicate their findings, students often place more effort into one area while other areas fail to meet expectations. This activity takes students through a process so they spend equal amounts of time on each part to produce a well thought out visual representation of their data.

Activity Prep:

This activity has been designed in such a manner that it can take place on the trail or back in the lab. No matter what location is used for this activity, the data chart must be transferred to a white board for the next activity. Each group will need a white board and dry erase marker if the group is completing this in the lab. If the instructor chooses to do this on trail natural found items like fir cones, sticks, and rocks may be used to create the graphs.

Assessment:

You will know if students understand the content of this lesson by observing if:

Students choose the appropriate graph that best represents their data and conclusion.

Students present a conclusion based on evidence and can support their conclusion with reasoning by using experience-based evidence.

Analyzing Data Facilitation

Call students together around the data, which at this point, should be written on a white board.

Tell the students that while *they* know what this data represents, if they were to show it to the general public, people would not be able to quickly and efficiently process the data to find meaning.

Therefore, the path most traveled to present large amounts of data is to create a graph or graphs so that ideas can be visually digested. This way the audience does not have to complete mental math to arrive to the same conclusion the trail group was already aware of.

The most important, and often hardest, part of the graphing process is choosing the appropriate graph.

Explain to the students that in just a moment they will placed in three groups. Once in these groups they will receive a graphing resource chart. They will then have five minutes to discuss in their small groups what type of graph to use to convey their field study data and what titles will be on the x and y axis of their graph.

These graphs should have a title, labeled x and y-axes, and a key.

Distribute one white board and dry erase marker to each group after their five minutes are up and have all groups start working on their graphs at the same time. Give them another five minutes to work together to create their graph.

When the time is up, ask each small group to present their graph to the rest of the group. If the instructor also created a graph, now is the time to present that to the students.

Compare each graph: is the same information in the same location in each, or is it in various locations? Are all the graphs the same, and do they convey the point the students were aiming for?

Find something positive to say about each graph. Then with the aid of the students, set about taking ideas from each group's graph, to assemble the parts for the final graph. This will allow the instructor to aid the students in the group decision making process that must happen to create the final graph they will use in their presentation.

Once the final graph is recorded, give students a few moments to reflect silently on what the graph shows and come up with their own conclusions about their data.

Ask students to share their conclusion with the group, along with anything else they may have thought of while digesting the data. It may help to give them sentence frames such as: I noticed _____. I was surprised by _____. There seems to be a pattern ____. Our original question was _______ (supported/unsupported) with this data. The data seems to be affected by ______.

The conclusions and observations the students make in this portion of the field study may come back into the conversation when wrapping up the presentation and talking about larger implications of their research.

07/ Conclusions and Arguments

"Stay open minded. Things aren't always what they seem to be."

- Scottie Waves

Conclusions and Arguments

Goal: Students will offer conclusions and arguments to statements about observed phenomena.

Time: 20 – 40 minutes

Materials:

1 Set of Multifarious Cards
See resource section

Journal and Pencil
1 per student

Skill Acquisition:

Communication of differing opinions

NGSS Connections:

Practices

Constructing explanations and designing solutions.

Engaging in argument from evidence

Core Ideas

Ecosystems: Interactions, Energy, and Dynamics - Interdependent relationships in ecosystems

Crosscutting Concept

Cause and effect

Understandings:

Conclusions can often be made at the end of a field study. However, it is also important to identify any unmeasured factors in the study that may have influenced the conclusion.

Reinforcing Key Concepts:

Generate and justify explanations of natural phenomena

Identify and describe ways to test a plausible explanation for a natural phenomenon that has more than one possible cause

Background:

Students often come to Mount Rainier Institute with a fear of being wrong. This fear can dampen discussion and run counterproductive to the goals of scientific exploration. Therefore, this activity focuses on phenomena in nature that could be explained with multiple answers. The hope is that this activity will open the doors to deeper discussion in preparation for the Field Science Symposium.

Activity Prep:

This activity asks students to think critically, supply explanations, and propose how those ideas should be tested. There will be disagreements throughout this process, which makes it important to set up this activity as a respectful academic dialogue. These types of conversations typically create a richer discussion and often provide a deeper understanding of the topic. They also shed light on thoughts or ideas that may not have been previously considered. Because each group is different, the instructor has room to choose what to emphasize in transitions and introductions based on the group's prior knowledge or experience.

Assessment:

You will know if students understand the content of this lesson by observing if:

Students communicate without interrupting peers, on points of differing opinions.

Students can describe at least one way their explanations may be tested.

Conclusion and Arguments Facilitation

Gather students and tell them one of the things that creates sound science is peer review. Remind students that they will later present their field study to their peers, and that their peers will have questions and comments directed towards their field study.

Tell students that the conclusion of a field study is often linked to the scope of the study and the specific question asked. Many times, in scientific journals, the reader will find a statement from the researchers that, while they found a positive correlation between the presence of species A and the overall health of species B, other influences cannot be ruled out. The researchers will recommend further study in this area with a focus on these possible influences.

Ask students if they can think of a statement that could have multiple scientific explanations before an investigation or study was completed. An example statement could be: a tree's leaves are dying. Ask the students to provide multiple reasons as to why the tree is dropping its leaves. Answers could include: drought, fungus, insects, or it is a deciduous tree and it's fall.

Ask students to come up with a statement that has multiple reasons as to why or how this natural phenomenon is taking place. After a few statements have been shared with the group. Then ask, how can we determine one conclusion was more plausible than another? The goal is to think about how students would go about providing data for these explanations.

Break the students into groups of 3 or 4 and give each group 5 cards from the Multifarious stack. Their assignment is to write down as many explanations as possible to the conclusion statements provided on the cards. Tell the students they will have about 5 minutes to complete this task.

After the 5 minutes are up students should be asked to pause. They should now use the next 5 minutes to come up with numerous ways to test their explanations.

Bring students back together for reflection. Ask each group to choose one statement from their Multifarious cards and the accompanying explanations to share with everyone.

Explain to the students that after each group has had a chance to share, the floor will be open for other individuals to present another possible explanation of how or why their phenomena is happening.

After the first group shares and a different explanation is presented from outside the first small group, ask the whole group how they would go about further study to see if one explanation had more of an influence on the natural phenomena than the other.

Continue this process until all small groups have shared.

Transitional/Closing Statement:

Tell the students, "Just as we have seen in this activity, there can be many explanations for one phenomenon and unless these explanations are tested or more data is provided, no answer is better than another. It is important to remember this going into your presentation as other trail groups may ask if you tested another angle. Always answer truthfully; it is ok to say "No, we didn't think about that" or "It didn't come up in our discussion." Be ready, however, to explain how you could go about testing that hypothesis."

08/ Symposium Preparation

"There are no secrets to success. It is the result of preparation,
hard work, and learning from failure."

- Colin Powell

Symposium Preparation

Goal: Students will prepare a professional presentation detailing their group's field study.

Time: 60 – 90 minutes

Materials:

1 Computer

1 Jump drive

1 Poster box

1 Set of PowerPoint template cards *see resource section*

Journal and Pencil
1 per student

Skill Acquisition:

Practice public speaking skills

NGSS Connections:

Practices

Obtaining, evaluating, and communicating information

Core Ideas

None Specified

Due to the open inquiry process completed with each field group during the field study, core ideas will be student-led during the symposium

Crosscutting Concept

Influence of engineering technology and science on society and the natural world

Understandings:

Organization of scientific information for the purpose of presentation is much different than conducting the study in the field

Reinforcing Key Concepts:

Outline the steps of the field study clearly and concisely for display on the PowerPoint presentation

Prepare the speech that accompanies the PowerPoint presentation, which should differ from the bullet points displayed on the PowerPoint

Background:

We like to recognize that so far, we have asked a lot of the students in the field study process—they have created their question and methods, obtained data, and analyzed their results. However, we do not want to give the impression that their field study ends there. After all, if scientists never shared any of their data with the world, we would have far less data at our fingertips. Scientists from all over the country come to this forest to study various ecological interactions.

Activity Prep:

At Mount Rainier Institute, we hold our Field Science Symposium Prep in one of our on-site labs. Materials such as the computer, jump drive, poster box, and poster paper should be set up in the lab the group will use prior to the group's arrival to the lab.

Assessment:

You will know if students understand the content of this lesson by observing if:

Students will practice demonstrate understanding of content in their final presentations by speaking clearly about content that enriches the slideshow.

Students will practice facing the instructor, project their voice, and speak clearly during the practice presentation.

Gather students in the lab for a short instructor-led presentation on a field study that has been completed at Pack Forest.

The object of this presentation is to demonstrate effective public speaking skills, allow students to see the presentation format they are expected to use, and see research conducted in the same location.

After the presentation, allow students to ask any questions they may have, then ask students to critique the presentation style the instructor used. The group will be able to draw on these critiques later in the activity.

Tell the students they are about to create their own presentation to present to the large group.

At this time, write each slide title from the PowerPoint on the white board. Tell students they will each be responsible for creating and presenting one slide.

Ask for volunteers for each slide and place their name on the whiteboard next to the slide name as a reminder.

Pass out the PowerPoint template cards. Each card represents a slide in the PowerPoint and provides a prompt about what information should be on the slide.

Next, ask students to find a quiet place to jot down their thoughts. After a few minutes, interrupt the students and explain that individuals will be called over to the computer to type up their slide. If they complete their slide before they are called up then the students should write down how they would verbally present the slide. They will be allowed to take a note card into the presentation with them. Students that were called to the computer first should proceed from the computer to writing notes on their verbal presentation.

Continue calling students over to the computer one by one as they are ready with their slide content. Make sure to save the presentation on the jump drive after each student has typed up their slide.

As students finish up, they should be directed in several ways. They should be directed to help the person/s responsible for data or conclusions and further implications.

The student/s responsible for data should be given the option to enter the data into the PowerPoint and create a graph with the graphing feature or create a poster with this information.

Give students a hard deadline for their section to be completed, as the instructor will want the last portion of the prep time for a practice presentation.

Assemble the students in the order they will speak. Ask them to look left and right and to remember who is beside them (this will save time later).

Remind students of the public speaking skills they should be practicing.

1) Face the audience.

2) Speak loudly and project your voice.

3) Glance occasionally at the notecard instead of reading from it the entire time.

This is also a great time to remind the students of their critiques on the earlier presentation given by the instructor, so they do not make the same mistakes.

The instructor will advance the slides and cue the group when to start in the final presentation, so this should also be done in practice.

Begin the practice presentation.

Ask for any clarification at the end of the presentation and give gentle reminders about voice projection, or any other things students may need to work on.

After the practice presentation, sit the students down for a discussion about any changes that need to be made.

Ask students what questions they might have if they were to view this presentation as the audience? If they come up with any questions, then they have identified holes in the information given, and those holes should be filled in before the final presentation is delivered.

Make sure that all changes are made to the students' notecards before they are dismissed. These notes will stay with the students so they can continue to read over them and practice, if they so choose, before the final symposium. This is extremely important for students with differing abilities.

Transitional Statement:

Tell the students, "On Thursday morning, you will be presenting this presentation to the rest of the group. You all have worked very hard in creating this field study, compiling and analyzing data, and creating this presentation. Please make sure that you look at your notes for your slide at least once between now and when our group presents. This will ensure that you are well prepared and all your hard work shows through in the presentation."

09/ Field Science Symposium

"I believe scientists have a duty to share the excitement and pleasure of their work with the general public, and I enjoy the challenge of presenting difficult ideas in an understandable way."

- Antony Hewish

Field Science Symposium

Goal: Students will present scientific information using public speaking skills.

Time: 45-60 minutes

Materials:

1 Computer

1 Projector

1 Projector Screen

2 Poster Easels

Skill Acquisition:

Demonstrate appropriate and effective public speaking skills

NGSS Connections:

Practices

Asking questions and defining problems

Core Ideas

None Specified

Due to the open inquiry process completed with each field group during the field study core ideas will be student led during the symposium

Crosscutting Concept

Science addresses questions about the natural and material world

Understandings:

Scientific knowledge should be shared and can inform political, ecological, and land management decisions

Reinforcing Key Concepts:

Present scientific information to a large group

Explain parts of the field study to audience members who ask specific questions about the group's study

Background:

At Mount Rainier Institute, we believe it is very important for students to close out their field study by communicating their findings with the rest of their school group. We don't want to give the impression that scientific findings are left in a notebook never to be looked at again. It is for this reason that the final day of programing includes a Field Science Symposium. While many students have presentation experience, a much smaller number have presented to large groups. Reminding them of the public speaking skills they learned during the Field Science Symposium Prep will be important before the symposium is underway.

Activity Prep:

At Mount Rainier Institute, we hold our Science Symposium in one of our on-site lecture halls. This hall is set up with rows of chairs facing a projector screen positioned at the front of the hall. We also provide two poster easels on either side of the room for the students to use. Every care should be taken so that the screen, easels, and other props do not obstruct students from view of the audience.

Assessment:

You will know if students understand the content of this lesson by observing if:

Students will demonstrate understanding of content in their presentations by speaking clearly about content that enriches the slideshow.

Students will face the audience, project their voice, and speak clearly during the presentation.

See presentation rubric on page 47

As students arrive at the lab, make sure they have their notes, journals, and pencils.

After all students are present, assemble students and explain that the purpose of this meeting immediately before the Field Science Symposium is to give them time to do any final preparation and to practice.

If practice is possible immediately, then begin practicing with public speaking skills in mind.

If practice is not immediately possible, finish the last-minute preparations and then practice. This practice time allows students to feel more at ease about presenting their slides.

At the scheduled time, move to the lecture hall, bringing along journals, pencils, posters, and the jump drive with the finished PowerPoint.

Enter the hall and sit as a group. If time allows, preload the presentation on the computer and minimize it for ease of transition.

The symposium host facilitates the remainder of this activity.

The host should welcome all students, school officials, and visiting guests with an air of excitement and pride.

Ask students to reflect on their field study. Did they find any challenges? If so, raise their hand.

Draw everyone's attention to the number of raised hands in the audience. Remind them that everyone worked hard to overcome these challenges and to create something they were proud to share. It is for this reason that the audience should show the upmost respect for each presentation group. Remind the audience to refrain from side conversations and to silence or turn off their cell phones.

Explain that after each presentation the group should stay standing after the applause to any questions the audience may have. This also means that it is up to the audience to

be active listeners and to hold any questions they have about the presentation until the end.

Call the first group up, aid students in hanging posters, if they choose to show their data on a poster instead of in the PowerPoint. Then draw the audience's attention toward the front of the room and give the floor to the trail group presenting.

After their presentation, facilitate the Q & A session. As this is going on, the next trail group's instructor should be loading their PowerPoint onto the computer.

Continue calling up, handing the floor over, and facilitating the Q & A sessions for each group, keeping an eye on the time to make sure each group is given enough time to present and answer questions without being rushed.

In conclusion, tell students that there are people who conduct field studies for a living. Share the list of active research happening in Pack Forest or the list of research happening in Mount Rainier National Park. Tell students that if they enjoyed the research process there are opportunities to volunteer in citizen science programs at Mount Rainier National Park where they can collect data that will be used in current studies. Eventually gaining a job in the field of ecology, environmental sciences, or biology could also be perfect for them.

Note 1: The symposium host at Mount Rainier Institute is that of the Education Coordinator or Director as we want this Field Science Symposium to feel professional and out of the ordinary for students. The host role can be taken on by an instructor, however, the Symposium gains an ordinary everyday feeling as students have been with the instructors and received instruction from the instructors the whole week.

Note 2: This activity was included as it is extremely important to encourage a positive learning community at Mount Rainier Institute. We also want students to gain practice with communicating scientific information. The Field Study Symposium calls for each trail group within the larger school group to prepare, present, and participate in the audience. Due to this fact the Field Study Symposium does not clearly translate into the framework of Kolb's learning cycle. Therefore, that framework was not used for this activity. However, this activity does serve as a reflection time for students.

Glossary

Affect – to have an effect or make a difference to. *verb*

Biodiversity – a measure of the **diversity** within an ecological community that incorporates both **species** richness (the number of **species** in a community) and the evenness of **species'** abundances. This can be calculated with Simpson's Biodiversity Index.

Correlation - extent to which two variables have a linear relationship with each other.

Dependent Variable – a variable (often noted as y) whose value depends on that of another.

Effect - a change that is a result or consequence of an action or other cause. *noun*

Experiment- When investigators apply treatments to the study subject and then measure and record the effect of the treatment on the subject.

Field Study – when observations and measurements are taken by investigators without applying treatments to the study subject.

Independent Variable – a variable (often noted as x) whose value does not depend on that of another.

Limitation – a restriction or weakness.

Scope – extent or range of view, outlook, application, operation, or, effectiveness.

Species abundance - number of individuals per **species**, and relative **abundance** refers to the evenness of distribution of individuals among **species** in a community.

Species richness - number of **species** present in a sample, community, or taxonomic group.

Variable – is not consistent or easily predictable.

References

Cowan, J. (2007). *On becoming an innovative university teacher* (2nd ed.). Maidenhead: McGraw-Hill Education.

Hayes, J., & Wilson, A. (2016, August 8). *Teacher Planning Guide*.

Healey, M., & Jenkins, A. (2000). Kolb's experiential learning theory and its application in geography in higher education. *Journal of Geography, 99*(5), 185-195.

Kolb, D. A. (2015). *Experiential learning: Experience as the source of learning and development* (2nd ed.). Upper Saddle River, NJ: Pearson Education, Inc.

National Research Council. Standards committee on conceptual framework for the new k-12 science education. (2012). *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington: National Academy Press.

Wiggins, G., & McTighe, J. (2005). *Understanding by design* (Expanded 2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Resources

Multifarious Instructor Answer Cards

To print: Select print on both sides – flip on long edge.

Print on durable paper and cut out for easy storage.

Statement: A leaf has turned brown and has fallen away from the tree.

Statement: There is a scar on the bark of a tree.

Statement: The river is flooding.

Statement: The birds in the forest are all calling at once.

Statement: The sky is growing darker.

Statement: There is an open area in the forest that just last year had standing trees but now no longer does.

Statement: The river has changed course since last season.

Statement: An animal has been recently listed as endangered.

Statement: Mount Rainier has changed in shape.

Statement: The ground is shaking.

Statement: A piece of trash is hanging in a tree.

Statement: Fish are disappearing from a waterway.

Statement: A burl forms on a tree.

Statement: A mushroom grows in an area where no other mushrooms are seen.

Statement: There is a pile of sticks and branches near a body of water.

Statement: A tree has died.

Statement: There is a boulder field in a valley.

Statement: A very large ant hill is full of activity, more so than usual.

Possible Answers:
Lighting struck the tree
The bark was harvested
Injury from frost
Injury from fire
Injury from machinery
Carving in the tree
Insects

Possible Answers:

It is fall
Drought
Disease
Fungi

Possible Answers:

Timber harvest
Forest fire
Storm winds

Possible Answers:

A storm is coming
Dusk is approaching
Eclipse

Possible Answers:

Alarm Call
Predator
Dawn Chorus

Possible Answers:

Beaver Dam
Trash
Rain event
Glacial Outburst

Possible Answers:

Earthquake
Heavy machinery moving
Tree falling
Low flying plane

Possible Answers:

Glaciers
Rock slide
Water
Eruption

Possible Answers:

Loss of Habitat
Overhunting
Pollutants
Loss of Genetic Variation

Possible Answers:

Large Rain Event
Glacial outburst
Debris flow

Possible Answers:

The rest of the fungi has not fruited yet.

Located in small shady patch.

Possible Answers:

Disease
Insects
Fungi
Wound

Possible Answers:

Newly Constructed Dam
Pollutants
Overfishing

Possible Answers:

A Human placed it there
Storm blew it there
Carried there by animals

Possible Answers:

Vibrations in the ground
Predator
Intruder

Possible Answers:

Site of a Lahar
Rock Fall
Avalanche
Glacial

Possible Answers:

Storm
Disease
Insects
Fungi
Poor Nutrients

Possible Answers:

Beaver
Deposited by Flooding
Human Caused

Multifarious Student Cards

To print: Select print on both sides – flip on long edge.

Print on durable paper and cut out for easy storage.

Statement: A leaf has turned brown and has fallen away from the tree.

Statement: There is a scar on the bark of a tree.

Statement: A very large ant hill is full of activity more so than usual.

Statement: The river is flooding.

Statement: The birds in the forest are all calling at once.

Statement: The sky is growing darker.

Statement: There is an open area in the forest that just last year had trees but now no longer does.

Statement: There is a pile of sticks and branches near a body of water.

Statement: The river has changed course since last season.

Statement: A piece of trash is hanging in a tree.

Statement: An animal has been recently listed as endangered.

Statement: Mount Rainier has changed in shape.

Statement: The ground is shaking.

Statement: There is a boulder field in a valley.

Statement: Fish are disappearing from a waterway.

Statement: A burl forms on a tree.

Statement: A mushroom grows in an area where no other mushrooms are seen.

Statement: A tree has died.

PowerPoint Template Cards

Introduction

This is where you will introduce your project:

List your initial questions and your final question. Then tell us what led you to your final question.

Definitions

This is where you should list any words and definitions from your field study that may not be familiar to the general public

Materials

List your materials here

Protocols

Describe the protocols for your field study here just like a recipe.

Data

Insert any graph here or feel free to create a poster to display during the presentation.

Results

What is your evidence for your results?

Limitations

List anything here beyond the scope of the study that skewed your data.

Discussion

What would you do differently next time?

While completing this field study did you come up with any questions you wish to further investigate?

Broader Implications

What could you imply from the conclusion of your field study?

Does your conclusion lead you to believe you have a recommendation for a certain field of study? If so what is this recommendation?