The Science of Nature Based Learning:

Evaluating the Nexus of Leadership, Agency, and Positive Emotions from Student Experiences through Participative Decision Making on Curriculum Intervention

by

JULIE ALLYSON BYLE

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written by Julie Allyson Byle
has been approved for the Department of Museum and Field Studies

_____
Dr. Jingchun Li

_____
Angela Myers

_____
Dr. Cathy Regan

Date_____

The final copy of this thesis has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

Byle, Julie Allyson (M.S., Museum and Field Studies)

The Science of Nature Based Learning: Evaluating the Nexus of Leadership, Agency, and Positive Emotions on Student Experiences through Participative Decision Making on Curriculum Intervention

Thesis directed by Assistant Professor Dr. Jingchun Li

This study evaluated student leadership behavior in an STEM education career pathways program called Nature Kids Jovenes de Naturaleza, an 8-week experiential education immersion camp based out of Boulder, Colorado. The goal of the program is to stimulate interest in environmental education and STEM careers for under-represented high-school students by positioning them in hands-on leadership roles. Student evaluations on leadership behavior and follow-up interviews were done on student cohorts over two different cohort years. Pre and post assessment data was collected and analyzed for significant change in participant knowledge and identity post-programming. Additionally, based on evaluation data that showed a positive correlation between curriculums that facilitated student agency and consequential positive emotions, a curriculum intervention of implementing agency into a section of the program where there was previously none was developed, executed, and analyzed. Results from the implementation showed an increase in positive emotions in students favoring the experience more when student agency was added into the curriculum. It is suggested that designing opportunities for student agency be added into program curriculum development. Future longitudinal studies are recommended to better understand the lasting effects of agency on student interest in STEM careers.

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1. Introduction

1.1 Research Purpose

Decades of statistical analysis of enrollment trends in higher education have provided us with the evidence of a decline in the interest of young people pursuing STEM careers. Further, non-dominant groups, such as low-income and Latino youth, are largely factored into the national average of declining retention rates in STEM fields (Department of Education 1994; National Science Foundation; 2015; Potvin, 2014). In order to understand this national trend, a research focus on student attitudes of science was found to be required if the nature of the problem was to be understood and remediated (Murphy, 2001; Pell, 2001). Consequently, studying student attitudes and behaviors in STEM education settings has become a focus of interest in education research (Osbourne, 2003).

Students' science identities and future goals are influenced by their science experiences (Aschbacher, 2010). Informal science education programs, such as afterschool and summer programs, in particular have shown to be a major influence on academic interest through feelings of enjoyment that lead to a positive commitment toward science (Osbourne, 2003). For example, learning science in informal environments has been found to foster development of positive science-related attitudes, emotions, and identities, learning science practices, appreciating the social and historical context of science (Rodari, 2009).

Additionally, informal education programs where there is an emphasis on student leadership roles though service learning are being recognized. Service learning is a teaching model that intentionally integrates academic learning and relevant community service and addresses the disconnect between higher education and society (Hullender, 2015). Intentionally designed learning opportunities that focus on increasing student's leadership knowledge, skills,

and values are positively associated with developing leadership capacity and have the ability to through attaining career development tasks and encouraging occupational identity processing (Komives, 2011;Pascarella, 2005).

Although there are correlations between leadership programs and positive outcomes in informal settings, I found that there is a gap in our knowledge base on how exactly being in a leadership role affects student emotions that contribute to their reported positive experiences. My hypothesis was that through better understanding the formation of students' emotions, I could give the informal STEM education field insight into creating the most enjoyable curriculum for students. Furthermore, many of the educational practices that have been used in STEM educational settings do not account for unique individual or collective cultural diversity or equity in their teaching and learning practices. Therefore, investigating the underlying mechanisms of the traits of being a leader that lead to positive emotions in underrepresented students was intriguing to me. This question was the drive for my research, and consequently the design and development of this thesis project.

1.2 Research Overview

To further explore and contribute to the existing body of knowledge on student leadership behavior, I aimed to understand how student experiences in an informal STEM leadership program affect student emotions. To do so, I studied two cohorts of underrepresented highschool students during their time in an informal STEM career-pathways program called Nature Kids de La Naturaleza (NKJN). The goal of the NKJN program is to educate students to become informed stewards and leaders in various environmental fields. Through an 8-week summer immersion program, students take on the roles of various STEM education professions allowing them to explore many science-related career paths. Each week the students are in a new location

which are independent immersive experiences with unique activities. Students apply for this program to gain an understanding of what a career may look like in the science field, and to relieve any financial burden which may force them to choose another summer job, they are paid a stipend to ensure they can participate.

My research had three main goals: to assess and evaluate the NKJN program at large, to study student leadership behavior through observations, and then to execute an intervention to see if it increased positive emotions. I began my study during the launch of the NKJN pilot program during summer of 2017 (Table 1). During this time, I sought to gain a comprehensive view of the entire programs components which led me to design and execute three distinct and innovative mixed-method evaluation tools that could be replicated: pre and post assessments on student identity, weekly evaluations on program curriculum, and weekly evaluations of demonstrated leadership behavior. Knowing I would have a thorough evaluation from summer 1, I could then have a launching point for a precise research focus for summer 2018 based on my most significant findings and be able to execute design based research on a single fixed component of the program in summer 2.

Table 1: Project Timeline

Date	Activity	Purpose
Spring 2017	Pre-Programming Planning	Create Evaluation Methodology
Summer 2017	Summer Season 1	Pilot Assessment and Evaluation
Fall 2017	Interviews and Data Analysis	Discover trends
Spring 2018	DBIR intervention design	Increase positive emotions
Summer 2018	Summer Season 2	Assessment, Evaluation and DBIR intervention
Fall 2018	Interviews and Data Analysis	Measure intervention impact
Spring 2019	Complete Project	Synthesize and share data

After performing data analysis from the assessment and evaluations from summer 1, I found that participative decision making, which is demonstrating the ability for a student to make decisions and take ownership over their learning, led to the highest correlations of positive affect in students attitude towards specific immersive experiences. I found that this participative decision making, which refers to a leader's input in making decisions (Arnold, 2009) was shown often in the most favored immersive experiences by the students. I also found that in the programs that gave students the most agency by participative decision making, was also the location where they also reported that they learned the most. This was a significant finding that matches research which shows when students are able to demonstrate agency in their learning, they acquire deeper understanding and skills and they become more competent learners in and out of school (Patrick, 2017). My students also reported from this experience that they would feel more comfortable considering a job in that field after highschool. This aligns with the research that shows when students are able to show agency in their learning, that they become better prepared to succeed in academics, but also in future careers (Hollister, 2015).

To better understand how agency played a role in positive experiences for students, I created a design based implementation research (DBIR) study to add student agency in an experience in summer 2 that formerly did not offer the opportunity in the previous curriculum during summer 1. My goal was to measure how adding in student agency to the program design would affect students' experience of the program. My hypothesis was that adding in agency would increase students' positive emotions of the experience.

The short-term importance of these findings are for applying evidence based student feedback to program design and implementation based on what was found to be a positive experience for students and the success of the NKJN program in future years. The broader

implication of this research project aims to address the outstanding need for research on student behavior in informal STEM education programs (NRC, 2009).

Finally, due to my own positive nature connecting experiences in my childhood that led me to being a scientist, I was interested in contributing to the body of research that illustrates feelings of enjoyment and interest in science combined with success in youth science programs leads to a positive commitment toward science (Osbourne, 2003). With this, my project was designed to expand and advance our knowledge base of student leadership behavior in informal STEM learning through developing, testing, and analyzing innovative methodology while providing appropriate means for communicating what has been learned. I do this through showing that developing educational practices that use student-centered and self-directed learning methods can result in positive emotions when students drive their own learning.

2. Background

2.1 Thorne Nature Experience

Founded in 1954, Thorne Nature Experience is Colorado's oldest and widely regarded as the most accomplished environmental education organization in the state. The guiding philosophy of Thorne's education programs is summed up in their mission, which is, "To build Earth stewardship by connecting youth to nature through joyful, hands-on, place-based environmental education experiences that foster an emotional connection to nature". Thorne runs a variety of age specific year-round education programs during the school year as well as offers summer programing. The specific education program that I studied, NKJN, is a product of a state-wide 5-year initiative to connect underrepresented groups to the outdoors by providing more access to open space and educational opportunities.

In addition to educational programming, Thorne has established the Boulder County Environmental Education Collaborative (BCEEC), a collective impact project consisting of 28 partnering organizations whose goal is to, "Ensure a continuum of environmental education and service learning opportunities with multiple contacts for preschool through high school for Boulder County youth." (BCEEC). Till this day, Thorne continues to serve as the backbone organization and primary funder for the BCEEC's collaborative efforts. With outstanding experience leading a multi-organization collaborative and existing, strong relationships with Boulder Valley School District (BVSD), local environmental education providers and land managers, and grassroots organizations serving Colorado families, Thorne is the ideal organization to provide the education and development needed to ensure the success of the NKJN program.

2.2 Nature Kids la Jovanes Naturaleza

NKJN was developed when Thorne Nature Experience applied to the Great Outdoors Colorado Inspire Initiative (GOCO). GOCO funds the development of programs who aim to connect youth and their families with the outdoors with a motto of: “For our quality of life to endure, we know that Coloradans must appreciate and care for our great outdoors. We can’t appreciate what we don’t experience”. This is why GOCO funds designating locations for kids and their families to play and connect with the outdoors, as well as funds educational pathway programs that encourage outdoor stewardship and leadership roles.

The creation of NKJN was due to the fact that youth living in Boulder County’s low-income neighborhoods lack the opportunity for summer or school-year pathways to leadership and career employment opportunities within the environmental arena. NKJN supports Lafayette’s low-income and Latino youth and their families with environmental education leadership programs. The collaborative design and implementation of this transformational leadership program provides programming that will inspire underserved Lafayette youth to engage and experience leadership in designed in career pathway experiences.

NKJN and my research project both involved the collaborative planning of people and organizations with unique specializations of expertise to successfully investigate the research questions at hand. Our design team consisted of informal STEM practitioners which are the education and learning science researchers at The University of Colorado Boulder, the education manager at Thorne Nature Experience, the directors and teachers of our program partner organizations, and many community members who wished to be involved. Leveraging the expertise of the partners, this collaborative research group plans to continue to lead future research proposals that fit within the themes of the NKJN aims to further explore the potential

impacts from this program. For example, the innovative framework of NKJN is being looked to as a national model, and will serve as examples to other rural, urban, suburban, or mountain communities across the country.

2.3 Nature Kids Program Curriculum

In the summers of 2017 and 2018, a cohort of high-school youth will participated in an eight-week, 440-hour program that included career exploration and skill-building, leadership development, and paid employment. A major aim of the NKJN program curriculum is to place students in leadership positions to help them refine and develop their specific environmental career focus. Therefore, opportunities for student leadership are woven throughout the program curriculum so each location fosters a leadership role for the participant. Additionally, staff members in each location are encouraged to let the student participants lead as much as possible.

Table 2: NKJN Student Experience Schedule

Immersive Experience	Student Leadership Role	Leadership Description
Cal-Wood Education Center	Naturalist and program leader internship	Leading family programming during weekend camps
Keystone Science School	Watershed science and recreation internship	Capstone Course: learning Colorado watershed science
University of Colorado Science Discovery: Mountain Research Station	Scientific research internship	Working with CU scientists and graduate students on field science at the high alpine research station
Thorne Nature Experience	Environmental educator internship	Leading K-8 youth education programs throughout Boulder county
Wildlands Restoration Volunteers	Restoration crew internship	Leading a restoration project at Coal Creek for volunteers

Nature Kids Jovenes de la Naturaleza Schedule

Week 1: Youth will spend the week at Cal-Wood Education Center in Jamestown. During the week, participants will: 1) participate in orientation and training activities for the employment portion of the program; 2) gain exposure to careers in environmental education and outdoor recreation through exposure to guest presenters from Colorado Parks and Wildlife and Outdoor Industry companies; 3) develop leadership skills through activities; and 4) expand their outdoor skills and knowledge of the natural world.

Week 2: Youth will spend the week at CU's High Alpine Research Center in Jamestown. During the week, participants will: 1) gain exposure to careers in environmental science through working with CU researchers to conduct field science projects; and 2) continue orientation and training activities and the development of leadership skills, outdoor skills, and knowledge of the natural world.

Week 3: Youth will spend the week working as a leader in Lafayette with Wildlands Restoration Volunteers. During the week, participants will assist with the planning, development, and implementation of a volunteer project which could include building a trail or restoring a natural area in their community. Participants will continue their leadership skill development and have the opportunity to put these skills to use at the end of the week when their families and other members of the local community join them to complete the volunteer project that they helped to plan and design.

Weeks 4 through 7: Youth will put their newly attained leadership skills and knowledge in outdoor recreation and natural science to use as environmental education interns. Interns will experience working with the professional staff of three different organizations (Cal-Wood Education Center, CU Science Discovery, and Thorne Nature Experience) to lead nature and gardening camps for youth and overnight family camps for members of their community.

Week 8: Youth will celebrate their successful completion of the Summer Environmental Education Corps leadership program by participating in a fun and educational weeklong journey with Keystone Science School, focused around leadership in the exploration of the many uses of water in Colorado and the West. Activities will include exploring a billion-dollar industry while rafting down the Colorado River, participating in a fly-fishing lesson, and exploring agricultural impacts on water supply while visiting a farm and learning about irrigation systems, impacts of livestock, and the many challenges faced by the modern-day farmer. At the end of the week, youth will further hone their leadership skills by participating in a mock town hall meeting, in which participants each take on the role of a Colorado water management stakeholder and work together to come up with policy and partnership recommendations that will improve how water is conserved and managed in the West.

3. Literature Review

3.1 Student Leadership Behavior

The purpose of my thesis research was to examine leadership behavior among students in an informal STEM experiential education program. Therefore, it was important to understand the work that has already been established on student leadership behavior. During my literature review, I found that student leadership behavior in informal learning environments was an emerging topic of research upon the fields of science, environmental education, and outdoor adventure programs.

Numerous studies have attempted to classify what constitutes as leadership behavior in an informal setting. For example, most commonly they describe that outdoor leadership behavior involves purposefully taking individuals or groups into the outdoors for recreation or education; teaching skills; problem solving; ensuring group/individual safety; judgment making; and facilitating the philosophical, ethical, and esthetic growth of participants (Ewert, 1983).
In an attempt to identify more competencies of an outdoor leader, Breunig, 2006 described eight core competencies essential to the practice of outdoor leadership. These were: foundational knowledge; self-awareness and professional conduct; decision making and judgment; teaching and facilitation; environmental stewardship; program management; and technical ability.

Beyond classifying leadership behavior, research assessing leadership in informal education settings started in the 1980s. For example, many studies in the 1980s explored outdoor leadership competency. The overall theme from these findings are consistent with the fact that there are many attributes to a leader and many traits can arise from being in a leadership position. The findings from assessment are that leaders in informal settings possess a wide and often divergent collection of skills and knowledge. For example, some cross-field indicators were as diverse as participant judgment, decision-making, outdoor skills, safety skills, interpersonal

skills, environmental ethics, and problem-solving skills. (Buell, 1983; Ewert, 1983; Priest, 1986; Priest, 1999; Raiola, 1986; Swiderski, 1981).

Further research on student leadership behavior aims to understand what being in a leadership role provides for participants. The results are that programs who foster student's leadership roles, especially service learning experiences such as the NKJN program provides benefits both personally and professionally. In addition to the professional development traits that Pascarella, 2005's work showed from having students in leadership roles positively influencing their leadership skills and occupational identity processing, studies on student leadership behavior have find that correlate to personal development involving tasks such as taking initiative, showing responsibility, and attaining decision-making roles (Paisley 2008). Being in leadership roles allows for these types of attributes to arise due to the opportunity for students to develop and share their own opinions about current issues and to engage in debate, discussion, and critique of those issues (Black, 2014).

Understanding research that students involved in leadership activities have higher levels of educational attainment and openly demonstrate personal change than do students who do not participate in these activities (Astin, 1993) makes a strong case for studying and implementing more leadership into curriculum. Additionally, understanding that leadership behavior affects the whole person in and out of the program experience, it is fitting for informal education programs to aim for leadership development roles for their participants.

Therefore, many leadership programs are intentionally designing learning opportunities focused on increasing student's leadership knowledge, skills, and values (Komives, 2011). With these larger program goals in mind it is important to have evidence of indicators of leadership behavior and positive youth development outcomes for their program aims such as evaluations

and longitudinal studies. Performing assessment and evaluations are commonly used methods to organize this type of data, which is based on the premise that assessment of student achievement plays a vital role in instruction, and that the main goal of assessment is to improve learning (Grounland, 1998).

Student leadership studies are complex as every informal education program aims may slightly vary. Additionally, there is not one standard baseline behavior for leadership as it can be demonstrated in various ways based on individual students in diverse learning environments. Therefore, to keep focus with my study, I aligned my research interest of leadership behavior with the 8 factors adapted from the Empowering Leadership Questionnaire (Arnold, 2009). This research paper describes the construction and empirical evaluation of a new scale for measuring empowering leader behavior. The 8 factors described in this research that I used in my research were: leading by example, coaching, encouraging, decision making, informing, showing concern, interacting with team and group management (Arnold, 2009).

3.2 Student Agency

Elaborating on the field of student leadership behavior, student agency is a topic that is being explored within the realm of student leadership and is often used interchangeably with the terms "student agency, student voice, and student participation" (Black, 2014). Perception of a sense of agency occurs when learners have opportunities for choices for playing significant roles in directing their own activity (Patrick, 2017), and is defined as the capability of individual human beings to make choices and act on these choices in a way that makes a difference in their lives (Martin, 2004). Student agency refers to the actions students can make to influence their own learning, and is context dependent and unique for each student in a given environment.

We can think of agency happening across different learning environments if we look at

agency as being the ability to take initiative in one's own learning. This can be illustrated in students who carry a high level of agency and are not passive participants in their learning, but active participants engaged in their own educational experiences that help them achieve the outcomes they desire. For example, for students in a single internship experience, yet spend time in different environments, they can bring elements of agency with them across contexts like they did in my thesis work at Thorne Nature Experience.

Historically, the idea of agency for contributing to cognitive processes involved in learning settings comes primarily from the Piagetian notion of constructivism (Piaget, 1967). This is described as knowledge being constructed through taking action in one's environment and then making adjustments to existing knowledge structures based on the outcome of those actions (Piaget 1967). The core features of agency enable students to play a part in their self-development (Bandura, 2011). Research shows that young people value the opportunity to have a voice on matters of concern to them (Eckersley, 2007) and prefer opportunities for participation that give them real agency and where they can see tangible results (Collin, 2008). Research has also supported the notion that the role of agency plays a part in self-regulation around student learning. In the context of learning, giving people agency and self-regulation can create learning experiences and knowledge that a learner perceives to be relevant to their lives. (Wolters, 1998; Zimmerman, 2001).

Applied to educational settings, personal agency can shape both the process and the outcomes of student learning, with the most prominent effect stemming from a strong motivational component for the student (Ford, 1992; McCombs, 1990). The psychology behind the motivational component from agency is that by giving students agency they will be more driven to achieve the agendas that they set for themselves. In doing so, feelings of agency and

self-efficacy in their decision making can lead students to work harder and persevere if confronted with challenges (Bandura, 1982).

Creating program curriculum with student agency in mind is important because it may affect the likelihood that information being taught is retrieved or is transferred to applicable contexts (Lindgren, 2012). Siddall says that learning only truly takes hold when the student perceives a gap between where they are and where they want to be, and therefore takes action to close that gap" (Siddal, 2016). And thus, great instruction only takes a student so far. However, agency, cultivated over an extended period, allows students to make the most important connections and decisions themselves (Siddall, 2016). In some cases, a topic that has prior personal context can make it easier for a learner to situate new learning within existing knowledge structures by making connections to previous experience (Lindgren, 2012). The outcome for the student is that their learnings is more easily understandable and adaptable for them because they could relate the subject matter to their own goals (Lindgren, 2012).

Taking this information to the implementation of agency into curriculum in the fields of STEM education and the learning sciences, the idea is that the most positive learning experiences will be those that are directed by the learner's own decisions. However, to be able to provide students with a sense of agency in their learning environment, it takes intentional curriculum planning by the instructors. When creating curriculum that allows for agency, teachers must understand the distinction between giving choice vs. giving pure freedom. This concept is explained in further detail in relation to Vygotsky's idea of scaffolding and the zone of proximal development which suggests that the role of education is to provide children with experiences which are in their zone of proximal development while encouraging advancing their independent learning (Vygotsky, 1962 & 1978). This is generally age dependent, and instructors cannot

expect that students will naturally embark upon meaningful and achievable learning inquiries simply by reducing oversight and lessening the restrictions on student activity (Lindgren, 2012). This is where implementing evidence based methodologies plays in an important role in appropriately incorporating student agency practices.

Currently, there are 3 main methodologies of which incorporating student agency that have found success. The first is engaging students in a dialouge that drives them to defend their own understanding through a set of arguments, which is known as the Socratic Method (Gose, 2009). Next, is problem-based learning (Hmelo-Silver, 2004) which gives students an active role by presenting a problem that must be solved through the student's own knowledge. Thirdly, is free-choice learning which is where students can make decisions about what, where, and with whom to learn (Falk & Dierking, 2002). Overall, each these learning modalities present the student with the opportunity to make their own choices in their learning. Due to the growing interest in this field, it has been suggested that studying outcomes of student agency through these particular styles choices could be valuable for assessment (Schwartz, 2009).

3.3 Design Based Implementation Research

Within the learning sciences, the practice of design-based implementation research (DBIR) offers a model for the design and testing of innovations within both classrooms and informal contexts for learning (Cobb, 2003; O'Neill, 2012). DBIR emphasizes iterative cycles of design and testing, and is well-suited for making evidence-based improvements in educational programs. This is done by compiling evidence from both implementation and outcomes that inform changes that design teams make to innovations for learning (Fishman, 2003).

DBIR is an emerging methodology that emphasizes intervening in existing programs while working with stakeholders to design, implement and refine interventions, while paying

careful attention to the organizational context (Penuel, 2011). Four core principles are described for this approach: a focus on persistent problems of practice from multiple stakeholders' perspectives, a commitment to iterative, collaborative design, a concern with developing theory and knowledge related to both learning and implementation through systemic inquiry, and lastly, a concern for developing capacity for sustaining change in systems (Mean, 2013).

Implementation research is the systematic study of the implementation of innovations (Fixsen, 2005; Werner, 2004). It is often conducted within larger outcome studies, with the aim of analyzing how and how much variations in implementation matter for innovation effectiveness (Furtak, 2008). The value of design research that supports implementation is based from its objective to develop theory that guides design decisions, as well as practical tools that can be used to support innovation from observed issues (Cobb, 2003). As in community-based participatory research, the collaborative nature of much design research positions practitioners as co-designers with teachers of solutions to problems, which can facilitate the development of usable tools that educators are willing to adopt (Penuel, 2007).

In regard to my research project, design based implementation research provided an opportunity to better understand the effect of creating programming that facilitates student agency. DBIR assisted in accomplishing this through isolating an experience and adding in the variable of agency into the curriculum where it didn't previously exist, to able to measure the difference in affect on students. By adding in agency into the curriculum, this allows the student to have a personalized experience to be able to make decisions and the researcher the opportunity to implement design and record the results of the implementation.

The major variable that I executed in my research design is the degree of agency allotted to students in a specific program during the time that they participated in NKJN. I was focused

on creating educational environments that empowered students to make choices that enhanced their learning experience through interface and reflection. For my research, I added in agency at WRV by adding in components that require student agency such as decision making, group management, informing, and coaching. I expand further on intervention in the methods and results sections.

4. Research Design

While envisioning the future needs for STEM professionals, NKJN is addressing immediate challenges youth are facing by providing them opportunities through access to pursue leadership positions in STEM fields. The more explicit we can be about the behaviors shown during leadership roles, the more structures we can set in place through personalized learning options and participatory learning environments which in turn can set the pace for expanding and broadening participation in STEM. The goal with my research is that my findings may help articulate the underlying processes around the behavior or participants in informal STEM settings. Therefore, to study student leadership behavior during their time in the NKJN program I created the following frameworks for assessment, evaluation, and design based implementation research:

4.1 Student Assessment

Assessment is understanding the effectiveness of a specific aim in a program. It is the process of gathering and discussing information from students to develop a deep understanding of what students know, understand, and can do with their knowledge because of their educational experiences. Further, the process culminates when assessment results are used to improve subsequent learning (NRC, 2009).

Unlike an assessment for content knowledge that measures a level of understanding, while assessing prior school experiences, attitudes, and personal connections, etc. there are no right or wrong answers. Rather, the goal in this type of broad assessment is to be able to gather and summarize information that helps us understand how students shape their understanding coming into the program and will approach the experience. All feedback was collected in a narrative format which provided useful data points for understanding each students' personal

prior experiences with science and education. Once I understood the pre-assessment answers, I then had a reference point on how to better build on that aspect throughout the program.

Therefore, to gauge how students are affected by a program, it was important to assess essential data points that students bring to learning tasks both before and after a program. I needed to know their previous experiences and attitudes coming in so that I could identify and quantify the knowledge and skills they have gained after the NKJN program. To get a baseline measure of student's identity and attitudes and funds of knowledge prior to programming, a pre-assessment was created and administered. In addition, to measure effectiveness of the program on student attitudes, a post assessment was administered after programming was complete. I created a pre and post assessment with the 10 following narrative points that relate with student's previous experiences with science that gave a picture into a current snap shot in time of their identity:

Pre and Post Student Assessment

1. Perceptions: A perception of an event is a personal interpretation of information from our own perspective.

2. Values: Values are lasting beliefs that motivate you to act one way or another.

3. Interest: Interest is a feeling of wanting to learn more about something or to be involved in something.

4. Intrinsic Motivation: Motivation is the level of effort an individual is willing to expend toward the achievement of a certain goal for its own sake, for the enjoyment it provides, the learning it permits, or the feelings of accomplishment it evokes.

5. Attitude: Attitude is a favorable or unfavorable evaluative reaction toward something or someone, exhibited in ones beliefs, feelings, or intended behavior.

6. Identity: Identity is one's personally held beliefs about the self in relation to a social group constructed through interactions with the broader social context in which dominant values dictate norms and expectations.

7. Experiences: Experiences are the nature of all prior engagements with learning and teaching science.

8. Emotions: An emotion is a strong feeling deriving from one's personal circumstances.

9. Understanding: Understanding is the comprehension of the meaning of something learned.

10. Retention: Retention is the likelihood of long term continuation in the environmental education or STEM field.

4.2 Evaluation of Curriculum

If assessment is the effectiveness of a program, evaluation is the value of a program. To evaluate the program curriculum on the ability to provide participants opportunities to display leadership behavior, I executed 2 evaluations on the curriculum design. The first was based on indicators described from The National Research Council's Strands for Learning Science in Informal Environments research (NRC, 2009) and the second was based on indicators from The Boulder Country Environmental Education Guidelines (BCEEG). The rational for doing this was to use the evaluation as a tool to develop a more comprehensive view of behavior of participants in STEM career leadership roles. This evaluation methodology will also stand as a deliverable for a program improvement tool in meeting these guidelines.

4.2.1. National Research Council

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes

of furthering knowledge and advising the federal government. Within this, The Committee on Learning Science in Informal Environments was established to examine the potential of non-school settings for science learning. The committee, comprised of 14 experts in science, education, psychology, media, and informal education, conducted a broad review of the literatures that inform learning science in informal environments (NRC, 2009). Their work included assessing the evidence of science learning across settings, learner age groups, and over varied spans of time as well as identified the qualities of learning experiences that are special to informal environments to be able to and develop an agenda for research and development (NRC, 2009).

The NRC has found that informal learning environments play a special role in stimulating and building on initial interest, and supporting science learning identities over time as learners navigate informal environments and science in school (NRC, 2009). The NRC's strands serve as a resource from which to develop tools for practice and research, and are encouraged to serve as playing a central role in refining assessments for evaluating science learning in informal environments (NRC, 2009). The goal from the creation of the six strands points to informal environments can articulate goals and serve as a conceptual tool for organizing and assessing science learning (NRC, 2009).

National Research Council Strands for Learning Science in Informal Environments:

> **1. Developing interest** (excitement, interest, motivation) Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.
>
> **2. Understanding science knowledge** (conceptual understanding) Come to generate, understand, remember, and use concepts, explanations, arguments, models, and facts related to science.
>
> **3. Engaging in scientific reasoning** (skills of inquiry and reasoning) Manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world.

4. Reflecting on science (nature of the scientist enterprise) Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena.

5. Engaging in scientific practices (participation)Participate in scientific activities and learning practices with others, using scientific language and tools.

6. Identifying with the scientific enterprise (identity) Think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science.

4.2.2. Boulder Country Environmental Education Guidelines

Specific to pre-program planning, our design team created curriculum to align with the Boulder County Environmental Education Guidelines (BCEEG). The guidelines are the first set of guidelines in the nation to promote a whole-child approach to environmental education and offer set of learning concepts for students starting with pre-K through high school. The whole-child approach involves engaging kids' hands (service), heart (social emotional awareness), head (knowledge/academics), and feet (place-based learning), each of which is critical to building nature connection, earth stewardship, and environmental literacy (BCEEG, 2016).

Boulder County Environmental Education Guidelines for teaching to the whole child:

1. The Head represents academic skills and knowledge. Students develop skills to investigate and think critically about natural and social concepts rooted in the academic standards. Students develop the communication skills and mathematical reasoning that enable them to gather, analyze, interpret and share information.

2. The Heart represents social-emotional learning, active needs, sensitivity, attitudes and self-efficacy. Students develop a sense of belonging to both their local, immediate communities and the larger global community as they progress through their learning. This is seen in attitudes of sensitivity among individuals who hold awareness for an appreciation of the natural and human communities around them, and a genuine caring for others and the earth as a whole. Environmental Education fosters a sense of self, belonging, and resilience. Powerful learning experiences begin with engaging the heart.

3. The Hands represent action and service. Students gain their civic voice through development of a positive sense of self and the power of their contributions to serving both natural and human communities. Through action and service, students develop the skills and abilities not only for employment but also for understanding the context of how and when to apply their skills and abilities. Students have opportunities to apply their learning in authentic situations, define a focus for projects, and envision, design, and implement those projects.

4. The Feet represent connection to place. Through exploration, students gain a direct connection to the places and communities where they live. This connection engenders a sense of belonging and desire to protect and care for natural and human communities. A progression of place is based on transparent or semi-permeable walls of the classroom and connection to natural and human communities. This progression begins with home and school, then expands out through the neighborhood, community, watershed, region, nation, and world.

4.3 Evaluation of Leadership Behavior

The Empowering Leadership Questionnaire (ELQ) describes the construction and empirical evaluation of a new scale for measuring empowering leader behavior (Arnold, 2009). This work was created through construction, validation, and cross-validation of a new scale for measuring effective leadership in empowering environments. In study 1, information about behaviors that are needed for people to lead effectively in empowered team environments were gathered. Next, they constructed a scale (the ELQ) to measure each category of empowering leadership behavior. In study 2, they evaluated the reliability and factor structure of the ELQ in several organizations. Lastly, in study 3, they cross-validated the instrument in a sample from several different organizations (Arnold, 2009).

To evaluate indicators of leadership behavior in NKJN program participants, I created an evaluation template with the 8 indicators of a leader adapted from the ELQ. On one column, I wrote the leadership behaviors, and on the other columns I had spaces to record if the student reported displaying that behavior, and if so, where and when in the program curriculum it

occurred. I distinguished the ELQ behaviors into two different arenas. Coaching, group management, informing, and participative decision making fell under the category of students demonstrating their cognitive intelligence for agency, whereas encouraging, leading my example, showing concern, and interacting with the team demonstrated their social and emotional intelligence.

ELQ Leadership Behaviors

1. Leading by Example: Leading by example refers to a set of behaviors that show the leader's commitment to his or her own work as well as the work of his/her team members. This category included behaviors such as working as hard as he/she can and working harder than team members. (Sample behavior: Sets high standards for performance by his/her own behavior.)

2. Coaching: Coaching refers to a set of behaviors that educate team members and help them to become self-reliant. This category included behaviors such as making suggestions about performance improvements and helping the team to be self-reliant. (Sample behavior: Helps my work group see areas in which we need more training.)

3. Encouraging: Encouraging refers to a set of behaviors that promote high performance. This category included behaviors such as acknowledging team efforts and encouraging team members to solve problems together. (Sample behavior: Encourages my work group to set high performance goals.)

4. Participative Decision Making: Participative decision making refers to a leader's use of team members' information and input in making decisions. This category included behaviors such as encouraging team members to express their ideas and opinions. (Sample behavior: Uses my work group's suggestions to make decisions that affect us.)

5. Informing: Informing refers to the leader's dissemination of company wide information such as mission and philosophy as well as other important information. This category included behaviors such as explaining company decisions to the team and informing the team about new developments in organizational policy. (Sample behavior: explains programs goals.)

6. Showing Concern: Showing concern is a collection of behaviors that demonstrate a general regard for team members' well-being. This category included behaviors such as taking time to discuss team members concerns. (Sample behavior: Treats group members with respect.)

7. Interacting with the Team: This construct incorporates behaviors that are important when interfacing with the team as a whole. This category included behaviors such as

keeping track of what is going on in the team and working closely with the team as a whole. (Sample behavior: Knows what work is being done in my work group.)

8. Group management: The final construct is that of group management. This collection of behaviors refers to the leader's management of team functioning. This category included behaviors such as helping to develop good relations among work group members and suggesting that team members evaluate their own work. (Sample behavior: Lets my group handle our own problems.)

4.4 Design Based Implementation Research

Once the statistical analysis from the pre and post assessments and leadership behavior observations were complete from summer 1, I found that the leadership trait of participative decision making was shown to be correlated to positive experiences. Based on my results from the leadership behavior evaluation from summer 1, the students least favorite immersive experience was the place with the least amount of student agency (Tables 7 and 9). The location of this experience was Wildlands Restoration Volunteers where students were involved in a large restoration project where there is an opportunity to add in more student agency. Conversely, the students favorite experience was where they were able demonstrate the most participative decision making at The Mountain Research Station. Beyond the behavioral observations, I received identity protected feedback from the students that they preferred the Mountain Research Station because they were able to make decisions in their learning activities for the day. Due to my findings that showed higher correlations between a positive experience and the 4 traits that fell under the category of cognitive intelligence for agency, particularly participative decision making, I chose to move forward focusing on student agency for my curriculum intervention.

Therefore, during summer 2 curriculum planning, I implemented an intervention at the WRV immersive experience during their restoration project day. I worked directly with WRV managers to implement student agency into the curriculum to determine whether adding in agency would affect their experience. To do so, we added in agency by creating the opportunity

for students to perform the following behaviors that all demonstrate agency which were coaching, informing, group management, and participative decision making. Although I was most curious about the effects from implementing curricula that allowed for participative decision making, I also added in the 3 other variables to learn more about them as they would be implemented in different times of the program and would have no overlap or affect time in the curriculum where we were implementing participative decision making.

DBIR Intervention Behaviors:

1. Coaching: To implement coaching, we had students use their voice to guide volunteers. Last year, WRV employees told volunteers how to participate. This year, students will be taking the reins and coaching volunteers how to execute a volunteer restoration project.

2. Group Management: To implement group management, we had students manage their own group. In 2017, WRV employees managed the groups, and in 2018 students were responsible for managing their groups of approximately 10 volunteers each.

3. Informing: To implement informing, we had students use field guides to teach native and non-native plant species. Last year, students rarely informed volunteers about the plants being used in restoration. This year, students will be bringing and using field guides to identify plants for volunteers.

4. Participative Decision Making: To implement participative decision making, we had students co-design a restoration project with WRV for volunteers. In summer 1, students were told what to do on restoration day. In 2018, students took ownership of their own unique project mapping out locations, tools, and plants to be able to facilitate and guide their own groups on restoration day prior to programming. During training week, students were given

4.5 Data Analysis

The statistical analysis for this project was created with Maxwell's typology of validity categories in mind which include descriptive validity, interpretive validity, and theoretical validity (Maxwell, 2012). Descriptive validity is defined as the events recorded during evaluation as being accurate. To meet this, in addition to behavioral coding, and behavioral observations, I held participant interviews with the students as well as met with program managers to help strengthen and justify findings. This type of validity from qualitative research can be strengthened by multiple people describing their own accounts of a behavior or behavior they have seen (Eisenhart, 2005). Collecting a variety of qualitative data including such as the interviews, observations, and field notes helped me create thorough descriptions to be able to triangulate my behavior observations with participant feedback and existing theory.

To address interpretive validity, which is understanding ones underlying meaning behind their behaviors, I held pre and post programming assessments on student identity and formative and summative funds of knowledge, and conducted weekly evaluations with all participants for them to explain to me their unique experience in their own words. An important aim of this project was to understand the behaviors being displayed during curriculum from the perspective of the participants vs. that of myself, the evaluator. To do this, I held the interviews with the participants of high importance where there was an air of honesty, safety, and vulnerability where they were free to describe to me what their experiences meant to them, any prior experiences they were drawing from, and what the behaviors they displayed really meant. I created this safe space by describing who I was, sharing details of my own personal background, and sharing my humble aims of improving programming for their experience and for the students who may participate in the program in the following years. I let students know that I was not

looking for any particular answer from them and they were encouraged to say both positive and negative comments about their experiences and all feedback would remain anonymous. I made sure to write my field notes word for word as they expressed them to me in a casual conversational tone.

Lastly, theoretical validity is the area where I could align my account of an observed behavior to a theory to add to its validity in the existing body of knowledge of student behavior. Maxwell, 2012 offered suggestions that the particular theoretical validity one is looking for depends upon a consensus in the relevant research field to be able to compare your work to current conceptual frameworks in order to consider alternative, plausible explanations. The main conceptual frameworks I was interested in were in the fields of student emotion towards science, student leadership behavior, student agency, and existing cultural funds of knowledge.

To establish and test patterns in the data, I triangulated the data. This allowed me to establish patterns using multiple data sources rather than rely solely on one data source to help strengthen my claims. Furthermore, a focus on triangulation assisted me in recognizing disconfirming evidence and alternative explanations (Mathison, 1988). For example, rather than dismissing any disconfirming evidence, I incorporated it all into my findings to allow for a holistic version of the results to be displayed and explored. For example, there were programs that were ranked high in preference, yet the students did not display all aspects of agency like leading a group at MRS in summer 1(Table 7). In one sense this could be evidence to invalidate the hypothesis that agency leads to positive emotions. On the other hand, this data shows that there are nuances in both the programs design and the particular participants preferences for why someone might deem an experience as positive.

4.6 Evaluator Role

In order to address a potential threat to validity that could arise as me being the sole evaluator on the front lines of the program, it was necessary to consider my role and the ways in which I would interact with the participants, collect data, and interpret results (Miles, 2014). In regards to the researcher's role, it has been suggested that there are two main topics a researchers role which are subjectivity and the complexity of research relationships (Maxwell, 2012).

By subjectivity Maxwell proclaims that researchers "take account of the actual beliefs, values, and dispositions they bring to the study, which can serve as valuable resources, as well as possible sources of distortion or lack of comprehension" (Maxwell, 2012). To aid in this, he recommends keeping memos of reflection to 'bracket' one's experiences and perspectives during their work. In doing so, one may be able to witness their own beliefs more clearly to be able to see past them, and to recognize the insights and conceptual resources that these experiences and perspectives provide" (Maxwell, 2012).

For maintaining research relationships, he states that one must recognize the importance of the relationship between researcher and participants as a "real, complex process that can have profound, and often unanticipated, consequences for the research" (Maxwell, 2012). Throughout my study with NKJN, I was careful to maintain an understanding of the relationships I held with the participants as well as the educators and our design team. I treated them as complex and constantly evolving relationships which helped me to better understand the research process and my role in it.

5. Data Collection and Analysis

5.1 Pre-and Post-Identity Assessment

Pre-Assessment:

Prior to summer programming, I met with each student to administer a pre-assessment (Appendix A1). This assessment was done in person one-on-one by me asking a series of questions about their perceptions of certain variables before entering the programs. Each student was provided with a definition of what each term meant. Once the student was clear on the assessment definitions, I first asked them if they had a positive or negative experience with that variable. Second, I asked them to elaborate on why it was positive or negative. Lastly, I showed them a Likert scale with numerical definitions and asked them to rate their experience with the variable from a 1-10 point scale system. 1 representing extremely negative experiences, 10 representing extremely positive experiences, and 5 representing a neutral experience (Table 3).

Post Assessment:

Post-summer programming, I met with each student individually to deliver a post-assessment (Appendix A1). This was done by meeting one on one with each student either at their school or at a local coffee shop. Each student was provided again with a definition and example of what each term meant. Once the student was clear on the variables, I first asked them if they had a positive or negative experience with that variable. Second, I asked them to elaborate on why it was positive or negative. Lastly, I showed them a Likert scale with numerical definitions and asked them to rate their experience with the variable from a 1-10 (Table 3).

Table 3: Likert Scale of Measurement

Numerical Value	Meaning
0	All Negative
1	Mostly Negative
2	Frequently Negative
3	Occasionally Negative
4	Rarely Negative
5	Neutral, Neither Positive or Negative
6	Rarely Positive
7	Occasionally Positive
8	Frequently Positive
9	Mostly Positive
10	All Very Positive

5.2 Curriculum Evaluation

Throughout the duration of the summer, I met with each student at the end of the week at the designated program location according to the program schedule to administer a weekly evaluation. This evaluation was done one-on-one with each student in a written format with the students verbally responding to the questions I was asking regarding if the curriculum facilitated experiences that were aligned with the National Research Council's strands for learning science in informal environments (Appendix A2) as well as if the curriculum was aligned and provided them opportunities to embody aspects described in the BCEEG guidelines (Appendix A3).

5.3 Student Leadership Behavior Evaluation

Throughout the course of the summer, I observed each student at each location to observe whether or not they had demonstrated a specific leadership behavior (Appendix A4). If I saw the student display a behavior, I checked the box with an X and then then described when in the curriculum they had specifically performed that leadership behavior.

5.4 Students Preferred Immersive Experience

Upon completion of the summer, I asked each student to rank the immersive education experiences in order from 1-5. Number one representing that it was their favorite experience, and number five meaning it was their least favorite experience. This was done to be able to make connections between how they ranked their experiences with what happened in the curriculum, and how much agency they were able to execute at each program location (Table 9).

5.5 Design Based Implementation Research

To be able to measure how adding in opportunities for student agency into the curriculum affected the students experience, I designed and implemented four activities based on descriptions of leadership behaviors that would facilitate giving students agency in their experience during the curriculum at WRV. During the WRV experience I made observations of the students to see if they displayed leadership behavior during the times of the new curriculum implementations. With this curriculum being identical to last year with the addition of only adding in facilitating student agency, I could then narrow down see if there was increase in this location for their preferred experience based on agency alone. Additionally, post programming I had one-on-one conversations with the students about their experiences and recorded their spoken feedback about the designed curriculum intervention activities to understand their views of the implementation (Table 13).

5.6 Quantitative Analysis

Pre and Post Assessment

To measure changes in student identity over time, I calculated all differences in student responses from their pre and post assessment data to find the percent of change over time. In addition to quantifying the in overall changes in each variable for each participant, I was interested in discovering the overall lowest and highest rated aspects both pre-programming and post programming as well as collective overall impact of the program as a whole.

Evaluation

To measure how the NKJN curriculum met standards from the National Research Council's Learning Science in Informal Environments and the Boulder County Environmental Education Guidelines, I documented each aspect when it was met in the curriculum. I then tallied the numbers to calculate which aspects of the evaluation were met at each immersive experience location.

Leadership Behavior Observations and Preferred Experience

To measure the connection between students' favorite experience in relation to the types of leadership behavior they displayed, a Spearman's rank correlation test (Gauthier, 2001) was used to test which leadership behavior was correlated with the students' ranking of the localities. The test was conducted in R. 3.1.1.

6. Results

6.1 Results and Interpretation from Summer 1

6.1.1. Pre and Post Assessment Results

Upon completion of my summer 1 pre and post assessment, I found that the biggest difference in students identity post programming came down to their overall values of science. The second biggest difference post programming was their emotions around science, and thirdly was their interest in science. The lowest change post programming was their experiences with science. Additionally, at the beginning of the program the highest ratings during student assessment were around motivation and the lowest were understanding. By the end of the program, the highest rating was around their emotions towards science. Again, the lowest was their understanding of science. Values grew over the summer upon learning things such as Leave No Trace at Thorne, doing restoration work for local areas in WRV, and learning about farmer's livelihoods and water rights in Colorado.

Emotions were most influenced by connecting to student's hearts through working with children at Thorne, working with families at Cal-Wood, and seeing views from Mountain Research Station. Interest in nature based careers grew the most from experiences at the Mountain Research Station where students got to work one on one with scientists.

The lowest change from pre to post programming was experiences in nature. All students still reported experiences being a positive aspect of the program, yet there wasn't a big leap in increase of experiences, as their experiences prior to the program had been enjoyable and was the driving reason for wanting to join the NKJN program. This same reasoning can be said for both motivation to pursue a nature based career and to retain in the STEM fields beyond the summer program (Figure 1).

Figure 1: Summer 1 Pre and Post Assessment Results

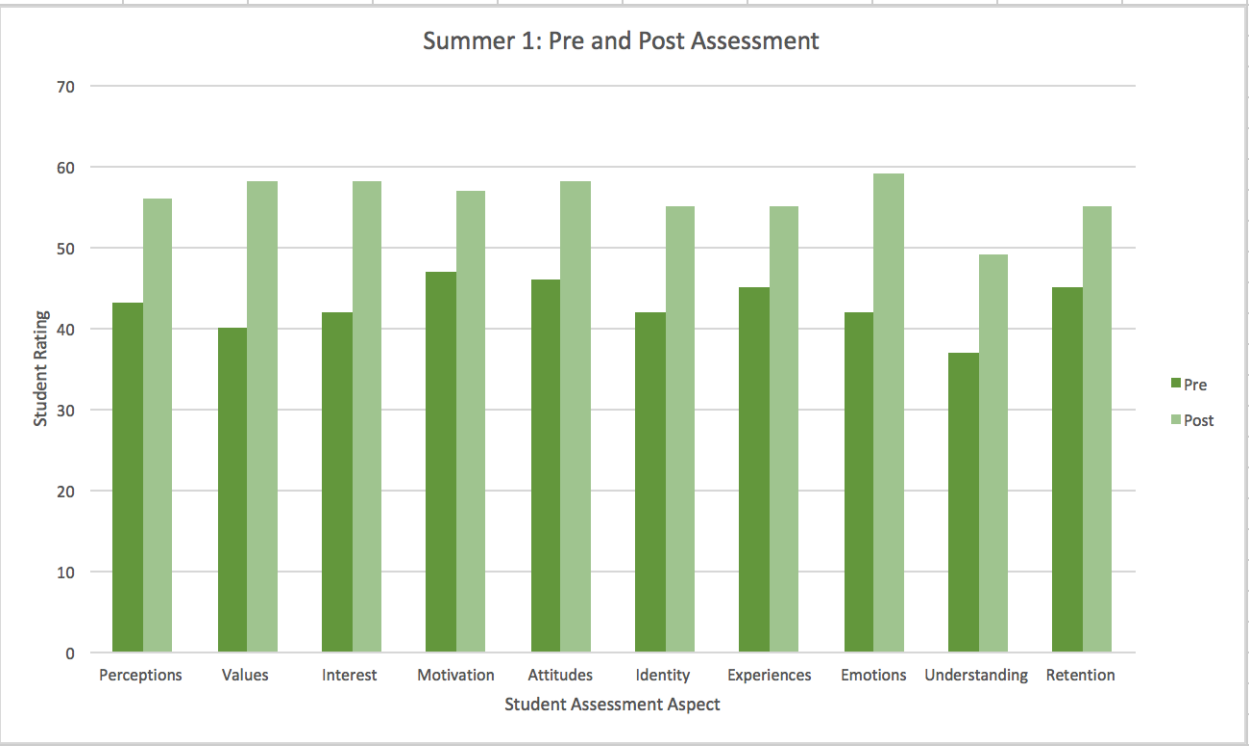


Table 4: Summer 1 Pre and Post Assessment Snapshot

Lowest rated **pre**-assessment: Understanding
Highest rated pre-assessment: Motivation
Lowest rated **post**-assessment: Understanding
Highest rated post-assessment: Emotions
Lowest impact overall: Experiences
Highest impact overall: Values

6.1.2. Program Curriculum Evaluation: National Research Council Learning Strands

Upon completion of the NRC LSIE program curriculum evaluation from Summer 1, the Mountain Research Station was the only experience where the program curriculum met all of the standards for the NRC LSIE (Table 5). This could be because the MRS was the program with the most curricular aims towards learning and practicing science. At Cal-wood not all participants reported understanding scientific knowledge, engaging in scientific reasoning, or identifying with the scientific enterprise. Although the Cal-Wood camp was nature based and was based on environmental education, the scientific process or investigation, data collection was not emphasized in the curriculum. Students also reported not talking about STEM careers at Cal-Wood like they did at MRS and Thorne. This is similar for the results from Keystone Science School, as not all participants reported engaging in scientific reasoning or identifying the scientific enterprise. The aim of the KSS curriculum was focused on water rights and stewardship, so again, the process and culture of STEM was not as prominent as it was at MRS and Thorne. The most common standards to meet were developing interest in STEM, reflecting on science, and engaging in scientific practices. The least common standard to meet was identifying with the scientific enterprise.

Table 5: Summer 1 National Research Council Evaluation Results

	Cal-Wood	Keystone	MRS	Thorne	WRV	Total (trait)
Developing Interest	6/6	5/5	6/6	6/6	6/6	29
Understanding Science Knowledge	5/6	5/5	6/6	6/6	6/6	28
Engaging in scientific reasoning	5/6	4/5	6/6	5/6	5/6	25
Reflecting on Science	6/6	5/5	6/6	6/6	6/6	29
Engaging in Scientific Practices	6/6	5/5	6/6	6/6	6/6	29
Identifying with the scientific enterprise	3/6	4/5	6/6	6/6	4/6	23
Total (location)	31	28	36	35	33	

6.1.3. Program Curriculum Evaluation Results (BCEEG)

Upon completion of summer 1 programming, every student reported that the were able to use their head, heart, hands, and feet during program curriculum at all locations with the exception of 3 students not using their hands at Keystone Science School (Table 6). Hands represented action and service in their leadership role and this was not a major part of the curriculum. With such low variability from this evaluations, the BCEEG did not have

significance gaps that could point us in a direction that could potentially indicate a preference leading to a favorite experience. All of the programs were familiar with the standards in the BCEEG and did a thorough job of aligning and implementing them into their respective curriculums.

Table 6: Summer 1 BCEEG Evaluation Results

	MRS	WRV	Thorne	Keystone	Cal-Wood	Total
Head	6/6	6/6	6/6	5/5	6/6	100%
Heart	6/6	6/6	6/6	5/5	6/6	100%
Hands	6/6	6/6	6/6	2/5	6/6	40%
Feet	6/6	6/6	6/6	5/5	6/6	100%

6.1.4. Leadership Behavior Evaluation Results

Upon completion of summer 1, the location with the most demonstrated student leadership traits were shown at Cal-Wood. The least amount of leadership traits were at Keystone Science School. The main significance I found when testing these leadership behaviors against the students ranked preferred experience, is that the students preferred experiences where they exhibited agency and least preferred experience where they had the least agency. For example, the MRS was rated as the students overall favorite experience, and it was in this location where they demonstrated the most agency through participative decision making.

When it came to participative decision making, the ratings were highest at their favorite immersive experience which was The Mountain Research Station and their opportunity to participative decision making at Wildlands Restoration Volunteers was rated among the lowest (Table 7 and 8). The only leadership behavior that was significantly correlated with the students' preference of localities was "participative decision making" ($P = 0.01$). The more decision

making behaviors are observed, the higher a locality is ranked by the students. All other leadership behaviors lack significant correlations with locality ranking.

The main way students demonstrated participative decision making was through being able to choose their personalized experience to work with a scientist or graduate student. The participants got to choose what they study, who they would work with, and how they would help with their project. Student interviews during weekly evaluations and post-assessments provided the qualitative data to support this finding where they stated they liked feeling they had a choice in their learning and got to pick something that interested them.

Conversely, at WRV which was the students least preferred experience, they were observed the least out for any program for being able to exhibit agency through participative decision making. Out of all the measurement tools, it was this data showed that the factor in students having positive emotions regarding a programs design, had to do with how much agency through participative decision making they were given in their experience. Additionally, the results from summer 1 provided results to form a hypothesis that designing curriculum with opportunities for student agency would lead to an increase of positive emotions of an experience that previously had the lowest ratings. The most common traits I saw over the entire summer 1 were interacting with the group and encouraging. The least amount was participative decision making and group management. This finding helped make my case for adding in more student agency through increasing their decision making and group management skills in summer 2.

Table 7: Summer 1 Student Behavior Observations Results

Trait and Location	Cal-Wood/6	KSS/5	MRS/6	Thorne/6	WRV/6	Total
Leading by Example	6/6	2/5	2/6	6/6	6/6	40
Coaching	6/6	0/5	1/6	6/6	4/6	17
Encouraging	6/6	5/5	5/6	6/6	6/6	46
Participative Decision Making	3/6	2/5	6/6	1/6	1/6	13
Informing	6/6	2/5	1/6	5/6	4/6	18
Showing Concern	6/6	5/5	6/6	6/6	6/6	29
Interacting with Group	6/6	5/5	6/6	6/6	5/6	46
Group Management	5/6	1/5	0/6	4/6	4/6	14
Total Traits	44	22	27	40	36	

Table 8: Summer 1 Leadership Behavior Matrix

Trait	Location with trait shown most often	Location with trait shown least often
Leading by Example	Cal-Wood, Thorne, WRV	KSS and MRS
Coaching	Cal-Wood, Thorne	KSS
Encouraging	Cal-Wood, Thorne, WRV	KSS MRS
Participative Decision Making	MRS	WRV, Thorne
Informing	Cal-Wood	MRS
Showing Concern	Cal-Wood, Thorne, WRV, MRS	KSS
Interacting with Group	Cal-Wood, Thorne, MRS	KSS, WRV
Group Management	Cal-Wood	MRS

Summer 1 Leadership Behavior Overall:

Cal-Wood Education Center
Lowest: decision making and group management
Highest: leading, coaching, encouraging, informing, concern, interacting with group

Keystone Science School
Lowest: group management, coaching, leading by example, decision making, informing
Highest: showing concern, interacting with group, encouraging

Mountain Research Station:
Lowest: group management, informing, coaching and leading by example
Highest: making decisions, interacting with group, showing concern, and encouraging

Thorne Nature Experience
Lowest: decision, group management, informing
Highest: leading, coaching, encouraging, showing concern, interacting with group

Wildlands Restoration Volunteers
Lowest: decision making, group management, informing, coaching,
Highest: leading by example, encouraging, showing concern, interacting with group

6.1.5. Summer 1 Students Preferred Immersive Experience

Feedback from summer 1 showed that the students overall preferred experience from the career pathways program was The Mountain Research Station. Next was Cal-Wood, then Thorne, then Keystone, and WRV being last. Students reported liking the MRS for many reasons. Among the top reasons were natural beauty, feeling of importance while helping scientists, and social connection with peers. The main reasons for a participant to rank an experience as low was due to boredom, lack of freedom, long hours, heat, bugs, or difficulty working with other people such as young children while teaching or a not feeling a social or emotional connection to a facilitator they were working with (Table 9).

Table 9: Summer 1 Preferred Student Experience

Summer 1 Favorite Overall Program
1. Mountain Research Station
2. Cal-Wood Education Center
3. Thorne Nature Experience
4.Keystone Science School
5. Wildlands Restoration Volunteers

6.2 Results and Interpretation: Summer 2

6.2.1 Summer 2 Pre and Post Assessment Results

At the beginning of the program the highest ratings during student assessment were around their attitudes, values, and experiences with nature. The lowest was their understanding of nature careers. Upon completion of my summer 2 pre and post assessment results, the highest rated was values of nature, and the lowest was understanding. The biggest difference in students post programming was student identity. The lowest change post programming was showing a difference in chances of retaining in a nature based career. Verbal responses from students helped clarify these rankings. Based on spoken feedback students wanted to retain in the STEM fields after participating in the NKJN program.

The assessment results from summer 2 pre and post assessment showed the biggest affect the NKJN program had was in student identity (Figure 2). Students had reported not feeling like they had an identity as a steward of nature pre-programming, but post-programming they did. The least difference was in student retention. Students either showed a similar or increase in their rate of retention in continuing in a STEM career. As with the first summer, all students chose to participate in the NKJN program due to interests in STEM education so this was good news that

retention numbers did not significantly change for the worse. However, the participants who did not feel like they had a high sense of identifying with the STEM fields did not lack experiences in nature, they had parents who had symptoms of biphobia. For example, participants gave examples of times when their parents did not let them play in nature afterschool, go on hiking trips with friends, go bike riding, hike mountains, or go camping due to the parents disinterest in the activities, and/or fear of the outcomes of their children participating in these activities.

In both summer 1 and summer 2 the lowest the rated aspect was understanding of STEM careers both pre and post programing. This suggests that the NKJN program could benefit from adding in more scientific knowledge into the curriculum throughout the duration of the summer experiences. I would suggest adding a segment at their orientation week about the flora and fauna of Colorado to help the participants get more familiar with the ecology they will be teaching to the students they work with and to deepen their sense of place to their environment in general. Having a care and understanding for sense of place showed to be important for them to rate their experience as a positive one through their spoken feedback during post-assessments.

Figure 2: Summer 2 Pre and Post Assessment Results

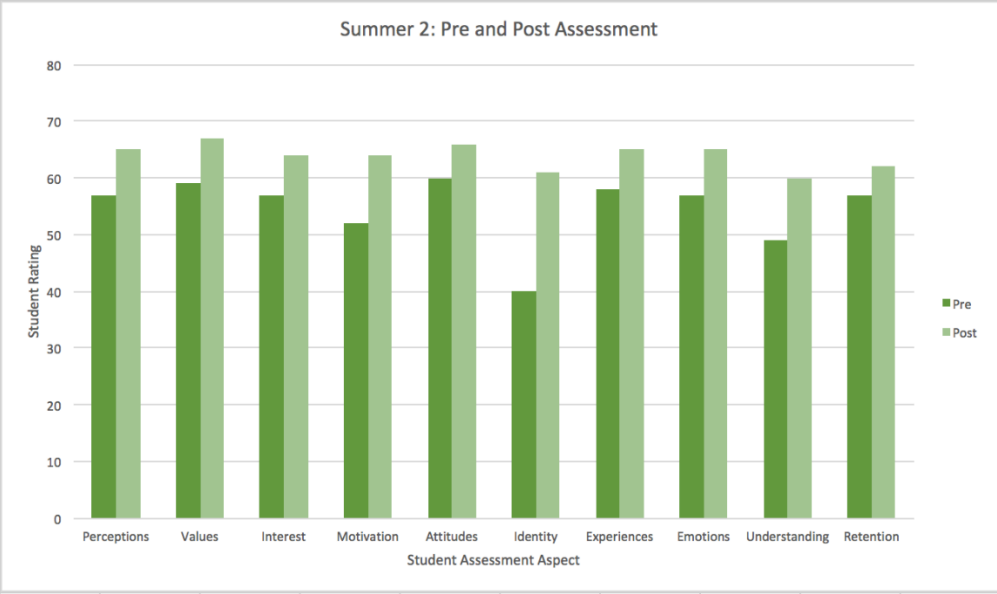


Table 10: Summer 2 Pre and Post Assessment Snapshot

Lowest rated pre-assessment: Understanding
Highest rated pre-assessment: Attitudes
Lowest rated post-assessment: Understanding
Highest rated post-assessment: Values
Lowest impact overall: Retention
Highest impact overall: Identity

6.2.2 NKJN Program Curriculum Evaluation Results (NRC)

Upon completion of the NRC LSIE program curriculum evaluation from Summer 2, the Mountain Research Station was the only experience where the program curriculum met all of the standards from the NRC LSIE. The location with the lowest learning strand was identifying with the scientific enterprise at Cal-Wood. The lowest score was from Cal-Wood in regards to identifying with the scientific enterprise. This can be explained by the nature of the program. This programs purpose was to connect with families and was more focused on engaging with the

families and practicing leadership skills rather than talking about scientific careers such as at the Mountain Research Station. The most common overall aspect met was understanding science knowledge and the least common was identifying with the scientific enterprise. It is interesting that the most common aspect was understanding science knowledge, as the post assessments say the least amount of impact the overall program had was understanding science knowledge (Table 11).

Table 11: Summer 2 National Research Council Evaluation Results

Strand & Location	Cal-Wood	Keystone	MRS	Thorne	WRV	Total
Developing Interest	6/7	5/5	7/7	7/7	6/7	31
Understanding Science Knowledge	7/7	5/5	7/7	7/7	7/7	33
Engaging in Scientific Reasoning	5/7	4/5	7/7	6/7	2/7	24
Reflecting on Science	6/7	5/5	7/7	6/7	4/7	28
Engaging in Scientific Practices	4/7	3/5	7/7	6/7	7/7	27
Identifying with the Scientific Enterprise	0/7	4/5	7/7	6/7	1/7	18

6.2.3. NKJN Program Curriculum Evaluation Results (BCEEG)

Upon completion of summer 2 programming, every student reported that the were able to use their head, heart, hands, and feet during program curriculum at all locations with the

exception of one student reporting the curriculum did not teach to their head at Cal-Wood. This can be explained from student feedback where they already knew all of the content being taught in the program when it came to the field guides, trails, botany knowledge, etc. that they were teaching to the families (Table 12).

Table 12: Summer 2 Boulder County Environmental Education Guidelines Results

	Cal-Wood	Keystone	MRS	Thorne	WRV	Total %
Head	6/7	5/5	7/7	7/7	7/7	86%
Heart	7/7	5/5	7/7	7/7	7/7	100%
Hands	7/7	5/5	7/7	7/7	7/7	100%
Feet	7/7	5/5	7/7	7/7	7/7	100%

6.2.4 Student Leadership Behavior Observations

Upon completion of summer 2, the location with the most demonstrated student leadership traits were shown at Thorne Nature Experience. The least amount of leadership traits were at Keystone Science School. Decision making was shown most at MRS, WRV, and Keystone respectively. The least amount of decision making was shown at Cal-Wood and Thorne (Table 13 and 14).

Table 13: Summer 2 Leadership Behavior Observations

Trait and Location	Cal-Wood	Keystone	MRS	Thorne	WRV	Total
Leading by Example	5/7	5/5	7/7	7/7	7/7	31
Coaching	3/7	0/5	1/7	6/7	6/7	16
Encouraging	7/7	5/5	7/7	7/7	7/7	33
Participative Decision Making	3/7	5/5	7/7	3/7	7/7	25
Informing	7/7	5/5	7/7	7/7	7/7	33
Showing Concern	7/7	5/5	7/7	7/7	7/7	33
Interacting with Group	7/7	5/5	7/7	7/7	7/7	33
Group Management	3/7	1/5	3/7	7/7	6/7	20
Total Traits	42	31	46	51	48	

Table 14: Summer 2 Leadership Behavior Matrix

Trait	Location with trait most often shown	Location with trait less often shown
Leading by Example	All equal but Cal-Wood	Cal-Wood
Coaching	Thorne and WRV	Keystone
Encouraging	Equal	N/A
Participative Decision Making	MRS and WRV and Keystone	Cal-Wood and Thorne
Informing	Equal	Equal
Showing Concern	Equal	Equal
Interacting with Group	Equal	Equal
Group Management	Thorne	Keystone

Summer 2 Leadership Behavior Overall:

Cal-Wood Education Center
Lowest: coaching, decision, group management
Highest: Encouraging, Informing, showing concern, interacting

Keystone Science School
Lowest: coaching
Highest: leading by example, encouraging, decision making, informing, showing concern, interacting with group

Mountain Research Station
Lowest: coaching, group management
Highest: leading by example, encouraging, decision making, informing, showing concern, interacting with group

Thorne Nature Experience
Lowest: decision making, coaching
Highest: leading by example, encouraging, informing, showing concern, interacting with group, group management

Wildlands Restoration Volunteers
Lowest: coaching, group management
Highest: leading by example, encouraging, informing, showing concern, interacting with group

6.2.5 Students Preferred Immersive Experience

The student feedback from summer 2 showed that the students overall preferred experience from the career pathways program was Keystone Science School. Next was the Mountain Research Station, then WRV, next was Thorne, and then Cal-Wood (Table 15). Compared with Summer 1, the MRS dropped one level down, Thorne dropped one spot down, and Cal-Wood dropped down 4 spots. On the other hand, WRV climbed up two spots and KSS ascended up 3 spots (Table 15). I believe WRV climbed up due to the intervention of agency in the curriculum. Other factors were that we incorporated child care into the program which took the burden off of participants and volunteer families on restoration day. My hypothesis for why KSS increased was for two major reasons. One is due to an accidental event that happened in

summer 1 where there was a logistical mistake in the wording of the campground location which sent participants to the incorrect campsite that was many hours away. Secondly, in summer 2 the social dynamics of the participants displayed a more tightly knit group. In summer 1, a personal argument between two participants occurred (outside of the NKJN program) which led people having to choose sides of friendship which added a level of tension during for them the trip I was told during post-assessments. The jump in enjoyment for KSS for Summer 2 is what overrode MRS receiving the number 1 spot again. The most significant change was the drop from Cal-Wood. I believe that social dynamics also played a role in this change. The design of the curriculum at Cal-Wood is different from any other of the programs because it is only for a weekend, not all participants attend at once, and every weekend that there is a family camp, and the families are different. This is a case where a DBIR study would be valuable to cut down the statistical noise that these variables add to understanding the participant experience.

Table 15: Summer 2 Preferred Student Experience

Students Favorite Overall Program
1. Keystone Science School
2. Mountain Research Station
3. Wildlands Restoration Volunteers
4. Thorne Nature Experience
5. Cal-Wood Education Center

6.2.6 Design Based Implementation Results

In comparison to summer 1, the results from the DBIR intervention of agency at WRV in summer 2 showed an increase of student behavior of coaching, decision making, informing, and group management. The biggest difference was in observed participative decision making. My results show an increase in positive emotions towards WRV as a preferred experience-the rating

for WRV for preferred experience went from last at number 5, to number 3 out of the five experiences (Figure 3). These results from the DBIR intervention support the hypothesis that implementing student agency into the curriculum would affect the experience of the students.

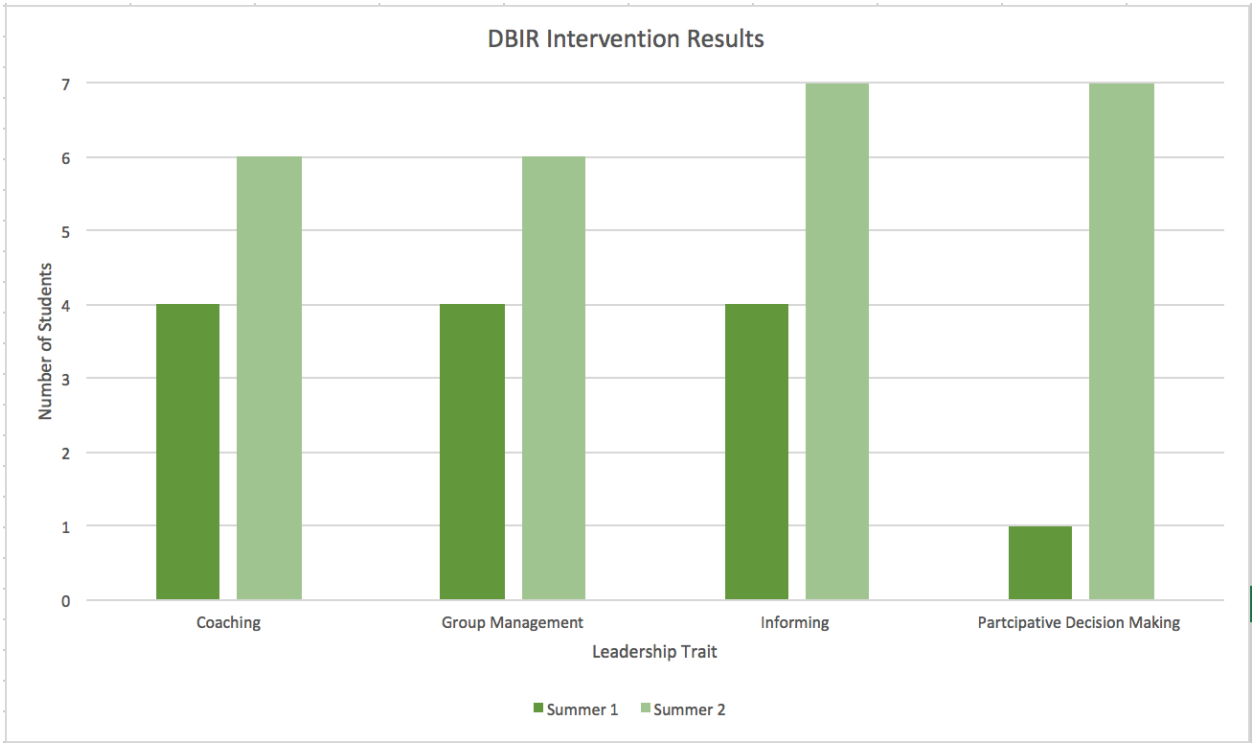
How agency is implemented is key to the success of its implementation. The specific leadership behavior matters and the amount of agency must be appropriate for the learning environment. For example, it must be contextual for the aim of the program. Where it would be appropriate to give students agency in teaching volunteers during a WRV stewardship lesson, it would be more appropriate to implement coaching at Thorne to coach students on how to play a game.

The finding that participative decision making was shown as the lowest leadership behavior at WRV in summer 1 and the influence it has on students preferred experience could not be ignored and was be a clue to which aspect of agency is most important. Thus, this is why I implemented ways students could have more agency at WRV in summer 2. While comparing data from summer 1 and summer 2 in student experience at WRV, I found differences in the students displayed leadership behavior, overall preference for the program ranking, as well as meaningful spoken feedback from the students associated with the new curriculum.

To kick off the WRV training week, students were asked to help assist with the planning for the restoration day which fell under the category of participative decision making. They were told that they were going to be instructing the volunteers of all the plant they would be planting, the tools they would be using and the locations where they would be planting the plants which fell under the category of informing. Next, the students were responsible for teaching the volunteers how to use the tools in a preprogram demonstration as well as in the field which counted as coaching. Lastly the students were told they were responsible for organizing the pace

of the planting and keeping moral high among the volunteers in their designated group for the entire day which counted as group management.

Figure 3: Design Based Intervention Results



7: Discussion

7.1 Adding to Literature

7.1.1. Student Agency

To elaborate on the connection between agency and leadership across contexts, research has shown that programs who intentionally design for students to have leadership roles have the ability to positively influence leadership behaviors. In many of these leadership programs, students are given agency which means that students have a level of control and autonomy in their learning as they make choices on what they are learning. Student agency is indeed a dynamic quality that is created and shaped as teachers and students negotiate their learning environments. Yet, the interesting correlation is the relationship of agency being an important aspect of positive leadership development and holds consistent when comparing results across environmental education settings.

Knowing that students can bring agency across contexts, agency can be best tested against and in relation to multiple environmental educational environments by weaving in central themes of consistent measureable variables into evaluation. In the case of my thesis research, I looked at specific strands of agency through designated leadership behaviors and there was an intrinsic undertone of agency in leadership that was observed and analyzed through student participation and student interviews. Specifically, in my research I saw a statistically significant correlation between leadership, agency, and positive emotions through participative decision making which refers to a student's input in making decisions in their own learning.

My results of implementing student agency into the design at WRV are proportional in the case of increased positive attitudes in students. However, the less agency they got to exude the better chance it was a more negative experience (Thorne and Cal-Wood in Summer 2). In

comparison to summer 1 where students reported the least amount of agency and lowest preferred experience, summer 2 was a big change for them that required a substantial amount more agency on their behalf.

For example, once the activities started where I knew it was an intervention moment, I could see students being more actively engaged in the task they were doing. During training week at WRV, the students were much more engaged in summer 2 knowing that they were going to have control of the day and paid attention more to the directions for training. At the beginning of the restoration day, the students had created their own ice breaker games which would fall under the category of group management. The students came prepared and showed enthusiasm and excited to be at the event. When it was time for the students to teach the volunteers how to use the tools, they were engaging with each other and the volunteers, demonstrating tasks, and taking the role seriously. I witnessed all of the students with volunteers (with the exception of one was assigned to be the coordinator for the day and run food and drinks), coaching the families on the best places to plant based on the maps they drew of the riparian area near Coal Creek.

Furthermore, when there is an experience where there is choice, student experiences were positively affected as reported by their positive emotions. For each student, having the chance at participative decision making in the design collectively increased the positive emotions of the students at WRV. This proved that with conscious and contextually relevant curriculum planning, student emotions can display a positive increase during an experiential education program. I noticed an overall increase in enjoyment of the students through their connection with others and the families, taking selfies, laughing, sharing stories, and feeling confident and joyful in comparison to summer 1where students were seen going through the motions.

Moving forward, I saw the effect that agency had on student motivation. Bandura, 1982 mentions the psychology behind the motivational component from agency is that by giving students agency, they will be more driven to achieve the agendas that they set for themselves. I saw this at the MRS when students were allowed to set their own agenda for the day in regards to what research project they were focusing on. Additionally, a common thread stemming from motivation on their preferred experiences, was their sense of place to the environment they were in. For example, at WRV participants reported feeling more motivated during the restoration project because they grew up on that creek and wanted to protect it.

Additionally, my research on participative decision making aligns with research that shows that young people value the opportunity to have a voice on matters of concern to them (Eckersley, 2007). This stood out in my study at Keystone Science School when students were role-playing as stakeholders for water quality rights, which is similar to Martin's, 2004 findings when he found positive results from the capability of individual human beings to make choices and act on these choices in a way that makes a difference in their lives.

Another interpretation of these findings is that students felt a higher sense of trust and respect when being given partial or complete control of a situation. Spoken feedback showed that students enjoyed feeling in control during their experience at WRV in comparison to summer 1 where spoken feedback indicated students felt like they were merely "workers" and not instructors. Students in summer 1 reported feeling more constrained and there was a sense of boredom, lack of concentration, and wish to leave. The students in my study reported that their time is valuable and they have many outside obligations with family, friends, personal time, etc.

My study showed that participants in the NKJN program like to have a say in matters of relevance to them when it comes to their learning. Every student brought in prior knowledge

from life experiences, and had goals for their future. Having this inner compass in place, adding in agency is way to allow students to incorporate personal relevance into the program which is beneficial to the students and the people they are teaching. Honoring funds of knowledge participants carry is important for teachers to demonstrate responsive teaching for appropriate curriculum that is both educationally stimulating, age appropriate, and culturally relevant. Considering adult life post high-school, where students may experience a higher level of agency in their life when it comes to picking where to live, where to go to college, what classes to take, etc. With this, I would suggest starting act of giving students agency earlier to help with career development such as in the case with afterschool and summer informal programming. With a high level of agency written into program aims, students could balance assistance and autotomy which may ultimately help with decision making throughout their life and trusting their own judgement. Doing so in an informal, ungraded container such as a nature camp, may take the pressure off of getting it right the first time and leaves room to change their mind as they see fit after trying a new experience.

Overall, it is an exciting time to incorporate youth voices from direct feedback into curriculum as a novel way to develop curriculum that honor multiple ways of learning in both research approaches and educational practices. I would encourage more of these kind of collaborative opportunities to form for research practice partnerships to continue. Currently, organizations such as The Children & Nature Network and the Natural Start Alliance are collaborating to facilitate this kind of evidence and practice-based information to make the case for affirming the voices, experiences and cultural ways of knowing of our youngest participants in nature-based education.

7.1.2 Leadership Behavior in Experiential Education

One of the main benefits I saw in the design of the NKJN program was the opportunity for students to learn about potential STEM careers through experiential education. Further, I saw that in activities where students thought that it had task value for their futures they were more engaged. For example, students in my study not only mentioned they enjoyed doing activities that they could benefit from in their future whether it be college or the workplace, but in what they did not deem as being useful or having task value that would be meaningful in their lives. This varied between students as each student had different interest and future goals for their careers. For example, one participant did not enjoy teaching environmental education to young children at Thorne, but highly enjoyed doing water chemistry experiments at MRS. Another example is a participant who felt bored during an experience because he already had experience in that training and felt it was repetitive.

This aligns with previous literature that states that task value is the degree in which an individual believes that a particular task is able to fulfill their personal needs or goals. Eccles, 1995 described this with three components including interest (the enjoyment that a student derives from engaging in a task) importance (the degree to which a student believes it is important to do well on a task), and utility (the degree to which an individual thinks a task is useful in reaching some future goal (Eccles, 1995).

Another line of research that both compliments these findings is the work of Rodari, 2009 that stated informal science learning environments can be particularly important for developing students positive science-specific interests (Roadri, 2009; Pascarella, 2005). Participant feedback confirmed that the experiences they went through in nature had an impact in how they viewed certain careers and whether or not they would peruse them knowing what it was like. The

students discovered traits from the experiences they participated in that either enforced or changed their views on each career. This was further validated in my research where students were leaders in the career pathways program and then gave feedback of how it affected their future college and or career decisions.

Overall, this project further confirmed as well as added to prior research that show youth experiences in science programs serve as a major influence on academic interest, and that if these feelings of enjoyment are present they will likely to lead to a positive commitment toward science (Osbourne, 2003). This was shown through correlations of the effect of the experiences the students had during the program and the results and spoken feedback of retention in environmental education and stewardship.

7.1.3 Design Based Research and Co-Design

My research methods proved appropriate in regards to the DBIR model offering a system for the design and testing of innovations within contexts for learning (Cobb, 2003; O'Neill, 2012). The nature of DBIR emphasizes iterative cycles of design and testing, and was well-suited for making evidence-based improvements in educational programs. This was done by compiling evidence from both implementation and outcomes that informed changes in curriculum innovations for learning and in this case increasing positive emotions (Fishman, 2003).

Lastly, when it came to project design effectiveness, the program managers, administrators, and teachers were all a valuable piece of this projects success. It was a collaborative process that aligned with the findings that the value of design research that support implementation is based from its objective to its develop theory that guides design decisions as well as practical tools that can be used to support innovation from observed issues (Cobb, 2003).

As in community-based participatory research, the collaborative nature of much design research positions practitioners as co-designers of solutions to problems, which can facilitate the development of usable tools that educators are willing to adopt (Penuel, 2007).

7.1.4. Challenging Deficit Views

Informal learning sites for STEM education, such as afterschool programs and summer camps, are becoming increasingly more common, meaning that opportunities for learning are happening more often throughout one's lifetime outside of school settings. These are places where the term informal is used as there is some level of structure in the content design, yet there is still room for interpretation and agency in being an active participant in their learning. In addition, informal learning spaces can offer opportunities for cultural equity that may be constrained by or affected in other formal institutional structures. As opposed to the structure of formal classrooms, museums in particular are getting more recognition as cultural sites for learning and are starting to include culturally responsive pedagogy. Regardless of race, class, or gender, an informal learning program can be a learning space where the individual has agency in how they interpret, communicate, and make sense of an idea presented.

Although informal spaces are places where there is typically more agency in personal sense making vs. formal environments, popular media says families often generate explanations that fall short of classical definitions of explanation, especially scientific explanation (Brewer, 2000). In addition, the cultural assets that youth from non-dominant communities bring to learning and engaging STEM are often perceived as deficit or are delegitimized by sociohistorical narratives and systemic practices of oppression on multiple scales (Calabrese, 2013). Further, deficit views in education around language and multilingual audiences are also

apparent in informal settings. There is a belief that linguistic diversity is not common, families will primarily speak the dominant language and will not be willing to translate, and that developing multilingual resources, such as museum tiles, is too challenging and cost-prohibitive (Garibay, 2015).

Unfortunately, these beliefs illustrate perceived deficits of families' values and behaviors around sense making in informal learning settings. To help challenge this, it is important to remember that content and dialogue should be studied together to understand collaborative sense making in families (Ash, 2007). Additionally, better understanding various funds of knowledge in individuals may challenge deficit theory, as there is an interplay of contexts that happen in informal spaces such as the socio, cultural, personal, and structural that affect the student experience that may go unnoticed.

Moving forward, there is increasing evidence that informal learning spaces can be places for civic engagement (Archibald, 2004) and even as places that inspire social change in our communities (Brown, 2009). While reviewing the literature, I found evidence of how cultural awareness of personalized funds of knowledge families use in sense making conversations can legitimize multiple forms of knowledge and practice alongside more traditional ones. I believe that having this evidence can strengthen the argument that informal science education sites can be a place for equity through valuing a wider range of cultural practices that reflect individual lives.

Through observing the role of funds of knowledge in this informal STEM program through a cultural lens, I was able to gather examples from unique sense making dialogues from ethnographic study methods. Assessments and evaluations can be limited in their methods and only touch the surface, yet from an anthropological perspective, an ethnography can offer more

thorough insights that may add critical data beyond a simple assessment. Understanding culturally unique funds of knowledge in informal STEM learning spaces can lead to a more just social system by challenging deficit thinking through acknowledging various types of sense-making. With these new insights, we can make better informed decisions for more socially just education programs that honor the differences rather than see them as a deficit.

Overall, solutions offered from my observations emphasize the importance of valuing previous life experiences as funds of knowledge during science conversations as a sense making tool, and for additional research to be done on funds of knowledge in informal STEM learning spaces. When it comes to considering implications for the design of inclusive learning environments, I suggest that program designers account for creating opportunities for connection of prior knowledge to new scientific knowledge. Additionally, I suggest that both parents aim to support scientific conversations with their children and that informal learning practitioners offer suggestions to adults on how to successfully support their youth in pursuing STEM careers.

7.1.5 Funds of Knowledge as a Tool for Challenging Deficit Views

Educational researchers refer to the knowledge people develop through daily experiences with their cultural heritage as funds of knowledge. Further, that these funds of knowledge represent a person's expertise, and educational researchers have recognized that designing environments that draw from expertise facilitates success for students such as underrepresented minorities in STEM (Torres, 2018).

In my study, I saw funds of knowledge displayed in multiple ways with the NKJN participants. Students would draw on their funds of knowledge for both their sense making in scientific explorations in nature, conversations with teachers and friends, as well as draw on

funds of knowledge for active participative decision making in the curriculum intervention. Upon assessment and evaluations students mentioned their funds of knowledge stemming from previous experiences with family, friends, and in school settings. The evidence of their funds of knowledge was shown both in interviews as well as in behavioral observations in the immersive programs. The most significant examples of drawing upon funds of knowledge was at Cal-Wood listening to family conversations. I believe that this qualitative data challenges deficit views though family funds of knowledge and knowledge transfer between students and families.

On an individual level, I saw that personal context can make it easier for a learner to situate new learning within existing knowledge structures by making connections to previous experience which align with (Lindgren, 2012). The outcome for the student is that their learnings is more easily understandable and adaptable for them because they could relate the subject matter to their own goals (Lindgren, 2012). I saw this in locations where students had been before with their families or with curriculum that had previously learned in formal or informal contexts.

My observations align with LC Moll's, 1992 definition of funds of knowledge when she describes funds of knowledge as the skills and knowledge that have been historically and culturally developed to enable an individual or household to function within a given culture. Applying this to curriculum design, I would suggest integrating funds of knowledge into informal STEM curriculum activities to create a richer and more-highly scaffolded learning experience for students. Implementing funds of knowledge into project based learning practices can be considered inclusive pedagogy because students engage in problem-driven projects that are designed to be authentic to them (Polman, 2012) which in turn creates an atmosphere of learner-centered environments (Bransford, 1999) When a student can help create a project or

curriculum authentic to them and their funds of knowledge, they can then make more connections between their prior knowledge and the content.

Next, my study aligns with McClain's 2014 study where found evidence of families' funds of knowledge. Though drawing on their prior experiences, she witnessed the family facilitation processes in how past experiences mediated science conversations. She found that parents and children would remind each other about previously shared experiences to forge more meaningful connections to the informal learning site as well as use these points to explain and defend their observations. Further, when families sourced a prior experience, they almost exclusively named an experience from a non-school setting, with everyday experience and programs for science learning being the most common experiences cited (McClain, 2014). McClain found family science conversations to serve four primary facilitation processes in conversation which were reminding, prompting, explaining, and orienting (McClain, 2014).

Collectively, these authors help compile more evidence of the complexity of family sense making that draw from personal funds of knowledge in relation to facilitation styles and personal identity. It is important to note that although there is less curricular structure, informal learning centers aren't immune to structural inequality too. As students cross over into informal learning settings, these studies show how educators and program designers consistently have to challenge and defend dominant forms of science discourse that are encouraged in formal schooling.

However, moving forward with research, I believe that informal learning programs have an advantage to facilitate and study more diverse conversations around sense-making to better understand family participation techniques and challenge social exclusions. Furthermore, continuing to do more ethnographic studies in informal STEM programs complements the research that shows the heterogeneity of family sense making knowledge is a typical feature of

third spaces and challenges hybrid discourses that are at odds with classical approaches and criteria for abstract knowledge transfer (Gutierrez, 1999). Gutierrez also suggests that instead of viewing this hybrid form of sense making discourse as diluted "disciplinary discourse," it is better to view the linguistic moves as emblematic of a generative social practice associated with family life that should inform theory (Gutierrez, 1999).

Moving forward with solutions, Tan, 2018 offers a suggestion to better support families with the agency to author their own experiences in informal programs. She suggests that we identify the problems they care about from different vantage points salient to them, and how they wish to address these problems in ways that feel safe and productive (Tan, 2018). She adds that many sense making conversations in informal experiences are grounded in lived experiences of both privilege and oppression, with roots of systemic oppressions they experienced (Tan, 2018). Therefore, understanding and facilitating sense making involves an ongoing process of negotiating across scales of injustice and intersecting identities to challenge and transform existing narratives and locations of educational experiences (Tan, 2018).

Overall, challenging deficit theory continues to be a valuable topic of interest across the learning sciences, and the anthropology of education fields. Utilizing ethnographic studies data around family sense making in informal STEM learning settings can be a way to add to the body of evidence that various funds of knowledge are not to be deemed deficit, but as significant learning tools. Through using ethnographic methods to compile data that goes beyond simple assessments of visitor studies, the researcher will get a more in depth look into the lives and motivations of families, and how they perceive and interpret the world based on their own cultural heritage. Let us continue to understand and educate ourselves about funds of knowledge

families use in sense making, reject deficit theories and challenge misconceptions about others, and make socially just learning accessible to all families.

7.2 Project Limitations

Explanation for variation in student experiences could be described by some observed limitations in this project. To begin, my student cohort sample size was small by nature of the program. A larger sample size could carry further explanatory power that could be gained in the analysis in order to best support student experiences. Another aspect to be considered is that there was a different cohort of students each summer. If there were the exact same participants each summer there could be a comparison of student feedback from summer 1 to 2. Additionally, this project was only over the course of 2 summers. Having a longer study on this program would be beneficial to better understand participant satisfaction for program improvement.

Additionally, another weakness is that although the methodology of these studies provides a realistic snapshot of a moment of a student activity time, it does not provide a broader look at how that moment fits into the overall ongoing development of the students science related behavior across contexts and time. Further, there may be some acting or censored behavior as families know they are being watched while talking with their kids and may be able to infer what behaviors the evaluators are looking for.

Furthermore, the nature of evaluation research is exploratory and can have many moving parts. One of the main benefits of performing a specific DBIR intervention is to control for background noise and variation from where a change could be occurring. This is why I intentionally only implemented one type of leadership behavior at one specific location. Although DBIR is more interested in only studying one variable at a time in attempt to cut

statistical noise, there is still room for underlying experiences not present by the eye. Although each student had variability in their background, behavior, and goals, writing in curriculum where students had agency allowed for them express it however they did in a unique way while still counting as agency. These ideas could be further supported in future studies where there is an emphasis on student case studies to better understand drivers of behavior through ethnography to understand the culture and understand the true meaning of behavior traits and personal motives.

Upon reflection at this point, I would offer a couple suggestions to the field of experiential education career pathways programs terminology. First, is a specific definition of, and goal of, what retention means that is written into program aims and outcomes. From my evaluations retention could mean pursuing a career in the STEM education field, nature based learning, working on a farm, being a steward of nature, or even just being a steward of the land and following principles from Leave No Trace. Having a definition will help with program aims as well as assessment and evaluations.

Another issue that that consistently arose with the students is the terminology and distinction of nature careers vs. science careers. For example, at the MRS when talking to students about careers in science, the students saw the scientists working in nature, teaching environmental education, but being called scientists. Understanding and defining the distinction between nature vs science or choosing to see them synonymously could help students articulate which direction they would like to go in their future if they choose a STEM field for the college plans or career goals.

Moving forward, further confirmation of increase in positive emotions due to participative decision making could be done by additional curriculum interventions at other sites

in the program to add to the body of knowledge on agency in experiential learning environments. Additional research such as longitudinal case studies on student retention over time could reveal to what degree the agency had on students to peruse nature based careers and how agency affected these decisions. Lastly, comparison studies of students who did not have any prior interest in nature careers pre-programming could analyzed to see if post-programming outcomes matched with students who did choose a nature based career and how much the program affected their motivation for pursuing a STEM career.

7.3 Programming Suggestions

7.3.1 Positive Emotions

My results show that participative decision making in student participants is an affective technique for increasing positive emotions in student experiences in the NKJN program. To accomplish this kind of outcome, collaboration between students and educators should be considered from design, to development, to implementation, and evaluation. This section is designated to apply this research to action.

To begin, creating an atmosphere of collaboration and co-design for all facilitators involved is key. This can begin by recognizing and speaking to the significance of acceptance of diversity at the beginning of the program, and the importance of maintaining a safe space for honoring unique perspectives throughout programming. With this, time and effort for organizing collaborations between researchers and practitioners must be prioritized and scheduled. Developing these partnerships takes time to develop common questions, create new methods, and assess and evaluate them. In addition to student-teacher collaboration, teacher-teacher

collaboration is important for having curriculum with the luxury of student choice. Teachers will be the people on the front lines of the implementation and are a valuable asset to a design team.

Next, taking the time to do student surveys and assessment pre-programming is an effective strategy to know your goals. Aspects and indicators for assessment and evaluation should align with the mission and aim of the program, the body of literature on theories you are interested in, and leave room for emergent trends one may discover and want to explore along the way.

Moving on, implementing agency should be considered in the program design phase. Each program will need to further refine the aspects of how to implement agency based on the aim of the program and the intended outcomes of the program. Starting with outcomes then working backwards could be a useful exercise for program managers to make sure that they are doing their best to create positive experiences. For example, there are some aspects of a nature connecting experience that are more universal than others. Using pre-programming questionnaires can also could be a powerful way to choose particular desired behaviors. Then, isolating specific activities based on responses program resources can provide a blueprint of the activities needed to increase the desired behaviors that elicit a positive response in students.

Curriculum planning is complex when trying to attend to many interests, and knowing your student audience is key to creating content they will enjoy. Pin-pointing areas in the curriculum where only one feature could be modified can help simplify adding in agency. For example, writing in an opportunity for student choice into daily curriculum is a way to balance both the aims of the program and giving students time to choose how they are spending their time and give them opportunities for reflection of the content that was learned. However, in the case that a pre-programming assessment is not possible, iterations can be made throughout

programming for quickest change. For instance, at Keystone Science School, there were 2 facilitators and when the group was divided into what they wanted to do, the teachers could split up and entertain both ideas in the group.

Another technique that can be used to increase positive emotions if there is less opportunity for implementing free choice learning, is giving agency in how students can synthesize, reflect, and share their learning experiences. For example, at the beginning of the day, let students know that they will have the freedom to choose how they will present what they learned at the end of the day. This way, the students will not feel pressure to when the day is over to have to report in a way they don't resonate with. Letting students describe what they have learned through song, poetry, photo-voice, etc. is allowing them to be agents in their learning experience.

In addition to conscious curriculum planning, responsive teaching should also be kept in mind. The literature shows that a key element of responsive teaching is developing caring relationships with students and creating a classroom characterized by care, and that teachers must learn about their students and become knowledgeable about the diversity in their classrooms (Gay, 2000).To do this teachers can plan and implement instruction that incorporates and values diverse identities of students as members of various communities, including cultural, ethnic, social, gender, age, class, and geographic groups.

Lastly, creating time for teachers to have frequent check-ins with students can help with student satisfaction, as well as assist in developing theories that work for the context of the program. If feedback is given during programming, educators must not be restricted to make iterations in real time. A program facilitator must be attuned to the needs of their students, and if they can perceive that something is not working, having an alternative plan can be critical to

keeping student engagement and participation high. This allowance of check-ins and in program iterations is at the root of DBIR. This way teachers can make changes in context to the program they are in and at the same time help the program in real time and create evidence based claims from their programs which results in knowledge about how their students learn. Based on this information, the creation of new curriculum can be designed for future years and be shared with other networks.

However, we must remember that there is utility in students not enjoying an experience that their peers may enjoy for personal and career development. For example, students reported enjoying things they didn't know they would enjoy such as white water rafting, and conversely reported not enjoying something as much as they thought they would such as camping. Knowing what they did not enjoy was just as important as what they did enjoy for helping them make future decisions on the direction of their career. One student reported that upon entering the program thought they would like to pursue a nature based career, and post-programming reported that although he would like to continue to be a steward of nature, this experience helped him clarify that he didn't not want to be a scientist or environmental educator as a full-time career.

7.3.2 Implementing Student Agency

Participative Decision Making

Participative decision making was best demonstrated at the MRS when there was a structured time slot for students to work with a scientist. However, within the confines of this timeslot, they had the choice written in that students could pick 1 of 3 options: working with pikas, water quality, or pine beetles. The students were thrilled at the choice and were more engaged than in times where the whole group had a mandatory obligation to be there. Post-

programming students reported across the board that being able to pick what activity they participated in for the day this was their favorite aspect of the curriculum at MRS.

Informing

Another suggestion aspect for implementing study agency in programming is giving students the chance to inform others of what they already know and can share through teaching. For example, students who reported positive attitudes at Cal-Wood enjoyed informing the families of what they already knew about camping, fishing, field identification, leave no trace, and bear awareness.

Managing a Group

Trusting students to manage a group was highly effective for influencing student positive emotions. At WRV students managed their own groups during a field restoration project and reported feeling enjoyment from "being in control". Students were assigned to their groups of approx. 5-10 volunteers from start to finish on restoration day. The students reported feeling valuable to the program when they felt they were relied on by the WRV managers for a successful day.

Coaching

During their time at Thorne, the participants reporting that coaching students in sports and games was among their favorite activities. Additionally, the participants enjoyed coaching students on how to use collection equipment such as nets when collecting inverts in ponds. They enjoyed sharing what they knew with younger students. Showing trust in students to do these

tasks may give them the confidence that the choices the make are valid and can increase their trust in their own decision making.

Additional suggestions based on student feedback showed that agency is also brought up through activities such journal time, friendship time, and free time. These were times during programming where students got to display agency in their day and reflect on their experiences. During these times student got to choose where they went and who they talked to and reported using these times to reflect on programming, deepen friendships, and connect with the sense of place where they were stationed.

7.3.3 Equitable Programming

Moving forward with creating equitable educational programing, there are crucial aspects to implement that program directors must account for while creating the content and intellectual design of their programs. It is important to include equitable practices into programming to supply access for all students, and key to honor and understand specific cultural practices into program design. Ignorance of these cultural practices may heighten the decline of STEM participation and contribute to the achievement gap many minorities and underprivileged youth face. In particular, it is important to avoid using deficit approaches, which can accidently be enacted if educators inadvertently mistake differences as the shortcomings of individuals. These can stem from past experiences or perspectives. When there is a lack of knowledge and understanding of the students, educators focus to fix a perceived problem rather than initially preparing and designing for differences in ways that respect and build on student funds of knowledge as assets.

When creating informal science education programs, one must account for program design including but not limited to pre-program research, pre and post assessment methodology, an evaluation plan, curriculum, materials, accessibility, staffing, and budget all within the scope of the programs mission and aims and with what resources are allocated. One of the most important factors in program development is knowing your community and knowing your students. It is also important to consider what you can reasonably accommodate with your program resources. While each program is unique and has their own complexities, I have outlined below the most important aspects that I would suggest in to developing an informal science program that factors in equity.

1. Pre-Programming Research

During the initial stages of program design the program director must be up to date on the current issues, know the current statistics on specific demographics, and have thoroughly reviewed relevant literature on the type of learning they would like to implement to make sure it is the right fit for the programs mission (IE: place based education, experiential education, etc.).

Another aspect is to have knowledge on is the community needs through pre-program surveys. Prior to programming it is critical to do front end community surveys for who will be being served (Diamond, 2016). Conducting community interviews to see what may be lacking, where there are barriers, what is desired, and what is relevant in their lives will make for a community based approach to program planning. Going into a community, visiting schools, offering online-surveys, and having interviews is a good step in learning your audience to see what is needed to be inclusive. It is critical to make connections with students' families and communities to provide opportunities for the exchange of accurate cultural information. In

addition, developing these appropriate and measureable indicators during planning is key to performing a sound evaluation of the value of the program later.

2. Selecting Participants

Having equity as a priority in planning involves making sure your program is accessible to all races and classes. This can mean many things as there are multiple barriers to access to programs such as limited funds, lack of transportation, language barriers, and even misinformed information about what an informal science program is. To make sure your program has diversity, it is encouraged to reach underrepresented groups by going to their community and advertising and offering scholarships where needed and providing community liaisons to bridge any communication or cultural mismatches.

3. Designing Program Content

Program content and curriculum should always circle back to the mission of the program so you are honestly delivering what you are advertising to the community. Adding in opportunities for student agency is important in the context of being exclusive making known there are various respected ways of knowing and learning cross-culturally. To inform design work, there are three approaches in regards to responsive pedagogy which are bridging, navigating, and challenging or reshaping content knowledge (Moje, 2004).

During the bridging perspective of responsive pedagogy, the students' culture and experiences are intentionally invited into the pre-planning conversation as a way to connect, or bridge, to the content area curriculum at hand (Moll, 1992). Next, in the navigating perspective, students are taught how to navigate cultural and discursive communities such as informal

program settings. To be able to teach from a navigating perspective, a teacher much be aware of the mismatches between students' cultures and the culture of the program and intentionally teach and encourage students to successfully navigate the gaps (Bang, 2010).

Lastly, in the challenging perspective, students are encouraged to utilize their cultural backgrounds and experiences to reshape what counts as traditional knowledge in educational literacy practices. This perspective is where traditional knowledge can start to matriculate into the curriculum and claim a space for marginalized voices and to construct new knowledge to the benefit of all parties involved in the educational process" (Moje, 2004).

5. Responsive Teaching

To incorporate responsive pedagogy, it requires that teachers learn about their students' lives outside of school, have a sociocultural consciousness, and "hold affirming views toward diversity" (Villegas, 2007). Villega's define sociocultural consciousness as "the awareness that a person's worldview is not universal but is profoundly influenced by life experiences, as mediated by a variety of factors, including race, ethnicity, gender, and social class". Responsive teaching honors, values, and cultivates differences, rather than expecting students to conform to the dominant culture and practices of school, and seeks to engage all students in the curriculum. The goal of responsive pedagogy is to include all students in the curriculum and value students for who they are in order to ensure equitable instruction for all students and to create a learning environment in which students are seen and cared for.

4. Assessment

When developing a program with equity in mind, it is best to write out an assessment

plan prior to programming so aspects can be added in to the program design that meet desired program aims. A project originally designed with assessment in mind is much more likely to yield beneficial data in hopes to meet these goals. Assessment measures the impact of a program, and when it comes to culturally being inclusive, writing in metrics that measure for points of equity in particular is crucial. Things to include in assessment of program equity would be tracking diversity of students, retention and consistency rates, if learning goals are being met, etc. that are specific to feedback from the community and learning goals of the program.

5. Evaluation

Evaluation measures the value of a program. The value of a specific program will vary in unique ways that are decided on prior to and those that are emergent during programming. When writing the program design, it is wise to first know your desired long term outcomes first. Using a logic model, for example helps identify elements most likely to yield useful evaluation data. Therefore, using a logic model of implementation is a suggested tool for making sure that a program is following a structured format (McCawley, 2001). Outcomes should be based on program objectives. Indicators to measure behavior should specify which behaviors are targeted by program. Evaluations are context dependent on what is appropriate in the environment. Some examples include informal conversations, semi-structured interviews with open ended questions, and structured interviews which are best for statistical analysis with questions that are pre-determined where they can be coded.

6. Analyzing and Sharing Data

Once a calendar year or specific amount of time has passed for the program duration, it is important to now look back and reflect on what went well and what can be improved. Having done pre and post assessments and evaluations will give clues on where you came up short on a specific aspect, such as in this case meeting equity concerns. Each program will have their own unique way to interpret what success means to them. Depending on what research methodology was used, whether qualitative or quantitative, we can then discover what is deemed statistically significant using graphs to explain data. Once the results are analyzed and complete it is best to share them with all stakeholders. This would include the program staff, parents of students in the program, the local community, other informal STEM programs, and then continue on to publications for the greater environmental education community.

8: Conclusion

8.1 Significance

The increasing attention to the topic of student attitudes and emotions was driven by a recognition that there is a decline in interests in STEM fields and many students are alienated by a discipline that has increasing significance in contemporary life, both at a personal and a societal level. While the body of research conducted has been good at identifying a problem, it has had little to say definitively about how the problem might be remediated. Consequently, the field of informal education had much to learn to develop a thorough body of literature in the study of student agency.

This research was an attempt to take a stab at it this by providing the informal STEM education field a more narrow look into what aspect of leadership behavior correlates to positive student emotions in program curriculums. Although studies have been done on leadership behavior, and there are multiple traits of a leader, this study explored in depth what aspect of leadership behavior correlates with developing students positive emotions. Furthermore, this project highlights the importance of communication and collaboration through evaluation and program design iterations and gives us insight into the nature of learning and leadership development.

8.2 Major Findings

In this study, I evaluated student leadership behavior in an STEM career-pathways program whose aim was to facilitate leadership experiences for their future career development. I found that the educational experiences where students had agency in the curriculum were most highly favored over experiences where there was no student agency in the curriculum. Based on

these initial evaluation results, I created a design based intervention to better understand the effect of implementing agency into the curriculum on student emotions in the location where there was no agency previously written in. I then compared student evaluation data from summer 1 and summer 2 on agency and favored experiences.

After examining the results, my statistical analysis concluded that adding in agency into the curriculum at WRV resulted in an outcome of increase in preference for the experience. In particular, participative decision making, informing, coaching, and group management are aspects of curriculum that were successful in this programs context for increasing positive emotions of the experience. This knowledge can be used as a launching point to inform and improve curriculum design for the additional 3 years of the 5 year NKJN program and provides a review of the many facets of research on understanding students' attitudes and emotions.

8.3 Future Directions

The NKJN program provided a model for testing positive emotions in an informal STEM career pathways program and my findings point to the need for informal STEM education programs to consider adding in opportunities for student agency into curriculum to positively affect student emotions of the experience to the extent possible by their location, resources, and aims. While I found correlations in this specific program, there is expected to be variation between students, programs, and curriculums which should be considered in future studies when determining research focuses.

The results of the study contribute to our growing knowledge of leadership behavior, and lay the groundwork for future experiments aimed at teasing apart the specific aspects of experience and may be important in further determining the effect of participate decision making

for student emotions. To delve deeper into these topics, there is a need for further study in other locations to appreciate the extent of the influence of agency on student experience.

Future research should consider studies investigating the long-term impact of agency and leadership behavior in the retention of students in STEM fields. Longitudinal retention studies with students could further show us the effect of these experiential programs impact over time.

While it would be difficult and unnecessary to completely transform the nature of environmental education programs curricula, this work offers a better understanding of the attributes of a program design that can lead to eliciting positive emotions in students and ways to implement agency to increase improve the quality of the students' experience. My thesis project argues that the amount of agency students have is a central feature in explaining the nature of adolescent's positive emotions towards STEM education while in the NKJN program.

Moving forward, I would suggest informal STEM practitioners to identify areas of their programs where they can implement agency as a central feature in their curriculum design. To do so, I encourage practitioners to use assessments and evaluations to understand the specific activities that lead to positive emotions in their students while keeping in mind contextual factors such as ethnicity, social class, and cultural ways of knowing science through personal funds of knowledge. Additionally, I would urge researchers to continue studying this domain as central concern for research if we are to offer prescriptive solutions and advice to STEM educators on how to improve the quality of student educational experiences in informal STEM learning.

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APPENDIX A: Evaluation Templates

Appendix A1: Pre and Post Identity Assessment

Element	1-10 on Likert Scale	Positive/ Negative	Example
Perceptions			
Values			
Interest			
Motivation			
Attitudes			
Identity			
Experiences			
Emotions			

Appendix A2: National Research Council's Learning Science in Informal Environments Strands

Learning Strand	Yes/No	When in Curriculum
Developing Interest		
Understanding Science Knowledge		
Engaging in Scientific Reasoning		
Reflecting on Science		
Engaging in Scientific Practices		
Identifying with Scientific Enterprise		

Appendix A3: Boulder County Environmental Education Guidelines

Whole Person Part	Yes/ No	When in Curriculum
Head		
Heart		
Hands		
Feet		

Appendix A4: Student Leadership Behavior Evaluation Chart

Behavior	Activity	Activity	Activity	Activity	Activity
Leading by example					
Coaching					
Encouraging					
Participative Decision Making					
Informing					
Showing Concern					
Interacting with team					
Group Management					

APPENDIX B: Program Curriculums

Appendix B1: Cal-Wood Education Center Curriculum: Family Camp Agenda

Saturday

8:30 - 9:30 Instructors arrive at Cal-Wood

• Be sure to bring your own lunch for Saturday.
• Meeting point: The main parking lot - "Lago"
• Equipment - Grab the white passenger van in the main parking lot near the lake (the keys are in the van). And they go to the lodge to see the state of the food and the jugs of water.
• At the Lodge:
• Check list of participants and observe number of families and notes (health and others).
• Grab a black radio to be in communication with the office and other camps
• Grab yellow spokes (frequency # 8.1) and extra batteries. They will be in the basement
• 3 radios: Leader 1 & 2, and one for Assistants.
• Search and upload materials to facilitate integration games:
• Maps, lamps, "Box: Family Camps" will be in front of Rafa's office
• Fill water jugs - several (minimum 5). They are next to the men's restrooms in the lodge
• The name of the cook is: "John"
• Ask about the location of the food - 2 refrigerators and a cardboard box - and ice packs - 5 minimum.
• Usually found in refrigerators outside the kitchen and compresses in the back refrigerator.
• If the food is ready - they take it to the truck to be transported to the "Mina Mica" camp, along with the water and the teaching material. And the process of preparing the camp begins.
• If the food is not ready - The team is divided [Leader 1 or 2 handles the participants in the mine camp] In the camp. The assistants begin to check the state of the tents and the sleeping bags. Meanwhile Leader 1 or 2 checks the state of the food, fills water jugs, and assists in what is needed and waits for the return of the van to load the food.

• Upon arrival at the camp. Each member of the team has to familiarize with the location and equipment available in the white tent. Essential: locate the medical kit, lamps, check gas tanks.
The assistants must check each campaign house to check that they are in optimal conditions to be used by families. In addition, they should make an inventory of the sleeping bags and sleeping pads of each house in order to accommodate families according to the number of members. And they remain in the camp mine to wait for the families, continue preparing the camp.

• Purpose: To make the camp look ready and ready to welcome families. Let's say - do not see a camp "asleep" | Open and all prepared.
Put garbage stations near each table (use the white cans that are inside the white tent and put white bags) and tie 2 large black bags in the trees, fret washing station, check that there is

enough toilet paper, minimum 15 rolls, 5 for each bathroom, take tables and fit them in the "L" shape, put water jugs on several tables, check that the bathrooms below have water.
Israel: (make a map on the computer to know where things are going)

10:30 - 11:00 Arrival at Cal-Wood of the families

• "Welcome Committee: Leader 1 & 2 wait for families in the Lake.
• While Assistants finish giving you the final details for the preparation of the family camp.
• Leader 1 & 2 give their welcome speech - roles, expectations, and provide itinerary of activities to families. Check with the group coordinator about special cases (allergies, physical impairments, etc). And they guide families to the camp in family cars.

11:00 - 12:00 Families arrive and are directed to the camp

• The feasibility of family vehicles that can make the trip to the mine camp is inspected. And families and suitcases are divided in the cars of the participants. The passenger van is used to carry extra families and suitcases. Try to make the tour take place in a round.
• Verify that all families are in the group - be alert if a family will be arriving later. Alert Cal-Wood staff at the Lodge. (As?)
• Once arriving at the camp. The cars have to be parked in reverse on the way to the mine, in the eastern part of the main camp.

12:00 - 12:30 Putting things in the camping tents

• Upon arrival at camp. It is the responsibility of the assistants to pay attention to the children and young people. Provide available games in the mine camp for participants to use and maintain inventory control after each use. In short, the attendees will be the hosts of the children and youth. There are toys and balls inside a plastic box that is inside the storage tent.
• It is essential to remind families about the good camper's ethic: Do not leave a trace!
• Have garbage stations ready, tables prepared for families.
• Once the cars are parked and the families are counted. The process of granting bell houses to each family by size and necessity begins. Families with small children can be located near the main camp so they have easier access to the bathroom.
• The assistants facilitate and guide in this process.
• It is informed about acceptable hours of common areas and sleeping.
No noise schedules in the residential area: from 9:00 p.m. at 7:30 a.m.
• Leaders and assistants should sleep on the edge of the camp and central area to be available to families during the night in case of an incident that requires their intervention.

12:30 - 2:00 Lunch (each family must bring their lunch) and orientation

• Review pending notifications: good behavior, animals, participation, responsibilities:
• Remember: do not leave a trace - Collect garbage, do not cut trees, do not move bones, and stay out of the central area. In short: Do not take anything but good memories and photographs, and leave only the footprints of your shoes.
• Explain the camp's agenda.
• Small speech about animals (bears and pumas), ticks, and our role so that they do not approach the camp.

- WATER!! It is very important that you drink water constantly. The Gatorade is available to those who really need it (children). This is especially important on the Sunday before leaving for the lake.
- Bathrooms. There are three bathrooms available for families, two of them are for women and one with a urinal for men. Ask families not to throw garbage like diapers and feminine towels in the bathrooms, only toilet paper.
- Sunblock and insect repellent. To us the dark ones also burn the sun, so we must remind families to use it. Tell them where the blocker and the repellent will be.
- Assign volunteers. Tell them to cook for dinner and breakfast so that they assign themselves, as well as for cleaning.
- Before continuing with the next activity. And every time the camp becomes "empty" all the garbage stations have to be collected, centralized in a black bag and stored in the van. This in order to prevent wild animals from being attracted to the camp.
- You cannot go to the next activity if the camp is not clean!

2:00 - 5:00 integration games, walk, introductory natural science activities

- Depending on the weather - the walk "round the river" is made to visit the waterfall.

5:00 - 6:30 Return to camp & prepare dinner

- The food for dinner is in the coolers that were collected in the morning at the lodge.
- Know what's in the coolers before making them public: You can only get it out of dinner! You have to protect / store breakfast food for the next day. And to prevent children from reaching out with the goodies for the campfire.
- Mobilize the group of volunteers to cook and clean up. Establish garbage stations.
- Strategy for success: clean as it gets dirty.
- Establish 3 zones: "cooking area", "cleaning area", "hand washing area"
- Cooking Zone: preparation and cooking.
- Use plastic tables to create stations to cut and prepare food
- Turn on burners and take out pans from the main store
- Cleaning area: 3 brown tubs and drying section.
- First with soap, the second with a "chlorine piquet", third only water
- Hands Washing Area: check that the hand washing station is ready. This station is rented. Ask those who prepare foods to wash their hands.
- While the preparation is taking place - which is guided by the leaders. The assistants are in charge of formulating, guiding and taking care of the young people and children participating with the realization of games and recreational activities.

6:30 - 7:30 Dinner and Cleaning

- Before continuing with the next activity. And every time the camp becomes "empty" all the garbage stations have to be collected, centralized in a black bag and stored in the van. This in order to prevent wild animals from being attracted to the camp.
- You cannot go to the next activity if the camp is not clean!

• Eventually everything has to be stored in the white store. ALL CLEAN AND ORGANIZED! Garbage in the vans.
• At this time. If there is no water or it is below the level. A "run" is made to the lodge to recharge the water drums and leave the garbage in the garbage containers located behind the kitchen and the food left over.
• The assistant begins to collect the toys used by the youths and guides them in activities to collect firewood for the fire.
• After cleaning everything, the remaining time can be used for personal / family things. Example: prepare moms, change diapers, have everything ready in their stores, etc.

7:30 - 9:00 Bonfire

• The Assistant initiates the process of lighting the fire with the young people. If you cannot light the fire, seek the assistance of one of the leaders to light the fire.
• Leaders must ensure that everything that belongs to the "White Store" has to be inside and secured. The food in the van, along with trash, and take a garbage station to the campfire area.
• General warning: Inform young people and families about regulations around the fire. Good behavior, expectations, schedules and others.
• Deal treats, S'mores.
• Assistant - design night games for children and young people: hiding places, trails, etc. ...

9:00 - 9:30 Astronomy | Tales and Legends

• Try to encourage conversation around the campfire and encourage the flow of appropriate stories with a theme that talks about the importance of promoting family outdoor activities and how these activities can be supported more among the Latino community.

9:00 - 9:30 Prepare to sleep

• Ask families about conditions in their bell house.
• Does anyone need more blankets, lamps?
• Pick up the trash station at the campfire, along with any food trail.
• Check that the surroundings of the White Store are clean and organized and there is no sign of garbage and / or food.
• Save garbage, food in the van.
• Remind families to close the windows of their cars and leave all food and toothpaste in the cars, so they do not have any of this in the tents.
• Remind volunteers who are going to make breakfast to be ready by 7:30 a.m.
• Remind families that as soon as they get up, start picking up things from the store so they can clean them and pack the cars.
• Inform families of the completion of the campfire at 9:30 p.m. and the morning hours in the camp.

9:30 - 10:00 Cleaning, Final organization, to sleep!

• Close the changarro at 10 p.m.

---------- GOODNIGHT! ----------

Sunday

7:00 - 7:15 Coffee time

• Leader 1 or 2, provides water and stove to prepare coffee. At the request of the parent group.

7:15 - 7:45 Breakfast preparation

• The breakfast process begins. The breakfast food is taken out of the coolers and the seasons are established: cooking, cleaning, and hands.
• It is cleaned immediately after being used. Efficiency with the rotation of materials use.
• Parent assistance is mobilized for breakfast. This under the leadership of the Calwood team.
• Establish garbage stations.
• Assistant - observe young people and the toys they use. Do not play in the food preparation area - central camp.

7:45 - 8:30 Breakfast

• Ensure that families are responsible for the trash and do not leave food thrown in the camp.
• As the families finish their breakfast they are informed of the day's activities: finish cleaning the camping tents / walk to the river / to the top of the mountain / trek to the mine / mountain biking - depending on the weather conditions and group interest.

8:30 - 9:00 Cleaning and finish in pick up camp

• Families can finish putting their bags in the vehicles they used to get to the camp.
• Families should use brooms and dust collectors to sweep and collect dust / trash in their stores and close them very well. The assistants give the "green light" to each family.
• Each family makes sure that their bell house is clean and ready for the next camp
• Families return what was lent to them, such as lamps.
• Leaders make sure that all furniture, as well as kitchen utensils, are stored in their assigned places.

• Attendees check the camp they put garbage, toys, water jugs, etc. Put the garbage, suitcases in the white van
9:00 - 11:30 Family Activity • Mountain bikes, forestry activity or maps. • Divide the families into two groups. Each activity must last 1 hour in total before returning to the camp and exchanging activities.
11:30 - 12:00 Go to the Cal-Wood parking lot • Before leaving the camp. The families are divided into two groups: A & B. To then facilitate the division of families for fishing and archery activities. • The white van leaves first and is followed by the families' vehicles. They park in the lake. Families are reminded of the division of groups A & B. And it is not reported who in whom. • Attendants - One goes to the archery area to prepare it. • Leader 1 or 2. He goes to the fishing area to make sure that NO ONE makes use of the fishing rods without prior instruction and under the supervision of an adult. • Leader 1 or 2 goes to the lodge and leaves the garbage. Recharge water and grab lunch sandwiches and put ice with lunch. Fill a cooler with ice and take a gallon plastic bags to put the dead fish and families take them.
12:00 - 12:30 Lunch • Sandwiches are distributed in the lake area under the large trees. • At the end of lunch, fishing and archery begins.
12:30 - 2:00 Group A – Fishing Group B - Archery • Before initiating the corresponding activities, the instruction on the proper use of the equipment (bow or string) is carried out. Children may not use the bow or cane without adult supervision. Youth under adult approval. • Each station has the support of a leader and an assistant. To have an assistant only. This must be in the fishing area, after having prepared the archery area.
2:00 - 3:30 Group A – Archery Group B - Fishing • Families are rotated: From fishing to archery and vice versa. • Rules, expectations, and proper use of the equipment by adults, youth, and children are again reported.

3:30 - 3:45 Talk about the experience

• Final comments - talk about the importance of encouraging family outdoor activities and how easy it is to "go to the mountains in Colorado"
• Program evaluations are provided.
• They are given leaflets from the Cal-Wood camps and tell them that we still have scholarships. They are also given a brochure of the family camps that are still available for them to give to other families.
• Water bottles are collected
• The process of "closing operations" begins - fishing and archery

Appendix B2: Keystone Science School Curriculum

Basin Voyage 2018 – Curriculum Overview
Keystone Science School's Basin Voyage program takes students on an adventure exploring the Colorado River watershed. The program is designed to prepare students to create policy recommendations for the Colorado Water Plan.

Overall Program Objectives
Through participation in the Basin Voyage program, students will be able to:

- Explain the characteristics of a watershed, and identify major watersheds in the US, Colorado, and those impacting the Metro Basin.
- Identify key dates and events in water law history;
- Explain the various positions and interests which make up the stakeholders within the Metro Basin Roundtable;
- Recognize the social, economic, and environmental implications within water management strategies;
- Collaborate towards solutions for the Colorado Water Plan.

Stakeholders
Students will learn about the issue of water management within the Colorado Watershed through the lens of a particular stakeholder. Those stakeholders to be represented by students include;

1. Headwaters County Commissioner - intersection with land use policy and planning, politician
2. Front Range Water Provider - urban demands, trans basin diversions, conservation
3. Agriculture - livestock industry, food production, conservation easements
4. Energy Development - mining/drilling, power generation and distribution, public health, water quality
5. Recreation Interests - river access and flows, snowmaking, trout fishing
6. Ecological interests (The Nature Conservancy, USFWS, CPW, NRCS)

Day 1: Monday July 23
KSS → Lafayette → Peak One Campground, Frisco
Watersheds & Land Use

9:30am:	Instructors depart KSS
12:00pm:	Pick up students in Lafayette
12:30pm:	Program Orientation/Pre-Surveys
	Lunch
	What is a Watershed and Colorado Land Use
	Visit Loveland Pass (Continental Divide) and hike
4:00pm:	Drive to Peak 1 Campground
4:30pm:	Camp orientation and set up
5:00pm:	Move into tents, free time
6:00pm:	Dinner @ campground (teach backcountry cooking)
7:30pm:	Evening Program
10:00pm:	Quiet Hours

Day 2 - Tuesday July 24
Peak One Campground
Water Quality, Quantity & Energy

8:00am:	Breakfast and pack lunches
9:00am:	Plumbing the Colorado activity
10:00am:	Depart for Frisco Marina
10:15am:	Arrive at Frisco Marina
10:45am:	Pontoon Boat Ride on Dillon Reservoir (Water Storage)
12:45pm:	Off boat and eat lunch
2:00pm:	Wastewater Treatment Plant Tour
4:00pm:	Stakeholder development and understanding
5:00pm:	Free Time
6:00pm:	Dinner @ campground (students help prepare)
8:00pm:	Evening Program
10:00pm:	Quiet Hours

Day 3 - Wednesday July 25
Peak One Campground → Elk Creek Campground, Glenwood Springs
Aquatic Ecology & Water Quality

8:00am:	Breakfast, pack lunches
9:00am:	Dillon Marina and Fly Fishing
11:00pm:	Hike in Summit
	Lunch
	Stream Survey
3:30pm:	Drive to Elk Creek Campground
5:00pm:	Set up camp and free time
6:00pm:	Dinner @ campground (students help prepare)
7:30pm:	Evening Program

10:00pm: Quiet Hours

Day 4 - Thursday July 26
Elk Creek Campground

Recreational, Agricultural, Personal, & Municipal Water Needs
8:00am: Breakfast, pack lunches, dinner and supplies if you want to go to hot springs
9:00am: Agriculture lesson
11:30am: Depart for Glenwood Springs
12:15 pm: Rafting with Blue Sky
4:00pm: Glenwood Hot Springs (or another activity)
5:30pm: Dinner- Mac n cheese- park style
6:30pm: Drive back to Elk Creek Campground
7:30pm: Town Hall Meeting
10:00pm: Quiet Hours
Elk Creek Campground in Glenwood contact: Number (970)-984-2240

Day 5 - Friday July 27
Elk Creek Campground → Lafayette → KSS
7:00am: Breakfast
Pack
Post-Surveys and Debrief
9:00am: Depart for Lafayette
12:00pm: Drop students off in Lafayette

Gear and Packing List
- 2 Water bottles
- Day Pack
- Hat
- Sunscreen
- Appropriate swimsuit
- Rain jacket
- Sleeping Bag (KSS can provide loaner)
- Sleeping Pad (KSS can provide loaner)
- Hiking shoes
- Water shoes/sandals with backs (optional)
- Clothes for 5 days (includes hiking clothes and layers for the cooler evenings)
- Pillow
- Headlamp

Appendix B3: CU Science Discovery Mountain Research Station Curriculum

Science Discovery
UNIVERSITY OF COLORADO BOULDER

CU Mountain Research Station: 818 County Road 116, Nederland, CO, 80466
http://colorado.edu/mrs
Station phone: (303) 492-8842
CU Science Discovery: (303) 492-4615 Alexandra Rose cell phone: (415) 264-1972

CU Mountain Research Experience 2018

Offered by CU Science Discovery in partnership with INSTAAR and the CU Mountain Research Station

TIME	MONDAY 7/30	TUESDAY 7/31	WEDNESDAY 8/1	THURSDAY 8/2	FRIDAY 8/3
AM	Meet at Science Discovery (9:30 am) Travel to MRS	Breakfast at dining hall (7am) Ready to go: 8:30AM Intro to Remote Sensing Camera Assembly and Exploration	Breakfast at dining hall (7am) **Field Research Teams:** Pika Populations (7:30) -or- Studying climate change's impact on alpine plants -or- Birds and Bugs -or- Alpine Lake Ecology	Breakfast at dining hall (7am) **Field Research Teams:** Pika Populations (7:30) -or- Evolution and Ecology of Carrion Beetles -or- Phenocams and Black Sand in the Alpine	Breakfast at dining hall (7am) Group hike to Arapahoe Glacier overlook
Lunch	Lunch at MRS (*Bring bag lunch)	Lunch in Field	Lunch in Field	Lunch in Field	Lunch in Field
PM	Geocache and Orienteering Activity ~1:30PM Hiking tour of MRS; Overview of MRS research with Dr. Bill Bowman	Data collection and Analysis	**Field Research Teams:** Pika Populations (7:30) -or- Climate change's impact on alpine plants -or- Birds and Bugs -or- Alpine Lake Ecology	**Field Research Teams:** Pika Populations (7:30) -or- Evolution and Ecology of Carrion Beetles -or- Phenocams and Black Sand in the Alpine	Return to MRS Finish cleaning lodge Depart MRS (3pm) Arrive Science Discovery (~ 4pm)
Dinner	6PM MRS Dining Hall	6PM MRS Dining Hall	**4:00PM** Ozone Garden 6PM MRS Dining Hall	6PM MRS Dining Hall	6PM MRS Dining Hall
Evening	Ice Cream Party	Girls on Rocks final presentations	MRS Summer Seminar Dr. Chris Ray	Experience Share-Out and Wrap-Up	

Appendix B4: Thorne Nature Experience Curriculum

Thorne Instructor:	N/A
Thorne Class Name:	At Home in the Woods
Thorne Class Dates:	June 20-24, 2016

Monday			
Location and Daily Theme:	Heil Valley Ranch - Shelter & Habitat		
	Purpose	**Activity**	**Description**
Northeast	Opening	Weather Report/Gratitude	On the first day, also set expectations for the week.
East/Southeast	Inspire/Activate	Habitat Stories & Oh Deer!	Share stories of animals seen in nature getting what they need from their habitats. Oh Deer! game where deer collect resources.
South/Southwest	Focus/Take A Break	Hike & Habitat/Animal Scavenger Hunt	Hike towards spot to make debris huts. Use senses to find animals & habitats while hiking. Ask questions on at least 2 different levels starting with easy to answer.
South/Southwest	Focus/Take A Break	Body Radar & Debris Huts	Tell story about finding something special using body radar. Use body radar to choose spots for debris huts. Go over expectations and recommendations for building debris huts.
South/Southwest	Focus/Take A Break	Sit Spot & Debris Hut break down - LNT	Tell a story about doing a sit spot. Allow students to practice sit spots in/near their sit spots. Make sure to naturalize area that debris huts were built in.

West	Gather and Share Stories	Story of the Day & Team Name	Discuss stories as a group and ask each other questions about discoveries. Come up with a team name for the group.
Northwest	Reflect	Journal	Give students time to write/draw about their favorite parts of the day.
North	Integrate	Take Home Question	How can you tell what an animal is getting from its habitat?
Northeast	Closing	Weather Report/Gratitude	
Supplies Needed:	Journals		

Tuesday			
Location & Daily Theme:	Walden/Sawhill Ponds - Animals & Survival		
	Purpose	**Activity**	**Description**
Northeast	Opening	Weather Report/Gratitude	
East/Southeast	Inspire/Activate	Bird Language Story	Share story about when birds warned you of danger. Have kids help to act out.
South/Southwest	Focus/Take A Break	Bird Language Scenarios & Bird watching	Act out the 5 different things that birds talk about. Use binoculars to look at different birds. Try & discuss what they're talking about.
South/Southwest	Focus/Take A Break	Cougar Stalks Deer & pond explore	Show pictures of deer and mountain lion. Explain special adaptations of both animal that help them to survive. Play cougar stalks deer. Mountain lions sneak up on deer redlight

			greenlight style, go back to start if seen moving. Explore in pond after.
South/Southwest	Focus/Take A Break	Going on a hike game, 10 essentials, rule of 3s, wander	Teach rule of 3s - 3 seconds -attitude, minutes-air, hours-warmth, days-water, weeks-food. My name is Mikaela and I'm bringing matches on the hike. My name is.. Lead into real 10 essentials. Students can wander & play within sight & speaking distance.
West	Gather and Share Stories	Story of the day	
Northwest	Reflect	Sit spot and journal	
North	Integrate	Take Home Question	How can you figure out how an animal is feeling?
Northeast	Closing	Weather Report/Gratitude	
Supplies Needed:	binoculars, bird guides, 10 essentials info, cougar and deer pic, water nets, tubs		

<u>Wednesday</u>			
Location & Daily Theme:	Chautauqua Park - Food & Fire		
	Purpose	**Activity**	**Description**
Northeast	Opening	Weather Report/Gratitude	
East/Southeast	Inspire/Activate	Plant Stretch & Talk	Do a little plant part yoga. Talk about different parts of plants you eat from the grocery store.

South/Southwest	Focus/Take A Break	Edible Plant Game & Hike	Play the edible plant memory game in pairs. Take turns finding matches and reading info about edible plants. Give each kid an edible plant card to find as you hike to Bluebell shelter.
South/Southwest	Focus/Take A Break	Flint & Steel & Firekeeper	Practice using flint & steel in bluebell shelter. Play firekeeper. Kids sneak up and try to steal fuel- sticks from the blindfolded firekeeper. Use spray bottle for sparks from the fire to tag kids out.
South/Southwest	Focus/Take A Break	S'more prep, Grasshopper catching, & Juncos & Jays	Set out materials for s'mores near wildflower patch. Set goal for students to catch enough grasshoppers to survive off of. Share info about eating grasshoppers. Take a break in the shade and then play Juncos & Jays. Lots of kids are Juncos - hide nests, get seeds from tree to feed and grow population. Jay tries to steal from nests. Hawk can be added to protect Juncos - help balance game.
West	Gather and Share Stories	Story of the day	While eating s'mores discuss stories from the day.
Northwest	Reflect	Sit spot & Journal	
North	Integrate	Take Home Question	Was it harder to get your own food (grasshoppers, flint & steel, & S'mores) or be an animal collecting food (Juncos & Jays)?
Northeast	Closing	Weather Report/Gratitude	
Supplies Needed:	Edible plant game & info, flint and steel, solar oven, s'mores, bug boxes, maybe land insect nets, juncos & jays		

Thursday			
Location & Daily Theme:	Coot Lake & Tom Watson Park - Camping & LNT		
	Purpose	**Activity**	**Description**
Northeast	Opening	Weather Report/Gratitude	
East/Southeast	Inspire/Activate	Bird Language Story	Camping spot with Spotted Towhee story using Body Radar
South/Southwest	Focus/Take A Break	Body Radar & Tent	Practice using body radar and use it to find a good spot to set up the tent. Set up the tent and relax inside.
South/Southwest	Focus/Take A Break	Awareness- blind walk & free explore with nets	Practice sensory awareness and then blindfold eachother taking turns leading eachother safely to interesting objects to experience. When finished, free explore near the lake.
South/Southwest	Focus/Take A Break	Campsite Map - LNT & play	Students draw pictures of their perfect campsite on the activity pages - including everything they need to be comfortable for a week. Tape together to see how they affect each other. Discuss LNT principles when camping. Free play & make believe camping after.
West	Gather and Share Stories	Story of the day	
Northwest	Reflect	Group sit spot	
North	Integrate	Take Home Question	What makes a spot safe for us? For animals?

Northeast	Closing	Weather Report/Gratitude	
Supplies Needed:	tent, blindfolds-6, campsite activity, water nets, tubs		

Friday			
Location & Daily Theme:	S. Mesa Trail/Doudy Draw - Water & Celebration		
	Purpose	**Activity**	**Description**
Northeast	Opening	Arrive & Journal then Weather Report/Gratitude	Journal since we did group sit on Thursday
East/Southeast	Inspire/Activate	Damselfly Story & Incomplete Metamorphosis Game	Tell story about damselflies. Play rock paper scissors incomplete metamorphosis game.
South/Southwest	Focus/Take A Break	Creek Study & Explore	Test the water for quality using macroinvertebrate guides. Play & explore in/near creek.
South/Southwest	Focus/Take A Break	Filter water & lemonade	Discuss different water filtration methods. Use water filter pump to make lemonade.
South/Southwest	Focus/Take A Break	Web of Life, body radar, & nature altar building	Are we connected to nature? Play web of life game to demonstrate how animals need plants that need the sun, etc. Then use body radar to find a special object to put on our closing nature altar - maybe it reflects you or something important to you in nature.
West	Gather and Share Stories	Altar & Stories of the week	Share what we brought to the altar and why. Act out our favorite parts of the week - guess each others.
Northwest	Reflect	Sit spot & Journal	

North	Integrate	Take Home Question	What skills do you have to help you feel at home in the woods?
Northeast	Closing	Weather Report/Gratitude	
Supplies Needed:	Macroinvertebrate guides, water nets, tubs, water filter, lemonade		

Appendix B5: Wildlands Restoration Volunteers Curriculum

Monday, June 19 – Thursday, June 22 8:30 AM-3:30 PM

Course Overview

	Monday, June 19th	Tuesday, June 20th	Wednesday, June 21st	Thursday, June 22nd
Objectives	Students will… • Understand the basics of ecological restoration • Practice different leadership styles • Differentiate between different tools and use them safely • Assess risk in the field	Students will… • Be able to identify key plant species • Learn the basics of ecological science • Practice ecological restoration in the field	Students will… • Practice advanced leadership skills • Practice ecological restoration in an urban environment • Be introduced to partner agencies and possible environmental careers	Students will… • Practice ecological restoration in the field • Reflect on their experiences • Celebrate their accomplishments
Schedule	8:30-9 Intro and overview 9-11:30 Leadership basics (getting started, leadership styles, learning styles, assessing crew) 11:30-12:30 Intro to ecological restoration 12:30-1 Lunch 1-2 Intro to ecological restoration (cont.) 2-3 Tools 3-3:30 Assessing Risk	8:30-9:30 Transport to field and safety warm-up 9:30-12 Hike, including ecology and plant ID lessons 12-12:30 Lunch 12:30-2:30 Ecological restoration practice 2:30-3 Transport back to Lafayette 3-3:30 Wrap up	8:30-9 Teambuilding 9-11 Leadership skills (listening, conflict management, feedback) 11-12:30 Ecological restoration in our backyards 12:30-1 Lunch 1-1:30 Working with land partners 1:30-3 Careers in natural resources 3-3:30 Wrap up	8:30-9:30 Transport to field and warm up 9:30-11:30 Ecological restoration practice 11:30-12 Lunch 12-2 Ecological restoration practice 2-3:30 Transport back, wrap up, and reflection
Notes	This day will be on site in Lafayette. No transportation necessary.	This day will be in the field (location TBD—possibly Eldorado Canyon State Park). Transportation will be needed. Several ecological restoration approaches will be practiced, including seeding, erosion control, trail work, and planting. The exact order of this work by day will be decided once location is determined.	This day will be on site in Lafayette, both in the classroom and outside. No transportation necessary, although we will likely walk to Coal Creek Trail depending on location.	This day will be in the field (location TBD—possibly Eldorado Canyon State Park). Transportation will be needed. Several ecological restoration approaches will be practiced, including seeding, erosion control, trail work, and planting. The exact order of this work by day will be decided once location is determined.

Wildlands Restoration Volunteers Training Week

Monday AM: Intro, Leadership

Introductions, agenda overview: 30 minutes (discussion)

Getting started: 1 hour

oExpectations for the week (discussion and reflection) o Stewardship: the what and why (presentation)

o What is the role of a crew leader? (brainstorm)

Learning Styles: 30 minutes (activity)

Assessing Crew: 30 minutes (presentation and role play)

Introduction to Ecological Restoration: 1 hour (presentation and discussion) LUNCH: 30 minutes Monday PM: Tools, Risk, More Eco Restoration

More Ecological Restoration overview: 1 hour (presentation and activity)

Tools: 1 hour (small group activity)

Risk Assessment: 30 minutes (presentation and scenarios)

Tuesday AM: Transport to field, ecological science hike

Transport to field and safety warm up: 1 hour

Hike with plant ID and ecology info: 2.5 hours (activity) LUNCH Tuesday PM: Practice, transport back

Ecological Restoration practice: 2 hours (activity and reflection/debrief)

Transport back: 30 minutes

Wednesday AM: Leadership

Icebreaker: 30 minutes (activity)

Listening: 30 minutes (activity)

Conflict Management: 30 minutes (activity)

Feedback: 30 minutes (activity)

Leadership in the field: 1 hour (discussion) LUNCH Wednesday PM: Project Planning

Overview of July 22nd project: 30 minutes (presentation)

Project Planning overview: 1 hour (presentation and activity)

Planning: 1.5 hours (discussion and activity) Thursday AM: Transport to field, practice

Transport to field and warm up: 1 hour

Ecological Restoration practice: 2 hours (activity) LUNCH Thursday PM: Practice, wrap-up, transport back

Ecological Restoration practice: 2 hours (activity)

Transport back and wrap up: 1.5 hours (debrief and reflection)

Wildlands Restoration Volunteers Restoration day

Date and Time: June 30th 9:00-1:30 (Crew Leaders meet at 8:45)
Meeting Place: end of Elysian Field Drive in Lafayette

Project: pull 4 types of invasive spp., plant ~100 native riparian plants along Coal Creek

Number of Participants: approx. 100 signed up….expect 70-100 total (depends on attrition)

Food: breakfast will be bagels and cream cheese and fruit, lunch is pizza and cold drinks (pop, juice and fizzy water)

Educational Activities: Martin Ogle will be leading a riparian activity for children all morning. We will have kids cycle through the activity as the morning goes on…usually kids want to go at different times, with or without parents, so be prepared for some fluctuation in crew size over the course of the morning. Martin is also going to be telling an interpretive story for those who are interested around lunch time.

Other things: There will be crews led in both Spanish and English. I won't know how many Spanish-speaking crews there will be until the day of the project. We will find ways to provide interpretation for those crews that are instructed in Spanish.

A Colorado College researcher is going to be conducting interviews with families during the event. Her name is Koki, and she will come and introduce herself and ask permission before pulling families aside for 20 minutes or so.

Interns: 7 NKJN interns will be paired with an adult crew leader to lead a crew for the morning. They have been through a leadership/CL training week and I would like you to challenge them to lead a significant amount of the activities if they are comfortable. They have practiced CUSSing tools, leading introductions, and know the weeds and methods of removal we will be focusing on. They have also planted riparian container plants and have been on a site visit with Rob Burdine (OSMP manager). They should be an excellent resource for the project and the location!

Needs:

- Buy juice and fruit and cream cheese for breakfast
- Pick up coffee (Saturday morning)
- Buy fizzy water and pop for lunch
- Pick up bagels (donated by Einsteins on Friday)
- Help load tools (Friday afternoon)
- Help unload tools (Saturday afternoon)
- Help greet and register folks in the am (will likely be paired with a Spanish-speaking intern)

- Help Martin with young kids' station (the interns are excited about this, so we'll rotate them through)

Wildlands Restoration Volunteers Plants

Common teasel (Dipsacus fullonum)
Family: Caprifoliaceae
Native to Europe and Asia

Remove by pulling, be sure to wear gloves! Pile the pulled weeds next to the trail and Rob will pick them up after the project.
A biennial that was introduced to North America from Asia and Europe, teasel can grow to over 6 ft tall. The plant develops lanceolate basal and stem leaves with a wrinkled/rough surface. The flower head is large and egg-shaped, with tiny white-to-violet flowers that bloom April-September.

Musk Thistle (Carduus nutans)
Family: Asteracaea
Native to Europe and Asia

The heavily prickled plant with significantly larger (1.5 inches to 3 inches) than normal purple flowers is a nuisance plant in Colorado. It grows to up to 6 feet tall and has waxy and dark green spines.

The best way to dispose of smaller weeds is to just pull them out. Make sure to have gloves! For larger plants, use loppers or a cutting tool to cut them off from their stem. Leave their carcasses by the road in piles to be picked up later by the land management people.

Moth mullien (Verbascum blattaria)
Scrophulariaceae family
Native to Eurasia and North Africa

Moth mullein is a biennial that develops a stalk with white or yellow flowers in its second year of growth. Its deep taproot makes it easy to pull effectively. Please pull and stack next to the trail for Rob to collect after the project.

Canada thistle (Cirsium arvense)
Family: Asteraceae
Native through Europe and North Asia

Canada thistle is a perennial plant that is best controlled by cutting off the flowering heads. Please cut flowering heads with hand pruners or loppers and bag to be thrown away after the project.