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Inquiry-Based Professional Development: How Did The Activities In The Mississippi Rivers Institute Affect Participant Confidence In Teaching Environmental Education?

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INQUIRY-BASED PROFESSIONAL DEVELOPMENT: HOW DID THE ACTIVITIES IN THE MISSISSIPPI RIVERS INSTITUTE AFFECT PARTICIPANT CONFIDENCE IN TEACHING ENVIRONMENTAL EDUCATION?

by

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To my family. I could not have done it without your continuous support and encouragement during this long journey. Thank you!

"Water, like religion and ideology, has the power to move millions of people. Since the very birth of human civilization, people have moved to settle close to water. People move when there is too little of it. People move when there is too much of it. People journey down it. People write and sing and dance and dream about it. People fight over it. And all people, everywhere and every day, need it. We need it for drinking, for cooking, for washing, for food, for industry, for energy, for transport, for rituals, for fun, for life."

Mikhail Gorbachev, 2000

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CHAPTER ONE

INTRODUCTION

"Becoming a learner as a teacher in the Rivers Institute was immensely important, because I put myself in my students' shoes. I now understand how active field investigations can scaffold and further deepen knowledge of science and related subjects."

Rivers Institute 5th Grade Teacher

Overview

This capstone is a two-pronged study. First, I will outline the steps needed to organize and implement a successful, inquiry-based professional development opportunity. Second, I will discuss the quantitative and qualitative gains reported by participants of this professional development opportunity, known as the Mississippi Rivers Institute.

This capstone will seek to answer the question "How did the activities in the Mississippi Rivers Institute affect participant confidence in teaching environmental education?" In this study, seven specific content areas are considered: (a) river and watershed inquiry; (b) use of science notebooks in the classroom; (c) forest inquiry; (d) macroinvertebrate inquiry; (e) geology inquiry; (f) engineering activities; and (g) an overall confidence in using inquiry in the classroom.

In my effort to answer this overarching question, there are subsequent questions

that will become part of the study. Some of these questions include: What components of the Rivers Institute professional development design were most effective or significant for participants? In what specific content areas covered at the Rivers Institute do participants feel their confidence levels have increased the most? How do demographic factors such as a participant's age, gender, or number of years teaching affect their confidence level? How do participants of the Rivers Institutes describe and rate their confidence and attitudes towards teaching macroinvertebrate, engineering, geology, and forest inquiry? Specifically, how do participants describe the impact of this three-day, field-based professional development workshop on their confidence in teaching these environmental education and inquiry-based concepts?

Answers to questions like these are invaluable. According to the National Commission on Teaching America's Future (NCTAF, 2016), professional development opportunities for educators have been found to be the most significant factor in improving student learning in schools. However, not all professional development models are created equal, and not all are effective. So, what are the most effective models? What aspects of the Rivers Institute make it successful? While many licensed teachers utilize graduate-level courses and continuing studies to promote their education, these classes are often set either in a classroom on some university campus, or online. This style of instruction is the opposite of what participants in the Rivers Institute receive. Instead, participants are immersed in an active, contextual learning environment that models the learning experience teachers might create for their students.

In direct contrast to the lecture-style, classroom-based approach to teacher

education, the Rivers Institute offers educators three days of field-based instruction and inquiry that address the natural overlap between science processes and content, and the skills of literacy, using rivers as the context. Focusing on the 2014 Mississippi Rivers Institute, this capstone will detail the steps required to organize and implement a successful professional development workshop, and will illustrate the qualitative and quantitative improvements that participants experienced as a result of engaging in the Rivers Institute.

This chapter will provide the reader with an insight into my personal experiences with, and interest in, the environment, specifically with water related issues. I will detail the origin of the Center for Global Environmental Education (CGEE) at Hamline University, which runs the Rivers Institute, and discuss the pre-cursor professional development workshops that lead to the Rivers Institute. Finally, this chapter will introduce the Rivers Institute and will provide an overview of this professional development opportunity.

My Interest in the Environment, Specifically Water

As a native Minnesotan, born and raised in the Twin Cities, I have had the amazing opportunity to grow up on the lakes and rivers of the metro, as well as the rest of the state and Wisconsin. Growing up in the 1980's, I feel fortunate that my formative years were not consumed by cell phones, video games and cable TV. It was always a treat to visit my grandparent's house where my brother and I along with our cousins would often crowd around a tiny TV in the basement to play a rousing round of Tetris or Mario Brothers on their first generation Nintendo console. However, it was never long until a

parent made their way downstairs to break things up and usher us out into the light of the day to play outside. The impromptu games and hours-long backyard explorations are some of the fondest memories that I have of my childhood and were the catalyst to my fascination with nature. My appreciation for the natural environment quickly led to a sense of activism, and I became involved with school and community environmental groups at a young age. It was my mother who instilled in me a sense of justice and the fire to fight for what I believe is right.

I am most passionate about water quality and scarcity issues, and believe that education is the key to improving access to clean water and appropriate sanitation, two basic human rights. My early experiences on the water (both frozen and liquid) in Minnesota and Wisconsin fueled my passion for this incredible resource and served as a foundation for my college years. In 2007, I was lucky enough to be able to study abroad during my junior year of college and traveled to Ghana, West Africa. My experiences in Ghana made it one of the most influential times of my life. While I was there, I experienced firsthand the impact that a lack of clean water and proper sanitation has on individuals as well as entire communities. It was there that I also witnessed what an impact education and awareness campaigns can have on the overall health of a community.

The group that I traveled with stayed in a small compound in the town of Medie, just north of the capitol of Accra. A few years prior to our visit, villagers led a large appeal to raise funds for a communal water pipe project. The digging of a well meant that the women and children of the village would no longer have to spend hours every day

hauling drinking water, providing them and the entire village with both independence and security. While I'm certain that this particular well was not the culprit, I ended up contracting giardia, a microscopic intestinal parasite found in soil, food or water that has been contaminated with feces from animals or humans who have already been infected (Parasites-giardia, 2015).

While I had the ability to travel back to the U.S. and receive treatment for my incredible discomfort, I was very aware of the new friends I had made that had no such luxury. Giardia and other diarrheal infections are the largest cause of childhood mortality in many African countries, often outpacing HIV/AIDS. This experience was the impetus for my passion for clean water and sanitation for every individual, and is the reason why I wish to continue my education of the environment and natural resources so that I can have a positive effect on others.

Origin of the Center for Global Environmental Education

Beginning as early as 1988, Hamline University began holding institutes focusing on Arctic exploration developed in coordination with explorer Will Steger's organization. The first few of these institutes won Hamline national awards and recognition for its innovative summer programming. Kindergarten through high school teachers from across the country were invited to the Institutes which brought science and topical experts together for the opportunity to learn and to be inspired.

During the 1989 Institute, Hamline's campus served as the readying station for the international trans-arctic expedition team which brought exploration team members from six different countries together to pack for their adventure. Utilizing television

news, written curriculum, newspaper, and daily updates sent via various computer linking systems in France, Australia, the United State, China, Japan, England and the Soviet Union, 25 million people around the world were reached. By the end of this expedition in March of 1990, teachers worldwide were calling for the continued development of adventure learning projects for their classrooms.

Teachers found the one-of-a-kind environmental and adventure learning program to be invaluable. The need of teachers for adventure-based learning that connected their students to internationally-renown scientists and specialists paved the way for Hamline's Center for Global Environmental Education (CGEE) to be founded in 1991 as part of the University's Graduate School of Education.

For multiple years after this initial exploration, the promise of adventure learning was further developed by the inception of educational programs that focused on the work of explorer Dan Buettner. Like Steger, Buettner was able to connect with students and learners all over the world as he explored Africa and Central America, this time traveling by bicycle. These extensive tropical and exotic explorations sparked an interest locally to create week-long summer institutes on related topics. Over time, this adventure-learning model transformed from distant places to adventures much closer to home.

Precursor to the Rivers Institutes

Along with other environmental education themed projects, CGEE started the Rivers of Life program in 1997. Designed by former CGEE faculty member, Peggy Knapp, EdD, and other CGEE staff, the project used an extensive website to examine issues facing the Mississippi River while engaging students and teachers around the

world in investigating and learning about the streams and rivers in their own back yards. The annual program culminated in a student expedition on the Mississippi where hands-on learning and inquiry were highlighted. Reflecting on the project in her publication *Rivers of Life: Teaching and Learning in an Environmental Context*, Knapp describes the program and her focus on project-based learning, stating:

> As a curricular framework, Rivers of Life is designed to provide resources and strategies for teaching and learning within an environmental context. The intent is to provide teachers with guidelines, projects, and resources that are flexible enough to adapt to a wide variety of classroom applications as they use rivers and watersheds as the context for learning. (2001, p. 37)

The Rivers of Life program was developed in response to teachers' growing concerns of being able to implement the changes occurring in Minnesota's High School Standards for Graduation. Teachers' fears of having to find time to incorporate new ideas and practices into an already packed-full agenda created the need for a professional development opportunity that models the experiences that they wish to replicate for their students. In other words, if teachers are expected to teach to new standards, including complex thinking skills, it is vital that they have an advanced understanding of the material and of how their students learn that material. Furthermore, an effective professional development experience must focus on teaching techniques as well as content, not just one or the other (Birman 2000).

The Origin and History of the Rivers Institute

Out of the ideas and practices initiated in the Rivers of Life program, the hands-on format of the Rivers Institute was born.

In 2004, CGEE saw the need for inquiry-focused, place-based professional development for Minnesota educators. With generous funding from such organizations as Medtronic, 3M, Andersen Corporate Foundation, and Aimee Butler Family Foundation, to name a few, along with the support of many of CGEE's faculty and staff, the first Rivers Institute was designed and focused on the Mississippi River. The goal of the Rivers Institute is to assist teachers in improving the way they understand and teach science in order to help their students achieve the abilities and knowledge required to meet benchmarks in science standards. These standards are currently assessed through Minnesota Comprehensive Assessments tests that are administered in grades 5 and 8, and again upon the completion of high school biology coursework.

The Rivers Institute was developed in direct alignment with CGEE's mission of fostering environmental literacy and stewardship in that it assists educators' mastery of core science concepts and skills through the lens of watershed education and aids them in translating the skills and lessons they learn directly to their classroom and students. With a workshop of 50 educators, the Rivers Institute also encourages teachers to foster the connection between youth and the natural world, bolstering their interest in Science, Technology, Engineering and Math (STEM) subjects as fields of study, and potential career paths.

Although the Rivers Institute is designed for 3rd-8th grade educators, many formal and non-formal educators of students of all ages have expressed their gratitude for such a valuable experience. As outlined by the 2013 annual report generated by CGEE for potential funders, the Rivers Institute is designed to help educators:

1. Understand the teaching and learning opportunities represented by their watershed;
2. Learn specific social science and natural science content relevant to the river;
3. Explore specific literacy and engineering strategies that enrich and deepen science investigations;
4. Investigate existing resources and programs to enrich their teaching;
5. Identify community resources that bring content expertise and local context into the classroom;
6. Engage in critical thinking that connects cultural and natural patterns into an interdisciplinary system of thinking.

Due to decades of inquiry-based learning institutes and workshops, CGEE has long been recognized as a national innovator in providing K-12 educators with STEM-based professional development, utilizing a consistent foundational learning strategy that focuses on an inquiry-based, hands-on learning style.

My first experience at the Rivers Institute was in 2005, the second year of the program. It was the summer after my freshman year at Hamline and I was working as a student worker for CGEE. Two years later, CGEE recognized the success of the 50-person Rivers Institute (usually held the last week in July) and saw the need to reach

teachers in the broader east metro area and pursued funding to develop a smaller, 25-person institute on the St. Croix River, known as the St. Croix Rivers Institute (usually held the last week of June).

After two years of marked success on the St. Croix River, funding was increased in order to double the amount of teachers reached by increasing the institute's capacity from 25 educators to 50 educators. Since 2004, the St. Croix and Mississippi Rivers Institutes have reached over 850 educators, impacting over 200,000 students throughout Minnesota and western Wisconsin.

It is unique to be able to work with such a rich source of data from teachers who have experienced a common professional development workshop. This capstone project provides a rare opportunity to look at the incoming and outgoing confidence levels of participants after experiencing the high-caliber activities and instruction that they receive at the Rivers Institute.

Summary

As I have outlined in this chapter, this capstone project is the first time that such valuable pre- and post- workshop data have been collected from participants in the ten years of the Rivers Institute's existence. Prior to this capstone study, there had been no measurement of the change in attitudes that participants had described undergoing during the three-day institute. Only post-institute evaluations of instructor effectiveness filled out by participants on the last day have been documented. For this capstone, I will focus on the participants and outcomes of the 2014 Mississippi Rivers Institute, held July 28-

30, 2014, where 53 area educators participated in the three-day field-based workshop using the Mississippi River as a context for learning.

This capstone will identify the process of creating this exceptional inquiry-based professional development workshop, and will look at participant confidence levels in multiple areas upon beginning the Rivers Institute and at its end.

Chapter Two will provide an analysis of the literature available detailing the rise of the environmental and conservation movements of the 1960's, the definition of environmental education, the implementation of professional development in environmental education, best practices in environmental education professional development, and why the Mississippi Rivers Institute is an effective workshop for teachers.

Chapter Three will break down the activities that the participants in the 2014 Mississippi Rivers Institute experienced as well as the methodology used to collect data on teacher learning and attitudes in 7 specific academic areas. Chapter Three will also introduce an Implementation Handbook that will serve as a guide to anyone interested in reproducing the activities and teaching techniques used in the Rivers Institute. The Implementation Handbook will be provided in its entirety in the Appendix. In Chapter Four, I present the data collected from the Rivers Institute participants along with data analysis. Finally, I will summarize my findings in Chapter Five.

CHAPTER TWO

LITERATURE REVIEW

Introduction

In order to pinpoint the specific literature that informs my question, "How did the activities in the Mississippi Rivers Institute affect participant confidence in teaching environmental education?" – it is essential to unbox the overarching question into smaller components. First, how did the environmental and conservation movements of the late 1960's lead to the need for environmental education? What is environmental education? How did the environmental movement lead to the development of environmental education and its implementation in the classroom? What is the history of professional development as it relates to environmental education? What are the current best practices for professional development for environmental education? Finally, based on these findings, why is the Mississippi Rivers Institute a highly successful professional development experience for environmental educators?

This chapter reviews the available literature pertaining to the need for environmental education professional development and analyzes the best practices for implementing a professionally valuable learning experience. The review that follows will provide an analysis of the literature available on professional development design and impact, information on current research regarding the effectiveness of inquiry-based

approaches in science and in workshop design for teachers, and the importance of teacher knowledge in their subject matter as it relates to effective teaching and learning.

Setting the Stage: The Environmental and Conservation Movements

Public interest in environmental concerns and civic engagement reached a fever pitch in the late 1960's, leading to the development of the environmental and conservation movements. The civil unrest that accompanied the Civil Rights Movement and the protests over the Vietnam War in the 1960's created a culture of dissent that challenged the status quo. The growing awareness of environmental concerns fueled the passage of environmentally focused legislation during the late 1960's and on through the 1970's (Carter & Simmons, 2010).

The change in attitude was spurred by a number of incidents that, together, provided the impetus for change. One defining event of the time was the June 1969 burning of the Cuyahoga River in Cleveland, Ohio. The river, which had been polluted for decades with industrial waste and runoff, actually caught fire and burned. While this was not the first time the river had burned, images of the incident were published on the cover of Time Magazine in July 1969, raising its profile to the national stage (Rotman, 2010).

The appalling images of the Cuyahoga River burning were just one example in a myriad of detrimental environmental events. The massive oil spill that spewed three million gallons of crude oil into the Pacific Ocean off the shore of Santa Barbara, CA just six months earlier became the largest spill of its time and remains the third largest spill in

United States history (Mai-Duc, 2015). While Rachel Carson had documented the devastating use of pesticides on the environment in *Silent Spring* in 1962, it was not until the end of the 1960's that the environment as a topic of concern broke into the mainstream consciousness.

The national unrest over environmental degradation and pollution was sanctioned in April of 1970 with the first Earth Day celebration. Designed to demonstrate support for environmental protection, the movement was in large part lead by college campuses and K-12 classrooms across the nation. That same year saw the foundation of the Natural Resources Defense Council and the formation of the Environmental Protection Agency (EPA) by President Nixon.

Nixon went on to sign off on a multitude of laws aimed at protecting the environment, including the Clean Water Act, the Clean Air Act, and the Endangered Species Act (Dykstra, 2008). Significantly, on January 1, 1970, the National Environmental Policy Act (NEPA) was signed into law and survives today as the environmental law of the land (Carter & Simmons, p. 6).

Established in 1944, The National Science Teachers Association (NSTA) is the world's largest organization devoted to bolstering innovation and excellence in science teaching and learning for students of all ages, and is currently headquartered in Arlington, Virginia. Today, NSTA has more than 55,000 members comprised of scientists, administrators, teachers, and others invested in comprehensive science education (National Science Teachers Association – NSTA).

In 1970, The National Science Teachers Association (NSTA) reported the findings of a national study in which they found a critical lack of environmental education programming and curriculum development in United States schools. That study, coupled with the foundation of Earth Day and a burgeoning environmental awareness prompted President Nixon to address Congress in August of 1970. Nixon asserted that,

> It is also vital that our entire society develop a new understanding and a new awareness of man's relation to his environment – what might be called "environmental literacy." This will require the development and teaching of environmental concepts at every point in the education process. (Nixon 1970, p. vii)

The events of the 1960's and early 1970's lead to an increase in awareness of environmental issues within the collective American consciousness. During this time, the out-of-date concepts of outdoor education, nature study, and conservation education lead to the need for a new area of study, environmental education. The idea of the protection of the environment as a national interest was promoted by many scholars. As one former conservation consultant for the Ann Arbor Public Schools explained in an article published in 1969,

> One might question why I have chosen the term 'environmental education' rather than the familiar 'outdoor education' or 'conservation education.' The choice is not merely semantic. Neither conservation nor outdoor education as they are now practiced have the necessary orientation to meet the urgent needs of today's

> society. Their shortcomings lie in the narrowness of their perspectives. (Swan, 1969, p. 27)

Furthermore, the editor at that time of *The Journal of Environmental Education*, Clay Schoenfeld, defined environmental education as,

> A recognition by man of his interdependence with his environment and all of life, and his responsibility for developing a culture which maintains that relationship through policies and practices necessary to secure the future of an environment fit for life and fit for living. (1970, p. 5)

Schoenfeld acknowledged that, "the newer term attempts to do a more precise and at the same time a more comprehensive job of describing our ecological efforts to come to grips with the degradation of man's interlaced surroundings" (Schoenfeld, 1970, p. 5).

In 1983, Ronald Regan's National Commission on Excellence in Education published *A Nation at Risk*, a report that brought to light the many failings of the United States educational system. While the study was concerned with education as a whole in the country, its findings lead to the development of environmental education standards by the North American Association for Environmental Education (Richardson, Liang, & Wake, 2014).

The growing national and global concern over environmental issues in the 1960's lead to the need for environmental awareness and education as well as the implementation of using the environment as a context for learning. In the next section, environmental education is defined and its background explored.

Environmental Education

The increased national and global attention on pollution and environmental degradation that occurred in the 1960's set the stage for the foundation of environmental education and its implantation in the classroom. In the inaugural edition of *The Journal of Environmental Education* in 1969, William Stapp outlined environmental education as a way of generating citizens who are environmentally literate and who are motivated and empowered to solve environmental problems.

There are two widely agreed upon documents that provide the foundation of the environmental education field: the 1976 Belgrade Charter and the 1978 Tbilisi Declaration (Bennett & Heafner, 2004). Both documents originated from the work that took place at United Nations Educational, Scientific, and Cultural Organization (UNESCO) conferences. The Belgrade Charter of 1976 emphasized a need for environmental education to as a way to inform the global population of environmental concerns and create a population of lifelong learners of challenges facing our natural world.

A few years later, the Tbilisi Declaration formalized the findings of the Belgrade Charter and clarified expectations and goals for environmental education around the globe (UNESCO, 1980). A tenant brought forth in the declaration emphasized an urgency to enhance ordinary preservice and inservice training programs for education professionals directed at making them proficient in including an environmental component in their teaching activities (UNESCO, 1980).

A result of the 1977 intergovernmental conference on environmental education in Tbilisi, Georgia, the declaration called for an interdisciplinary approach to environmental education as well as curriculum development (Paul & Volk, 2002). Essentially, the Tbilisi Declaration paved the way for a national strategy for teaching environmental education (Marcinkowski, 2010).

Although these documents attempted to provide a roadmap for environmental education, the term environmental education is interpreted in a variety of ways, not all of which are created equally (Earnst, 2012). Today, the Environmental Protection Agency defines environmental education as a mechanism that provides individuals with a way to explore environmental concerns, engage in problem solving, and take action to better the environment.

A result of this is a deepening of knowledge of environmental concerns and the development of the skills necessary to make responsible, informed decisions. Notably, environmental education is not a means of advocacy for a specific political viewpoint. Instead, it is a way of enhancing problem-solving skills by using the local environment as a context for learning.

In the 1990s, considerable support to professionalize the field of environmental education came about in the United States in the form of criticisms of practices within the field (Marcinkowski, 2009). Based on the early 1990's findings of multiple studies (e.g., Adler, 1992, 1993; Kwong, 1995; Sanera & Shaw, 1996), researchers argued that the despair and misinformation about the environment that they believed was promoted in the media had made environmental education too advocacy-oriented. These fears lead to a

national assessment of the status and future of environmental education in the United States (Marcinkowski, 2009, p. 36).

Fast forward to the late 1990's and early 2000's, when a study conducted by the National Environmental Education Training Foundation (NEETF) as well as the work of Lieberman and Hoody (1998) contributed to the foundational literature base highlighting the benefits of using the environment as the basis of instruction (Parlo & Butler, 2007). Throughout the relatively short history of environmental education in the United States, the mission of the field has moved from a simple to a more complex framework. While the 1970's models of environmental education relied primarily on providing content, it became apparent that professional development opportunities for educators needed to incorporate the intricacies of the relationship between humans and our environment.

Professional Development

In a recent report for the Learning Policy Institute, the authors define professional development as organized, methodical professional learning that produces changes in teacher practices and improvements in student learning outcomes (Darling-Hammond, Hyler, & Gardner, 2017). This structured professional learning can take place in the form of a half-day workshop, a two-hour seminar, or an online continuing studies course offered by a local college or university.

However, not all professional development experiences are created equally, and not all are effective. According to Wade, professional development in environmental education is dominated by activity-based, nationally-produced curricula. It is

overwhelmingly science based instead of interdisciplinary and is concerned less with educational context and more with environmental content (1996).

These sentiments highlight some of the criticisms that have surrounded environmental education. A common criticism of environmental education has been a perceived emphasis on teaching values and morals at the expense of skills and knowledge (Gigliotti, 1990).

Environmental Education Best Practices

According to Shepardson, Harbor, Cooper, & McDonald, a robust environmental education professional development program should encourage the development of socially active and environmentally-responsible citizens devoted to environmental issues. However, experiences with professional development in environmental education vary widely. The availability of environmental education professional development opportunities alone is not an issue. Gulamhussein finds that the real issue is not the fact that teachers lack access to professional development offerings, it is that the standard workshops are inadequate and insufficient in changing teachers' practices (2013).

Yoon et al. points out (as cited in Gulamhussein, 2013) that stand-alone workshops, while the most common model for professional development delivery, have a terrible track record for actually effecting change in teacher practice. In fact, Darling-Hammond et al. points out (as cited in Gulamhussein, 2013), recent studies have found that although 90 percent of educators reported engaging in professional development, most of those educators described that the experience was worthless.

In that same status report on professional development experiences of teachers both abroad and in the United States, the authors note that,

> Every year, virtually all of the nations' three million teachers participate in some form of professional learning: These activities can include workshops, study groups, mentoring experiences, opportunities to view other teachers' classrooms, and numerous other formal and informal learning experiences. (Darling-Hammond, Wei, Andree, Richardson & Orphanos, 2009, p. 7)

The report, published by the National Staff Development Council, presents fundamental components of their research pertaining to the development and strength of educator workshop models on implantation in the classroom and student achievement. A few of their discoveries include:

- Based on 2004 data from the National Schools and Staffing Survey, approximately 90% of all K-12 teachers in the United States have participated in short-term conferences or workshops to meet their professional development needs.
- In order for professional development for teachers to be effective, it must be ongoing, intensive, and rooted in practice. It must also focus on the teaching and learning of specific academic content, be linked to other school initiatives, and develop strong working relationships among the participants.
- Quality professional development for teachers is directly tied to gains in student achievement.

- While research shows that teachers need over 50 hours of professional development in a given area to influence their skills and student achievement, most professional development workshops in the U.S. are one-day opportunities. According to the 2004 National Schools and Staffing Survey, 57% of teachers reported that over one year they had received less than 16 hours of professional development, while only 23% said they had received at least 33 hours per year, and, significantly, only 5% reported that they had participated in a program that lasted 40 hours or more.
- Teachers in the U.S. note that the majority of the professional development that they receive is of little use. However, 6 out of 10 teachers reported that content-related experiences and workshops were valuable for them, while less than half found professional training in other areas to be helpful.
- Teachers in the U.S. spend less time planning curriculum and instruction than teachers from other countries.
- The nations that outperform the U.S. on international assessments devote major resources to professional development for their teachers. In fact, professional learning and teacher development are often embedded into teachers' work hours.
- U.S. teachers participate in short-term professional development opportunities, but the U.S. is far behind in providing extended professional development programs and collaborative communities within schools.
- Unlike their international colleagues, U.S. teachers often shoulder the cost of their professional development opportunities.

The report surveys the key aspects of valuable professional development experiences while emphasizing the need for rigorous, long-term professional development for U.S. teachers. This study parallels another comprehensive analysis of 1,300 studies depicting the complete field of professional development research. Yoon et al. (as cited in Gulamhussein, 2013) notes that researchers found that the only professional development opportunities deemed impactful on student achievement were intense, lengthy workshops.

In a publication by the National Commission on Teaching and America's Future, the author notes that

> For years, educators and policymakers have referred to ongoing education for teachers as professional development (PD) or PD trainings that teachers "receive." We use the term professional learning because it recognizes teachers as agents of their growth and emphasizes that learning is an experience driven largely by the learner. (Calvert, p. 4)

These sentiments highlight the necessity to treat teachers as active, empowered participants in their own learning and emphasizes that professional development cannot simply involve the regurgitation of facts and figures. The modeling of inquiry and inquiry-based instruction by facilitators encourages teachers to think like a student and emphasizes the process of science over teacher-oriented instruction.

As it pertains to science, inquiry refers to the varied ways in which scientists use observation and evidence to study the natural world and offer explanations for their

findings (Richardson, Liang & Wake, 2014). Researchers have found that educators who are confident in their teaching ability are more likely to use inquiry and teaching strategies that are centered around students. In contrast, educators with low self-confidence (a low sense of efficacy) are more likely to utilize strategies centered around teacher direction, specifically lecture style instruction and rote memorization (Moseley, Reinke, & Bookout, 2002).

In 2010, The North American Association for Environmental Education (NAAEE) published a report, *Guidelines for the Preparation and Professional Development of Environmental Educators*, in which they provide six overarching guidelines for competency in environmental education.

1. Environmental Literacy: Teachers should be proficient in analysis, questioning, and interpretation skills, and must have an understanding of environmental systems and processes.

2. Foundations of Environmental Education: Teachers must possess a basic understanding of the history of environmental education, including its goals, practices and theories.

3. Professional Responsibilities of the Environmental Educator: Educators must be sensitive to the responsibilities of practicing environmental education and emphasize education over advocacy.

4. Planning and Implementing Environmental Education: Teachers must be knowledgeable of their learners, the materials available to them, and proficient at curriculum planning.

5. Fostering Learning: Teachers must empower learners to utilize open inquiry and encourage students to reflect on their own perspectives on the environment.

6. Assessment and Evaluation: Teachers must have the knowledge and commitment to implement effective assessment and evaluation.

Additionally, the NAAEE report highlights several essential approaches to environmental education instruction, including the methods of inquiry, cooperative learning, project-based learning, and hands-on observation, to name a few (2010).

Finally, Meichtry and Smith outline three fundamental needs of teachers that can be addressed with effective professional development opportunities. First, training in the use of outdoor sites is necessary in order to bolster confidence in using place-based inquiry and teaching methods. Making a personal connection to the local environment is a powerful experience for students and teachers alike and is helpful as a learning model. Place-based education provides a way of learning grounded in the local environment and improves education outcomes by highlighting the students' sense of interconnectedness to where they live.

Second, training obtained from professional development workshops must be in alignment with school curriculum and state standards. Third, the availability and use of professionally produced curricula is vital to the effectiveness of any professional

development program. Creating a community of teachers to share advice, resources and even lesson plans is a powerful way to stress collaboration over isolation. Generally, the ideal professional development workshop utilizes standards-based teaching strategies, community resources, and field investigations (Meichtry & Smith, 2007).

Teacher-Perceived Obstacles and Impediments to Best Practices

An effective professional development opportunity can provide a teacher with a renewed sense of commitment to their profession and an increased sense of confidence in teaching. However, unless teachers feel supported by administrators, their colleagues and the larger school community, it can be very difficult to implement new practices or procedures.

In a qualitative study of the first year of implementing an environmental education program, teacher perceptions of building a new program were examined. The authors found that the implementation of new programs requires significant effort by the teacher and can be very stressful. Additionally, in cases where the existing program is very different from the desired one it is much harder to implement (Winther, Volk, & Shrock, 2002).

In a study of 21 public high school science teachers in Pennsylvania, authors Kazempour & Amirshokoohi found that more than 50% of respondents indicated that persistent pressure to cover material to prepare students for tests as well as time constraints were significant perceived obstacles to the teachers (Kazempour, M., &

Amirshokoohi, 2014). This is a common complaint throughout much of the available literature.

Ernst expands on the personal barriers to adding or increasing environmental education in their schools, noting that a lack of planning time, class time, and funding, along with a perception that teachers do not view environmental education as critical instruction as other subjects can all be barriers to implementation (Ernst, 2012). Historically, many educators have viewed environmental education as something superfluous for which extra planning and class time must be found.

With the amount of material that teachers must cover in a short amount of time, coupled with a lack of administrative support and funding and the potential negative reactions of colleagues and parents, the idea of implementing new environmental education programs can be daunting. Additionally, an impediment to instituting best practices in environmental education can be a teacher's perception of having an inadequate background in science. An educator's perceived lack of a hard science background can be debilitating to their confidence in their ability to teach environmental education.

Why the Mississippi Rivers Institute?

So, why the Mississippi Rivers Institute? Why is this professional development opportunity a highly successful professional development experience for environmental educators? The Rivers Institute was designed with much of the above research in mind. By providing a comprehensive three-day institute instead of the conventional one-stop

workshop approach, and by infusing science content with curriculum, standards and instructional improvement, the Rivers Institute aspired to lessen the divergence between what teachers experienced at professional development opportunities and what they actually found useful and could implement in their classrooms.

As Calvert stated recently in a publication for the National Commission on Teaching & America's Future, "The heart of the matter is this: For many teachers, professional development has long been an empty exercise in compliance, one that falls short of its objectives and rarely improves professional practice" (2016). The Rivers Institute seeks to incorporate the best practices in environmental education professional development as defined by the research previously mentioned.

Much of the literature on the topic suggests that one-day workshops are not effective and that intensive inservice workshops are significantly more effective at bringing about meaningful change in the classroom than single-day trainings (Winther, Volk, & Shrock, 2002).

In *EE Teacher Inservice Education: The Need for New Perspectives* the author states their findings from a post-workshop survey that,

> Inservice workshop facilitators are more knowledgeable in environmental content than classroom pedagogy or the educational priorities of state and school districts. Respondents reported that inservice providers are more knowledgeable about environmental issues and content than educational practices. (Wade, 1996, p. 4)

The Rivers Institute mitigates this problem by using facilitators who are not just experts in environmental content but also classroom teachers. This allows participants to familiarize themselves with pedagogy as well as material specifics. In this respect, the Rivers Institute does not emphasize *what* to teach more than *how*.

Quality environmental education workshops require pedagogical approaches that integrate practical experiences to learning and content knowledge (Orr, 1992). This line of thinking relates directly to the design of the Mississippi Rivers Institute. For many participants, the instruction style of the Rivers Institute is a new experience, and their time spent at the workshop could be their first or only interaction with environmental education.

The success of the Mississippi Rivers Institute is in large part a result of the collaboration between formal and informal partnerships. Efforts are made to combine the expertise of local and state environmental specialists with the pedagogical experience of classroom teachers (2010).

The Mississippi Rivers Institute incorporates curricula from Project WET (Water Education for Teachers). Aimed at both formal and informal educators of K-12 students, Project WET is known internationally and is an interdisciplinary water science and education program. Minnesota Project WET is a nationally recognized program that provides excellent water education resources and curricula. At a Project WET workshop, classroom teachers and all forms of educators receive hands-on, interactive lessons that encourage critical thinking by focusing on water and water issues. Participants are

provided with training, support and materials, and are considered knowledgeable to teach water education upon completion.

Gruver and Luloff point out (as cited in Parlo & Butler, 2007) that while pre-packaged curricula can be useful, professional development workshops often lack relevancy to the local area by not being place-based. The Rivers Institute is designed to eliminate this problem by grounding educational experiences in the teachers' local environment, utilizing local experts and linking activities to state education standards.

The goal of an effective professional development program is to equip teachers with the knowledge and skills necessary to select, establish, and implement environmental curricula compatible with their unique classroom setting and that aims to yield knowledgeable, literate students (Shepardson et al., 2002). Shepardson et al. add that

> Professional development programs that engage teachers in conducting environmental science research positively affect teachers' understanding of environmental science concepts and issues as well as their abilities to design and conduct research-based field studies. (2002, p. 39)

The Mississippi Rivers Institute achieves this by having participants design and conduct their own engineering projects and share them with their colleagues.

Throughout my research, I have discovered that there is a dearth of discussion concerning the practical and successful application of environmental education in teacher education programs. My research will contribute to the collective work on the best

practices in environmental education professional development and will provide a valuable roadmap for the successful creation and implementation of quality environmental education programming.

Summary

In this chapter, I have examined the conservation and environmental movements of the 1960's and 1970's and how they lead to the creation a national awareness of environmental issues and the formation of formal environmental education. I examined the history of environmental education professional development as well as the current best practices for environmental education professional development. Finally, I explained how the Mississippi Rivers Institute is an effective professional development opportunity for both formal and informal educators.

In the next chapter, Chapter Three, I will introduce the participants in this study, and describe the model and design of the pre-and post-assessment surveys used to conduct the study. In Chapter Three I will also highlight the creation of an Implementation Handbook that I have designed. This manual details the marketing, planning, and communications necessary to implement a similar three-day workshop and breaks down the personnel needed to provide an effective learning experience. The Implementation Handbook will serve as a guide to reproducing the activities, resources and teaching techniques used in the Mississippi Rivers Institute to any other setting.

CHAPTER THREE

METHODOLOGY

Introduction

The purpose of this study is to compile data to address the question "How did the activities in the Mississippi Rivers Institute affect participant confidence in teaching environmental education?" For this study, seven specific areas are considered: (a) river and watershed inquiry; (b) use of science notebooks in the classroom; (c) forest inquiry; (d) macroinvertebrate inquiry; (e) geology inquiry; (f) engineering activities; and (g) an overall confidence in using inquiry in the classroom.

This is not a longitudinal study in that it does not determine the long-range impact of the Rivers Institute as a professional development program on classroom practice over many years. Instead, this study provides a snapshot of the beginning confidence levels of the 2014 Mississippi Rivers Institute participants with seven unique instruction areas and compares it to their level of confidence upon completing the three-day course. This chapter introduces the participants in this study, their demographics and what grades and subjects they teach. Next, the model and design of the pre-and post-assessment surveys used to conduct the study are examined, including both quantitative and qualitative data. Finally, this chapter will highlight the creation of an Implementation Handbook that will serve as a guide to reproducing the activities and teaching techniques used in the Rivers

Institute. The Implementation Handbook will be provided in its entirety in Appendix A.

Setting the Stage

The Rivers Institute is a three-day, two-credit, field-based graduate-level course that addresses the natural overlap between science processes and content and the skills of literacy, using rivers as the context. The 2014 Mississippi Rivers Institute, which this study is focused on, was held Monday, July 28-Wednesday, July 30, 2014. Six months prior to the institute, marketing efforts start in full force to get the 50 participant slots for the course filled. Course informational flyers are dispersed to schools and learning centers around the state, thousands of emails are sent to Minnesota and western Wisconsin educators, and course descriptions are posted to countless environmental education-themed websites and newsletters throughout the state.

Participants who are interested in the course must submit an application (Appendix B). Since funding for the Rivers Institute covers the participation of only 50 educators, there are usually space limitations; meaning not all those who apply are accepted. Participants are selected for the institute based on what grades and subjects they teach, as well as their response to the "Personal Statement." The personal statement gives the applicant a chance to provide more detailed information, such as, "What is your interest in water, rivers or watersheds?" "What do you hope to learn by participating in the Rivers Institute?" "Describe the specific kinds of science concepts that interest you most, including process standards, related curricular units, and/or hands on investigations?" "How do you think this program might help your students learn literacy skills, science or both?"

The Participants

Fifty-three educators took part in the 2014 Mississippi Rivers Institute. However, only 41 participants are included in this study. After collating the pre- and post-assessment surveys it was apparent that a handful of surveys were incomplete in some way. Therefore, the surveys from participants who did not answer the second page of questions, did not answer all questions, or both are not included in the data, and the participants are not listed in this report.

The following data is taken from the applications of the 41 participants used in this study. In accordance to the security statement given to participants, individual names are not included so as to maintain anonymity.

Demographically, 36 of the 41 participants at the Rivers Institute were female, and five were male. The application that participants fill out prior to the institute asks them for their year of birth, not their exact age with month and date. Therefore, to uniformly find the mean of the participants' ages, I've subtracted the year of birth from 2014 year. The mean or average age of the participants was 40 years, while the median age was 37.

Fourteen of the 41 participants have their Bachelor's degree, while 27 of the participants have earned some form of Master's degree. Combined, the 41 participants have 520 years of teaching experience, making the mean of years teaching 13. The median for years of teaching is 12.

The participants teach grades spanning from pre-kindergarten to high school, and represent a wide variety of subjects taught, from visual arts to biology, social studies to chemistry.

Demographic Data

Table 1. *List of the grades taught by the 41 participants*.

Grade(s) Taught	**Number of Teachers**
PreK-5	1
K – 3	1
K, 3, 4	1
K, 3, 7	1
K-5	1
1	2
2	2
2 and 3	1
3	2
3-5	1
4	4
5	3
6	2
6-8	3
6 and 8	2
7	2
7 and 10	1
7 and 8	4
8	3
9-12	2
11-12	1
7-8, 11-12	1

Table 1 indicates that twenty-nine of the 41 participants taught at the 4-8 grade level. This is by far the majority of the participants (71%), with only a few participants teaching grades pre-k through 3rd grade or at the high school level.

Table 2. *List of subjects taught by the 41 participants.*

Subjects Taught	**Number of Teachers**
All	6
Art	1
Biology, Chemistry	1
Biology, Life Science	1
Citizen Science	1
Earth Science	3
Elementary, All Subjects	3
ESL, Science, Social Studies	1
General Education	2
General, Science Inquiry	1
Life Science	3
Life Science, Earth Science	2
Life Science, Environmental Science	1
Math, Science	3
Media Specialist	1
Multi Subjects	1
Physical Science	1
Science	6
Science, Social Studies, Math	1
Self-Contained	1
Social Studies, English, Reading	1

Table 2 shows that twenty-five of the 41 participants indicated that they taught some form of science. While 61% of participants identified as science educators, participants come from many different subject areas and backgrounds.

Next, the model and design of the pre-and post-assessment surveys used to

conduct the study are examined, including both quantitative and qualitative data. Finally, this chapter will highlight the creation of an Implementation Handbook that will serve as a guide to reproducing the activities and teaching techniques used in the 2014 Mississippi Rivers Institute. The Implementation Handbook is provided in its entirety in Appendix A.

The Survey

The intent of this study is to gather data to address the question "Does a participant's experience at the Rivers Institute have a positive impact on that teacher's confidence in teaching various activities in their classroom?" Fifty-three educators participated in the Rivers Institute. All participants were given the same pre-institute survey (Appendix C) when they checked in at the institute on the morning of the first day. All participants were then given the same post-institute survey at the wrap-up session at the end of the third, and final, day (Appendix D). All participants had the choice of whether or not they wanted to take the pre-and post-surveys, and were given the option to use a code word or number to maintain anonymity.

As was mentioned in the previous section, the pre- and post-institute surveys were collated after the institute, and it was discovered that a dozen of them were incomplete in some way. For example, some participants did not see that there was another side to the survey so only answered the first few questions, while others failed to answer some of the questions completely on either the pre-survey, the post-survey, or both. In an effort to maintain continuity between the pre- and post- assessments, only the results of 41 participants are included in this study due to their incomplete nature. In summation, 41 out of 53 surveys were included in the data.

Pre- and Post-Assessment Survey Questions

Data was gathered from participants using a paper questionnaire, or pre-assessment survey, given to them at the beginning of day one of the 2014 Mississippi Rivers Institute, Monday, July 28, 2014. Participants signed in with the lead logistics coordinator where they received a 6"x9" spiral-bound CGEE science notebook with the institute agenda inside as well as a liability waiver and the survey. Upon arriving at the Institute, participants were asked to fill out the following information and to rate their comfort level with seven different content areas. Below are the questions from the pre-assessment survey that participants were asked to fill out. The complete pre-survey can be found in Appendix C.

Pre-Assessment:

Figure 1. *Pre-Assessment Survey.*

Name: _____

If you prefer to remain anonymous, please write a code word or number that you will use on the post-assessment in order to maintain continuity.

Gender: _____ Year born: _____ Years teaching: _____

Grade level taught: _____ Subject/Content area: _____

For the following questions, please rate your comfort level by circling the number that best pertains to you.

1 = Not comfortable at all. 4 = Very comfortable.

Question #1: River	What is your level of comfort with river & watershed inquiry?
Question #2: Notebooks	What is your level of comfort with using science notebooks in the classroom?
Question #3: Forest	What is your level of comfort with forest inquiry?
Question #4: Macro	What is your level of comfort with macroinvertebrate inquiry?
Question #5: Geology	What is your level of comfort with geology inquiry?
Question #6: Engineering	What is your level of comfort with engineering activities?
Question #7: Inquiry	Overall, what is your level of comfort with using inquiry in your classroom?

Participants were instructed to bring their completed pre-survey back to the lead logistics coordinator when they had finished.

Over the next three days, the teachers participated in a multitude of STEM-focused professional development activities and were introduced to a variety of content specialists and leaders in the field of environmental education. What follows is a brief account of the activities experienced during the institute. The full breakdown of the institute can be found in the Implementation Handbook (Appendix A).

The Three Days of the Rivers Institute

Day One: Monday, July 28, 2014. Participants began arriving at Crosby Farms Regional Park on the Mississippi river in St. Paul as early as 7:15 am. Upon their arrival, participants signed in with the lead logistics coordinator where they filled out a nametag, received a 6”x9” spiral-bound CGEE science notebook with the institute agenda inside and were given a liability waiver and pre-assessment survey to fill out and return.

With all 53 participants registered, lead faculty instructor, Cara Rieckenberg, EdD, gave a brief overview of the Institute, highlighting the goals of the three-day workshop: To explore how using rivers as a context can help your students meet specific Minnesota education standards in science and language arts among other curricular areas, and to model inquiry-based science and engineering investigations in a watershed context.

The theme for the morning was that rivers and watersheds are complex systems that can be observed, measured and understood. Cara introduced participants to the spiral notebooks they had been given upon signing-in, highlighting the organization of the notebook, science literacy connections, as well as the use of graphics and sketches as valuable pieces to incorporate. After introductions, the morning of the first day, Monday, was spent on board the Magnolia Blossom, a Mississippi River paddle boat.

During the two-hour boat ride, participants began to populate their science notebooks with observations, sketches, unfamiliar vocabulary used by instructors, and even curriculum connections. Meanwhile, Lyndon Torstenson from the National Park Service discussed the importance of the Mississippi River as “America’s Greatest Classroom.”

After the boat ride, the focus for the afternoon moved to how water moves through the biosphere in a variety of ways. Participants engaged in transects of the floodplain forest as well as the process of the transpiration of leaves. The first day wrapped up with Cara handing out 11”x17” paper along with instructions for homework.

On their specific piece of paper, participants were told that they had just inherited riverfront property and one million dollars to do what they wanted with that property.

Day Two: Tuesday, July 29, 2014. Participants gathered at the Visitor Center at Fort Snelling State Park. The primary focus for Tuesday morning: Organisms develop features that allow them to live in specific sets of ecological conditions. Split into two smaller groups, half of the participants engaged in a guided macroinvertebrate inquiry, while the other half performed a guided geology inquiry. The afternoon session involved participants switching to the opposite activity from that which they had done in the morning.

The wrap-up activity for day two involved the science notebooks, or journals. The focus was to raise the level of confidence of participants with utilizing science notebooks themselves, and in turn with their students. Using colored pencils, crayons, markers, highlighters, and post-its, participants gave their science notebooks depth and further meaning by highlighting important concepts for them, questions, anything the participant thought was valuable to feature.

Day Three: Wednesday, July 30, 2014. Participants gathered at Fort Snelling State Park again for the third and final day of the Rivers Institute. The main focus of the day centered on the fact that landscapes are shaped by a variety of forces and processes, both natural and manmade. Land use has an impact on water quality, and integrating engineering design into environmental activities that meet state standards.

Divided into small groups, participants were charged to find engineering answers to a variety of problems, including water filtration, irrigation systems, oil spills, etc. The complete list can be found in the Implementation Handbook (Appendix A).

The Rivers Institute wrapped up Wednesday afternoon with a discussion of the week's activities. At this point, participants were asked to complete the Post-Assessment Survey of their confidence within the seven content areas (Appendix D) as well as an overall evaluation of the Institute (Appendix E).

Data Analysis

The pre-and post-assessment surveys allowed the analysis of teacher demographics and how the confidence levels-of-participants were affected, either positively or negatively, by their participation in the Rivers Institute. For this study, we coded the data on a 4-point Likert-style scale ranging from 1 for "not comfortable at all" to 4 indicating "very comfortable." We utilized the 4-point scale to force a plus or minus choice rather than a 3 or 5-point scale that would include a neutral option (Likert, 2001). The findings from the Likert scale questions will inform the results of the study in chapter four.

Outcomes

While all 53 participants were fully engaged in the 2014 Mississippi Rivers Institute, only the pre- and post-assessment surveys of 41 of the participants are included in this study due to the incomplete nature of some of the survey responses. Along with the Likert scale used on the pre- and post-assessment surveys, anecdotal information from participant reflections and evaluations will be used to illustrate the success of the

Rivers Institute. As described in *Toward a Definition in Mixed Methods Research,* one of the three overarching classes of research studies currently being labeled "mixed methods research" is:

> *Quantitatively driven approaches/designs* in which the research study is, at its core, a quantitative study with qualitative data/method added to supplement and improve the quantitative study by providing an added value and deeper, wider, and fuller or more complex answers to research questions; quantitative quality criteria are emphasized but high quality qualitative data also must be collected and analyzed. (Johnson, Onwuegbuzie, & Turner, 2007)

With this in mind, the qualitative data provided by the participants along with the quantitative Likert scale findings will help to illustrate whether participant interaction in the three-day Rivers Institute had a positive or negative effect on the teachers' confidence within the seven categories previously mentioned.

The data analysis posed an unexpected opportunity. The ability to recreate the outcomes of this study leans heavily on the ability to recreate the Rivers Institute itself. That said, the idea to document the processes that went in to forming the 2014 Mississippi Rivers Institute was born. While portions of the day-to-day operations of the institute are described in this and other chapters, a complete guide to the marketing, application process, logistics and activities associated with the Rivers Institute will be provided in the Implementation Handbook (Appendix A).

Summary

In an effort to research the impact of the 2014 Mississippi Rivers Institute on participants' levels of confidence in seven different content areas, the research method used was to design a pre-and post-survey (Appendix C and D) to be administered to participants before and after their experience at the Institute. Each of the completed pre-and-post assessment surveys were collated to determine if the 41 participants who successfully completed both surveys gained more confidence in the seven content areas surveyed.

In the next chapter, Chapter Four, I present the quantitative data collected from the Rivers Institute participants along with data analysis. I will also examine the qualitative data gathered from the final workshop evaluation.

CHAPTER FOUR

RESULTS

Introduction

This chapter will present the quantitative data collected from the Rivers Institute participants along with data analysis. In addition to the pre- and post-assessment surveys, participants were also asked to fill out an overall evaluation of the three-day Rivers Institute at the end of the third day (Appendix E). The qualitative responses given in these anonymous evaluations will provide further evidence to support the main question of this study, "How did the activities in the Mississippi Rivers Institute affect participant confidence in teaching environmental education?" The seven specific content areas, as previously stated, are: (a) river and watershed inquiry; (b) use of science notebooks in the classroom; (c) forest inquiry; (d) macroinvertebrate inquiry; (e) geology inquiry; (f) engineering activities; and (g) an overall comfort-ability level with using inquiry in the classroom.

Pre- and Post-Assessment Results

The pre-and post-assessment surveys introduced earlier were fully completed by 41 participants of the 2014 Mississippi Rivers Institute. The Pre-Assessment survey was completed on the morning of Monday, July 28, 2014, at the beginning of the Institute, while the Post-Assessment survey was completed at the end of the Institute on the

afternoon of Wednesday, July 30, 2014. Attendants of the Rivers Institute were instructed that their participation in the pre-and post-assessment surveys was completely voluntary and that all surveys would remain confidential.

The purpose of the pre-assessment was to determine the baseline for participant comfort-ability levels with seven content areas: (a) river and watershed inquiry; (b) use of science notebooks in the classroom; (c) forest inquiry; (d) macroinvertebrate inquiry; (e) geology inquiry; (f) engineering activities; and (g) an overall comfort-ability level with using inquiry in the classroom. The purpose of the Post-Assessment Survey was to discover whether or not participant interaction with the activities during the Rivers Institute had a positive or negative affect on their comfort-ability within the previously-mentioned content areas.

Below are the results of the pre-and post-assessment surveys broken down by question, as well as the average change in comfort-ability from the pre-assessment survey to the post-assessment survey. Calculation of the average, or the arithmetic mean, for each question was figured by using the following equation:

Average = Sum of answers/number of answers,

keeping in mind that the number of answers will always be 41.

Question 1: Survey Results and Data Interpretation

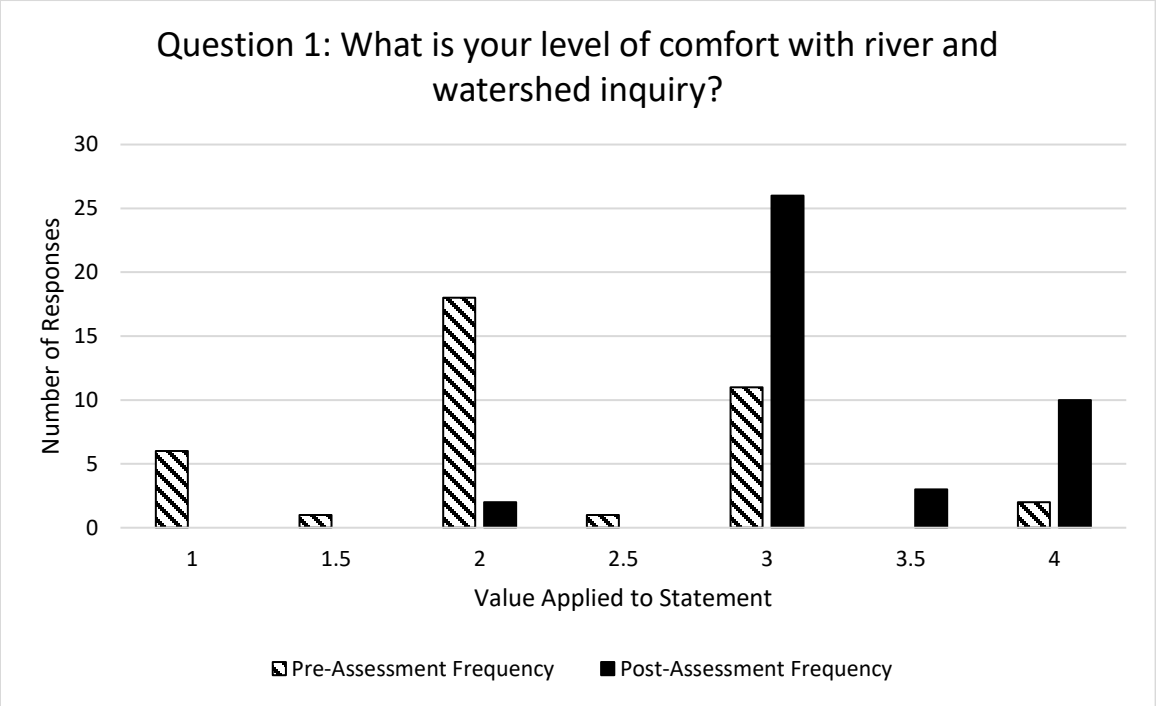

Figure 2. *Pre-and post-assessment frequency of responses to question one (1=Low, 4 = High).*

Pre-Assessment Score	Pre-Assessment Frequency	Post-Assessment Frequency
1	6	0
1.5	1	0
2	18	2
2.5	1	0
3	11	26
3.5	0	3
4	2	10

Table 3. *Frequency distribution of question one.*

There are very few, if any, facets of human culture or learning that cannot be tied to a river or watershed. For Question One, participants were asked, “What is your level of comfort with river & watershed inquiry?” In the Pre-Assessment Survey, the majority of

participants indicated that their comfort-ability with river and watershed inquiry was at a two out of four on the Likert scale, with the second most popular rating being a three out of four. In the Post-Assessment Survey, however, most participants selected a three for comfort-ability, with more than half of the participants choosing this rating. Interestingly, no participants indicated a comfort-ability level of less than two in the Post-Assessment Survey.

Participant responses from the overall course evaluation administered at the end of the institute reflected similar results to the quantitative results above. One participant recognized that they "Never really knew what a watershed was and learned lots about the locks and dams," while another participant noted their better understanding of the Mississippi and Minnesota Rivers, including their geology and cultural significance. These responses illustrate that, when asked what some of the top learning outcomes participants were taking away from the institute, many cited an increased knowledge of rivers and watersheds.

Question 2: Survey Results and Data Interpretation

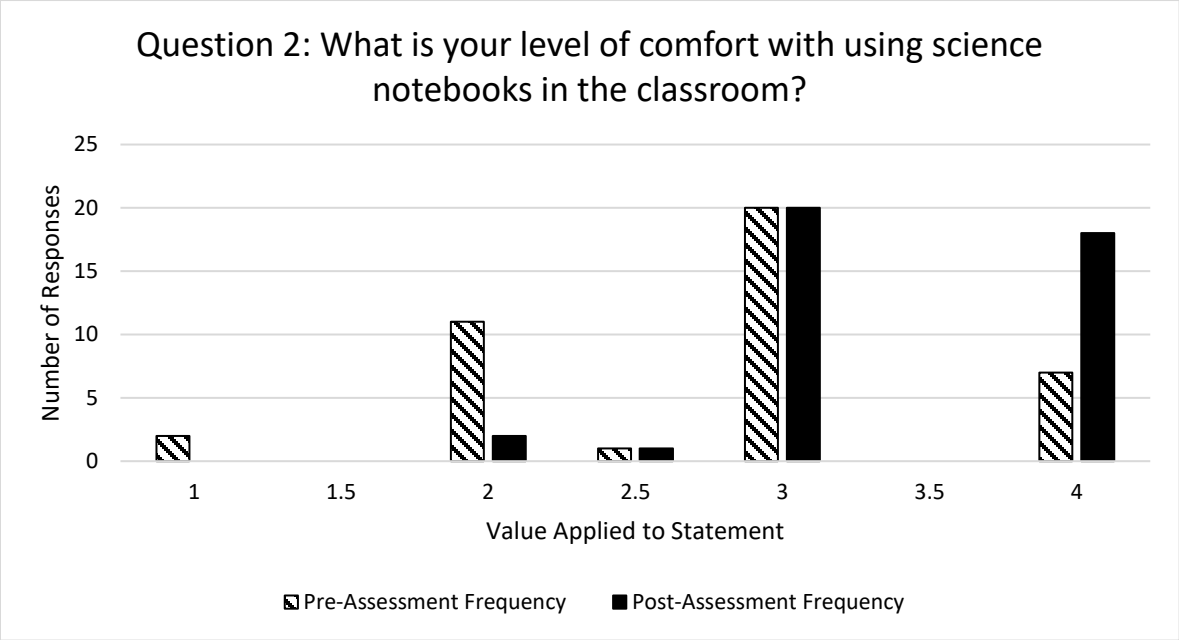

Figure 3. *Pre-and post-assessment frequency of responses to question two. (1=Low, 4 = High)*

Pre-Assessment Score	Pre-Assessment Frequency	Post-Assessment Frequency
1	2	0
1.5	0	0
2	11	2
2.5	1	1
3	20	20
3.5	0	0
4	7	18

Table 4. *Frequency distribution of question two.*

For Question Two, participants were asked, “What is your level of comfort with using science notebooks in the classroom?” In the Pre-Assessment Survey, participants reported a wide range of comfort-ability with using science notebooks in their

classrooms. While the majority of participants indicated a score of two or three, there were participants who reported the lowest level of comfort-ability (one) and the highest level of comfort-ability (four). Interestingly, the same amount of participants reported a score of three in both the Pre-and Post-Assessment Surveys. However, in the Post-Assessment Survey, no participants indicated a comfort-ability level of less than two, and the second-highest report rate for comfort-ability was four. These results indicate that while the comfort-ability level of the majority of participants remained the same, the levels for many increased to the highest score.

The quantitative data shows that of all seven content areas, participants came to the 2014 Mississippi Rivers Institute feeling the most comfortable with using science notebooks or journals in their classroom with an average pre-institute Likert scale score of 2.8. The comments from participants in the overall course evaluation support this data, with one participant noting, “I already use science notebooks in my classroom. I’m pretty strict about how they’re set up.” However, participant remarks also leave room for improvement with one person commenting that, “Although we used the science notebooks and had a couple of writing assignments, I would have appreciated more structure in how to set up notebooks and more ideas on how to incorporate literacy.”

Question 3: Survey Results and Data Interpretation

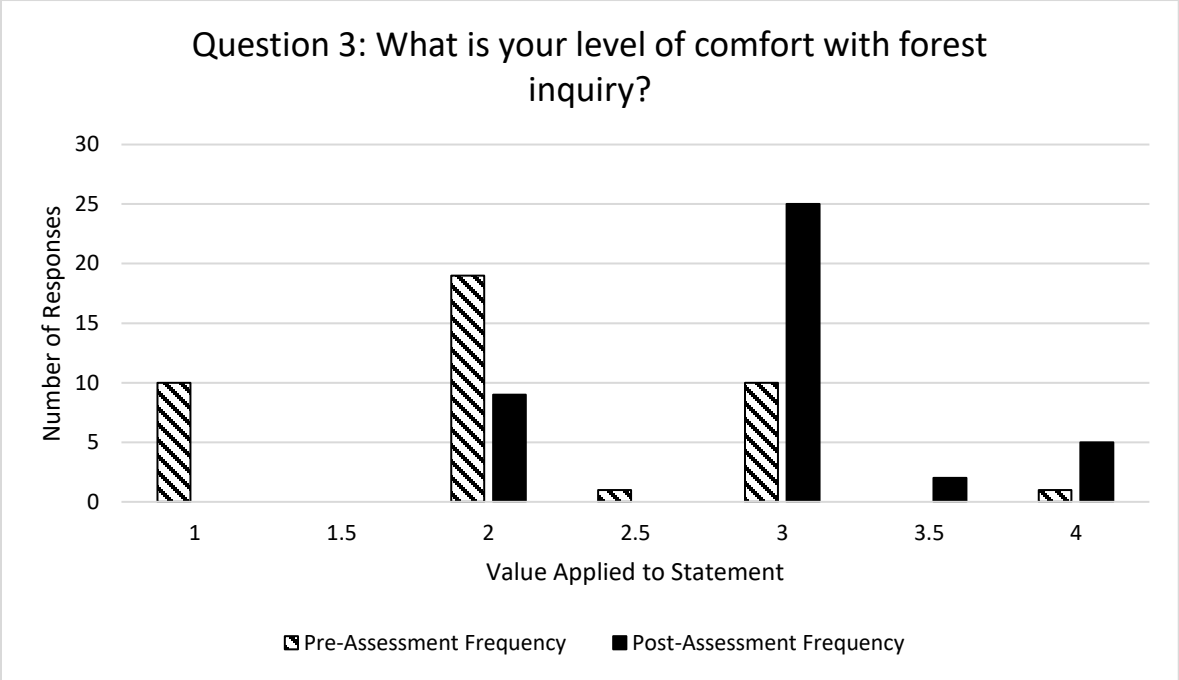

Figure 4. *Pre-and post-assessment frequency of responses to question three (1=Low, 4 = High).*

Pre-Assessment Score	Pre-Assessment Frequency	Post-Assessment Frequency
1	10	0
1.5	0	0
2	19	9
2.5	1	0
3	10	25
3.5	0	2
4	1	5

Table 5. *Frequency distribution of question three.*

For Question Three, participants were asked, “What is your level of comfort with forest inquiry?” In the Pre-Assessment Survey, a large amount of participants reported low comfort-ability levels with forest inquiry. All but one participant indicated a score of

three or below, with a score of two as the most popular. In the Post-Assessment Survey, participants indicated increases in comfort-ability across the board. With no participants indicating a comfort-ability level below two, the majority of participants reported a comfort-ability level of three, more than twice that of the Pre-Assessment. These results indicate that the comfort-ability levels of many participants increased over the course of the Rivers Institute.

Question 4: Survey Results and Data Interpretation

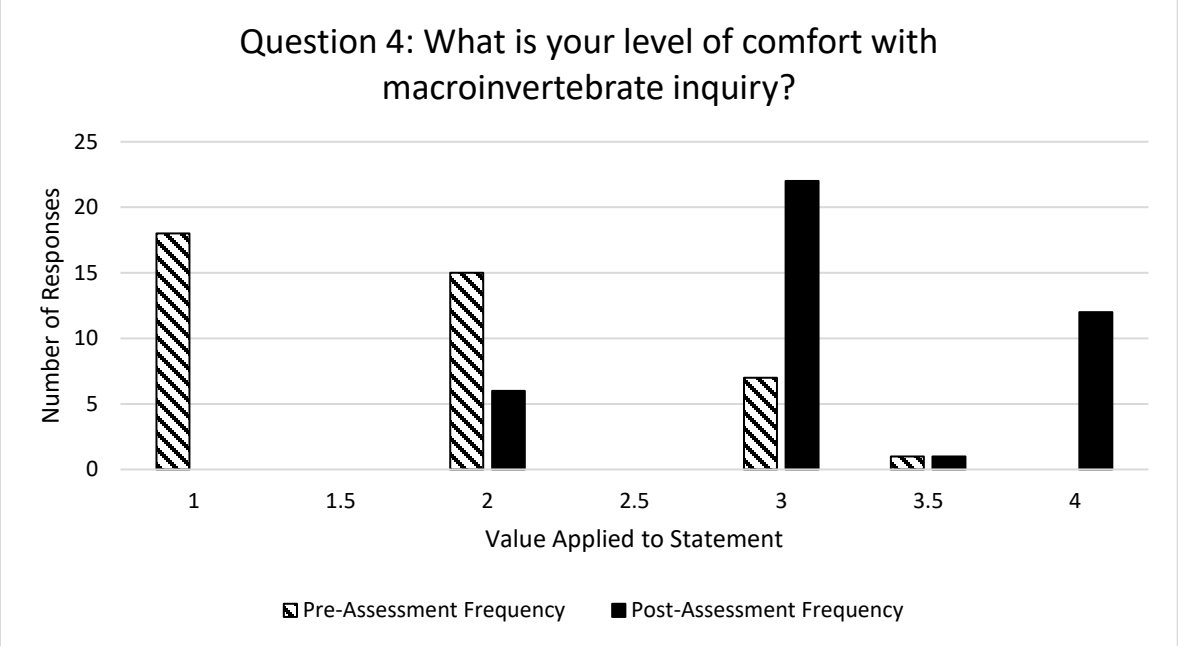

Figure 5. *Pre-and post-assessment frequency of responses to question four (1=Low, 4 = High).*

Pre-Assessment Score	Pre-Assessment Frequency	Post-Assessment Frequency
1	18	0
1.5	0	0
2	15	6
2.5	0	0
3	7	22
3.5	1	1
4	0	12

Table 6. *Frequency distribution of question four*.

For Question Four, participants were asked, “What is your level of comfort with macroinvertebrate inquiry?” In the Pre-Assessment Survey, participants reported low overall levels of comfort-ability with macroinvertebrate inquiry. In fact, participants indicated in the Pre-Assessment survey for this question the lowest levels of comfort-ability. However, participants reported some of the highest levels of comfort-ability in the Post-Assessment survey, with only six participants ranking their comfort-ability level with macroinvertebrate inquiry with a score of less than three.

These Pre-Assessment Survey results indicate that the comfort-ability level of macroinvertebrate inquiry among the majority of participants was markedly low prior to the Rivers Institute. However, the Post-Assessment Survey results show that the activities that participants experienced during the Institute helped to increase their confidence with macroinvertebrate inquiry. Post-institute evaluation responses echo these findings with the fact that the majority of participants indicated that their experience with the macroinvertebrate activities was a top take-away upon leaving the institute.

Question 5: Survey Results and Data Interpretation

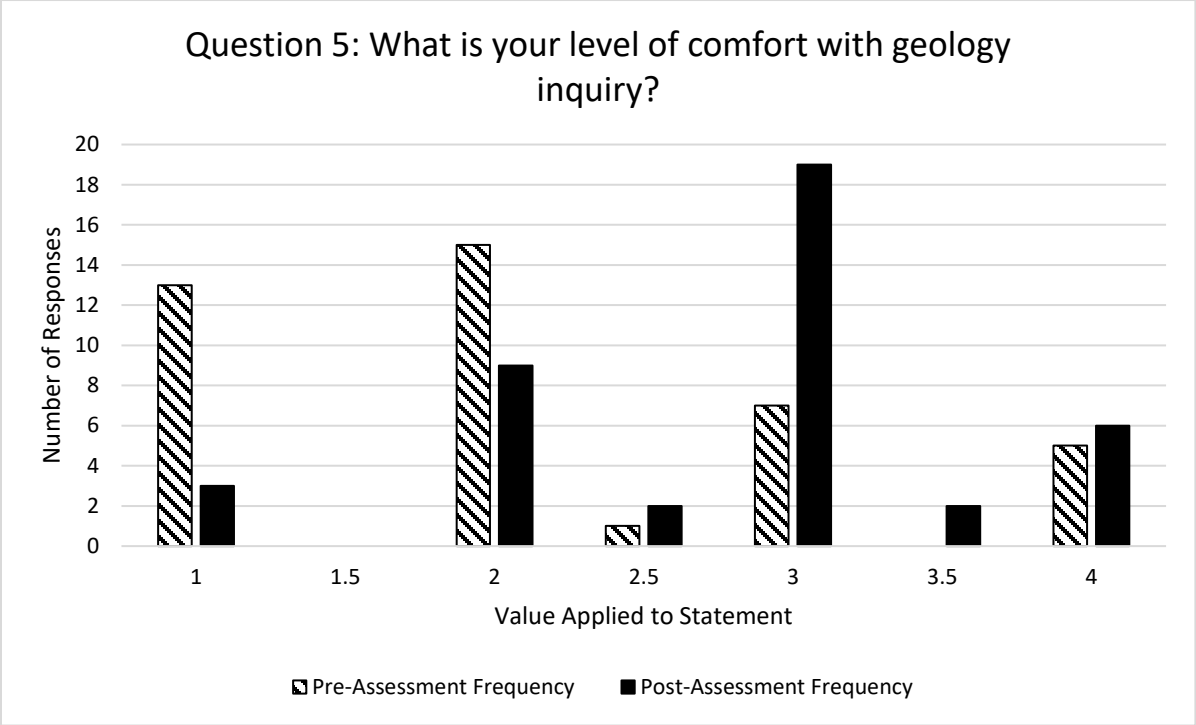

Figure 6. *Pre-and post-assessment frequency of responses to question five (1=Low, 4 = High).*

Pre-Assessment Score	Pre-Assessment Frequency	Post-Assessment Frequency
1	13	3
1.5	0	0
2	15	9
2.5	1	2
3	7	19
3.5	0	2
4	5	6

Table 7. *Frequency distribution of question five.*

For Question Five, participants were asked, "What is your level of comfort with geology inquiry?" In the Pre-Assessment Survey, participants indicated that their

comfort-ability with geology inquiry varied across the board. Most participants recorded a comfort-ability level of two in the Pre-Assessment Survey, with a comfort-ability level of one as the second most recorded.

The Post-Assessment Survey showed that participants' levels of comfort-ability increased, with the most widely reported level being three. However, this question pertaining to the use of geology inquiry techniques is the only one where some participants still indicated the lowest level of comfort-ability in the Post-Assessment Survey. This result suggests that the geology inquiry activities introduced at the Rivers Institute may not have registered deeply with some participants. Anecdotal evidence from participants suggests that more time spent on the stream table activity would have been helpful.

Question 6: Survey Results and Data Interpretation

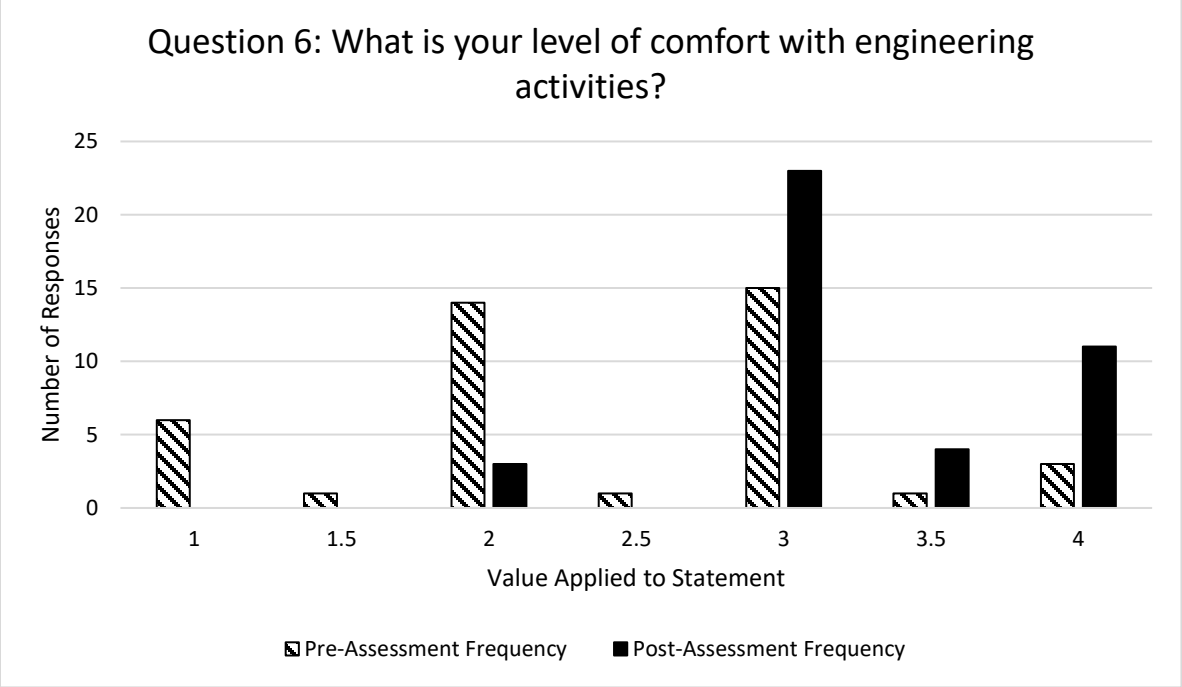

Figure 7. *Pre-and post-assessment frequency of responses to question six (1=Low, 4 = High).*

Pre-Assessment Score	Pre-Assessment Frequency	Post-Assessment Frequency
1	6	0
1.5	1	0
2	14	3
2.5	1	0
3	15	23
3.5	1	4
4	3	11

Table 8. *Frequency distribution of question six.*

For Question Six, participants were asked, "What is your level of comfort with engineering activities?" In the Pre-Assessment Survey, participants indicated that their comfort-ability level with utilizing engineering activities varied widely with individuals reporting responses in every score. However, in the Post-Assessment Survey, no participants indicated a comfort-ability level of less than two, with the highest report rate for comfort-ability of three. The Pre-and Post-Assessment Survey results for this question regarding the use of engineering activities indicates that the comfort-ability level of most participants increased after partaking in the engineering activities at the Rivers Institute.

While participant survey responses do not show the largest increase in comfort-ability with engineering from the pre-assessment to the post-assessment, many individuals indicated in the final evaluation that the engineering activities they engaged in were the most positive aspect of the Rivers Institute. Multiple participants conveyed their excitement to try out the engineering challenges with their students, and some pointed out how relatively easy it would be to incorporate engineering activities into many lessons.

Question 7: Survey Results and Data Interpretation

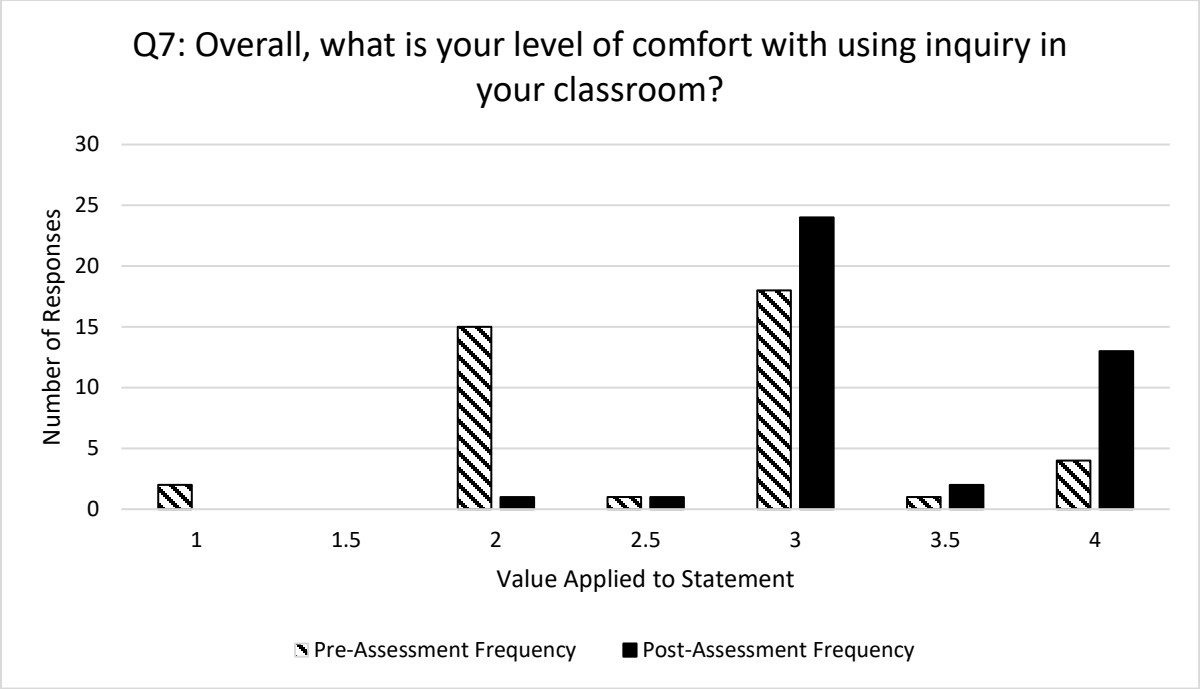

Figure 8. *Pre-and post-assessment frequency of responses to question seven (1=Low, 4 = High).*

Pre-Assessment Score	Pre-Assessment Frequency	Post-Assessment Frequency
1	2	0
1.5	0	0
2	15	1
2.5	1	1
3	18	24
3.5	1	2
4	4	13

Table 9. *Frequency distribution of question seven.*

Finally, for Question Seven, participants were asked, “Overall, what is your level of comfort with using inquiry in your classroom?” In the pre-assessment survey,

participants reported fairly positive scores for comfort-ability levels with using inquiry in their classroom, with most participants reporting a score of two or three while only a few indicated lower and higher comfort-ability levels.

After the Rivers Institute, the majority of participants reported a score of three, with the highest score, four, reported second most frequently. As was the case with questions one through six, the Pre-and Post-Assessment Survey results for question seven indicate that the activities that participants experienced as well as the knowledge gained during the Rivers Institute increased their overall comfort-ability with the content.

Similar to the rest of the questions, participants backed up their quantitative responses to question seven with qualitative statements in the final evaluation. One person noted that, “Reviewing direct inquiry, guided and open made me think more about how to change my approaches with visuals.” Other participants echoed this sentiment that the hands-on experiential learning through directed inquiry, guided inquiry and student-led inquiry was very valuable.

Survey Results and Data Interpretation

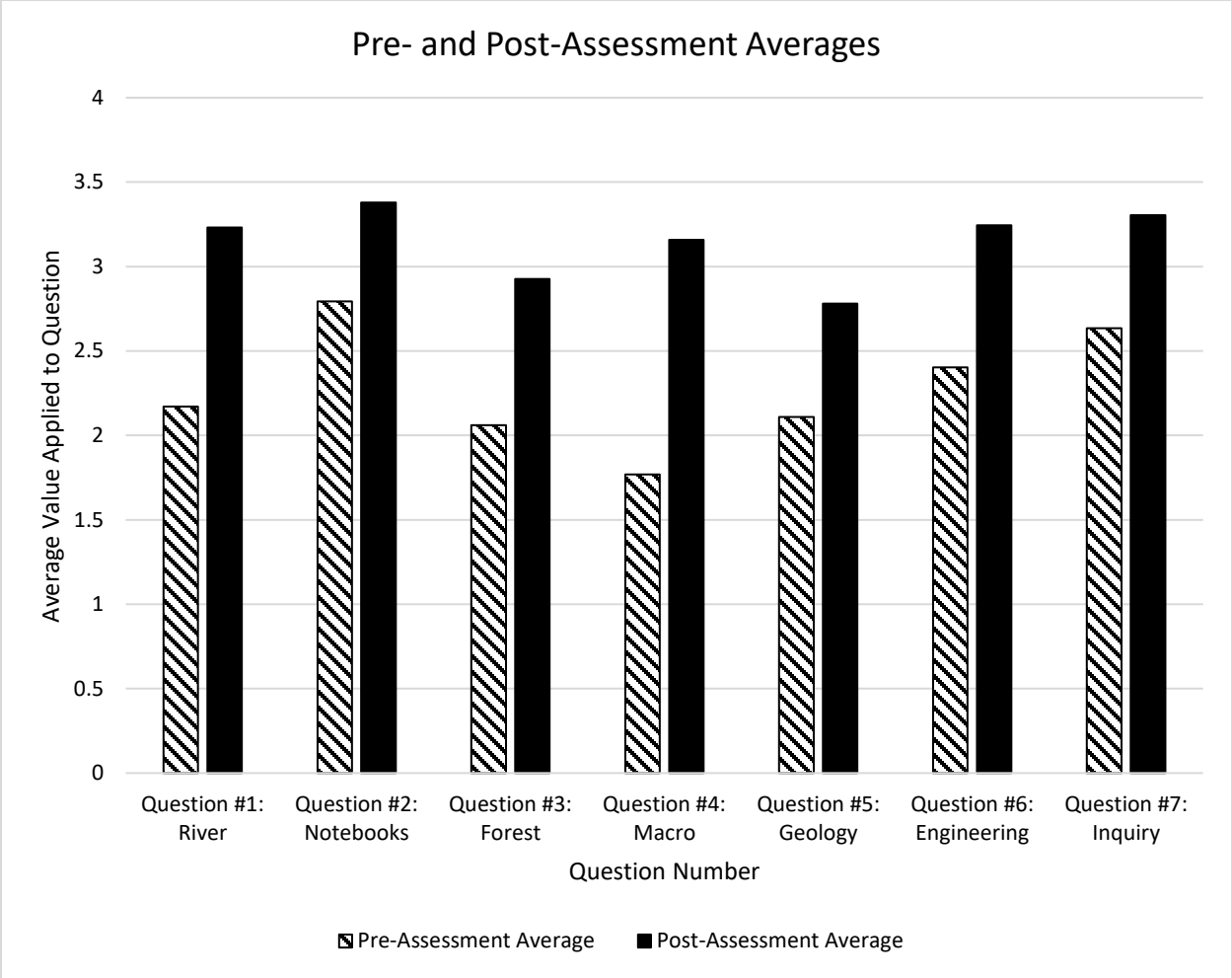

Figure 9. *Pre- and Post-Assessment Averages (1=Low, 4 = High).*

Question	Pre-Assessment Average	Post-Assessment Average	Change in average comfort-ability level
#1: What is your level of comfort with river & watershed inquiry?	2.2	3.2	+1.1
#2: What is your level of comfort with using science notebooks in the classroom?	2.8	3.4	+0.6
#3: What is your level of comfort with forest inquiry?	2.1	2.9	+0.9
#4: What is your level of comfort with macroinvertebrate inquiry?	1.8	3.2	+1.4
#5: What is your level of comfort with geology inquiry?	2.1	2.8	+0.7
#6: What is your level of comfort with engineering activities?	2.4	3.2	+0.8
#7: Overall, what is your level of comfort with using inquiry in your classroom?	2.6	3.3	+0.7

Table 10. *Pre- and Post-Assessment Averages.*

Interpretation of Averages

Overall, participants in the Rivers Institute reported increased levels of comfort-ability in all seven categories that were surveyed: (a) river and watershed inquiry; (b) use of science notebooks in the classroom; (c) forest inquiry; (d) macroinvertebrate inquiry; (e) geology inquiry; (f) engineering activities; and (g) an overall comfort-ability level with using inquiry in the classroom. Findings from all seven areas of study show an increase of at least 0.6 in level of comfort-ability. This, the lowest increase amount, was found to be related to the use of science notebooks in the classroom. The area that showed the highest increase in comfort level for participants was macroinvertebrate study with an average change in comfort-ability level of +1.4.

In addition to these quantitative results, there are a multitude of qualitative anecdotes gathered from the Mississippi Rivers Institute Evaluation administered at the end of the institute (Appendix E). In this evaluation, participants are encouraged to provide feedback on their experience over the three days. Below are a selection of respondents' comments:

Comments on the Overall Effectiveness of the Workshop:

"Great hands on activities that can easily be put in place in a classroom."

"I liked the reflection time at the end. It was nice to reflect with teachers of similar grade level."

"It provided ideas and options on how to solve problems when teaching science."

What useful ideas did you gain that you expect to apply to future educational work?

"Refreshed my interest and gave tools as teaching options."

"I have 40 million new ideas and am anxious to start putting them together!"

"Lots of stuff going right into my teaching practices – observation first! Get them outside! Hands on!"

"There were so many ideas – I don't know how to include them all!"

"Affordable and easily accessible supplies."

What was the most positive aspect of the Mississippi Rivers Institute?

"Reviewing direct inquiry, guided and open made me think more about how to change my approaches with visuals."

"I am looking forward to teaching social studies and science in a more meaningful way."

"Getting exposed to a lot of ideas and finding they are accessible to what I teach."

"The effectiveness of each day. Packed a ton of stuff in, but gave us adequate reflection time."

"All the knowledge from the experienced instructors and their enthusiasm for teaching and learning."

"Activities. Location. I feel like I can actually do all of the activities that we experienced."

"Hands-on experiential learning through directed inquiry, guided inquiry, and student-led inquiry. Thank you for 90% of our time/learning based outside."

"Meeting like-minded people and working with them on activities. Great networking with other teachers who are interested."

"Interactive, hands on, lots of people knowledge, easy to use materials, new resources, learning outside is awesome."

What are the top three "take-aways" you are leaving the institute with?

"Outside is an opportunity for learning; inquiry is highly engaging; inquiry/sequence cubes will help with problem solving skills."

"A science notebook is necessary – buying composition notebooks! I loved being outside. I haven't done this with kids – time to change that! everything is connected with everything else!"

"Better understanding – content – on geology of Mississippi/Minnesota Rivers; ways to incorporate inquiry in Lower river area; use of literacy – poetry, etc. cross curricular ties."

Other Comments

"Loved it! So many takeaways – I've never felt this excited and satisfied by 'staff' development."

"Thank you so much for sharing your dedication, passion and enthusiastic teaching as well as your love for the outdoor learning environment. It was truly a gift to attend this course – Thank you to the folks at Hamline and the Institute's fundraisers. The knowledge gained by participants will spread and impact so many youth."

"Great institute! Glad I came!"

Conclusion

This chapter presented the quantitative results from the Pre- and Post-Assessment Surveys successfully taken by 41 of the Rivers Institute participants as well as the qualitative anecdotes from participant evaluations. In each of the seven content areas, there was at least a half-point increase in participants' confidence levels. The results of the survey show that the experiences that participants had at the institute were effective and meaningful, and the results of the evaluation provide a narrative of the most impactful parts of the institute for participants.

Chapter Five presents a general review of my interpretations from the research data, as well as recommendations for future research. Chapter Five concludes with a

revisiting of the literature review, limitations of my work, and recommendations for future research. Finally, I will discuss my personal growth and offer a conclusion to my research.

CHAPTER FIVE

CONCLUSION

Summary

Addressing the global water crisis in *Civilization, the Magazine of the US Library of Congress* in 2000, Mikhail Gorbachev noted,

> Water, like religion and ideology, has the power to move millions of people. Since the very birth of human civilization, people have moved to settle close to water. People move when there is too little of it. People move when there is too much of it. People journey down it. People write and sing and dance and dream about it. People fight over it. And all people, everywhere and every day, need it. We need it for drinking, for cooking, for washing, for food, for industry, for energy, for transport, for rituals, for fun, for life.

Environmental concerns have grown exponentially since then, and the water crisis specifically has never been so dire. The need for comprehensive environmental education for students in the United States and abroad is the best way to achieve an environmentally conscientious population of citizens. This feat will not be accomplished until we have established effective environmental education professional development for educators.

This capstone study set out to answer the question "How did the activities in the Mississippi Rivers Institute affect participant confidence in teaching environmental education within seven content areas?" These areas are: (a) river and watershed inquiry; (b) use of science notebooks in the classroom; (c) forest inquiry; (d) macroinvertebrate inquiry; (e) geology inquiry; (f) engineering activities; and (g) an overall comfort-ability level with using inquiry in the classroom.

In this final chapter, I will revisit the literature reviewed in chapter two and discuss the limitations of my work. I will then suggest recommendations for future research and improvements to my work and how those results should be communicated. Finally, I will discuss the personal growth that I have achieved through this capstone process and will offer a conclusion to my research.

Literature Review

The Environmental Protection Agency currently defines environmental education as,

> A process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions. (2017)

In order to achieve an environmentally conscientious society, environmental education curricula must be present in K-12 schools. Accomplishing this requires that teachers are provided with quality, effective professional development opportunities. However, as Darling-Hammond et al. points out (as cited in Gulamhussein, 2013), recent

studies have found that, “while 90 percent of teachers reported participating in professional development, most of those teachers also reported that it was totally useless.”

I was surprised to run across this sentiment throughout my research. Almost every article I came across cited the ineffectiveness of short professional development workshops as perceived by participants. The majority of teachers were receiving one and two hour seminars mainly on content and teaching to pass state tests. After completing the Mississippi Rivers Institute, I completely see why educators find these types of learning opportunities irrelevant, as introductions and directions for the day could eat up almost an entire hour.

Calvert summarizes my sentiments in a publication for the National Commission on Teaching & America’s Future, writing, “The heart of the matter is this: For many teachers, professional development has long been an empty exercise in compliance, one that falls short of its objectives and rarely improves professional practice” (2016). Instead, the Mississippi Rivers Institute incorporated the best practices in environmental education professional development into a three-day, 24 hour workshop. The experience was intense, but, as we saw from quantitative and qualitative results, it proved to be an effective professional development exercise for educators.

Limitations

Throughout this process I have become acutely aware of some of the limitations of this study. Some of the most glaring of which have to do with continued funding,

stakeholder expectations, state and federal policy changes, the willingness of educational organizations to develop and run effective professional development opportunities for environmental education and, finally, scope of the institute itself.

The Mississippi Rivers Institute has been funded in the past by a limited number of large grants from Minnesota-based corporations and organizations. However, the days of large, single-donor grants seem to be numbered. In their absence, we are now seeing the need to seek smaller grants from a myriad of sources. While this can expand the marketing potential to reach new subsets of teachers and make new resources available, it can also lead to challenges in negotiating with funding stakeholders and can be a time-intensive endeavor.

The health of the Mississippi River is, inherently, vital to the success of the Mississippi Rivers Institute. Reminiscing on his childhood along the river, one participant reflected,

> The river itself during this time was a swirling ribbon of grey foam and banks littered with tires, bottles, cans, other garbage and even large parts of cars. There were clam shells but no evidence of living clams. We could spot carp skimming the surface. We never turned down an opportunity to swim in a body of water, even the weediest ponds, but we didn't go in this mess.

His thoughts highlight the fact that state and federal changes in environmental policy can have a huge effect on the success of a professional development opportunity held on and near the river. While policy can have an impact on the Mississippi Rivers

Institute, the content and pedagogy learned by these educators are passed along to participants' students, colleagues, family and friends, which, in return, leads to the popularity of environmentally responsible policy.

Additionally, while the Mississippi Rivers Institute is a relatively lengthy workshop for a professional development experience, time is always a constraint. Put cleverly by a past instructor it often feels like putting ten pounds of instruction and pedagogy in a five pound bag. There are always exercises that participants wish they had more time to work on, or concepts they could dive deeper into.

Finally, the scope of this research involves gathering only pre- and post-workshop comfort levels in seven areas of instruction and does not follow participants' attitudes as they enter a new school year in the fall.

Recommendations for the Future

Overall, the feedback from the final evaluation taken by participants on the last day of the institute was overwhelmingly positive. That evidence, along with my research which showed that gains were seen in all seven of the confidence-level measures prove that the Mississippi Rivers Institute is an effective professional development workshop and is evidence of the positive impacts on teachers' confidence in teaching environmental education topics in their classroom.

However, there were a number of suggestions from participants to enhance the institute experience. When asked on the *Mississippi Rivers Institute Workshop Evaluation* at the end of the Institute, "What changes should we make next year to improve the

Institute?" participants provided a number of valuable assessments. Coupled with the observed limitations of my study noted above, the participants' comments will be helpful for anyone attempting a similar professional development program.

As to be expected from a group of 50 people, there were various comments about not being able to hear the facilitators when instructing outdoors and the want for more time to delve into topics, there were a couple of comments that appeared more than once:

> "Differentiate activities based on teacher skill level (self-identified). Provide info and/or skills on teaching controversial river topics such as dams, water wars, human impacts, etc."

> "Try to aim some activities to grade level groups (primary, intermediate, middle school, high school). Sometimes it was hard to grasp what a high schooler can do compared to a young child."

> "Perhaps address some adaptations to different audiences – how student groups might react to activities. The teacher audience is very differently behaved in the field."

> "Each day get together with peers based on grade level to say how to add to classroom."

> "Maybe group talk time about what works/challenges/how can we make these activities fit in our classrooms?"

Furthermore, as mentioned in the study limitations section, I would suggest that future research of this topic should focus on the long-term impact of the content and

pedagogical gains reported by participants. I would recommend that anyone attempting to recreate a similar study look at the comfort levels of participants not just after the three-day workshop but upon their return to the classroom in the fall. Did comfort-ability levels remain the same, increase or decrease? How much of the content and pedagogy learned at the Institute made its way back to their classrooms?

Communicating Results

The original intent of this capstone project was to explore the best practices in environmental education professional development opportunities. My research will contribute to the dearth of publications on this topic and will hopefully lead to positive changes in professional development experiences for formal and informal educators, making them more impactful and valuable.

Additionally, I intend to use the Implementation Handbook that I developed as a roadmap for future workshops. It can be used as a template to set up a similarly effective institute anywhere in the country, greatly increasing the impact of the quality work provided by all of the players in the Mississippi Rivers Institute.

Personal Growth

In preparation for writing this capstone, I consulted with the lead faculty instructor for the 2014 Mississippi Rivers Institute, Cara Rieckenberg, EdD. After serving as a co-facilitator at the Rivers Institutes for many years, Cara was named as lead faculty instructor in 2011. Cara earned her Master of Science degree in Experiential Education

from Minnesota State University, and her Educational Doctorate of Leadership from the University of St. Thomas.

An exemplary educator, Cara has proven her excellence in teaching science and has been an invaluable asset to environmental education in the state. In fact, Cara was named the Elementary recipient of the 2014 Medtronic Foundation Science Teaching Award presented by the Minnesota Science Teachers Association (MnSTA).

Currently, Cara's fulltime position during the school year is as Program Coordinator for the School of Engineering and Arts in Golden Valley, MN. Her experience working in schools with students and other educators was helpful for me since I do not work in a classroom setting. Cara was able to provide valuable insight into the teaching experience as well as the trials and tribulations facing educators. Her firsthand knowledge of the time and resource constraints felt by many classroom teachers as well her understanding of traditional professional development opportunities greatly informed my study. With all of this in mind, I feel that I grew professionally from this experience by getting to dive into the life of a formal educator, and I learned about myself that classroom instruction is potentially not for me.

Conclusion

The results of the Pre-and Post- Assessment Surveys conducted at the Mississippi Rivers Institute indicated positive gains in all seven content areas measured: (a) river and watershed inquiry; (b) use of science notebooks in the classroom; (c) forest inquiry; (d) macroinvertebrate inquiry; (e) geology inquiry; (f) engineering activities; and (g) an

overall confidence in using inquiry in the classroom. While the largest change in comfort teaching a certain subject was in macroinvertebrates, significant changes in comfort with river and watershed inquiry, and forest inquiry were also present, and each area showed a rise in confidence amongst the participants.

These findings, along with the comments provided by participants after the workshop are evidence of the positive impacts on teachers' confidence levels and of the effectiveness of the Rivers Institute. This study suggests that the types of experiences offered at the Mississippi Rivers Institute are valuable for K-12 teachers, and the Implementation Handbook the I created serves as a valuable guide for constructing similar powerful experiences across the United States and around the world.

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Appendix A

Implementation Handbook

Background

The Rivers Institute is a three-day, two-credit, field-based course that addresses the natural overlap between science processes and content and the skills of literacy, using rivers as the context. The 2014 Mississippi Rivers Institute, the focus of study for this capstone, was held Monday, July 28-Wedensday, July 30, 2014. The following is a narrative highlighting the instructors, the marketing and pre-institute preparations, as well as the daily activities experienced by the participants. The purpose of this Implementation Handbook is to provide a guide for others to replicate the success of the Institute.

The Instructors

The wide variety of instructional methods leads to a richness of learning opportunities for participants with varying learning styles. All of the instructors meet several months in advance of the institute to ensure that a relatively consistent instructional approach is utilized. However, the unique teaching styles and backgrounds of the instructors assure that participants have a depth of knowledge and experiences to draw on.

Cara Rieckenberg, EdD

After serving as a co-facilitator at the Rivers Institutes for many years, Cara Rieckenberg, EdD, was named as lead faculty instructor for both the St. Croix and Mississippi Rivers Institutes in 2011. Cara earned her Master of Science degree in Experiential Education from Minnesota State University, and her Educational Doctorate of Leadership from the University of St. Thomas.

An exemplary educator, Cara has proven her excellence in teaching science and has been an invaluable asset to environmental education in the state. In recognition of her efforts, Cara was named the Elementary recipient of the 2014 Medtronic Foundation Science Teaching Award presented by the Minnesota Science Teachers Association (MnSTA). Cara's fulltime position during the school year is as Program Coordinator for the School of Engineering and Arts in Golden Valley, MN.

David Grack

A graduate of Hamline's MAEd:NSEE program, David is a classroom biology teacher and environmental science educator who has worked with children from kindergarten to twelfth grade. He has taught many continuing education courses through Hamline's School of Education, one of which relies heavily on his book, *Birds of the Northwoods Activity Book: An Activity and Learning Guide,* which was published in 2007. David has been a co-facilitator of the Rivers Institute for many years.

Ed and Sil Pembleton

For over 30 years, Ed and Selisa (Sil) Pembleton have educated people on the environment wearing the hats of naturalists, conservationists, and avid outdoors people. As a 14-year employee of the National Audubon Society, Ed's work has been invaluable in pointing national and international attention towards rivers and cranes. Ed also served as Director of the Aldo Leopold Education Project which serves as the environmental education arm of the Pheasants Forever program. Sil is an accomplished writer of wildlife books for children and has acted as Director of Education for the Maltby Nature Preserve, focusing specifically on science education.

The two delight in providing kids and adults with an introduction to the natural world and all its wonders. Ed and Sil currently work as naturalists and educators for the Jeffer's Foundation, facilitating workshops for students and teachers around Minnesota.

Carl Haensel

For the last 20 years, Carl has served in a wide range of capacities, including acting as regional manager for a large metropolitan aquatic resource program to fly-fishing guide to serving as an educational consultant. Currently, Carl owns and operates Namebini, an outdoor guide service and guest house located on Sucker River just north of Duluth. An environmental educator, photographer, biologist, and fishing guide, Carl has assisted at the Rivers Institutes for four years.

Lee Schmitt

Lee is recently retired as the Director of Professional Development at CGEE in Hamline's School of Education. In this capacity, Lee worked to support state and national

science initiatives, provide project management, oversee the grant writing process, and work directly with in-service teachers and schools.

Some of the professional development opportunities that Lee has been instrumental in creating include Minnesota Science Teachers Education Project (MnSTEP), Teaching Inquiry-based Minnesota Earth Science (TIMES), Chemistry Coursework for Additional Licensure (ChemCAL), Physics Accreditation for Science Educators (PhASE), just to name a few. Lee has served as a geology instructor at the Rivers Institutes for many years.

John Olson

John Olson, science content specialist at the Minnesota Department of Education, has been a part of both the St. Croix and Mississippi Rivers Institutes for years. John's direct work with Minnesota K-12 science standards, assessments and graduation requirements gives him a unique point of view and teaching instruction. Additionally, John's expertise in the geology of Minnesota has been an invaluable part of the Rivers Institutes.

Janine Kohn

Janine Kohn is the Minnesota Project WET Coordinator at Minnesota Department of Natural Resources. Janine facilitates the Project WET (Water Education for Teachers) activities that Rivers Institute participants go through. According to the DNR's website on Project WET, the course "trains classroom and other educators in hands-on, interactive lessons that are focused on water and encourage critical thinking. By providing training, materials, and support to these educators and water festivals for

students, MN Project WET works to improve Minnesotans' understanding of our water resources."

Upon successful completion of the Rivers Institute, participants are considered trained in the interdisciplinary water science and education program and receive a certificate that they are "Project WET certified." 2014 was Janine's second year instructing at the Rivers Institute.

Teri Heyer

Teri Heyer is a Watershed Forester with the United States Department of Agriculture (USDA) Forest Service. Specializing in urban forestry connections, Teri works as the Urban Connections Coordinator for the Minneapolis/St. Paul area. Teri has been involved with the Rivers Institute for many years, providing activities on the floodplain forest and forest inquiry.

Lyndon Torstenson

Lyndon is Manager of Educational Partnerships at the National Park Service where he is also a Park Ranger. Lyndon works with school-age children in hands-on activities and experiences in and along the Mississippi River. His work connects kids with science and the heritage of the Mississippi National River and Recreation Area. Lyndon has been a co-instructor for the Rivers Institute since its inception in 2005.

The wide variety of backgrounds from these outstanding naturalists and educators provide Rivers Institute participants with unique and invaluable knowledge and teaching practices.

Marketing and Pre-Institute Specifics

Starting six months prior to the institute, marketing efforts start in full force. Course informational flyers are dispersed to schools and learning centers around the state (Appendix F). Emails are sent to a network of almost 6,000 Minnesota and western Wisconsin educators that has been amassed from years of CGEE's professional development opportunities. Course descriptions are posted to countless environmental education-themed websites and newsletters which reach tens of thousands of educators throughout the state. The Rivers Institute is also listed in the Hamline course catalog.

Participants who are interested in the course must submit an application for review (Appendix B). Due to the fact that funding for the Mississippi Rivers Institute covers the participation of only 50 educators, there are usually space limitations meaning not all those who apply are accepted. Participants are selected for the institute based on what grades and subjects they teach, as well as their response to the "Personal Statement." This statement gives the applicant a chance to provide more detailed information, such as, "What is your personal interest in water, rivers or watersheds?" "What do you hope to learn by participating in the Rivers Institute?" "Describe the specific kinds of science concepts that interest you most, including process standards, related curricular units, and/or hands on investigations?" "How do you think this program might help your students learn literacy skills, science or both?"

Once an individual has been accepted to the Institute they are sent an initial communication. Because applications roll in over the course of multiple months, this first communication is important because it provides the participant with a contact person

should something come up, and also gives them an opportunity to provide us with an email that they will be checking over the summer if they don't use their school email over summer break. Over the course of the next few months leading up to the Rivers Institute, participants receive two more communications. One is sent two weeks before the Institute, and the final one is sent the Monday prior to the Institute.

The Institute

Monday, July 28, 2014

Participants began arriving at Crosby Farms Regional Park on the Mississippi River in St. Paul on Monday, July 28, 2014 as early as 7:15am. Upon their arrival, participants sign in with the lead logistics coordinator where they fill out a name, receive a 6"x 9" spiral-bound CGEE science notebook with the institute agenda inside as well as a liability waiver. Participants are also given the Pre-Assessment Survey at this time to complete and give back to the coordinator along with their signed liability waiver (Appendix C). Coffee and bagels are provided on this morning, so participants have a chance to get caffeinated and have something to eat while they work on their forms and socialize.

With all participants registered, we began promptly at 8am with a warm welcome and faculty and staff introductions. Lead faculty instructor, Cara Rieckeberg, EdD, then gave a brief overview of the Institute, highlighting the goals of the three-day workshop: To explore how using rivers as a context can help your students meet specific Minnesota education standards in science and language arts among other curricular areas, and to model inquiry-based science and engineering investigations in a watershed context.

After introductions and a couple of ice-breaker exercises to get participants interacting, Cara described the activities for the morning. The theme for the morning was that rivers and watersheds are complex systems that can be observed, measured and understood. First, Cara did a science notebook introduction focusing on the journals they had been given at registration. She discussed the organization of the notebook, science literacy connections, as well as the use of graphics and sketches as valuable pieces to incorporate. After those instructions, it was time to move on to the first activity!

Once everyone had gathered their things and refilled their coffee, the group walked the short 500ft to the Watergate Marina next door to board the Magnolia Blossom, a beautiful paddleboat under the direction Captain Dan. With the marina situated at the confluence of the Minnesota and Mississippi Rivers, there is the unique opportunity to traverse up the Minnesota River and back down the Mississippi to Lock and Dam 1 before turning around and proceeding back to the docks.

During the two-hour boat ride, participants began to populate their science notebooks with observations, sketches, unfamiliar vocabulary used by instructors, and even curriculum connections. Because the Magnolia Blossom is a large vessel, it offers the instructors a floating classroom of captivated participants. Lyndon Torstenson from the National Park Service describes the importance of the Mississippi River as "America's Greatest Classroom."

Fully disembarked from the Magnolia Blossom, participants made the short walk back to Crosby Farm Regional Park where facilitators debriefed their time on the river and the record of thinking that they had made in their science notebooks.

Done with a busy morning, everyone enjoyed sitting down to lunch and decompressing. Over lunch, participants are encouraged to talk with one-another to share their experiences. The same as it is for their students, talk is fundamental to literacy learning for the participants. Talk is a rehearsal of writing and promotes cognitive development, while allowing ideas to be considered, challenged and revised.

Next, it was time to dive in to the afternoon activity where the main focus was on how water moves through the biosphere in a variety of ways. Working with forest inquiry in a directed manner, the group split up in to two groups. One group performed a transect of the floodplain forest while the other looked at the transpiration of leaves.

Both groups came back from their investigations and the group as a whole debriefed the day and discussed what was ahead. The day wrapped up with Cara handing out 11”x17” paper along with instructions for homework. On their specific piece of paper, participants were told that they had just inherited riverfront property and one million dollars to do what they wanted with it.

Tuesday, July 29

On Tuesday morning participants gathered at the Visitor Center at Fort Snelling State Park. Not to be confused with the Historical Site, the State Park is located off of Post Road and offers a variety of excellent locations to perform geology investigations and macroinvertebrate activities.

The same as the day before, participants checked-in with the coordinator and we were underway by 8am sharp. The first thing to do was to check in from Monday and to share the reflections that they wrote the previous night. This was coupled with another

overview of the course to keep everyone on the same page as well as a discussion of the expectations for participants based on whether they were planning to take the course for the two graduate-level credits that they had the opportunity to buy, or if they were wanting to pursue the 21 Continuing Education Units (CEU's).

Once this had been discussed the first activity of the day was introduced by instructors. The main focus for Tuesday morning: Organisms develop features that allow them to live in specific sets of ecological conditions. The large group was divided into two smaller groups to investigate this. In one group, participants executed a guided macroinvertebrate inquiry with David, Carl and Janine. The other group went with Ed, Sil, John and Lee to perform a guided geology inquiry.

Both groups came back together after the morning session to discuss the activities they just participated in, and to debrief the guided inquiry process, keeping in mind that science is a way of knowing the world that is based in evidence, argumentation, imagination and reason. Lunch was next!

After lunch, the same smaller groups from the morning were reassembled, but this time they switched activities. The group that did the macroinvertebrate study in the morning were sent with the geology instructors and vice versa. This time, however, both the macroinvertebrate and geology inquiries were open inquiry.

Once both groups successfully completed their inquiries, both groups came back together at the Visitor Center for one last activity for the day. Being the end of the second day, participants had gotten very familiar with instructors advising them to write down their observations and questions during all activities. In an effort to get them to be even

more comfortable with utilizing science notebooks themselves, and in turn with their students, this afternoon's activity was to illuminate and discuss science notebooks. With colored pencils, crayons, markers, highlighters, and post-its, participants gave their science notebooks depth and further meaning by highlighting important concepts for them, questions, anything the participant thought was valuable to feature.

Day two wrapped up with a discussion of the day's activities and a look at the next day. A reminder was given for participants to bring their riverfront properties to share the next morning.

Wednesday, July 30

The third and final day of the Rivers Institute started the same as the first two, with registration and a check-in on thoughts people had jotted down in their notebooks. After everyone was settled in, Cara wrapped-up the homework assignment from the night before by instructing participants to look at the number on the back of their 11"x17" riverfront property and to line up accordingly. She explained that this activity was from the Project WET curriculum called "Sum of the Parts."

After a lively discussion over the Sum of the Parts activity, we dove into the major activity of the day: Engineering. The main focus for this activity is that landscapes are shaped by a variety of forces and processes, both natural and manmade. Land use has an impact on water quality, and integrating engineering design into environmental activities that meet state standards. The full list of environmental engineering activities can be found in Appendix H.

Participants were split up in to smaller groups of 6-7 people and given one of eight engineering challenges:

1. Water Filter Challenge

Problem: You are lost along a muddy river and without clean water to drink. Design and build a filtration system to filter out contaminants from river water and make it as 'clean' as possible.

2. Irrigation System Challenge

Problem: Water is needed, but it is too far away! Build an irrigation system that moves two cups of water at least three feet from the primary source. At the end of the system, split the water into three equal amounts into three separate containers that are at least six inches away from each other.

3. Oil Spill Challenge

Problem: An oil spill has occurred. Design and build a system to contain and clean up the oil spill.

4. Watercraft Challenge

Problem: You're stuck on a deserted island with limited supplies for escape. Before risking your life on a haphazardly designed boat, design and build a prototype with these limited supplies you just happen to have along. Your prototype should be able to float and hold 25 'weights' for at least 30 seconds.

5. Can you Canoe Challenge

Problem: Design a canoe, at least eight inches in length, (adhering to canoe design as experienced on Monday) that can float at least 4 minutes with at least 15 'weights' without falling apart or sinking.

6. Paddleboat Challenge

Problem: Design and build a boat or raft that paddles itself across a container of water using a rubber band as its power source. The boat or raft should be able to hold at least 10 'weights'.

7. Water Filter Challenge – Part 2

Problem: You are lost along a muddy river and without clean water to drink. Design and build a filtration system to filter out contaminants from river water and make it as 'clean' as possible.

8. Neutral Buoyancy

Problem: Neutral buoyancy is helpful for SCUBA divers, fisherman, and more. Make the diving bird neutrally buoyant – neither rising nor sinking.

In order to best perform these challenges, participants were able to use a wide variety of materials, including: fabric squares, sand, dried grasses, gravel, coffee filters, scissors, string, tape, cups, water buckets, rubber bands, popsicle sticks, weights, balloons, etc. As participants designed their engineering solutions, instructors frequently reminded them to keep in mind the science literacy connections of technical writing and the recording processes by keeping careful notes on what they and their team did at each

step. When participants finished their prototypes, each practiced writing instructions that gave specific information to guide other teams in recreating their design.

Once participants had written their instructions, one individual from each team stayed with their prototype while the rest of their team rotated to look at the engineering challenge of another group. The leader that stayed with their prototype was responsible for recounting their design and implementation process to the other teams, relying heavily on the notes they took during their building process as well as the instructions they wrote afterwards.

After all of the materials were put away, participants regrouped for lunch and prepared for the final activities of the Institute. The afternoon of this day was dedicated to discussing the technicalities and struggles of teaching outdoors, and the usage of science notebooks. Participants were given the opportunity to further engage with instructors on topics that had been discussed throughout the Institute. These topics included engineering, taking a geology stroll, talking trees (forest survey), invasive species, science notebooks, Minnesota Department of Education standards, etc.

At the end of the day when participants began to wrap up their conversations and pack their things, each individual was asked to complete a post-assessment survey (Appendix D) as well as an overall evaluation of the course (Appendix E).

Project WET

As was illustrated in the section above, Project WET (Water Education for Teachers) is a major part of the experience and curriculum of the Rivers Institute. Project WET is a water science and education program for formal and non-formal

educators provided through the Minnesota Department of Natural Resources. This international, interdisciplinary program trains educators in water-focused lessons aimed at K-12 students. Project WET activities are hands-on and provide a comprehensive water education in an effort to improve Minnesotans' understanding of our ample yet vulnerable water resources.

An accompaniment to the Project WET training, the Project WET Curriculum and Activity Guide 2.0 contains over 90 water-related investigations and activates that provide a complete and easy-to-use compilation of biological, geological, chemistry and social study focused activities that are easy to use for both formal and non-formal educators. There are many Project WET activities that are used throughout the Rivers Institute, all of which are cited in the appendix.

Conclusion

The Rivers Institute Implementation Handbook outlined here is intended to be a roadmap for individuals, organizations, governmental agencies or anyone else seeking to replicate a successful professional development workshop for local educators. The institute format of a three-day, two-credit graduate course outlined here can be shaped to fit whatever space and time constraints may limit the organizers and participants.

The hope is that any individual or entity, either nationally or internationally, interested in reproducing a similar institute using rivers and watersheds as a context for learning can use this handbook to customize a valuable learning experience that would be meaningful to their specific geographic area. Whether intended for formal or informal

educators, science teachers or community educators, the success of the 2014 Mississippi Rivers Institute as outlined by this handbook can be reproduced by anyone, anywhere.

Appendix B

Online Application

Rivers Institute Application

All fields are required unless noted.

Personal Information

First Name

Last Name

Email Address

Phone Number

Date of Birth

Gender

(Select)

Home Address

Street

City

Zip Code

Rivers Institute

Please indicate the Rivers Institute you wish to attend.

(Select)

If we are unable to admit you to the Institute of your choice, are you interested and able in attending the other?

(Select)

Do you live or work in the Minnehaha Creek Watershed District? (Visit the MCWD website for a list of cities.)

(Select)

Have you participated in a Rivers Institute through Hamline before?

(Select)

If yes, when and which one?

School Information

School Name

School District

Address

City

Zip Code

State

Mississippi

County

Phone Number

Grades Taught

Subjects Taught

If you are not a classroom teacher, please explain your current employment situation as it related to education.

Highest degree earned, when, and where

Personal Statement

Due to space limitations, we are unable to accept all applications. To help us understand why you would like to be a Rivers Institute participant, please write a personal statement (400 words or less) addressing the following questions:

- What is your personal interest in water, rivers or watersheds?
- What do you hope to learn by participating in the Rivers Institute

- Describe the specific kinds of science concepts that interested you most, including process standards, related curricular units, and/or hands on investigations.
- How do you think this program might help your students learn literacy skills, science or both?

Submit

Appendix C

Pre-Assessment Survey

Rivers Institute Pre-Assessment Survey

Name: _____

If you prefer to remain anonymous, please write a code word or number that you will use on the post-assessment in order to maintain continuity.

Gender: _____ Year born: _____ Years teaching: _____

Grade level taught: _____ Subject/Content area:_____

For the following questions, please rate your comfort level by circling the number that best pertains to you.

1 = Not comfortable at all. 4 = Very comfortable.

1) What is your level of comfort with **river and watershed** inquiry?
   1 2 3 4

a) Have you done this with your students before? YES NO

b) If yes, have you done it: Once More than once (please circle one)

2) What is your level of comfort with using **science notebooks** in the classroom?
   1 2 3 4

a) Have you done this with your students before? YES NO

b) If yes, have you done it: Once More than once (please circle one)

3) What is your level of comfort with **forest** inquiry?
   1 2 3 4

a) Have you done this with your students before? YES NO

b) If yes, have you done it: Once More than once (please circle one)

4) What is your level of comfort with **macroinvertebrate** inquiry?
   1 2 3 4

a) Have you done this with your students before? YES NO
b) If yes, have you done it: Once More than once (please circle one)

5) What is your level of comfort with **geology** inquiry?
1 2 3 4
a) Have you done this with your students before? YES NO
b) If yes, have you done it: Once More than once (please circle one)

6) What is your level of comfort with **engineering** activities?
1 2 3 4
a) Have you done this with your students before? YES NO
b) If yes, have you done it: Once More than once (please circle one)

7) Overall, what's your level of comfort with using **inquiry** in your classroom?
1 2 3 4
a) Have you done this with your students before? YES NO
b) If yes, have you done it: Once More than once (please circle one)

Your answers to this survey will be used by me, Sara Robertson, as a part of my Master's degree capstone. Your answers will remain anonymous unless you decide to provide your name. If you have any questions, please contact me at srobertson01@hamline.edu. Thank you!

Appendix D

Post-Assessment Survey

Rivers Institute Post-Assessment Survey

Name: _____

If you prefer to remain anonymous, please write a code word or number that you will use on the post-assessment in order to maintain continuity.

Gender: _____ Year born: _____ Years teaching: _____

Grade level taught: _____ Subject/Content area:_____

After having gone through three days of hands-on investigation and inquiry, please rate your comfort level by circling the number that best pertains to you.

1 = Not comfortable at all. 4 = Very comfortable.

1) What is your level of comfort with **river and watershed** inquiry?
   1 2 3 4
a) Are you likely to do this with your students in the future? YES NO

2) What is your level of comfort with using **science notebooks** in the classroom?
   1 2 3 4
a) Are you likely to do this with your students in the future? YES NO

3) What is your level of comfort with **forest** inquiry?
   1 2 3 4
a) Are you likely to do this with your students in the future? YES NO

4) What is your level of comfort with **macroinvertebrate** inquiry?
   1 2 3 4
a) Are you likely to do this with your students in the future? YES NO

5) What is your level of comfort with **geology** inquiry?
   1 2 3 4

a) Are you likely to do this with your students in the future? YES NO

6) What is your level of comfort with **engineering** activities?

1 2 3 4

a) Are you likely to do this with your students in the future? YES NO

7) Overall, what's your level of comfort with using **inquiry** in your classroom?

1 2 3 4

a) Are you likely to do this with your students in the future? YES NO

Your answers to this survey will be used by me, Sara Robertson, as a part of my Master's degree capstone. Your answers will remain anonymous unless you decide to provide your name. If you have any questions, please contact me at srobertson01@hamline.edu. Thank you!

Appendix E

Mississippi Rivers Institute Workshop Evaluation

Statement	Strongly disagree	Disagree	Agree	Strongly agree
I have a better understanding of the science opportunities represented by the river				
I have a better understanding of the engineering opportunities represented by the river				
I have a better understanding of the literacy opportunities represented by the river				
I was able to practice specific skills of science literacy during the past three days				
I learned new social science content relevant to the river during the past three days				
I learned new natural science content relevant to the river during the past three days				
I learned new strategies for teaching literacy skills through science content				
I was able to engage in critical thinking that connects content and practice of science, engineering, and literacy skills into an interdisciplinary system of thinking.				
I have a better understanding of watersheds and human impact on them				
I have a better understanding of how to teach the standards in my content area using the river as a context				
I have a better understanding of the skills and processes of inquiry instruction				
I have a better understanding of the skills and processes of outdoor instruction				
I have a better understanding of the intent of science notebooks for learning				

For those statements above where you marked ‘strongly disagree’ or ‘disagree’, please provide insights as to why you disagreed so we can make improvements for future Institutes.

1. How would you rate the overall effectiveness of the workshop (achieved course goals and objectives and encouraged new ways of thinking on rivers, science, engineering and literacy)? (circle the appropriate number)

INEFFECTIVE < 1 2 3 4 5 6 7 > VERY EFFECTIVE

Comments:

2. To what extent did this workshop provide you with useful ideas which you expect to apply to future educational work? (circle appropriate number)

NO USEFUL IDEAS < 1 2 3 4 5 6 7 > MANY USEFUL IDEAS

Comments:

3. What was the most positive aspect of the Mississippi Rivers Institute?

4. What are the top three take-aways you are leaving the Institute with?
5. What changes should we make next year to improve the Institute?

6. Other comments?

Grade Level Evaluator Teaches: _____

Primary Subject Evaluator Teaches: _____

Appendix F

Mississippi Rivers Institute Marketing Flyer

2014 Rivers Institutes featuring Waters to the Sea

- **Free for Educators**

St. Croix River Institute June 23-25, 2014

Mississippi River Institute July 28-30, 2014

Our natural affinity to water makes rivers and watersheds a useful and familiar context for teaching and learning. Join us this summer, as Hamline University's Center for Global Environmental Education (CGEE) presents its acclaimed Rivers Institute, a three day field-based professional development opportunity that inspires, educates, and prepares 3rd-8th grade teachers to engage students in STEM disciplines through hands-on, inquiry-based investigations at local watersheds.

Goals

Standards-informed Rivers Institutes are designed to increase teachers' knowledge in water related content, enhance STEM-focused investigation skills, expand literacy skills, and help area educators translate professional experiences into meaningful, engaging classroom investigations for students.

Eligibility

The focus for the institutes is on elementary and middle school classroom teachers, as well as science specialists and teams of teachers. All educators are welcome to apply.

Objectives

Through their work in a Rivers Institute, participants will:

1. Understand the teaching and learning opportunities represented by their watershed;
2. Learn specific social science and natural science content relevant to the river;
3. Explore the natural overlap between science processes, literacy skills, inquiry and STEM integration, and engineering design;
4. Engage in critical thinking and real life application of skills and knowledge that lends itself to interdisciplinary system of thinking;
5. Investigate existing resources and programs to enrich their teaching.

Activities to Accomplish Objectives include:
During the River Institute experience, participants will:

- Explore the watershed from the vantage point of the water while in canoes;
- Articulate field investigations through accurate, richly described scientific observations;
- Create and utilize science notebooks;
- Participate in learning activities utilizing Waters to the Sea*, and Project WET materials, as well as several other classroom resources and tools;
- Participate in inquiry-based investigations of flood plain forests, unique geology features, macro-invertebrates and engineering with water in mind;
- Share strategies for helping students 'think like a scientist,' 'design like an engineer,' and 'write like an author.'

Waters to the Sea	Rivers Institutes participants will receive and explore Waters to the Sea, a suite of award-winning multimedia learning modules that help students grades 4-8 understand critical water issues through engaging stories and visualizations. This educational resource is accompanied by an instructional companion for teachers use in elementary and middle school settings.

Process
Rivers Institutes take place over three days, with pre- and post-course components. Participants interact directly with professionals working on the river to investigate how concepts taught and experienced in the field can be directly transferred to classroom practice. Core concepts in science, engineering and literacy will be introduced and explored, as well as strategies for integrating curriculum using the river as a context for learning.

What else?
Each Rivers Institute participant will receive:
- Three full days of experiential instruction and lunches;
- 21 CEUs (including hours in the areas of reading preparation and technology);
- The *Waters to the Sea* multimedia tool and additional resources for your classroom;
- The option to purchase two graduate-level credits at a reduced rate.

Full scholarships are provided for teachers admitted to the program.
Scholarship assistance for the 2013 Rivers Institutes is provided, in part, through the generous financial assistance of 3M Foundation, Andersen Corporate Foundation, Patrick and Aimee Butler Family Foundation, and Xcel Energy Foundation. With their ongoing support we enable hundreds of teachers to improve the way they understand and teach science, and help thousands of students connect with the natural world.

2014 Rivers Institutes Options:

St. Croix River Institute
June 23-25, 2014 (Monday, Tuesday, Wednesday)
8am-4pm daily

Mississippi River Institute
July 28-30, 2014 (Monday, Tuesday, Wednesday)
8am-4pm daily

The application for either River Institutes is available at
www.hamline.edu/cgee/riversinstitute.

If you have any questions, please contact Sara Robertson at srobertson01@hamline.eduor 651-523-2895.

Appendix G

Institute Agenda

Course Goals	▪ To explore how using rivers as a context can help your students meet specific MN education standards in science and language arts among other curricular areas ▪ To model inquiry-based science and engineering investigations in a watershed context
Course Objectives	▪ Understand the science, engineering and literacy opportunities represented by the river ▪ Practice specific skills of science literacy ▪ Learn social science and natural science content relevant to the river ▪ Investigate strategies for teaching literacy skills through science content ▪ Engage in critical thinking that connects the content and practice of science, engineering, and literacy skills into an interdisciplinary system of thinking
Structure of Institute	▪ Practice the skills of observation and visual note taking ▪ Practice the skills of scientific inquiry to investigate aquatic and terrestrial ecosystems and the surrounding geology ▪ Share strategies for helping students 'think like scientists' as they practice the skills of literacy ▪ Explore engineering challenges and practice the engineering design process ▪ Participate in learning activities from Project WET ▪ Participate in learning activities from Waters to the Sea ▪ Create plans to implement science, inquiry and literacy investigations in their classrooms
Connecting Science and Literacy	▪ Scientists gather and use data to support their thinking ▪ Writers use experience and choices to shape a text ▪ Students must learn to write like a reader and read like a writer ▪ Data that comes from direct experience fosters ownership and motivates the writer to write towards meaning ▪ Authentic science experiences motivate students to read for information ▪ Note-taking moves experience into long-term memory ▪ The use of revising a text helps a writer clarify meaning ▪ Scientists keep notebooks containing their questions, procedures, data, and thoughts, written over the duration of an investigation. ▪ Scientific writing reflects a students' synthesis of understanding of the concepts and the process of their science inquiry. ▪ Talking and writing are both fundamental to learning in both science and literacy

Date/Time	Main Focus	Activity	Science Literacy Connection	Waters to the Sea Connection	Project WET Connection
Monday, July 28					
8am-11:45am	Rivers and watersheds are complex systems that can be observed, measured and understood	▪ Introduction of Instructors ▪ Brief overview of Institute ▪ Observation Activity ▪ Science Notebook Introduction (Organization, science literacy, graphic organizers - +-Know-Observe-Wonder-Learned-Questions for Later) ▪ River Exploration and Observation (observations, sketches, vocabulary in context, thoughts of curriculum connections) ▪ Debrief Observation Experience with 'Snapshot' activity ▪ Observation versus Inference (poem) ▪ Going from Observations to Questions (Q-Matrix)	**Vocabulary in context** (Participants will jot down new vocab from naturalists during canoeing exploration) **Record of Thinking** (Science notebooks are an ongoing record of student thinking and scientific inquiry process.)	Understanding Watersheds: Mississippi Watersheds Journey Down Minnehaha Creek: Native Life: Changing Climates and Habitats What is an Ecosystem? Energy Pyramid Understanding Watersheds: Major US Watersheds	River Talk
12:00pm-12:45pm	Share discoveries of observations	Lunch Conversations	**Talk** (Student/Participants talk is fundamental to literacy learning. Talk is a rehearsal for writing. Talk allows ideas to be considered, challenged and revised. Talk promotes		

			cognitive development.)		
12:45pm-3:00pm	Water moves through the biosphere in a variety of ways	▪ Forest Inquiry (**Directed Inquiry**) *Sil, Ed, Intern, David, Sam, Carl*	**Science argumentation** (Participants will analyze the development plans of fellow participants and will include evidence for each of the statements made about the analyzed plans.)	Explore the Mississippi Headwaters: Early Logging: Lumberjacks and Timber Barons, Forest Ecology Video What is an Ecosystem? Forest Food Web Journey Down Minnehaha Creek: Introducing the Watershed, Big Woods QTVR Panorama	Just Passing Through
3:00pm-4:00pm		▪ Return to boat for journey back ▪ Debrief from Day ▪ Evaluation/Reflection ▪ Give writing assignment ▪ Sum of the Parts Homework *(due Wednesday morning)*	**Reflection** (Participants write a paragraph that informs reader about their experience and thoughts on what the previous day's experience meant to them.)		Sum of the Parts

Date/Time	Main Focus	Activity	Science Literacy Connection	Waters to the Sea Connection	Project WET Connection
Tuesday, July 29					
8am-9am		▪ Check in from Monday ▪ Share reflections ▪ Discuss science literacy ▪ Brief overview of course assignments/syllabus review	**Reflection** (Participants will write a paragraph that informs reader about their experience and thoughts on what the previous day's experience meant to them.)		Blue River
9:00am-11:15am	Organisms develop features that allow them to live in specific sets of ecological conditions	▪ Macroinvertebrate Inquiry (**Guided Inquiry**) *David, Carl, Janine, Sam, Terry Hollis* ▪ Geology Inquiry (**Guided Inquiry**) *Ed, Sil, John and Lee*	**Recording observations** – What do you see? **Vocabulary** – How can you describe what you see? **Data charts** – How will you organize what you see? **Note taking** – What processes did you use, what interactions are you having with colleagues, what important points do you want to remember? **Presentation of findings** – What evidence supports the findings of your study? **Evidence-based discussions** – What evidence supports the findings of your study?	Explore the Mississippi Headwaters: Trouble in Paradise? Recreation and Tourism, Fish Habitat Activity What is an Ecosystem? Energy Pyramid Testing for Water Quality: Water Lab Tutorial	Macroinvertebrate Mayhem
11:15am-12:00pm	Science is a way of knowing the world that is based in evidence,	Debrief Inquiry Process Inquiry Cubes			

	argumentation, imagination and reason				
12:00pm-12:45pm		Lunch **Those taking for Grad Credit, meet to discuss course requirements.*	**Talk** (Student/Participants talk is fundamental to literacy learning. Talk is a rehearsal for writing. Talk allows ideas to be considered, challenged and revised. Talk promotes cognitive development.)		
1:00pm-3:15pm	See Morning Notes	▪ Macroinvertebrate Inquiry **(Open Inquiry)** ▪ Geology Inquiry **(Open Inquiry)**	See Morning Notes	See Morning Notes	See Morning Notes
3:15pm-4:00pm		▪ Illuminate and Discuss science notebooks ▪ Discussion of teaching outdoors ▪ Debrief from day ▪ Evaluation/Reflection ▪ Give writing assignment	**Personal narrative** (Participants will read their reflection from previous day. Using data collected, they will rewrite their reflection from the day before, drafting it as a personal narrative. The text should help readers understand what it felt like to be on the river.)		

Date/Time	Main Focus	Activity	Science Literacy Connection	Waters to the Sea Connection	Project WET Connection
Wednesday, July 30					
8am-9:00am		▪ Check in from Tuesday ▪ Share narratives ▪ Sum of the Parts Wrap Up			
9:00am-12:00pm	Landscapes are shaped by a variety of forces and processes, both natural and manmade. Land use has an impact on water quality. Integrating engineering design into environmental activities that meet state standards	▪ Engineering Activities and Debrief	**Technical writing/Factual genre/recording processes** (As participants design engineering solutions, keep careful notes on what your team does at each step.) **Writing Instructions** (When participants have finished their prototypes, they will write a set of instructions that give specific information to guide another team in recreating their design.)		
12:00pm-12:45pm	Discussion of Integration – How? Why? Challenges.	Lunch	**Talk** (Student/Participants talk is fundamental to literacy learning. Talk is a rehearsal for writing. Talk allows ideas to be considered, challenged and revised. Talk promotes cognitive development.)		

12:45pm-1:45pm		▪ Debrief teaching outdoors ▪ Debrief science notebooks			
1:45pm-3:00pm		▪ Content Conversations ▪ More engineering, geology stroll, tree talk (forest survey), invasive species, science notebooks, history of park, MDE Standards	**Analyzing data for patterns** **Evidence-based discussions**		
3:15pm-4:00pm		▪ Debrief from day ▪ Debrief Institute ▪ Evaluations/Reflections			

Appendix H

Environmental Engineering with Water in Mind

Water Filter Challenge

Engineering Design Process:

1. Define the challenge and the resources available
    a. Identify and list constraints
2. Develop and draw a design
    a. Make observations and collect data
    b. Consider constraints
    c. Evaluate/test materials
    d. Draw schematic
    e. Create list of steps to construct design
3. Share drawing and list of steps with team of same challenge
    a. Offer feedback to other groups
4. Make adjustments from recommendations
5. Create
6. Test the design
7. Modify the design and test again
    a. What are advantages/disadvantages of materials tested and tried?
8. Prepare 30 second presentation of the process you used/a hiccup you overcame/something you're most proud of in your design/or anything else you'd like to share

Problem:

You are lost along a muddy river and without clean water to drink. Design and build a filtration system to filter out contaminants from river water and make it as 'clean' as possible.

Materials:

Fabric squares
Sand
Dried grasses
Gravel
Coffee filters
Scissors
String
Tape
Cups
Water buckets

Irrigation System Challenge

Engineering Design Process:

1. Define the challenge and the resources available
    a. Identify and list constraints
2. Develop and draw a design
    a. Make observations and collect data
    b. Consider constraints
    c. Evaluate/test materials
    d. Draw schematic
    e. Create list of steps to construct design
3. Share drawing and list of steps with team of same challenge
    a. Offer feedback to other groups
4. Make adjustments from recommendations
5. Create
6. Test the design
7. Modify the design and test again
    a. What are advantages/disadvantages of materials tested and tried?
8. Prepare 30 second presentation of the process you used/a hiccup you overcame/something you're most proud of in your design/or anything else you'd like to share

Problem:

Water is needed, but it is too far away! Build an irrigation system that moves two cups of water at least three feet from the primary source. At the end of the system, split the water into three equal amounts into three separate containers that are at least six inches away from each other.

Materials:

Plastic cups
Drinking straws
Tape
Measuring tapes (**To be used only for measuring three foot and six inch distance. Not to be used within design of irrigation system.)
String
Scissors
Modeling clay
Paper clips
Water buckets

Oil Spill Challenge

Engineering Design Process:

1. Define the challenge and the resources available
    a. Identify and list constraints
2. Develop and draw a design
    a. Make observations and collect data
    b. Consider constraints
    c. Evaluate/test materials
    d. Draw schematic
    e. Create list of steps to construct design
3. Share drawing and list of steps with team of same challenge
    a. Offer feedback to other groups
4. Make adjustments from recommendations
5. Create
6. Test the design
7. Modify the design and test again
    a. What are advantages/disadvantages of materials tested and tried?
8. Prepare 30 second presentation of the process you used/a hiccup you overcame/something you're most proud of in your design/or anything else you'd like to share

Problem:

An oil spill has occurred. Design and build a system to contain and clean up the oil spill.

Materials:

Oil (vegetable oil with cocoa powder)
Paper towels
Dried grasses
Tape
String
Scissors (*To be used only to cut materials. Not to be used within design of solution.)
Detergent
Plastic cups
Plastic spoons
Sand
Dish pans
Feathers
Cotton balls
Popsicle sticks

Watercraft Challenge

Engineering Design Process:

1. Define the challenge and the resources available
    a. Identify and list constraints
2. Develop and draw a design
    a. Make observations and collect data
    b. Consider constraints
    c. Evaluate/test materials
    d. Draw schematic
    e. Create list of steps to construct design
3. Share drawing and list of steps with team of same challenge
    a. Offer feedback to other groups
4. Make adjustments from recommendations
5. Create
6. Test the design
7. Modify the design and test again
    a. What are advantages/disadvantages of materials tested and tried?
8. Prepare 30 second presentation of the process you used/a hiccup you overcame/something you're most proud of in your design/or anything else you'd like to share

Problem:

You're stuck on a deserted island with limited supplies for escape. Before risking your life on a haphazardly designed boat, design and build a prototype with these limited supplies you just happen to have along. Your prototype should be able to float and hold 25 'weights' for at least 30 seconds.

Materials:

Tape
Paper Cups
Plastic Wrap
Straws
Paper Towels
Weights (washers, pennies, etc.) (*To be used to test weight capacity of boat.)
Scissors (*To be used to cut materials. Not to be used within design of solution.)

Can you Canoe Challenge

Engineering Design Process:

1. Define the challenge and the resources available
    a. Identify and list constraints
2. Develop and draw a design
    a. Make observations and collect data
    b. Consider constraints
    c. Evaluate/test materials
    d. Draw schematic
    e. Create list of steps to construct design
3. Share drawing and list of steps with team of same challenge
    a. Offer feedback to other groups
4. Make adjustments from recommendations
5. Create
6. Test the design
7. Modify the design and test again
    a. What are advantages/disadvantages of materials tested and tried?
8. Prepare 30 second presentation of the process you used/a hiccup you overcame/something you're most proud of in your design/or anything else you'd like to share

Problem:

Design a canoe, at least eight inches in length, (adhering to canoe design as experienced on Monday) that can float at least 4 minutes with at least 15 'weights' without falling apart or sinking.

Materials:

Popsicle sticks
String
Paperclips
Tape
Wooden dowels
Modeling clay
Dish pans (**Fill with water to test floatability of canoe)
Rulers (**To be used only for measuring length of canoe. Not to be used in creation of canoe.)
Wax paper
Weights (washers, pennies, etc.) (*To be used to test weight capacity of boat.)

Paddleboat Challenge

Engineering Design Process:

1. Define the challenge and the resources available
    a. Identify and list constraints
2. Develop and draw a design
    a. Make observations and collect data
    b. Consider constraints
    c. Evaluate/test materials
    d. Draw schematic
    e. Create list of steps to construct design
3. Share drawing and list of steps with team of same challenge
    a. Offer feedback to other groups
4. Make adjustments from recommendations
5. Create
6. Test the design
7. Modify the design and test again
    a. What are advantages/disadvantages of materials tested and tried?
8. Prepare 30 second presentation of the process you used/a hiccup you overcame/something you're most proud of in your design/or anything else you'd like to share

Problem:

Design and build a boat or raft that paddles itself across a container of water using a rubber band as its power source. The boat or raft should be able to hold at least 10 'weights'.

Materials:

Rubber bands
Popsicle sticks
Wooden dowels
Weights (washers, pennies, etc.) (*To be used to test weight capacity of boat.)

Water Filter Challenge - Part 2

Engineering Design Process:

1. Define the challenge and the resources available
    a. Identify and list constraints
2. Develop and draw a design
    a. Make observations and collect data
    b. Consider constraints
    c. Evaluate/test materials
    d. Draw schematic
    e. Create list of steps to construct design
3. Share drawing and list of steps with team of same challenge
    a. Offer feedback to other groups
4. Make adjustments from recommendations
5. Create
6. Test the design
7. Modify the design and test again
    a. What are advantages/disadvantages of materials tested and tried?
8. Prepare 30 second presentation of the process you used/a hiccup you overcame/something you're most proud of in your design/or anything else you'd like to share

Problem:

You are lost along a muddy river and without clean water to drink. Design and build a filtration system to filter out contaminants from river water and make it as 'clean' as possible.

Materials:

Fabric squares
Sand
Dried grasses
Gravel
Coffee filters
Scissors
String
Tape
Cups
Water buckets

Neutral Buoyancy

Engineering Design Process:

1. Define the challenge and the resources available
    a. Identify and list constraints
2. Develop and draw a design
    a. Make observations and collect data
    b. Consider constraints
    c. Evaluate/test materials
    d. Draw schematic
    e. Create list of steps to construct design
3. Share drawing and list of steps with team of same challenge
    a. Offer feedback to other groups
4. Make adjustments from recommendations
5. Create
6. Test the design
7. Modify the design and test again
    a. What are advantages/disadvantages of materials tested and tried?
8. Prepare 30 second presentation of the process you used/a hiccup you overcame/something you're most proud of in your design/or anything else you'd like to share

Problem:

Neutral buoyancy is helpful for SCUBA divers, fisherman, and more. Make the diving bird neutrally buoyant – neither rising nor sinking.

Materials:

Rubber bands
Balloons
Tape
Paper Clips
Toothpicks
Weights (washers, pennies, etc.) (*To be used to test weight capacity of boat.)

Background Information:

The mathematician Archimedes discovered much of how buoyancy works more than 2000 years ago. In his research, Archimedes discovered that an object is buoyed up by a force equal to the weight of the water displaced by the object. In other words, an inflatable boat that displaces 100 pounds of water is buoyed up by that same weight of support. An object that floats in the water is known as being *positively* buoyant. An object that sinks to the bottom is *negatively* buoyant, while an object that hovers

at the same level in the water is *neutrally* buoyant. Scientists later discovered ways to manipulate buoyancy and developed equipment such as the life jacket, which is filled with compressed air and helps to lower a person's average density, assisting in floating and swimming, as well as certain diving equipment (including submarines and submersibles) which have air chamber similar to swim bladders to regulate depth.

Buoyancy is important in a number of fields. Designers and engineers must design boats, ships and seaplanes in a way that ensures that they remain afloat. In the case of submarines, experts developed ways to make them sink and bring them back to the surface. Many objects were developed with buoyancy in mind, such as life preservers and pontoons.