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## Effective Environmental Education Practices For Designing Urban Watershed Curriculum For An Elementary Classroom

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EFFECTIVE ENVIRONMENTAL EDUCATION PRACTICES FOR DESIGNING  
URBAN WATERSHED CURRICULUM FOR AN ELEMENTARY CLASSROOM

by

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A capstone submitted in partial fulfillment of the requirements for the degree of  
Master of Arts in Education: Natural Science and Environmental Education.

Hamline University

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## ABSTRACT

Hatzenbihler, S. Effective Environmental Education Practices for Designing Urban Watershed Curriculum for an Elementary Classroom (2018)

As human consumption of water increases the strain on the world's water resources, the need for watershed education becomes more important to ensure water stewardship for future generations. Past studies have researched utilizing environmental education best practices, specifically water education best practices, to measure for program effectiveness and increases in knowledge and skill building of school-age children. Through the development of a place-based watershed curriculum for the elementary classrooms of Rochester, Minnesota, this capstone project puts into practice the findings from these studies to help answer the research question, *what are the most effective environmental education practices for designing urban watershed curriculum for an elementary classroom?* The watershed curriculum the project was created as a companion for the Las' *Rochester Water Primer* to meet the goal of increasing the watershed literacy of area students. Research shows that programs following best practices and utilizing place-based lessons leads to successful program results.

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## CHAPTER ONE

### Introduction

Over 40 years ago, leaders around the world brought environmental education into the spotlight through accepting the *Belgrade Charter* during a United Nations conference (UNESCO-UNEP, 1976). Environmental education as a field has grown and developed since the adoption of the Charter and additional governmental statements and acts. According to the US Environmental Protection Agency (EPA), environmental education increases public awareness and knowledge of environmental issue, teaches individuals critical-thinking, enhances individuals' problem-solving and decision-making skills, and does not advocate for a particular viewpoint (Environmental Protection Agency, 2018). Extensive resources have been developed by the North American Association of Environmental Education (NAAEE) to provide guidance for incorporating environmental education (EE) into classroom settings, stating that “environmental education must play an integral role throughout our education system - at the national level, at the state level, and in each and every classroom (NAAEE, 2010 p. 3).” Quality environmental education is multidisciplinary and is aligned with standards set by the traditional disciplines (NAAEE, 2004). Many environmental issues can be addressed through the approach of aligning environmental education with the traditional disciplines.

One such important environmental issue that is being addressed through environmental education is our global clean water crisis (Evans, 2012). Watershed

education programs work to connect people to their local water resources in an effort to improve the public's water literacy. This capstone investigates the following question: *what are the most effective environmental education practices for designing urban watershed curriculum for an elementary classroom?* Specifically, this capstone identifies practices that have been effective in water education by studying characteristics of successful EE programs. This capstone also explores practices that may be overlooked in environmental education program design that should be included when designing water education curriculum for a classroom. Finally, the 'best practices' findings from the literature review are incorporated into a place-based, urban watershed curriculum.

In the remainder of this chapter, I share my journey on how I became an environmental education professional that eventually led to a position that intersects environmental education and water education. Finally there is an overview of my project goals and the following chapters in this paper.

### **Becoming an Environmental Education Professional**

My environmental education career began along the shores of Lake George in New York State's Adirondack Mountains. As a child I spent my summers at our family's cabin at the northern end of the lake. The connection I made with the water, the plants, the night sky, and the natural world has influenced me ever since. Once I reached adulthood, I began to understand the importance of my childhood along the lake and how it would guide me to a career in environmental work. During my undergraduate studies, I was drawn to environmental classes that took me outside. I realized that I wanted a career that would make a difference in our world and as my passion for environmental work became apparent, I chose the natural path.



The education path of the environmental field, however, was not as intentional. In my college courses, I studied many scientists that spent years researching a particular species or ecological system and making a difference in its preservation. I expected my career to take a similar path. When I began searching for internships, I found one at a nature center near home as an education intern. It seemed like a great opportunity to be outside and learn from professionals in the environmental field; research could wait. I had several more education internships before I had a chance to try research and I thought once I tried research that I would be hooked. My research position was in the desert of New Mexico performing Aplomado Falcon species reintroduction. It was amazing to watch the young falcons as they learned how to survive, but it was lonely work and I wanted to share what I was doing with others. There was a lot of down time during my summer in New Mexico which I spent reading the two books that would guide me to return to the field of environmental education: *A Sand County Almanac* by Aldo Leopold (1949) and Richard Louv's *Last Child in the Woods* (2006).

I found my copy of *A Sand County Almanac* (Leopold, 1949) at an antique, flea-market store in Silver City, New Mexico on the same day I visited the Gila Wilderness. When I read about Leopold (1949) hunting wolves in the Gila and seeing the fire burn out of their eyes as the wolf died, I felt connected to the place and my work. I realized that Leopold (1949) and I had something in common: he would travel from the Gila to the Midwest, Wisconsin specifically, and I would be doing the same as my next job was in Minnesota as a teaching naturalist. I decided that I would wait to read the rest of Leopold's stories once I arrived in the Midwest. Instead, I picked up *Last Child in the Woods* becoming absorbed with Louv's explanation of the need for environmental

education (Louv, 2005). This made my path clear and I understood that the difference I would make for the world was through education.

Luckily, the teaching naturalist position in Minnesota was exactly what I needed to solidify my path. I again picked up *A Sand County Almanac* as I went down to the river with several colleagues to relax and fish. I was reading the chapter about Leopold spending time along the river and in that moment I had a very strong sense that I was exactly where I was supposed to be (Leopold, 1949).

### **The Land of Cloudy Waters**

When I moved to Minnesota I expected to be surrounded by lakes, but I had moved to Southeast Minnesota where rivers rule. During my first few years, I rarely thought much about water except when I taught classes at the pond or along the river. Water had a significant influence on my childhood, but I had put water aside for several years, and when my work first brought water back to the forefront I remembered how water connects all living things to the natural world and how important that is.

In 2016, I volunteered to be part of a team to bring a Smithsonian traveling exhibit to Lanesboro, Minnesota. The exhibit, titled “Water/Ways”, brought together a diverse group of organizations representing the humanities, arts, history, and science. The exhibit highlighted how water connects us with one another as people and with the natural world. This project led me to focus more on finding the human connection to the environment rather than approaching education from a fact only method. While the facts are important, their meaning increases when incorporated into the human context. One part of the project that significantly changed my thinking was the opportunity to listen to stories of people’s connection to water. By sharing their stories, the tellers came to the

conclusion on their own that water was important to them and their quality of life, and to the quality of life of the other living beings they care about. The facts and figures I could have shared weren't nearly as powerful as their own stories in determining their connection with water and its importance. This experience helped me alter how I approach sharing environmental information with others. I try to ask and really listen, then respond if necessary. The concept of using stories and personal experiences rather than facts and figures to teach environmental education practices is not as widely adopted in my experience as an educator; therefore, for this capstone I seek evidence to show how this concept can be incorporated in water education curriculum.

Another training I attended the following year also approached interaction from a humanities perspective as I had experienced during the Smithsonian project. I attended the Blandin Foundation on Community Leadership which focused more on a community as whole and how the individual experience plays a role in community work. The Blandin Foundation's mission "is to be a trusted partner and advocate to strengthen rural Minnesota communities. Our vision is healthy, inclusive rural communities (Blandin Foundation, 2018)." This training helped me understand that it is important to consider who is missing at the table and make sure everyone can be involved, especially those who may disagree. The key principles that were taught during the training were framing an issue, building social capital, and mobilization of the community. During my training I frequently thought about how environmental issues are framed. I began to understand why an educational program or information campaign was successful, or unsuccessful, by examining how the issue was framed. This training also helped me to learn how to better engage with people and listen to them. By building relationships, or social capital,

opportunities to bring more voices to the table increase which leads to more buy-in with the actions that are selected to address the issue. Finally, through well-planned framing and engaging a person's social network, a community can be mobilized to take action and improve their situation. I've observed many community stakeholders get frustrated with how issues are handled in their communities. Yet, when they try to address the issues the lack of intentional framing and social engagement prevents mobilization of the community to take action.

Thanks to these experiences, I was ready when the opportunity to work for a local city as an environmental educator focusing on water issues presented itself. In September 2017, I started my current position as the Environmental Education Specialist for the City of Rochester, Minnesota. One of my tasks is refreshing the education program for all target audiences in the city. One of the major audience groups is our local schools, including both teachers and students.

### **Water in Rochester, Minnesota**

In 2013, the City of Rochester, Minnesota hired a local grade school science teacher to develop a local resource titled *The Rochester Water Primer* (Las, 2013). This document detailed the concept of the urban water cycle and provided teachers with a resource on local data, as well as, a limited amount of activities that can be incorporated into their curriculum to highlight local examples (Las, 2013). A significant amount of time and resources went into developing the primer document, but sadly sharing this resource with local teachers did not occur in an intentional effort. Thus the document sat on the shelf and was under-used. My capstone project developed a more comprehensive watershed curriculum that can be used by local teachers in an effort to increase the use

and ease-of-use of *The Rochester Water Primer* (Las, 2013). The primer acted as a topic guide for my curriculum, but the additional activities and content were designed to follow best practices as shown in my research. The goal of my project was twofold: first to increase watershed education in classrooms through availability and use of the developed curriculum, and second to bring attention to *The Rochester Water Primer* and its companion resources.

Throughout my career as an environmental educator, I have learned the existing common practices in environmental education programs through trainings and hands-on experiences; however, I had yet to research evidence to support what I had learned and implemented in my previous education positions. This capstone project was the ideal opportunity to reflect on what environmental education practices I had used in my career and to find support or a lack of support for which practices actually lead to successful programs.

### **Chapter Summary**

This first chapter followed the professional experiences that has led me to a position in which I have been tasked to refresh an environmental education program on water to meet the needs of the city's teachers and students. My journey has brought me to ask the research question: *what are the most effective environmental education practices for designing urban watershed curriculum for an elementary classroom?*

The second chapter explores the facets of effective environmental education programs and how they can be applied to a classroom setting. Additionally, watershed education practices are studied to see how environmental education and water education intersect. Finally, the chapter discusses how practices that are currently not typical in

environmental education can affect students' ability to connect with water, thereby increasing the effectiveness of watershed curriculum.

Chapter three provides an overview of the capstone project including how curriculum was developed to be aligned with *The Rochester Water Primer* (Las, 2013) and selected program outcomes, as well as the intended audience, length, frequency, and use of the curriculum by local teachers. Finally, it includes a description of each of the lessons developed for the capstone project.

Chapter four reflects on the capstone project, including my major takeaways from the literature review and developing the lessons. Additionally, it explores the benefits to the profession and my thoughts on the capstone process.

## CHAPTER TWO

### Literature Review

This chapter provides a review of the literature that guided the capstone project, which explores the research question: *what are the most effective environmental education practices for designing urban watershed curriculum for an elementary classroom?* Through first exploring the components of effective environmental education programs and identifying associated program goals, the chapter goes on to examine watershed curriculum and best practices that have led to successful programs for youth. Finally, practices and factors that may be overlooked in environmental education but should be considered for water education are examined.

#### **Environmental Education (EE)**

This capstone project was utilized within the context of environmental education (EE). The terms *environmental* and *education* have broad meanings and goals, therefore it is important to begin with defining EE and what EE programs hope to accomplish.

**Defining environmental education.** The first definition of environmental education was published in *The Belgrade Charter* by United Nations Education, Scientific and Cultural Organization (UNESCO) and the United Nations Environmental Programme (UNEP) in 1976. The charter provided the following goal statement:

“The goal of environmental education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which

has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones” (UNESCO-UNEP, 1976; as cited in NAAEE, 2010, p. 1).

Since the adoption of *The Belgrade Charter*, the principles have remained as a strong foundation for the environmental education field and have been researched, critiqued, revisited, and expanded over the years. In 1978, *The Tbilisi Declaration* was the first expansion that outlined three broad goals for environmental education:

1. To foster clear awareness of and concern about economic, social, political, and ecological interdependence in urban and rural areas;
2. To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;
3. To create new patterns of behavior of individuals, groups, and society as a whole towards the environment. (UNESCO, 1978; as cited in NAAEE, 2010, p. 1)

In both documents the following list of outcomes that EE programs are designed to meet was provided: knowledge, values, attitudes, commitment, skills, motivations, and behavior. While not all programs attempt to meet the entire list of outcomes found in both the *Belgrade Charter* and the *Tbilisi Declaration*, it is important to identify a program’s outcomes and to evaluate the effectiveness to meet the desired outcomes. This will help determine if the program was successful and which improvements should be made.

The North American Association of Environmental Education (NAAEE) utilizes the *Belgrade Charter* and *Tbilisi Declaration* as founding documents in EE. NAAEE summarized these goals into a single ultimate goal: developing an environmentally literate citizenry (NAAEE, 2010). This statement succinctly encapsulates the focus of the



environmental education field; however, this ultimate goal does not layout the path on how to be successful in environmental education. So professionals in the field of EE have researched and tested a variety of methods to discover the most effective paths.

**Principles that guide environmental education.** Before exploring program characteristics that can be tested for effectiveness, understanding what influenced the characteristics is critical. According to NAAEE (2010), the key principles that environmental education uses to determine its approach to education are: systems, interdependence, the importance of where one lives, integration and infusion, roots in the real world, and lifelong learning. Additionally, environmental education follows several general principles of instruction starting with the learner being an active participant (NAAEE, 2010). By actively engaging in the current lesson, the learner has an opportunity to better meet their learning style needs (NAAEE, 2010). Building upon being an active participant, instruction is a process of building knowledge and skills that is guided by the learner's interest and provides opportunities for the learner to think independently and take effective, responsible action (NAAEE, 2010). Instructors must understand that learners' personal commitment begins with awareness of what surrounds them and to use this to foster curiosity and excitement by providing opportunities to explore their environment (NAAEE, 2010). This includes an emphasis on working in collaborative situations to develop community skills (NAAEE, 2010). Finally, instructors must offer differing perspectives and present information fairly and accurately to maintain a balanced approach (NAAEE, 2010).

When developing environmental education curriculum, all of these guiding principles need to be taken into consideration; however, not all EE curriculum will be

able to incorporate all of these components. Curriculum can still be used if not all of these principles are followed as long as the educator identifies and minimizes the deficiencies when possible. This is also true when considering the characteristics that make environmental education effective.

**Characteristics of effective environmental education.** EE programs designed with the characteristics of effective EE will hopefully lead to positive impacts associated with the development of an environmentally literate citizenry. The NAAEE (2004) created an *Environmental Education Materials: Guidelines for Excellence* resource that provides recommendations for creating and choosing environmental education materials. These guidelines established a common understanding of best practices in effective EE by creating the document via a diverse writing team of environmental education professionals, circulating drafts of the guidelines to over 1,000 practitioners and scholars in the field, and incorporating comments in successive revisions (NAAEE, 2004).

The work by NAAEE (2010) resulted in a resource titled *Guidelines for Excellence K-12 Learning* which identified six areas that can be referenced to determine if the best practices are being followed. The first guideline was ensuring fairness and accuracy when environmental education materials describe environmental issues and phenomena (NAAEE, 2010). This included providing a diverse set of perspectives on the topic along with factual accuracy and opportunities to reflect and inquire further (NAAEE, 2010). Depth is the next guideline which focuses on awareness, concepts, context, and scales (NAAEE, 2010). Materials with depth will address the natural and built environment and provide awareness on feelings, values, attitudes, and perceptions

surrounding an environmental issue (NAAEE, 2010). EE materials should also have an emphasis on building skills that learners can use to address environmental issues throughout their lives, including critical and creative thinking, skill application, and skills on how to take action (NAAEE, 2010). This leads into the next guideline that EE materials should be action oriented meaning that there should be a sense of personal stake and responsibility of the learner (NAAEE, 2010). Action can be promoted through civic responsibility, use of knowledge, personal skills, problem solving, and taking action on environmental issues (NAAEE, 2010). All EE materials should use instructional techniques that foster an effective learning environment to meet the instructional soundness guideline (NAAEE, 2010). A component of meeting this guideline is to consider the learner and how they learn, as well as how the topics are connected to their lives (NAAEE, 2010). The final guideline addresses usability stating that EE materials should be easy to adapt and use, plus well designed for the intended audience (NAAEE, 2010). It is critical for an EE program's success to include each of these six guidelines: fairness and accuracy, depth, skill building, action oriented, instructional soundness, and usability (NAAEE, 2010).

The NAAEE Guidelines for Excellence were used heavily in a research study that evaluated peer-reviewed research studies published between 1999 and 2010 that empirically evaluated the outcomes of youth environmental education programs (Stern, Powell, & Hill, 2014). The review suggested that there are several program elements that may positively influence the outcomes of environmental education programs: active and experiential engagement in real-world environmental problems; issue-based, project-based, and investigation-focused programs in real-world nature settings (place-based);

empowerment and student-centered learning geared towards developing skills and perceptions of self-efficacy (Stern et al., 2014). Stern et al. (2014) determined these program elements as critical to success through reviewing 86 programs and scoring them on a 0 - 2 scale that measured each outcome of interest associated with a positive, mixed, or null result attributed to the identified program elements. Stern et al. (2014) identified and defined twenty one program characteristics, eighteen of which were associated with EE best practices. The remaining three terms are typical in education, but not associated with EE best practices and were defined as the following: *traditional* referred to the sole use of traditional lecture style presentations, *lecture* was used if the program contained at least one lecture style presentation, and *inside* meant if the program was given exclusively indoors (Stern et al., 2014).

According to study, the top five program characteristics associated with positive findings were: immersive field investigation, data collection, guided inquiry, project-based learning, and investigation (Stern et al., 2014). These findings align with the action orientation guideline from NAAEE (2010). The program characteristic of traditional was associated with the lowest amount of positive findings (Stern et al., 2014). This finding supports the challenges that classroom teachers face when attempting to bring environmental education into a classroom and continue to follow traditional, lecture style practices (NAAEE, 2010). The next two lowest program characteristics were 'multiple points of view' and 'pure inquiry' (Stern et al., 2014). While the multiple points of view is important to meet the instructional soundness and fairness and accuracy guidelines from NAAEE (2010) further studies should be done to test if points of view from familiar people and classmates have a more significant impact. This study showed that pure

inquiry shouldn't be prioritized, rather guided inquiry will likely lead to more positive results.

Stern et al. (2014) also considered the outcome scores associated with observed program characteristics across the 66 articles in the review. The top five program characteristics that had the highest outcome scores according to the weighted average included: immersive field investigation, project-based learning, data collection, investigation, and reflection (Stern et al., 2014). Four of the five top program characteristics for outcome scores matched characteristics associated with positive findings, while the difference was reflection was shown to lead to desired outcomes more than guided inquiry (Stern et al., 2014). However, guided inquiry is next on the list in the sixth place showing that both were important as program characteristics (Stern et al., 2014). The three lowest program characteristics when considering outcome scores were inside only, lecture, and traditional which provided further support for the difficulties of bringing environmental education into the classroom (Stern et al., 2014).

When comparing the results from the separate considerations of positive findings and outcome scores with the study's summary of which program characteristics lead to positive program outcomes, Stern et al. (2014) does not include in their summary guided inquiry and reflection. Instead the summary identifies program elements that ranked lower, such as, issue-based learning, place-based learning, and outdoor instruction as key elements to positive outcomes (Stern et al., 2014). This is likely due to Stern et al. (2014) also including the various program authors' points of view which cannot be easily ranked in a table as it is a more qualitative assessment than quantitative. This systematic literature review of 86 programs from 1999 to 2010 provided circumstantial evidence

supporting program characteristics that are considered best practice through the consensus-based NAAEE establishment of Excellence Guidelines (Stern et al., 2014). Although Stern et al. (2014) intended for the study to show empirical evidence, most research to date is not structured to isolate and empirically analyze which program characteristics determine positive, desired outcomes.

**The ultimate goal of environmental education.** Stern et al. (2014) discussed that while the definitions of EE and its associated goals include knowledge, attitudes, and skills, their discussion also pointed out that many of the goals of EE stress the importance of behavior change to pro-environmental behavior. The study asked why most EE programs then focus on the knowledge component over behavior change (Stern et al., 2014). According to the Campaign for Environmental Literacy (2007), the five essential components of any EE program are: general awareness, knowledge, attitudes, critical thinking skills, and personal and collective action; however, the caveat is that literacy alone does not guarantee a change in behavior. Through researching pro-environmental behavior change in the book *Fostering Sustainable Behavior* by Dr. McKenzie-Mohr (2011), it is apparent that in order to reach the goal of behavior change, a completely different path must be taken that in many cases can have limited educational value. When creating programs for youth, the degree of behaviors that are totally in their control is limited compared to adults; therefore, it is important to create educational programs focused on knowledge, awareness, and skills so that when children are able to have a greater amount of control over their decisions, then they understand why one decision is better for the environment over another and how that decision impacts the world they depend upon (McKenzie-Mohr, 2011). While it is critical to create behavior

change programs, especially for adults, it is also critical to create knowledge, experience based programs for children to increase understanding (McKenzie-Mohr, 2011).

Developing an environmentally literate citizen occurs throughout the life of an individual starting in childhood; therefore, EE must take into consideration the cognitive development of students in order to develop lessons and activities that aligns with the learner's stage of development (NAAEE, 2010). For young learners, kindergarten through fourth grade, it is important to keep it simple, local, and link observations and learning about the local environment (NAAEE, 2010). As learners develop abstract thinking skills, environmental education can start to address local environmental systems and issues to explore personal responsibility and ethics (NAAEE, 2010). Although the complexity of environmental education lessons and activities change as a learner grows and develops, the key principles of environmental education and the general principles that guide EE instruction remain a constant.

In summation, the literature reviewed identified several program characteristics that are important for positive outcomes in environmental education programs, as well as several characteristics that should be avoided or limited as much as possible. The next section focuses in on a specific topic of EE: Water Education and identifies recommendations for developing effective water curriculum.

### **The Need for Watershed Curriculum**

In 1970, the Clean Water Act was established which stressed the importance of clean water as a resource to be protected and then in 1990, the National Environmental Education Act stressed the importance of environmental education as a method for addressing in part the clean water crisis (EPA, 2018). Through these documents, national

mandates from Congress and the EPA have been given to state and local authorities for watershed education (EPA, 2018). According to a national environmental literacy study in 1998, 74% of children indicated that they did not know what a watershed was (Zint, 2011). Education and outreach programs have been designed to address the disconnect between people and their water resources, examples like Project WET, a national education curricula, and local service learning programs like H2O for Life (Project WET, 1995). Through research and development of watershed education programs, several best practices have come to light to inform future water education curriculum.

**The goals of watershed curriculum.** Dr. Zint (2011) completed a literature review of watershed education-related research for the Bay Watershed Education and Training Program (B-WET) for the National Oceanic and Atmospheric Administration. Part of literature review and research was to determine the objectives of watershed education (Zint, 2011). Zint (2011) cited two research studies that developed science objectives for watershed education as the influence for the nine objectives for the B-WET program. Shepardson, Wee, Priddy, Schellenberger, and Harbor (2007) suggested the following objectives that students should understand about watersheds: watersheds cycle water and materials, are defined by elevation, consist of biological and physical components, and are changed by nature and human activity which includes pollution. Endreny (2010) built on and reworded the objectives from the Shepardson et al. (2007) research. Endreny (2010) defined a watershed, addressed pollution, the water cycle, physical and biological components, influences from nature and humans, and that topography determines watershed boundaries.



Considering the researchers' objectives, as well as several literacy initiatives, Zint outlined nine skills for a watershed literate individual: define 'watershed;' identify the local watershed(s); identify how watersheds are connected to the ocean; identify the functions that occur in a watershed; recognize that both natural processes and human activities affect water quantity and quality; identify connections between human welfare and water; identify possible sources of water pollution; identify water stewardship actions; identify how humans manage watersheds (Zint, 2011). Objectives serve as an important starting point in curriculum development; however, instructional best practices are also vital to success.

**Best instructional practices in watershed curriculum.** The importance of water education can be seen throughout the United States and the world through many case studies and curriculum research that has been done (Endreny, 2010; Evans, 2012; Hopwood, 2007; Kudryavtsev, Krasny, & Stedman, 2012; Schall, 2015; Shepardson et al. 2007; Zint, 2011). One of these studies sought to determine to what degree a watershed education unit increased students' combined watershed literacy (Schall, 2015). The Schall (2015) education unit incorporated several of the effective characteristics that had been identified by Stern et al. (2014) including active and experiential engagement in real-world environmental problems and issue-based, project-based, and investigation-focused program in real-world nature settings. In addition, the Schall (2015) study also aligned the watershed education unit with STEM practices and standards which deepened their understanding of connections that exist within a watershed and the human impacts on watershed functions.

One of the important factors in the Schall (2015) study was that the watershed education unit was designed as a place-based curriculum. Curriculum developers have provided teachers with curricula on water education, such as Project WET and B-WET, but since the programs were expanded nationally they lack the local connections to a student's watershed (Schall, 2015). When discussing place-based education, a distinction between place attachment (bond between people and place) and place meaning (essence of a place) is important as studied in Kudryavtsev et al. (2012). Their experiment showed that urban environmental education programs can have a significant change for students on place meaning, specifically ecological place meaning, but not a significant change of a students' attachment to the place (Kudryavtsev et al., 2012). This is important when considering an education program's goals. If an environmental education program has the goal of behavior change, then the type of urban environmental education administered in the study will likely be unsuccessful in reaching that goal; however, if the goal is to increase knowledge, skills, and understanding of a place then the program will be more likely to be successful (Schall, 2015).

When developing an education program that connects students with a place they are familiar with additional consideration should be made for how students' experiences and perspectives will affect how they interpret the lesson and information. A study by Evans (2012) identified this consideration especially as it relates to water education. The study explained that water education program designers should take into consideration both environmental conservation goals and science education goals when designing curricula (Evans, 2012). As Hopwood (2007) noted from his research, students may not take away from a lesson the intended subject focus of the teacher and further, students

often add unintended environmental meaning and implications. This concern raised by Hopwood informed Evans' study to explore what students' are concerned about and how they make meaning from water education that aligns with science education and conservation goals (Evans, 2012). Evans (2012) studied a group of students who participated in a regional water education program that included in school and outside school components by investigating the students' learning and perspectives before, during, and after the program participation.

Key findings in Evans (2012) outlined recommendations for educators and water education program developers that has also been supported by previous research. The first finding addresses the science standard for students to learn the global water cycle. This study showed evidence that by telling the story of how water travels in and out of a students' local, familiar environment, the students' understanding of the global water cycle and connections between regions was enhanced (Evans, 2012). Additional studies support this approach more broadly for science and environmental concepts (National Research Council, 2009; Rivet & Krajcik, 2007). When teaching the water cycle from a conservation program perspective, it is important to also include the built components of the water cycle; however the study observed that students described the process through places in nature more frequently than through the parts manipulated by humans (Evans, 2012). These findings suggested that educators need to compensate for the disparity in understanding between natural and human built components by providing more opportunities for students to explore the built environments both in and out of school (Evans, 2012). This disparity has been identified in several science education research

studies as an issue that needs to be addressed (Cardak 2009; Covitt 2009; Environmental Literacy Council 2000; Peacock 2004; Shepardson et al., 2007).

The next key finding is how students reason on issues around water quantity and water quality. Students in Evans's (2012) study showed an anthropocentric form of reasoning in reference to water quantity and an ecocentric way of reasoning in regards to water quality. Both reasoning's for water quantity and quality were connected to particular people, places, and experiences in their community and surrounding region (Evans, 2012). This suggests to educators that utilizing animals that the students care about in outdoor environments can increase students' interest in topics surrounding water quality, but when discussing water quantity focusing on human issues will likely be more intriguing for the students. While Evans's (2012) study makes a distinction between approaches for water quality or quantity, other researchers have shown that children reason about environmental issues both from the standpoint of humans and also in terms of love and care for animals and wildlife (Almeida et al., 2013; Manoli et al., 2007; Snaddon, Turner, & Foster 2008).

Evans (2012) summarized her study by encouraging water educator program designers to take into consideration not only the needs of conservation programs and science education, but also the interests, backgrounds and experiences of the students they seek to educate. One way to connect more with the intended students is through place-based education and understand that experiences both in and out of school will impact how students become more aware and informed about water resources (Evans, 2012).

Finally, Zint's (2011) literature review for National Oceanic and Atmospheric Administration's B-WET program summarized watershed education research that showed evidence as to what instructional practices can lead to the types of student outcomes identified as goals by watershed education. The instructional practices identified were:

- (long term) place-based hands-on science inquiry (Bodzin, 2008; Endreny 2010; Patterson & Harbor, 2005 as cited in Zint, 2011),
- Outdoor learning experiences (Bodzin, 2008; as cited in Zint 2011),
- demonstrations/models that make invisible parts of watershed systems visible (Covitt et al., 2009; as cited in Zint, 2011),
- Instructional technologies (e.g. web-based GIS maps and Google Earth) (Bodzin 2008; as cited in Zint, 2011), and
- Service learning. (Eflin & Sheaffer, 2006; as cited in Zint, 2011, p. 7)

When comparing the literature in regards to best instructional practices for watershed education several themes emerged that also align with best practices in environmental education. One of the themes is the importance of place-based education which was present in multiple studies and literature reviews found in this chapter. This bodes well for aligning the curriculum with local information about the watershed and its built structures. Another theme that both environmental education and water education used in multiple studies was learning through real-world, issue-based environmental problems. Finally, student-centered and action-oriented learning emerged as a commonality.

### **Chapter Summary**

The literature review provides clarification and recommendations for this capstone research question: *what are the most effective environmental education practices for designing urban watershed curriculum for an elementary classroom?* In addition to the general education principles that quality environmental education programs follow, the environmental education and water education best practices that should be included in the capstone project curriculum were identified and discussed. The findings from the literature review directly informed the design and content of the curriculum for this capstone project.

Chapter three provides an overview of the capstone project, including how curriculum was developed to be aligned with the *Rochester Water Primer* (Las, 2013) and selected program outcomes, as well as the intended audience, length, frequency, and use of the curriculum by local teachers.

## CHAPTER THREE

### Project Description

This chapter provides context for how this project was developed based on the literature reviewed for the research question: *what program characteristics lead to the development of an effective urban watershed curriculum for environmental education instruction in a classroom setting?* This chapter includes a detailed explanation of the project and its goals, as well as the target audience, education setting, and curriculum framework.

#### Overview

This capstone project was the creation of seven lessons that aligned with the first seven chapters of *The Rochester Water Primer* written by Las (2013) for a 4th grade classroom setting. The lessons vary in length from 15 minutes to 45 minutes and were designed to be adapted for shorter or longer time frames to meet the needs of 4th grade classes. Each lesson included extension activities that enable teachers to add more depth and local connections. Lesson plans and associated materials were created for classroom teachers to use as a guide and activities to be used when preparing their water units. The audience included Rochester Area school teachers and students who come from a variety of backgrounds, including private and public schools, that all live in or near the same urban community.

The overarching goals for designing companion lesson plans for *The Rochester Water Primer* were to:

1. Increase water resources literacy in the community
2. Increase knowledge and awareness of built water systems
3. Increase understanding of human impacts on water resources
4. Increase understanding of the ‘real’ water cycle and its implications locally and globally
5. Increase use of the *Rochester Water Primer* and the city’s Environmental Educator by area schools.

These goals were partially informed by the nine objectives that Zint (2011) identified in his literature review for the B-WET program.

The seven lesson plans were written with recommendations regarding effective environmental education and water education as discussed in chapter two. The curriculum framework was guided by North American Association of Environmental Education K-12 Excellence Guidelines, Project WET, and a local residential environmental learning center’s (RELC) template. The activities were inspired and modified from several resources that met the program characteristics for effective urban watershed curriculum including: active, investigation-focused engagement in real-world environmental problems; student-centered learning geared towards empowerment of skills and self-efficacy; project-based learning with a place-based focus; ability to take activities outside of the classroom in real-world nature settings; anthropocentric approach to water quantity; and an ecocentric approach to water quality. Resources for each lesson



were identified in the curriculum template and in the lesson descriptions later in this chapter.

### **Setting and Audience**

The lessons will be used by area school teachers in their classroom settings. This leads to a notable amount of variety and unpredictability in the space that the lessons could be implemented. This consideration was anticipated during the design of the lessons. There are 16 public schools in Rochester with a total of approximately 1500 4th graders and 9 private schools in Rochester with a total of approximately 275 4th graders. The selection of the 4th grade audience was in response to the Minnesota State Academic Science Standards that have a focus on water in this grade and the interest expressed by local teachers at this grade level. The lessons were developed during the fall semester of 2018 as part of the capstone project course.

### **Curriculum Framework**

The philosophy and goals for the curriculum were influenced by the key findings discussed in the literature review in chapter two. The resources developed by NAAEE (2004, 2010) provided guidelines for the development of the lessons in this project. Each lesson was designed with the six key characteristics of: fairness and accuracy, depth, emphasis on skills building, action orientation, instructional soundness, and usability (NAAEE, 2004). Keep it simple, local, and make close links through observations are the basic guidelines for studying environmental issues with 4th graders and were an integral guide for the lesson creation (NAAEE, 2010). Finally, each lesson was connected to real-world environmental problems that required students to investigate and problem solve which developed perceptions of self-efficacy as was suggested by Stern et al. (2014).

**Lesson structure.** The curriculum template was inspired by Project WET's format, a local RELC format, and considerations of what would best meet the needs of the Rochester Area Schools. The template includes: theme, universal concepts, Minnesota Academic Science Standards met, outcomes, materials, background, procedure, extension/service learning, relevant resources including the *Rochester Water Primer*. The seven chapter topics from the Rochester Water Primer are:

1. Rochester's Water Cycle
2. Rochester's Water History
3. Rochester's Natural Water Features
4. Rochester's Constructed Water Bodies
5. Rochester's Water Supply
6. Rochester's Wastewater Treatment System
7. Rochester's Stormwater Management System (Las, 2013).

The lessons were designed to meet Minnesota State Academic Science Standards that are relevant to each chapter topic. The Minnesota State Academic Standards are developed through several advisory panels and are revised on a schedule approved by the state legislature (Minnesota Department of Education, 2018). Currently the Minnesota Academic Standards for Science are in review and a final draft is scheduled to be sent for approval in May 2019 (Minnesota Department of Education, 2018). The science standards that have been included in the curriculum are:

- 4.1.2.1 Engineers design, create, and develop structures, processes, and systems that are intended to improve society and may make humans more productive,

- 4.1.2.2 Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product,
- 4.2.1.2 Solids, liquids and gases are states of matter that each have unique properties,
- 4.3.1.3 Rocks are an Earth material that may vary in composition,
- 4.3.2.3 Water circulates through the Earth's crust, oceans and atmosphere in what is known as the water cycle,
- 4.3.4.1 In order to maintain and improve their existence, humans interact with and influence Earth systems (Minnesota STEM Teacher Center, 2018).

**Developing each lesson.** Development for each lesson began by first reading the associated chapter in the *Rochester Water Primer* and identifying the major theme within each chapter. Notes were written for each chapter in regards to the theme and potential activity ideas for each lesson. Curriculum examples from a variety of sources named in each lesson description were then consulted as resources with activities that could be modified to fit the place-based curriculum for the project.

**Lesson one: Rochester's water cycle.** In this lesson students tell the story of the water cycle in Rochester, Minnesota through a modified version of Project WET's Incredible Journey (1995) where students simulate the movement of water within the water cycle by rolling dice and moving from station to station. In the Project Wet version, the activity had nine stations that showed how water moved throughout the globe. The modified lesson focused on specific locations in Rochester and added human built structures that manipulate water in the water cycle for a total of twelve stations. The stations in this lesson are as follows: clouds, river, lake, plants, animals, soil,

groundwater, drinking water well, sanitary sewer, wastewater treatment plant, parking lot, and storm sewer. After students move through the stations and have recorded their journey, they are provided with an opportunity to share with classmates and brainstorm how water cycles could differ around the world.

**Lesson two: Rochester's water history.** There was a plethora of historical information provided in the *Rochester Water Primer*, thus the lesson created was only able to cover a small portion of the history where water and engineering met. In 1978, Rochester experienced a flood disaster that led to a flood control project to prevent future catastrophes (Las, 2013). The inspiration for this lesson came from an optional activity that was used at Eagle Bluff Environmental Learning Center (Eagle Bluff) (2018). In this activity the students take on the role of some of the people who are likely to have worked on the flood control project and receive instructions through a scenario card. The students are tasked with choosing a plan to meet the needs on their scenario card and share their plan with the other roles. The activity encourages students to find fault in each other's plan because there are conflicting needs. The final task is to find a compromise and choose plan that works for all groups to recommend to city council. Extension activities include students researching what solutions have been installed as a part of the flood control project and to visit one of these structures in Rochester.

**Lesson three: Rochester's watershed.** The theme of this lesson is that all living things reside in a watershed and can impact the health of the watershed. This activity was modeled from a similar activity developed at Shangri La Botanical Gardens and Nature Center (2018). Students first define watershed and identify their local watershed,

then the students learn how watersheds connect different ecosystems and identify sources of nonpoint pollution through a build a watershed activity. An important piece of this lesson is that students make observations during the build a watershed activity that are followed by a discussion on positive and negative impacts humans can have on a watershed.

**Lesson four: fishing in Rochester.** Rochester is one of a few communities in Minnesota that doesn't have natural lakes; however, throughout history the citizens of Rochester constructed lakes throughout the area. This lesson explores the construction water resources through the animals that live there that students may be drawn to. The theme of this lesson is that wildlife populations rely on their habitats for survival. This activity was influenced by MinnAqua's Habitat Hideout lesson (2010) and Eagle Bluff's Biodiversity Hike activity (2018). Students learn about the lake habitats that are present in Rochester and how a habitat meets the needs of animal species, specifically fish. Each student or student group is assigned a specific fish species and is tasked with determining if that species can survive in Rochester. Students then discuss their reasons for their decision and if the fish can't survive in Rochester, what else it would need to survive. Their findings can then be confirmed by comparing the class' answers to fish surveys completed by the Minnesota Department of Natural Resources.

**Lesson five: Rochester's geology.** This chapter in the *Rochester Water Primer* provides information about Rochester's water supply which is sourced from underground aquifers in a karst landscape (Las, 2013). The uniqueness of a karst landscape and the close connections between surface and underground informed the theme of this lesson: water, rocks, and people are closely connected in a karst landscape. The activity focuses

on a game that was modified from Eagle Bluff's Chemistry of Karst activity (2018) in which the students become water that moves through the underground of a karst landscape. Students observe and discuss how water impacted the ground below the surface and what that means for digging wells and preventing pollution of groundwater sources.

**Lesson six: Rochester's wastewater treatment.** How water moves through buildings and infrastructure can be seen as a mystery to be solved. This lesson utilizes coloring sheets from the Follow Those Pipes activity in *That Magnificent Ground Water Connection: A Resource Book for Grades K-6* to visualize what pipes bring water into a home and out of a home to be treated (Frye, Pappo, Groves, & Moubry Feuerbach, 1996). Once students understand that all the water used in their house has to be treated before it can be returned to the environment, the students participate in an activity exploring water conservation actions that they can take to reduce their impact on the system and environment.

**Lesson seven: Rochester's stormwater management.** Students become stormwater management planners for their school to learn how stormwater is treated through green infrastructure and engineering solutions in a city setting. After studying various green infrastructure practices, students discuss locations at school where these practices could be installed. This lesson builds on previous lessons discussing the water cycle and engineering solutions and shows practical applications in a location that is familiar to the students.

**Assessment.** The scheduled update of the Minnesota Science Standards will trigger future reviews of the lessons to ensure alignment with any changes that are

adopted in the future. The standard update also has the potential of increasing a teacher's willingness to adopt the lessons in the 2019-2020 school year and be willing to provide feedback after utilizing the lessons as teachers will already be adjusting curriculum units to align with the updated standards. In addition to qualitative feedback from teachers, the capstone project will be assessed by tracking how many classrooms utilize the lessons, which lessons are used, and how many students are reached. This data will also be used to inform future improvements and additions to the lessons.

### **Chapter Summary**

Chapter three provides an overview of the curriculum that was developed for 4th grade classes in the Rochester, Minnesota area. First, it provided an overview of the project and the associated overarching goals, then the setting and audience was identified, and the curriculum framework, development, and assessment were reviewed. Finally, summary descriptions about each of the seven lessons created were provided.

Chapter four reflects on the overall capstone project experience and how it has impacted the researcher and benefited the profession. The chapter discusses limitations of the project, opportunities for future research, and provides final conclusions.

## CHAPTER FOUR

### Conclusions

The objective of this capstone project was to answer the question: *what program characteristics lead to the development of an effective urban watershed curriculum for environmental education instruction in a classroom setting?* Through the creation of seven lessons plans that serve as a companion to the *Rochester Water Primer*, program characteristics found to result in an effective urban watershed curriculum were applied. This project was selected due to education goals of the City of Rochester's water resources team to reach the audience of local students and teachers. The opportunity to research best practices in environmental education and water education and apply the practices through the creation of seven lessons has been rewarding, both personally and professionally.

This chapter examines the components of the literature review that had a significant influence on my capstone project, discusses project limitations and opportunities for future research. It concludes with thoughts on the benefit of my project for the water education profession and the overall capstone process.

#### **Lifelong Learner**

Over the course of my career I have experienced a diversity of learning opportunities that helped me grow professionally and personally. The research component of the capstone project has given me another tool for continued learning. As I



attended trainings, seminars, on-the-job trainings, and observing seasoned professionals, I took for granted the research that had occurred to provide the basis for the lessons I was learning. Through this capstone process, it became clearer why certain environmental education methods are considered best practices and found more evidence to support several of the approaches I had used in environmental education.

One of the key understandings learned through the literature research was the importance of both knowledge and behavior as goals in the environmental field. Many environmental education programs are designed to take the learner down the path of knowledge and skill building, this was supported in Sterns et al. (2014) when many of the programs reviewed reached goals on knowledge and skills. However, according to the foundational documents of environmental education, behavior is also a goal for environmental education programs (NAAEE, 2010). The disconnect identified by Dr. McKenzie-Mohr (2011) was that the path to behavior change is different than the program characteristics in education programs provide. Additionally, the development level of the learner and their locus of control must be taken into consideration when determining if an education program or a behavior change program is more appropriate (NAAEE, 2010). With this understanding, the path for this capstone project became clear once the individual learner and the needs of 4th grade students were considered.

After justifying why the program goals for this education capstone project were knowledge and skills, then the best practices for effective environmental education programs, and more specifically water education program, became the most influential component of the literature review for the creation of the project lessons. The activities were designed to include: active, investigation-focused engagement in real-world

environmental problems; student-centered learning geared towards empowerment of skills and self-efficacy (Stern et al., 2014); project-based learning with a place-based focus; ability to take activities outside of the classroom in real-world nature settings (Stern et al., 2014); and anthropocentric approach to water quantity; and a ecocentric approach to water quality (Evans, 2012).

The lessons also addressed the six guidelines of fairness and accuracy, depth, skill building, action-oriented, instructional soundness, and usability as outlined in *Guidelines for Excellence K-12 Learning* (NAAEE, 2010). Finally the specific goals of watershed curriculum developed were informed by a plethora of previous studies and the needs of the City of Rochester (Endreny, 2010; Evans, 2012; Hopwood, 2007; Kudryavtsev et al., 2012; Schall, 2015; Shepardson et al., 2007; Zint, 2011).

This section reviewed the learning discoveries made during the capstone process, which included the difference between behavior and goals of environmental education program for youth, as well as, the importance of water education and effective program characteristics that were applied. In the next section, the limitations of the project are identified and discussed.

### **Limitations of the Project**

Due to this project being designed by an environmental education specialist that works for the City of Rochester, the ability to ensure adoption of the lessons in local classrooms is limited because both the public and private schools are not required to use this new resource. While the literature review shows there is a need for this type of educational resource and the City of Rochester identified that it has the capability and desire to provide the resource, it is still up to the schools and individual teachers to decide

what resources will be used in their classroom. This limitation was considered during the development of the project and influenced the usability structure and additional support that may be needed to increase the likelihood of adoption in local schools. This project is seen as one step of a long-term project that will take several years to reach the full implementation goal.

Understanding the limitations that may prevent full adoption of the lessons in Rochester's 4th grade classrooms, several of the environmental education best practices identified in the literature review became unattainable. Many of the 66 studies that were reviewed by Sterns et al. (2014) showed that effectiveness was increased when environmental education programs took place outside in natural settings. Since this curriculum was developed for 4th graders in a traditional school setting, the teacher may not always have the option of taking the students outside to an appropriate nature location. The lessons were designed to allow teachers to choose an indoor or outdoor location to complete the activities depending on the needs of the class. The teachers are encouraged to incorporate an outdoor component through extension activities that build upon the activity.

Considering limitations early on in the design process has minimized the significant implications for the success of the project. As this project was specifically designed for the City of Rochester, another unavoidable limitation of the project is that it cannot be generalized to another location; however this was intentional as the best practices identified in the literature review showed the importance of place-based water education. The next section discusses future research project that could build upon the work in this capstone project.

## **Future Research**

An area of future research that would be key in addressing the question: *what program characteristics lead to the development of an effective urban watershed curriculum for environmental education instruction in a classroom setting?* would be a follow up study after implementation in a pilot group of local schools to determine if the implementation of the lessons leads to successfully meeting intended goals. Student pre- and post- questionnaires could be used to assess effectiveness and suggest initial improvements. This research would be completed prior to widespread adoption throughout the 4th grade classrooms in the city. As more classes adopt the curriculum, the study can continue to see if its effectiveness continues.

Another approach would be to test whether addressing the limitation of implementation in an outdoor vs. indoor setting has an effect on the success of the program to meet its goals. This research would need to be done after baseline data has been collected in order minimize other variables influencing the results. Finally, it would be interesting to modify the lessons for a different location and compare the evaluation results to see if the place-based aspect plays a crucial role as other studies have suggested.

## **A Benefit to the Profession**

Throughout the state of Minnesota and nationally, there are cities, communities, and watershed districts that are tasked with developing a watershed literate citizenry. This community of water educators gather in various settings to share knowledge and resources with one another. This capstone project is an additional resource that other communities can model and benefit from. Following the 2019-2020

school year and the initial feedback from teachers, I plan to share the lessons with other Minnesota communities that could modify the curriculum to meet their local needs. The project will be shared with water educators through various meetings, conferences, and presentations throughout the region.

After the capstone project is complete, a next step is to develop and implement a communication plan to make local teachers aware of the addition of the lessons to the *Rochester Water Primer* for adoption in the 2019-2020 school year. The communications will occur in the spring and summer of 2019 through a variety of methods including: email messages, in-person meetings with teachers who have reached out for resources before, online videos, and working with school administrations to make the appropriate connections throughout the districts.

Additional next steps after this curriculum development is ensuring that support will be available for teachers that would like to adopt the activities into their classroom. This support includes: requesting a city staff speaker on a water topic, requesting that the city's environmental educator teach the activities in their classroom, and taking their students on a Rochester water resources field trip. The field trip option has already been developed, tested, and shown to be successful at connecting students with the built components of the water cycle in Rochester. The field trip visits the wastewater treatment plant, a drinking water well and tower, and a local nature center with stormwater management structures and wetlands. A long-term goal of this capstone project is that all 4th grade classrooms in Rochester adopt a portion or all of the curriculum activities into their water units including the water resources field trip.

This capstone project has the potential to inspire similar projects which increases the value of the work done. The following conclusion summarizes this final chapter and my thoughts on the capstone process.

### **Conclusion**

This chapter explored the major influences on the project from the research process starting with the emphasis on developing programs with goals that meet the needs of the learners while following best practices for effective urban watershed curriculum. A discussion on project limitations, future research opportunities, and greater impact potential on the profession rounds out the remainder of the chapter.

While the requirements of the capstone project involved a significant amount of research prior to developing the project curriculum, the result of thoroughness from the process gives me confidence in the soundness of the final product. At times the research and chapter writing seemed daunting, but selecting a topic and research question that was important to me and my work kept me motivated. Once I reached the step when I was able to take what I had learned so far and create the curriculum lessons, it was easy to justify the amount of time and energy spent preparing. I wish that I had the foresight to know how much more I would enjoy creating the activities with the research supporting me than if I had skipped right to lesson creation. As I continue to work in this profession, I am thankful that I have that knowledge of how research informs your work and ultimately results in a better product.

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