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Marine Science Summer Enrichment Camp's Impact Ocean Literacy for Middle School Students

Victoria Jewel Young
Walden University

Walden University

College of Education

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Victoria Young

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Review Committee
Dr. Deanne Otto, Committee Chairperson, Education Faculty
Dr. Asoka Jayasena, Committee Member, Education Faculty
Dr. Shereeza Mohammed, University Reviewer, Education Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2017

Abstract

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on Ocean Literacy for Middle School Students

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MA, Armstrong Atlantic State University, 2005

BS, Kansas State University, 2001

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Although careers in science, technology, engineering, and mathematics have expanded in the United States, science literacy skills for K-12 students have declined from 2001 to 2011. Limited research has been conducted on the impact of science enrichment programs on the science literacy skills of K-12 students, particularly in marine science. The purpose of this study was to describe the impact of a marine science summer enrichment camp located in the eastern region of the United States on the ocean literacy skills of middle school students who participated in this camp. Weimar's learner centered teaching approach and the definition and principles of ocean literacy formed the conceptual framework. The central research question focused on how a marine science summer enrichment camp impacted the ocean literacy skills of middle grade students. A single case study research design was used with ten participants including 3 camp teachers, four students, and 3 parents of Grade 6-8 students who participated this camp in 2016. Data were collected from multiple sources including individual interviews of camp teachers, students, and parents, as well as camp documents and archival records. A constant comparative method was used to construct categories, determine emergent themes and discrepant data. Results indicated that the marine science camp positively impacted the ocean literacy skills of middle school students through an emphasis on a learner centered instructional approach. The findings of this study may provide a positive social impact by demonstrating active science literacy instructional strategies for teachers which can motivate students to continue studies in science and science related fields.

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Chapter 1: Introduction to the Study

From 2001 to 2011, K-12 students in the United States demonstrated a decline in science literacy. At the same time that science literacy was declining, careers in science, technology, engineering and mathematics (STEM) continued to expand (Carneval, Smith, & Melton, 2011). Research about climate change has also continued to develop, particularly in relation to marine science education (Kelly et al., 2014). However, limited research has been conducted about the understanding that students develop about oceans as a result of marine science instruction, particularly in relation to their experiences in marine education summer enrichment camps, which this study explored.

The marine science summer enrichment program that served as a research site had been in operation for over 10 years in the southeastern region of the United States at the time that this study was conducted. The mission of this 4-week summer camp was to improve ocean literacy for students in Grades 2-12 who participated in the camp. The camp curriculum was based on the national Next Generation Science Standards (NGSS) that address science process and inquiry skills and the National Oceanic and Atmospheric Administration (NOAA) Ocean Literacy Principles that address stewardship and conservation of the oceans (NGSS, 2014, NOAA, 2013). This study explored the impact of this marine science summer enrichment camp on ocean literacy skills for middle school students, particularly in relation to a learner centered teaching approach (Weimer, 2013). The potential findings of this study may lead to positive social change as educators, parents, and students may develop a deeper understanding of ocean literacy and learner centered teaching. This understanding may benefit society because improved ocean literacy for American citizens may result in improved policies and management of ocean resources for future generations.

Chapter 1 is an introduction to this study. This chapter includes background information for the study, the problem statement, and the purpose of the study. The research questions are included, which are based on the conceptual framework and research methodology of the study that is described in this chapter. Definitions of key words, assumptions, and limitations are included as well as the significance of the study.

Background

The focus in science education has been about how to increase student interest in science by including immersion activities or hands-on experiences to improve problem-solving skills and science literacy skills (National Research Council, 2012). Science literacy is defined as an individual's understanding of scientific principles, concepts, and process skills (Foster & Shiel-Rolle, 2011). Summer camps that are focused on science are designed to provide immersion activities to engage young people in science (Sterling, Matkins, Frazier, & Logerwell, 2007).

In earlier research, Cavanagh (2007) examined science summer enrichment camps for female students and found that participants demonstrated an increased understanding of content because they were supported by peer groups who shared their interests. In an examination of gender stereotypes in mathematics and science, Kurtz-Costes, Rowley, Harris-Britt, and Woods (2008) found that middle school students pursue interest supported by their peer groups. In a similar study examining gender-related beliefs of students in Grades 6-8, Leaper, Farkas, and Brown (2012) found that these students made decisions to engage in academic content based on peer support and relationships with peers. However, researchers who conducted these earlier studies did not explore the benefits of increasing science literacy to enable students to actively pursue future educational and career paths in science, particularly in relation to marine science.

Several researchers have explored summer camps as an environment to increase science literacy. These camps often have the necessary resources for students to explore science content more deeply, and teachers are able to provide instruction in a relaxing and entertaining context that is often difficult to replicate in a traditional classroom (Lindner & Kubat, 2014; Sezen Vekli, 2013). In other similar research, Bas, Teksoz, and Ertepinar (2011) examined the environmental attitudes of elementary school students living in Turkey and found that an emphasis on the local environment enabled students to connect science content with the environmental impact that these students experienced. In a case study of environmental education in nature schools located in Finland, Jeronen, Jeronen, and Raustia (2009) found exposure to the nature settings for students in Grades 2-3 improved their understanding of science concepts associated with life science. Thus, the lack of time to develop these resources can be challenging for teachers in traditional classroom settings, and therefore, alternative instructional models such as science summer enrichment camps or Finland’s nature schools often provide the necessary instructional support for teachers.

A review of the research indicated a gap in knowledge about ocean literacy for middle school students. Few studies about how science educators have used a learner centered teaching approach to improve ocean literacy have been conducted, particularly in the middle school level (Aktamis, Acar, & Unal Coban, 2015). This study was needed because limited research was found on the impact of a marine science summer enrichment camp on ocean literacy for middle school students, particularly in relation to a learner centered teaching approach.

Problem Statement

Summertime provides many educational opportunities for students interested in science. Some of these summer enrichment experiences have been found to improve student learning in science, particularly in relation to science literacy (Erdogan, 2011; Foster & Shiel-Rolle, 2011). Science literacy is defined as the understanding of science content and process skills (Hine & Medvecky, 2015). For K-12 students, the NGSS have defined these content and process skills as three distinct dimensions: (a) crosscutting concepts across the four domains of science, (b) science and engineering practices to deepen and apply knowledge of core ideas, and (c) disciplinary core ideas built on one another as a student progresses through the grades (NGSS, 2014). Many summer enrichment opportunities in science are based on the national science education standards.

To facilitate and nurture a scientifically-based worldview, science summer enrichment camps for K-12 students have emerged across the United States that are uniquely focused on science literacy related to the ocean. The goal of these summer enrichment camps is often to improve students' ocean literacy, which the NOAA (2016) defined as the ocean's influence on a person and the person's influence on the ocean by understanding seven essential principles, communicating effectively about those principles, and making responsible decisions regarding the ocean and its resources. These seven essential principles are as follows:

- Earth has one big ocean with many features.
- The ocean and life in the ocean shape the features of Earth.
- The ocean is a major influence on weather and climate.
- The ocean makes Earth habitable.
- The ocean supports a great diversity of life and ecosystems.
- The ocean and humans are inextricably linked.
- The ocean is largely unexplored (NOAA, 2013, p. 5).

However, limited qualitative research has been conducted on the impact of these marine science summer enrichment camps on the ocean literacy of students, particularly in relation to a learner centered teaching approach. Studies about these summer experiences often focus on exploring their impact on science literacy for urban youth and underrepresented minorities (Madden, Bedward, Wiebe, & Benitez-Nelson, 2014; Strand, 2002), but a preliminary review of the literature revealed that only a few researchers (Boyle et al., 2014; Gorospe, Fox, Haverkort-Yeh, Tamaru, & Rivera, 2013; Haley &

Dyhrman, 2009) had investigated the impact of marine science summer enrichment camps on the ocean literacy of middle school students.

This research gap is relevant to the field of science education, particularly in relation to science literacy in general. In a study about science camps in Europe and their impact on scientific literacy, Lindner and Kubat (2014) found that nontraditional methods of engaging students in science learning, such as summer enrichment experiences, are often more effective than traditional methods. In a study about building scientific literacy through summer science camps, Foster and Shiel-Rolle (2011) found that the Young Bahamian Marine Scientists (YBMS) program demonstrated modest increases in science literacy skills in pre and posttest assessments. In a similar study, Hymer (2005) investigated a science summer camp in Texas designed to strengthen the science literacy skills of primary grade students and found increased awareness and success in science literacy skills in students across the district. In an examination of the effects of outdoor science lessons for elementary school students on preservice teachers' self-efficacy, Carrier (2009) found that increased student enthusiasm for science and improved mastery of science skills delivered a positive experience for preservice teachers, particularly in reenforcing best instructional practices for outdoor lessons. In a Turkish study about teaching the nature of science in nature, Leblebicioğlu, Metin, Yardımcı, and Berkyürek (2011) found that students in Grades 6-8 improved in overall science literacy skills as a result of participation in a 10 day science camp. Thus, these studies support the relevance of this research gap because understanding the effectiveness of alternative science education programs, such as summer enrichment experiences in marine science, may encourage educators to develop and expand these types of nontraditional programs to improve science literacy for K-12 students, particularly in relation to a learner centered teaching approach.

Purpose of the Study

The purpose of this qualitative study, as reflected in the central research question, was to describe the impact of a marine science summer enrichment camp on the ocean literacy skills of middle school students who participated in the 2016 camp. In order to answer this central research question, related research questions were designed to align with multiple data sources, including (a) interviews with teachers, students, and parents associated with this camp; (b) reflective journals maintained by these participants; and (c) related camp documents. The first three related research questions were designed to describe the perceptions of teachers, students, and parents about the impact of this camp on the ocean literacy of participating middle school students. In relation to the conceptual framework for this study, the fourth and fifth related research questions were designed to describe teacher and student reflections about a learner centered teaching approach used at this camp to develop students' ocean literacy skills. The sixth related research question was designed with the intention of describing how camp documents and archival records reflected a learner centered teaching approach to improving the ocean literacy skills of middle school students.

Research Questions

The central and related research questions for this study were based on a review of the literature and the conceptual framework.

Central Research Question

How does a marine science summer enrichment camp impact the ocean literacy skills of students in Grades 6-8?

Related Research Questions

- What do teachers believe about the impact of this camp on the ocean literacy skills of middle school students?

- What do parents believe about the impact of this camp on the ocean literacy skills of their children?

- What do students believe about the impact of this camp on their ocean literacy skills?

- What reflections do teachers have about a learner centered teaching approach used at this camp?

- What reflections do students have about a learner centered teaching approach used at this camp?

- What do documents and archival records related to this camp reveal about a learner centered teaching approach to improving students' ocean literacy skills?

Conceptual Framework

The conceptual framework for this study was based on Weimer's (2013) research on learner centered teaching. Weimer contended that learner centered teaching involves five key changes to instructional practice. These changes involve (a) the role of the teacher, (b) the balance of power in the classroom between teachers and students, (c) the function of content, (d) the responsibility for learning, and (e) the purpose and processes of evaluation (pp.10-11). The goal of the instructional strategies that teachers used to develop ocean literacy is intended to help individuals make responsible decisions regarding the ocean and its resources. Weimar's research on learner centered teaching supports the need to implement instructional practices in science that result in conscientious and positive social change in relation to the policies and management of ocean resources. These five key changes to instructional practice in relation to the principles of ocean literacy are discussed in more detail in Chapter 2.

Nature of the Study

This study used a qualitative approach. The qualitative research design was a single case study that examined a contemporary phenomenon (Creswell, 2013; Yin, 2014). The case or unit of analysis was a marine science summer enrichment camp located in the southeastern region of the United States that was conducted in 2016. Teachers who were invited to participate in this study included those teachers who provided instruction to middle school students in Grades 6-8 who attended this camp in 2016, including one certified K-12 science teacher, one marine science graduate with a master's degree in marine science, and one undergraduate college intern majoring in marine science. Also, students in Grades 6-8 who attended this camp in 2016 and their parents were invited to participate in this study. A total of ten participants were selected to participate in this study. Data was collected from multiple sources, including post camp interviews, reflective journals maintained by teachers and students, and camp documents and archival records. Analysis of interview data included line-by-line coding that Charmaz (2006) recommended for qualitative research, and a content analysis was used for the documents and archival records (Gall, Gall, & Borg, 2007). Categories were constructed for all data sources, using the constant comparative method that Merriam and Tisdell (2015) recommended for qualitative research. Categories across all data sources were examined to find themes and discrepancy data that formed the key findings or results for this study. Results were analyzed in relation to the central and related research questions and were interpreted in relation to the conceptual framework and literature review.

Definitions

Climate change literacy: Climate change literacy is the understanding the effects of climate change on humans and how humans affect climate change (Kelly et al., 2014)

Ecoliteracy: Ecoliteracy is the understanding that nature is a systemic system with interconnecting and complex parts and that an individual's interactions have the ability to affect the network of complex parts, thereby affecting the whole system (Ramos & Ramos, 2011)

Informal science education: Informal science education includes science content and process skill education that occurs outside the traditional K-12 classroom such as summer camps, environmental outreach programs, and outside of school programs (Avraamidou, 2014)

Marine science: Marine science is the general sciences used to explore and understand marine ecology, which includes physical, chemical and biological components of the ecosystem. (Talley, Goodwin, Ruzic, & Fisler, 2011)

Ocean literacy: Ocean literacy is the understanding the ocean's influence on humans and the influence of humans on the ocean (NOAA, 2013)

Science literacy: Science literacy is the understanding of science content and process skills, including the ability to identify scientific issues, engage in conversation regarding the validity of scientific conclusions, and to be scientifically and technologically informed (Hine & Medvecky, 2015).

Assumptions

This study was based on several assumptions. The first assumption was that participants would respond openly and honestly to the interview questions. This assumption was important because their responses impacted the credibility of the findings. The second assumption was that the documents and archival records were accurate. This assumption was important because the accuracy of these documents and archival records supported the credibility of other data sources. The third assumption was that the marine science summer enrichment camp curriculum followed the NOAA ocean literacy principles. This assumption was important because curriculum alignment may impact the findings of the study.

Scope and Delimitations

A case study is a bounded study (Yin, 2014). Therefore, the scope of this study was the 2016 marine science summer enrichment camp, which was located in the southeastern region of the United States and was supported by a southeastern university. This camp offered a marine science summer experience for students over a 4-week period.

The participants, the time frame, and the researcher also delimit or narrow this study (Yin, 2014). The participants in this study included four middle school students in Grades 6-8 who attended the camp from June 6 to July 1, 2016, three camp teachers who provided instruction to middle school students, and three parents of participating students. Concerning the time frame, I collected data during a limited time period from March to April 2017. I was also a single researcher with limited time and resources to conduct this study.

Limitations

The limitations of a study are related to the design of the study. The first limitation of this design was related to the number of cases. This study was a single case study and Yin (2014) noted that both literal and theoretical replications are limited for single case studies. The single case study is limited in literal replication because it cannot be compared to another study with potentially similar findings. Theoretical replication is also limited because a single case study cannot be compared to a case with potentially contrasting findings (Yin, 2014). This limitation could mean that results might be difficult to replicate through other studies.

The second limitation was related to the small sample size (Merriam & Tisdell, 2015). The sample size of three teachers, three parents, and four students may have limited the findings of this study. Four student participants and three parent participants may not reflect the beliefs of the typical marine science summer camp participant or the typical parent. Three camp teachers may also not represent the beliefs of all teachers who provide instruction at marine science summer camps for middle school students. However, this limitation was addressed by collecting data from multiple sources. Documents were collected in relation to the camp curriculum and related content standards, instructional guidelines, and recommended assessments. Archrival records such as the original grant proposal were examined regarding curriculum implementation and assessment goals. These multiple data sources provided a rich description of the case.

The third limitation was related to the data collection process. Only one initial interview was conducted for each participant. Participants were also asked to review the tentative findings of this study for their credibility. Richer findings might have resulted if additional interviews were conducted for each participant. However, individuals may also have been unwilling to participate in multiple interviews, limiting the data for analysis. This limitation was addressed by using the strategy of member checks to solicit feedback from participants as well as collecting data from multiple sources.

Significance

This study will make an original contribution to research in the field of science education because an examination of the literature indicated that little is understood about the impact of a marine science summer enrichment camp on the ocean literacy of students who participate in such an experience (Lindner & Kubat, 2014). Science literacy camps, such as this marine science summer enrichment camp, tap into high interest areas of science with the intention of motivating students to consider careers in science (Bischoff, Castendyk, Gallagher, Schaumloffel, & Labroo, 2008; Foster & Shiel-Rolle, 2011) The research also suggests that nontraditional methods of engaging students in science education demonstrate increased science literacy (Culen & Mony, 2003; Lindner & Kubat, 2014).

This study may also support professional practice in science education because research provides foundational support for experiential models related to science instruction and assessment. In a study about the affective and behavioral components of an environmental literacy training program for preservice teachers in Malaysia, Ismail, Suandi, Muda, Rashid, and Yusof (2011) found instructors who were trained during summer camp programs were more likely to bring similar experiences to the traditional classroom setting. In similar research, Nelson (2010) evaluated teacher perceptions of the efficacy of Project Wild lessons in the classroom and found that 69% of participants were more likely to incorporate activities like Project Wild into their classroom instruction, based on their experiences in the summer camp program. In a study of 33 teachers involved in environmental education camp programs, Schusler and Krasny (2010) also found that teachers incorporated instructional strategies from the camp program into their classroom instruction. The use of experiential models in science instruction and assessment are effective in the development of professional practice according to these studies.

The potential findings of this study may also lead to positive social change due to an improvement in science literacy for students who participate in summer science enrichment experiences. Instead of being passively affected by changing technologies and climates, these summer camp students may be able to influence these changes as they become contributing members of their communities. Students who are scientifically literate demonstrate stewardship of local communities by developing solutions to issues grounded in science, ecology, and technology, which benefits society (Capra, 2007; Roberts, 2007).

Summary

Chapter 1 was an introduction to this study. This chapter included an introduction to the study, background information, an explanation of the problem, and a description of the purpose of this qualitative study, which was reflected in the central research question, was to explore the impact of a 2016 marine science summer enrichment camp on the ocean literacy skills of middle school students in Grades 6-8. In relation to the methodology, this study was a single case study that included multiple data sources, such as interviews with camp teachers, students, and parents; reflective journals that teachers and students maintained; and documents and archival records specific to this marine science summer enrichment camp. Weimer's (2015) learner centered teaching model provided the conceptual framework for this study. In relation to significance, this study will contribute to the field of science education by providing insight into the impact of a marine science summer enrichment camp on students' science and ocean literacy skills and on using a learner centered teaching approach to improve these skills for middle school students. A nontraditional approach to science education that involves a learner centered teaching approach, such as a summer enrichment camp that emphasizes ocean literacy as the backdrop, has the potential to engage students in science learning and to increase their science literacy (Culen & Mony, 2003; Lindner & Kubat, 2014). This study has the potential to contribute to positive social change because students who improve their science literacy may help society to develop policies minimizing the environmental impact of humans on the earth and to design solutions to resolve current scientific problems.

Chapter 2 includes the literature review. It also includes a description of the literature search and a more detailed description of the conceptual framework as it applies to this study. Additionally, an extensive literature review has been conducted to identify themes relevant to this study. The conclusion includes a discussion of these themes and the gaps in knowledge that emerged from a review of the literature.

Chapter 2: Literature Review

K-12 students have demonstrated a decline in science literacy from 2001 to 2011 (National Research Council (U.S.), 2012). However, STEM careers and research about climate change, science literacy, and ocean literacy continue to expand. Ocean literacy, which includes understanding the ocean and the impact of humans on the ocean, is particularly important because the ocean provides cultural, economic, and ecological benefits to humans (Carneval et al., 2011). However, limited research has been conducted about ocean literacy and learner centered teaching as mediums to improve science literacy for students. Therefore, the purpose of this study was to describe the impact of a 2016 marine science summer enrichment camp on the ocean literacy skills of middle school students who participated in this camp.

A review of the research literature indicates that this problem is relevant. In earlier research related to ocean literacy, Fortner and Teates (1980) examined student experiences related to marine knowledge and attitudes and found that students who live near a coastline demonstrate more ocean literacy knowledge than students who do not live near a coastline. In other earlier research, Fortner and Mayer (1983) investigated knowledge and attitudes about the oceans and Great Lakes of Grade 5 and 9 students in Ohio and found that preassessment is essential to identifying gaps in knowledge regarding ocean science. In a brief history of the ocean literacy campaign, Schoedinger, Tran, and Whitley (2010) found that the current ocean literacy definition emerged as a result of a need to define ocean literacy. Schoedinger, Cava, and Jewell (2006) examined ocean literacy principles in science education and found that these principles were broadly defined to enable teachers to integrate them into the curriculum easily. The identification of ocean literacy gaps and development of the ocean literacy standards is based on these early studies.

Concerning science summer camps, several studies are particularly significant. Garst and Ozier (2015) explored the use of summer camps as instructional and recreational mediums and found that students experience educational gains when they participate in summer camps. Riedinger (2015) explored identity development of young people who participated in an informal science summer camp and found that this science summer camp helped students to develop self-identity as scientists. Lambert (2006) explored the integration of science literacy into a high school marine science course and found that this integrated course was aligned with the national science education standards. These studies establish science summer camps as an appropriate medium to enhance science literacy in students.

Concerning science education at the middle school level, Rutherford and Ahlgren (1991) examined Project 2061, which was a long-term initiative of the American Association for the Advancement of Science to improve K-12 science education, and recommended that inquiry-based instructional practices be emphasized to increase science literacy at the middle school level. Hart (2010) explored environmental education as an integral part of science education through a meta-analysis of environmental education research and found that the inclusion of environmental education topics, such as ocean science, in science courses may provide the means for social change. Stevenson, Peterson, et al. (2014) explored the role of life experiences in building environmental knowledge and behavior among middle school students from North Carolina and found that their support for the environment was influenced by available resources to teach environmental topics such as ocean science. Based on these studies, science summer camps provide the resources and environment to integrate hands on science instruction as recommended by Project 2061.

This chapter includes a review of the literature. In this chapter, the literature search is described as well as the conceptual framework and how it is articulated in current research. The literature review is presented in three sections. The first section includes early and current research related to definitions of ocean literacy. Teacher preparation in ocean sciences is also discussed in relation to definitions of ocean literacy. The second section includes research related to middle school science curriculum, instruction, and assessment trends. The third section includes current research about curriculum, instruction and assessment trends in relation to science summer camps. This chapter concludes with a discussion of themes and gaps that emerged from this review.

Literature Search Strategy

The search strategies that I used in this review included an extensive keyword search as well as database alerts for current research. The databases that I used in the literature review to find peer-reviewed journal articles published within the last 5 years included ERIC, ProQuest, Science Direct, and Environment Complete. I also used online book databases, the e-library, and EBSCO e-books to find books related to the conceptual framework and science content. In addition, I used Google Scholar to broaden the literature search for both peer-reviewed articles and books related to ocean literacy. I also used the *cited by* feature in Google Scholar to find current, peer-reviewed articles that included cited articles from previous years. In addition, I created a variety of alerts in Google Scholar related to the conceptual framework and ocean literacy content to highlight current literature related to the dissertation topic. These databases were searched using the following key words: *climate change education, climate change literacy, inquiry-based, inquiry-based learning, learner centered teaching, marine science, middle school science assessment, middle school science curriculum, middle school science instruction, ocean, ocean camp, ocean literacy, ocean geosciences, ocean sciences, outdoor science education, place-based learning, teaching middle school science, teaching climate change, teaching ocean literacy, science camp, science education, science literacy, student-centered learning,* and *summer camp.*

This literature search was often challenging in relation to the research topic. The keyword search incorporated specific terms based on the ocean literacy framework to find supporting literature in current research. Research in ocean literacy tends to be topic specific, including such topics as climate change and ocean acidification or general topics such as science literacy and ocean science as content for instruction. Identifying this aspect of the research enabled me to expand the key word search to find relevant peer-reviewed articles.

Conceptual Framework

Weimer (2013) described a model for learner centered teaching that fosters an inquiry-based learning environment. This model is divided into five components related to key changes in instructional practice: (a) role of the teacher, (b) balance of power, (c) function of content, (d) responsibility for learning, and (e) purpose and processes of evaluation. Weimer contended that this learner centered teaching model also supports an inquiry-based learning environment that facilitates problem solving, cooperative learning, and research skills. Weimer's learner centered teaching model was used in this study as the conceptual lens to analyze the curricular, instructional, and assessment practices that teachers and students used at the 2016 marine science summer enrichment camp.

Role of the Teacher

In a discussion of the role of the teacher in instructional practice, Weimer (2013) asked three questions. The first question is "What needs to change?" (Weimer, 2013, p. 59). Weimer contended that students are not actively engaged in their learning; the teacher needs to allow students to experience both failure and mastery to learn content. For example, teachers could provide student examples as well as instructor examples in their instruction to demonstrate student understanding of concepts. In this way, the teacher is a guide and a resource rather than a dispenser of knowledge.

The second question that Weimer (2013) asked is "What hasn't changed?" (p. 64). To answer this question, Weimer cited a survey that Walczyk and Ramsey (2003) conducted of mathematics and science faculty from four higher education institutions.

Walczyk and Ramsey found that learning-centered instruction was infrequent and that teacher-centered instruction was the preferred method for classes without a research component. Weimer anecdotally noted that instructors are often more active in learning than students. In addition, Weimer cited a study that Kardash and Wallace (2001) conducted about perceptions of students in undergraduate science classes and noted that they found that teacher-centered instruction as lectures was the most common form of teacher-centered instruction.

The third question that Weimer (2013) asked is “Why hasn’t teaching become more learner centered?” (p. 68). Weimer noted that faculty members often prefer teacher-centered roles because facilitative roles are not as glamorous as the traditional lecture role. Weimer also noted that faculty often believe that they are “just not ready” to assume a facilitative role (p. 71).

In relation to the role of the teacher, Weimer (2013) described facilitative teaching in relation to seven principles that guide its implementation. The first principle is that “teachers let students do more learning tasks,” such as organizing content, problem solving, and summarizing (Weimer, 2013, p. 72). The second principle is that “teachers do less telling so that students can do more discovering” (Weimer, 2013, p. 74). According to the third principle, Weimer noted that “teachers do instructional design work more carefully” (p. 76). This design work includes four characteristics. The first characteristic is to engage students in their learning. The second characteristic is to set objectives that provide “authentic and legitimate work of the discipline” (Weimer, 2013,

p. 76). The third characteristic is that lessons should move students from their current level of understanding to the next (Weimer, 2013). The fourth characteristic of careful instructional design is that experience builds both knowledge of the content and the skills that need to be learned (Weimer, 2013). According to the fourth principle of facilitative teaching, Weimer noted that "faculty more explicitly model how experts learn" (p. 79). The fifth principle, Weimer contended, was that "faculty encourage students to learn from and with each other" through group work (p. 81). The sixth principle of facilitative teaching, according to Weimer, was that "faculty and students work to create climates for learning by fostering responsibility in learning (p. 83). Weimer's final principle was that "faculty use evaluation to promote learning" through follow-up and feedback (p. 83).

Weimer (2013) also discussed intervention issues that often emerge during attempts to teach in more facilitative ways, including when to intervene and how best to intervene. Weimer contended that interventions should happen when students compromise the learning of others, such as taking on too many projects. Weimer concluded interventions should be conducted case by case, which required the instructor to decide if an intervention will help or hinder the student over the long term.

Thus, Weimer defined the role of the teacher as a facilitator rather than a lecturer. In older models of instruction, Weimer noted that the teacher was the main source of information. When the teacher steps into a facilitating role, however, Weimer contended that students are expected to become more aware of their learning. Teachers as facilitators also assist students in building connections between them and the material to be learned.

Balance of Power

In a discussion about the balance of power in the classroom, Weimer (2013) noted that what needs to change but has not is teacher control. Intrinsically, Weimer contended, content and assessment are aspects of classroom learning that teachers need to control. Teachers often determine the value of assessments, assignments, and tests without evaluating the content and skills that students need to learn (Weimer, 2013). The best example is the course syllabus. Weimer contended that teachers do not ask students what they need to learn or give them a choice of what they are to learn. In an effort to motivate students to learn the instructional material, teachers often amend the syllabus to integrate control policies regarding grades, attendance, and behavioral expectations. The result is a decrease in motivation to learn rather than an increase in student performance and learning (Weimer, 2013). These policies to combat less desirable behaviors in the classroom result in what Singham (2007) calls the *syllabus creep*. Faculty members often justify their decisions for increased power by arguing that students are not ready for independent learning environments (Weimer, 2013). Weimer contended that faculty members exert control in their classrooms because it is an inherent part of the classical structure of teaching and learning. The resulting perceptions of both students and faculty are that the power and control for learning lie in the authority a teacher has in the classroom, which results in passive learning by the student and teacher-centered instruction by the faculty.

To change the balance of power between students and teachers, Weimer (2013) noted that power needs to be redistributed to enable learners to become self directed while providing a structure that supports skill development and content acquisition. Shifting the balance completely to the students, Weimer contended, often produces negative learning results. Weimer noted that students in introductory courses are not likely to have the background knowledge regarding the course topic to select a textbook appropriate for the course. Weimer anecdotally described how a fellow faculty member gave students a list from which to select their text for the course. The result was more active student engagement in the use of the text due to the selection process (Weimer, 2013). A learner centered classroom, Weimer noted, should demonstrate the equal distribution of power between faculty and students. For example, teachers could introduce a point system for the course in which students select assignments to obtain a score based on a scale that the instructor designs. The challenge for faculty is to carefully design the structure to facilitate learning, which can be a time consuming task. However, Weimer argued that this structure can lead students from dependent learners to independent learners. Weimer believed that “power sharing creates a more positive and constructive classroom environment” (p. 97). Thus, Weimer recommends developing shared power in the classroom to promote self directed learning.

Weimer (2013) believed that power redistribution in a learner centered classroom should occur in four areas to be effective. The first area is in relation to assignments and activities. By allowing students structured autonomy for assignments, Weimer argued that they learn to become self-directed and self-regulating in their learning. The second area of power redistribution is in relation to course policies. By allowing students to develop course policies, they become invested in the follow-through on policies (Weimer, 2013). Weimer noted that students in her classes preferred that only student volunteers answer questions asked of the class rather than being called on by the instructor. Students regulate policy through peer intervention and verbal reminders of policy. The third area of power redistribution is in relation to course content. Allowing student's choice in the topics for projects, Weimer contended, is a strategy for distributing power naturally. Allowing choice among reading selections for a class discussion, for example, is away to redistribute teacher power over content. The fourth area where power can be redistributed is in relation to evaluations. Weimer described a syllabus activity of a fellow faculty member who encouraged students to make suggestions regarding assignments, quizzes, and other course evaluation measures.

Weimer (2013) also noted that a number of implementation questions arise when teachers redistribute power in their classrooms. The first question teachers should ask, Weimer believed, is "How much power is enough to motivate students?" (p. 109). Weimer cited several studies that report better grades and more positive attitudes toward learning as a result of "very modest decision-making discretion" (Weimer, 2013, p. 190).

The desired results should be increased motivation and measurably increased performance on assessments. The amount of power that students are given in the classroom, Weimer contended, should not become detrimental to their learning or inhibit their learning. Too much power can be as disastrous as too little power. Weimer noted that a student failed a course by utilizing a student-designed point system that gave the student too much power over the grade. The student was unable to identify the needed requirements to obtain a passing grade and needed guidance from faculty to build skills. Thus power redistribution should provide clear structure and guidance toward success.

The second question that Weimer (2013) asked in relation to redistributing power in the classroom was “How much decision making are students ready to handle?” (p. 110). The answer to this question, Weimer contended, depends on how students and faculty are involved in making decisions. The amount of control students should have in their learning, Weimer noted, will depend on their “intellectual maturity and ability to operate in conditions where they have more freedom but also more responsibility” (p. 110). Teachers should scaffold instruction to help students learn how to make decisions about their learning. Weimer noted that students often self-report that they do not have effective study skills because they may not have been taught them.

The third implementation question that Weimer (2013) asked was “How do teachers know when they have abrogated legitimate instructional responsibility?” (p. 111). Weimer contended that the amount of control given to students in relation to their learning needs to be appropriate. For example, allowing students to evaluate peers without feedback from the instructor not only misappropriates power but also does not support student learning. In one example that Weimer shared, students had earned A's and B's, but they had not mastered the content in a meaningful way. As long as grading is utilized to navigate educational systems, Weimer contended, teachers need to maintain control of key concepts and related assessments.

In summary, Weimer (2013) concluded that the key is not to relinquish too much power for either students or faculty. Both groups must have appropriate control within the learning environment. Moving instruction to a learner centered approach reconnects the learner with the material. Active student engagement in the learning process provides students with motivation to progress as well as facilitates the creation of a positive learning environment for teachers and students.

Function of Content

In the discussion regarding the function of content, Weimer (2013) again begins with the question: "What has to change?" (p. 115). Weimer contended that a change in thinking is needed regarding "covering" the content (p. 115). To make this change is to recognize that covering the content does not indicate learning is occurring. Rather, it is a recognition that students race to the end of a course, only to not recall the information in subsequent courses or experiences.

Weimer (2013) also discussed why the function of content "needs to change and why it is not changing" (p.119). In their book about instructional design, Wiggins and McTighe (2005) contended that deep learning does not occur by covering the content.

Students tend to learn the information long enough to pass the test or course, and they forget the material later. According to a study that Bacon and Stewart (as cited by Weimer, 2013) conducted regarding information retention by marketing majors, students lost marketing information after only 2 years. Weimer contended that the function of content does not change because teachers experience pressure to be sure students are ready for the next school year, the next course, and the next lesson.

Weimer (2013) also asked the question: “How does content function in a learner centered course?” (p.123). Weimer noted that teachers want students to understand and master content, so it is more likely to be retained for future use. However, Weimer cautioned that teachers not only need to consciously consider the amount of work a student can do during a course but the relevance of the content to the discipline of study. Students often need help studying for a test in addition to learning content. Gardner (as cited by Weimer, 2013) found only 14% of undergraduates who participated in a research study that examined study skills had ever been taught how to study. Weimer recommended using content to facilitate skill remediation and to develop a knowledge base for learning more sophisticated skills. Only then, Weimer contended, will students engage in the content and the learning will become purposeful.

Developing the skills to learn makes the content accessible to learners. To help students develop learning skills, Weimer (2013) recommended that teachers adhere to the following six guidelines:

- Think developmentally by developing a clear understanding of the skills students may or may not have.
- Target skill development by identifying the skills students need to develop.
- Routinely engage students in skill development activities through short, regular activities that build toward student mastery.
- Take advantage of those ready-to-learn moments by identifying when students are most engaged in learning, such as before or after exams.
- Partner positively with learning center professionals by utilizing the resources and professionals available to improve student skills.
- Use supplementary material to support learning skill development in order to enable students to continue skill development outside of the classroom.

These guidelines, Weimer (2013) noted, should be supplemented by strategies that students can use to develop learning skills. These strategies include (a) developing reading skills, (b) partnering with the learning center, (c) learning about learning from each other, (d) using learning questions, (e) learning from exam results, and (f) writing to learn and learning to write. To be effective, Weimer contended that these strategies require both the teacher and learner to be reflective. When learning about how others learn, teachers and students need to reflect on their own learning to further discussion. Therefore, learning activities can take many forms, ranging from learning logs to exit slips summarizing content presented for the day’s lessons.

Weimer (2013) also discussed implementation issues in relation to the function of the content. The fundamental question concerns the amount of content that should be included in a course or lesson. While content can often be used differently to be more effective, Weimer noted faculty had continued concerns about what is not taught. By not teaching content, Weimer noted a perceived possibility that students are not getting everything they need to be successful in the course or in future courses. Therefore, Weimer asked the question: “How do we change attitudes about the function of content?” (p. 138). Weimer believed that a shift in the culture in relation to content needs to occur. Teachers need to decide what learning skills have enough value in order to teach less content. In order to make these strategies work, Weimer concluded that “implementation will have to be systematic, thoughtful and planned” (p. 140). By implementing a strategy to teach less content directly, faculty may find they are teaching more skills, and students will discover more content through those skills.

Responsibility for Learning

In a discussion regarding the responsibility for learning, Weimer (2013) again asked the question: “What needs to change and still hasn’t?” (p. 143). When students are not engaging in learning, Weimer noted that teachers often react by providing more structure. However, Weimer also noted that providing more structure often has the opposite effect by fostering passive learning in students. When an increase in punitive policies does not result in the desired effect, Weimer observed that teachers often employ extrinsic motivators with little long-term success for the learner. In related research Pike

(2011) found that the use of a point system can result in students worrying about how many points they have rather than what content they are learning. Instead, Weimer contended that teachers need to develop strategies to support learners in focusing on their role in learning.

Weimer (2013) also discussed the classroom climate that teachers create to promote student responsibility for learning. In a significant study that Weimer cited about classroom climate, Fraser, Treagust, and Dennis (1986) defined classroom climate as the relationships between students and other students and the teacher. Fraser et al. developed an instrument for assessing the psychosocial classroom environment in universities and colleges. This 49 item instrument included the following seven subscales that teachers can use to assess their classroom environment:

1. Personalization, which is defined as opportunities for interaction between professor and students and the amount of instructor concern for students;
2. Involvement, which is defined as the extent to which students actively participate in all classroom activities;
3. Student cohesiveness, which is defined as how well students know and are friendly with each other;
4. Satisfaction, which is defined as how much students enjoy the class;
5. Task orientation, which is defined as how clear and well-organized activities are;

6. Innovation, which is defined as the extent to which the instructor plans new and unusual class activities and uses new teaching techniques and assignments;
7. Individualization, which is defined as the degree to which students are allowed to make decisions and are treated differentially according to their individual learning needs (Weimer, 2013, p. 147).

These characteristics of the classroom environment, coupled with student perceptions, define the ideal classroom environment as one containing some student autonomy with frequent instructor feedback.

In addition to defining classroom climate, Weimer (2013) also discussed how classroom climate motivates students to accept their responsibility for learning. If students are to accept responsibility for their learning, Weimer suggested that teachers consider the following five features of relationships that promote the development of responsible learners and create positive learning environments: (a) logical consequences, (b) consistency, (c) high standards, (d) caring, and (e) commitment to learning. Weimer also cited a study that Macaskill and Taylor (2010) conducted about learner autonomy in relation to university students. Macaskill and Taylor found that autonomous learners are persistent when encountering learning barriers whereas learners who are not autonomous were more likely to give up. The results indicate that instruction related to content should provide depth rather than surface learning for autonomous learners. Weimer also noted that the danger in current learning environments is the memorization or regurgitation problem. Students learn the material long enough to pass the test and make no effort to retain the information for long term use.

Weimer (2013) also discussed how to involve students in creating, maintaining, and enhancing the classroom climate in order to ensure that the responsibility for learning falls on the learner. Weimer believed that the curriculum is often structured in a way that student accountability is diminished. Students have learned to wait for teachers and faculty to fill in gaps and to take a less than active role in their learning. Weimer contended that this strategy feeds the power imbalance without fostering student self-accountability.

Purpose and Processes of Evaluation

In a discussion about the purpose and processes of evaluation, Weimer (2013) again asked the question: “What needs to change and hasn’t? (p. 168)” Weimer described two problems with current evaluation methods that teachers use in the classroom. The first method is an overdependence on grades. Students and teachers are often more concerned with grades than the material that is learned according to research that Pollio and Humphreys (1988) conducted about student and teacher communication of student performance. The second method is the noninvolvement of students in the evaluation process. According to Weimer, little research has been done to evaluate the effects of student self-assessment. This lack of research may be due in part to similar issues that Weimer discussed in relation to the function of content. Weimer contended that students might need to be taught the skills to utilize assessments and evaluations as learning tools.

Weimer (2013) also asked the question: “How do the purpose and process of evaluation change?” (P. 175). Weimer wanted to know how the purpose and process changes in a way that benefits students and delivers what teachers need to inform content and instruction. In a discussion of finding a better balance between grades and learning, Weimer suggested that teachers need to use grades to reinforce long-term learning by teaching how content could be applied in other situations beyond the course. In similar research, Pollio and Beck (2000) found that faculty and student desire more emphasis on learning rather than grades, which supports Weimer’s assertion. Second, Weimer suggested that teachers should be encouraged to make evaluation experiences less stressful. Student success, according to Weimer, is inhibited by stress during evaluations. Third, Weimer suggested that teachers should use evaluation to assess learning, rather than to demonstrate the rigor of the content or to introduce new material. Weimer also suggested that feedback should be formative so students can learn from it. In similar research, D. R. Sadler (2010) found that faculty spends more time on the composition of feedback rather than helping students understand feedback. Weimer recommended separating feedback from evaluations or grades by delivering feedback before giving grades. This change would demonstrate to students that feedback from instructors has value beyond grades.

Weimer (2013) also discussed how teachers and students could use exams, assignments, and activities to promote learning. Weimer cited a study that Nicol and Macfarlane-Dick (2006) conducted in which they found a slow shift has occurred from summative assessments to formative assessments. In terms of maximizing the learning potential of examinations, Weimer suggested that teachers can use review sessions to facilitate study skills by presenting examples and recommendations for content organization. Examinations should also be structured to promote deeper thinking. Weimer contended that most examinations do not employ higher level thinking questions that reflect Bloom's taxonomy. Weimer also noted that teachers should employ debriefing sessions to help students learn content that they missed or misunderstood prior to their evaluations. Weimer believed that the time right after examinations is when students are at ready to learn and are more willing to engage in the evaluation process.

Weimer (2013) also discussed the development of self assessment and peer assessments skills in order to facilitate student responsibility for learning. Students should not only be encouraged to discover what they do well through self assessment, Weimer contended, but they should also be encouraged to address their weaknesses when learning. When conducting peer assessments, Weimer noted, students should be taught that critical feedback does not equal negative feedback. Weimer believed that assessing another student's work improves the assessor's work and also provides a lens for students to reevaluate their own work.

Weimer (2013) noted that several implementation issues arise when adjusting the purpose and processes of evaluations. The first implementation issue is related to course grades and the tendency of students to worry about the grade rather than the content that they need to learn to obtain the grade. To change this perception, Weimer believed that teachers need to engage in a slow, lengthy process transitioning to the value of learning over obtaining a grade. The second implementation issue is related to structuring self assessment and peer assessment to be effective in promoting learning. These assessments, Weimer believed, should count in the evaluation process so that students might understand the value of self assessments and peer assessments and to "take them more seriously" (p. 194). These implementation issues once addressed change the purpose and process of evaluation.

Thus, in rethinking the purpose and processes of evaluation, Weimer (2013) believed that teachers and learners need to move to a deeper understanding of how evaluation informs learning. Grades are a medium to measure mastery, Weimer maintained, but they can cause students and teachers to lose focus by becoming the pinnacle of learning. By equalizing the value of grades and evaluations against the content, Weimer contended, learning becomes the major focus for students.

Articulation in Current Research

Weimer's (2013) learner centered teaching model has been articulated in previous research. Avard (2009) explored student centered learning in an earth science, preservice teacher education course and found that students in learner centered teaching environments, which included hands on activities, group discussions, and assessments, made significant gains toward developing a positive attitude in learning new science material. In a study examining how environmental educators work with urban schools to teach about soil ecology, Johnson and Catley (2009) found learner centered instruction, such as asking students to conduct soil explorations with soil ecologists as guides, aides environmental educators in becoming better resources and becoming more accessible to local teachers and students. Clark and Button (2011) examined the interface of arts, science, and community in their study of university students' understanding of sustainability and found that when given authentic and appropriate tasks, students learn from each other and from their teachers and the teacher learns from the students. In the examination of multiple-choice tests as a barrier to higher level thinking skills in an introductory science class, Stanger-Hall (2012) found constructed responses were more effective than multiple choice test items in encouraging students to think more critically about content. In related research, Erinosho (2015) examined the impact of a science education program for junior high girls in Nigeria and found that participants developed a better understanding of science content and a more positive attitude toward science content after exposure to learner centered instruction methods to teach science-based content. These methods included discussion, problem solving, role playing, and peer-teaching.

Thus, current research indicates that a learner centered approach to instruction builds stronger student engagement in the content while increasing their understanding of core concepts in science education. Research also indicates that evaluations that include peer-assessments and self-assessments are valuable components of learner centered instruction. In addition, research indicates that efficacy in problem solving and critical thinking skills results when experts are used to guiding both teachers and students in their learning. Student achievement improves when students are engaged in their learning and when they are given opportunities to critically assess their learning, as predicted in Weimer's (2013) learner centered teaching framework.

Relevance to Study

Weimer's (2013) five key changes to practice in relation to learner centered teaching are relevant to this proposed study about the impact of a marine science summer enrichment camp on the ocean literacy of middle school students. Each of these five key changes to practice was examined at the study site through the interview and journal responses of camp teachers, students, and parents and in relation to camp documents. These five key changes to instructional practices also formed the theoretical propositions or hypotheses for this study, as Yin (2014) suggested. Understanding the related theory informs the field work in case studies. Weimer's learner centered theory provided the theoretical blueprint for this study. One proposition is that camp teachers would utilize an instructional pedagogy that engages participating students in learning marine science content rather than in obtaining a grade. A second proposition was that camp teachers would be facilitators in the learning process rather than dispensers of knowledge. The third proposition was that that power would be distributed equally to teachers and students in the camp classrooms. The fourth proposition was that students would be given opportunities to demonstrate responsibility for their learning at the study site. The fifth proposition was that evaluation would include the use of summative and formative assessments to foster a positive learning environment. Thus, Weimer's five key changes to instructional practice in relation to the learner centered teaching at the study site were the conceptual lens through which the findings of this study were interpreted.

Literature Review

This literature review was organized in relation to the following topics: (a) ocean literacy, (b) middle school science education, and (c) science summer camps. These topics were selected because they are critical to understanding the impact of a marine science summer enrichment camp on the ocean literacy of middle school students who participated in this camp. Therefore, in this review, current research was analyzed about the definition of ocean literacy, the history of ocean literacy, and best practices in professional development related to marine science education. In addition, middle school science education was included as a topic in order to examine current research on curriculum, instruction, and assessment trends in science education at the middle school level. The topic of science summer camps was also included in order to examine current research on curriculum, instruction, and assessment trends related to these camps.

Ocean Literacy

In this first section of the literature review, I analyzed research about how ocean literacy is defined. In addition, I discussed early and current research in marine science education, with an emphasis on several meta-analyses of the literature which are particularly significant. I also analyzed research related to best practices in professional development for marine science education.

Definition. The National Oceanic and Atmospheric Administration (NOAA) has defined ocean literacy as an understanding of the ocean's influence on humans and the influence of humans on the ocean (NOAA, 2013). The NOAA supports this definition according to the following seven principles:

- The Earth has one big ocean with many features.
- The ocean and life in the ocean shape the features of Earth.
- The ocean is a major influence on weather and climate.
- The ocean made the Earth habitable.
- The ocean supports a great diversity of life and ecosystems.
- The ocean and humans are inextricably interconnected.
- The ocean is largely unexplored (NOAA, 2013, p. 5)

These seven principles provide a more specific definition of marine science education by narrowing the topics that science teachers need to consider in conjunction with the science education standards. Although the ocean literacy principles were created before the NGSS, these seven principles can be aligned to current science education standards even in states where the NGSS have not been adopted. Mastery of these ocean literacy principles, according to NOAA, gives students a basic understanding of the ocean sciences, which includes physical, life, chemical, and earth sciences and their cultural connections to the ocean. A community of marine scientists and educators developed these definitions and principles as well as the *Ocean Literacy Scope and Sequences for Grades K-12* for students in Grades K-12 in order to guide educators in developing lessons and materials related to the ocean sciences. Marine science educators also developed these curricular products to increase public knowledge of ocean science and to address the lack of ocean sciences principles in the NGSS with the intention of increasing student understanding of the impact that oceans have on humans and the impact that humans have on oceans.

History. In related research about the history of ocean literacy, Schoedinger et al. (2010) noted that the ocean literacy definition and principles that NOAA developed are recognized as the conceptual framework for ocean literacy programs in the United States and in other countries around the world. In 2002, researchers, educators, and government agencies came together to define ocean literacy and to develop a framework for educators. The campaign began with an online conference that the National Geographic Society sponsored. Several papers were presented on ocean literacy, which resulted in a two-week conference titled Ocean Literacy through Science Standards in 2004. The campaign continued with the development of a scope and sequence for ocean literacy. Schoedinger et al. concluded that the result of this ocean literacy campaign was a flexible framework that encouraged teachers to incorporate the ocean literacy principles and scope and sequence into their science instruction.

In related historical research about the ocean literacy principles that was conducted in Nova Scotia, Canada, Guest, Lotze and Wallace (2015) noted that Canadian educational organizations also recognized the NOAA (2013) ocean literacy principles and their supporting framework as a tool to address gaps in marine science education. Due to the need to increase ocean literacy in its citizens, the Canadian Network for Ocean Education (CaNOE, 2014) was formed in 2015 with these principles as the conceptual framework for their outreach and educational foundation. Guest et al. noted that Nova Scotia also adopted these ocean literacy principles to facilitate ocean literacy and marine science instruction in their school systems. Guest et al. found that when students engaged in activities directly connecting their daily lives to the oceans, they developed a better understanding of the importance of the ocean in their lives. Guest also found that ocean science classes offered to Grade 11 students in Nova Scotia increased their interest in pursuing careers related to human interactions with the ocean. Guest et al. recommended that students be given more opportunities for these interactions, particularly concerning touch tanks to create meaningful experiences that expose students to the diversity of marine life.

Thus, NOAA defined ocean literacy and ocean literacy principles in order to address gaps in knowledge that students demonstrated in marine science education. The NOAA definition for ocean literacy is the result of the collaboration of marine scientists and educators. The Consortium for Ocean Science Exploration and Engagement

(COSSEE) network in the United States, as well as organizations in Canada, support this definition, which is the only consensual definition that currently exists.

Early research. In a study conducted over 40 years ago, Fortner and Teates (1980) administered the *Survey of Oceanic Attitudes and Knowledge* (SOAK) to Grade 10 students in Virginia in order to identify their experiences related to marine science knowledge and attitudes. Fortner and Teates noted that the United States Congress passed the National Environmental Policy Act in 1969 in order to support a holistic view of the environment and the impact of humans on the environment, including new educational policies. These policies included content related to environmental problems such as deforestation, extinction, and the limitations of natural resources. However, despite this focus on environmental education, Fortner and Teates noted that marine science education received little attention until the Sea Grant Improvement Act was passed in 1979. The goal of this act was to increase awareness and understanding of marine ecosystems and their impact on human systems. Fortner and Teates compared the knowledge and attitudes about marine science for students who lived in coastal areas in Virginia to students who did not live near coastal areas in Virginia. Fortner and Teates found that students living near coastal regions were more knowledgeable about marine science and had more positive attitudes about marine ecosystems than students who did not live near coastal regions. They concluded that living near coastal environments had a significant impact on the knowledge and attitudes of these students about marine science. Fortner and Teates recommended that educators provide targeted outreach and develop lessons to build connections to coastal ecosystems that could be integrated into the science curriculum. This study is important because it established a baseline understanding of the knowledge and attitudes toward the ocean students had prior to current programs and interventions.

In another early study, Fortner and Mayer (1983) examined the knowledge and attitudes of 55 Grade 5 students and 80 Grade 9 students in Ohio about the oceans and the Great Lakes and found that these students had little knowledge of marine and aquatic topics. The areas of poorest understanding were in relation to human connections to and dependence on marine ecosystems. Fortner and Mayer recommended that these findings be used to develop curriculum and materials to address these gaps in student understanding about marine science. Fortner and Mayer's study is significant because it was one of the first studies to consider prior knowledge as an evaluative technique for a marine science program.

In another early assessment of knowledge about marine science concepts and natural resource issues for students in Grades 4, 8, and 11in the state of Maine, Brody and Koch (1990) found that students had a poor understanding of ocean science, based on their scores on the *Maine Assessment of Educational Progress in Science* (MAEPS). A particular weakness was their cultural connections to the ocean. Brody and Koch defined these cultural connections as recreational, economic, and environmental influences that the ocean has on human populations. This study is also significant because it established a baseline understanding about how educators in one state examined student knowledge about marine science and related natural resource issues in order to develop curriculum to address these gaps in understanding.

Thus, these early studies are significant because they are foundational to the understanding of marine science education and because they established baseline data about the gaps students demonstrated in knowledge and attitudes related to marine science education. These early studies also presented the first research-based conclusions regarding the lack of understanding of marine ecosystems in K-12 education.

Current research. Marine science education integrates the four main domains of science education: life, earth, physical, and chemical. Current research indicates that the possibilities for integrating marine science education into other science domains are limitless. In a discussion about the promise of an integrated high school science course, Lambert (2006) identified marine science as an area of study that meets the broad requirements for an integrated science course, which could include marine science as a unifying theme. Lambert noted that the curricula for this integrated course would also need to be aligned with the NGSS. Lambert contended that marine science could be used to support an integrated science curriculum because it includes biology, chemistry, physics, meteorology, and geology. Lambert recommended that educators use marine science to address multidisciplinary concerns because teaching certifications are becoming more generalized, rather than specialized, for science teachers. This research is important because Lambert concluded that marine science provides support for integrated science courses at the high school level, which are growing in popularity.

In other research about the potential for curriculum integration, Gold et al. (2015) described how an arctic climate curriculum could be used as a model for bringing authentic scientific data into the science classroom for high school students. Gold et al. found that science teachers used the Arctic ecosystem to improve ocean literacy in classrooms to help students understand how scientists acquire and analyze data. In addition, Gold et al. found that the integration of an arctic climate curriculum into science units improved student understanding of science content. Students also reported a higher interest in careers associated with marine science.

Several meta-analyses of marine science education research also emphasize the potential for integration with other disciplines. In a review of methodologies used in 30 years of marine educational research in North America, Kim (2012) noted that the societal need to include the study of marine science in science education is due in part to reliance on the ocean for food, oxygen, transportation, recreation, and economic values. Kim’s analysis of research articles focused specifically on marine science education studies that used quantitative, qualitative, and mixed methods designs. Kim found that researchers used quantitative approaches to identify evidence of learning and qualitative studies to examine K-12 student experiences, and they employed mixed method approaches to evaluate both learning and experiences. Kim recommended using diverse methodologies to evaluate integrated curriculums such as marine science effectively. This study is significant because marine science education researchers often use a variety of methodologies to evaluate curriculum and instruction for courses related to marine science, which is advantageous because the research questions, related paradigms, and epistemology drive the research design.

In another important meta-analysis, Plankis and Marrero (2010) examined current ocean literacy research in United States public schools in relation to the results and implications of this research. Plankis and Marrero found that structured educational interventions such as technology-based marine science programs increase students' understanding of ocean literacy. They also found that when marine educators relate the ocean to students' everyday lives, students demonstrate a significant change in attitudes and behavior about protecting the oceans. Plankis and Marrero concluded that participation in marine science programs changes the behaviors of students toward the ocean through the use of locally-based problems and technology. They recommended longitudinal explorations of student attitudes and behaviors toward protecting the oceans in order to determine the efficacy of ocean science programs over time. This research is particularly significant because Plankis and Marrero found that technology-based marine science programs with local focus improve student understanding of marine science content.

Marine science education also creates a high level of student engagement with science content in general as well as an improved understanding of specific marine science content (Bischoff et al., 2008; Erdogan, 2011). Therefore, many studies focus on the attitudes, beliefs, and knowledge that students have about marine science. Cummins and Snively (2000) examined the effect of instruction on students' knowledge of marine ecology, attitudes toward the ocean, and their beliefs about marine resource issues. Cummins and Snively conducted a survey of 26 Grade 4 students in Victoria, Canada who had participated in a marine ecology educational program. Cummins and Snively found that students who participated in this program increased their interest in the oceans. Cummins and Snively concluded that hands-on instructional modules using interrelated concepts such as tides and waves facilitate this increase in marine science content understanding. Students also self-reported an increased appreciation and understanding of the impact of humans on the oceans. Cummins and Snively recommended that educators use local marine environments to increase the efficacy of instruction. This study is important because it demonstrates that student engagement in marine science activities produces positive changes in knowledge and attitudes regarding marine science content.

In other related research, Haley and Dyhrman (2009) described the Artistic Oceanographer Program, which was created to help Grade 5 students in Massachusetts develop positive attitudes toward marine science. The program focused on increasing students' understanding of marine science through art and science, and the program goals were also aligned with the grade level content standards in science, particularly in relation to ecology. Haley and Dyhrman found that ocean science content reinforces general science principles and results in high levels of student engagement in science. The art aspects of the program encourage student self-expression and help students connect with a content area they may have struggled with in a traditional science setting.

Haley and Dyhrman concluded that the combined use of art with hands-on science instruction reinforces the positive outcomes they observed in student understanding of ocean science. Haley and Dyhrman recommended that educators continue to use hands-on and art activities to teach students about ocean science because these approaches demonstrated efficacy to increase student understanding of ocean science content.

Marine science research is often conducted in relation to creating future opportunities for improving ocean literacy. Boyle et al. (2014) described the Consortium for Ocean Science Exploration and Engagement (COSEE) inquiry group report in relation to opportunities for creating lifelong ocean science literacy for individuals living in the United States. Boyle et al. noted that ocean literacy is often taught through varied mediums such as classroom activities, aquarium visits, outreach programs, and summer camps. Boyle et al. also found a continued decrease in understanding of ocean science topics, such as climate change, by high school groups who participated in the Liberty Science Center outreach programs, with the 2012 group demonstrating a 25% decrease. Boyle et al. noted that the report included recommendations for restructuring how science is taught in order to foster an increase in science literacy and ocean literacy. The use of guided inquiry and place-based activities to improve instruction for science literacy was also suggested. This report is significant because it provides current baseline data about ocean literacy and describes opportunities currently offered to students for improving their ocean science literacy skills.

The use of local resources and ecosystems has also been found to increase the impact of marine science education instruction. In using placed-based marine science and culture to connect students, Wiener and Matsumoto (2014) examined the use of pen pals between the Hawaiian and Washington coasts to expand understanding of ocean literacy principles. They described Ecosystem Pen Pals as a place-based program designed to connect students to other students living in different ecological areas. Students in Grades 4 and 5 were recruited to participate in this place-based program to share their understanding and cultural connections to coastal waterways with each other. Wiener and Matsumoto found that students developed positive peer relationships and improved understanding of the impact of humans on the ocean by writing and sharing their letters. Students also self-reported more concern about the potential impact of humans on the oceans. Wiener and Matsumoto concluded that although these pen pals did not meet the learning goals of the activity, they made strong connections between their cultures and marine ecosystems. The study is relevant because the results demonstrate the efficacy of utilizing local marine science environments to help students understand the impact of humans on these ecosystems.

In relation to place-based science education, locations near the ocean are often effective predictors of improved interest in conservation and ocean literacy. In a study examining the ocean as a predictor for marine conservation in Hawaii, Wiener, Manset, and Lemus (2015) evaluated the connection between ocean use and conservation. The study encompassed 422 participants, ages 18 to 55+, who self-reported as avid users of the ocean. Ocean use included subsistence, economic, and recreational use. Wiener et al. found the use of the ocean for recreation had the greatest impact on participants' interest in conservation. Wiener et al. concluded that how individuals use the ocean and their background in relation to the ocean impacts their attitudes toward ocean conservation. Wiener et al. recommended varied outreach activities to engage community members in ocean conservation. This study is important because it describes the impact of place-based activities on ocean literacy.

Technology can also be used to connect students to marine science content and careers related to marine education. Beaulieu et al. (2015) examined the use of digital globes to explore the deep sea and to improve earth science literacy for students in Grades 9-12 who participated in the Science on a Sphere program at the Ocean Explorium Museum in Massachusetts. Based on post survey data, Beaulieu et al. found that high school students who used these globes increased their understanding of ocean literacy principles and their engagement in marine science learning. This study is important because it demonstrates the effectiveness of utilizing technology to improve ocean literacy for students in Grades 7-12.

Web-based resources are also available to teachers to use in the classroom to enhance instruction related to of marine science. In a study that Gill, Marcum-Dietrich, and Becker-Klein (2014) conducted, teachers used the *Model My Watershed* web-based application in a place-based instructional model to enhance science and ocean literacy skills for high school students in Pennsylvania. The application was designed with two goals in mind. The first goal was to help students develop a deeper understanding of environmental policy development when solving problems. The second goal was to improve student learning in science through the use of local environmental issues in instruction. In pre and posttest data, Gill et al. found that all students demonstrated a significant improvement in understanding the content teachers presented about watersheds. Gill et al. also found that the use of the web-based application with integrated ocean literacy generated significant student gains in understanding of local marine and environmental issues. Gill et al. concluded that this web-based application provided students with the skills needed to investigate a marine science problem. This study is important because the use of technology in solving place-based marine science problems has been found to improve ocean literacy skills for high school students.

Technology is also used to enhance teacher knowledge and instructional practices about ocean literacy. M. A. Rose's (2010) study regarding the EnviroTech professional development program focused on how to improve environmental literacy and technology assessment skills for teachers. This professional development program used the bioaccumulation of mercury in fish as the environmental problem, which aligns with the seventh ocean literacy principle regarding the impact of humans on marine environments. M. A. Rose followed 19 teachers working with 244 students in Grades 6-8. Both teachers and students reported significant gains in understanding bioaccumulation and the impact of humans on marine life. Teachers supported student learning through the use of inquiry-based activities that included EnviroTech's databases and by asking students to analyze the data and to synthesise their conclusions about mercury bioaccumulation. Teachers were encouraged to utilize local resources such as community experts and a fish hatchery to enable students to understand the data they collected. M. A. found that teachers made significant gains in their understanding of environmental issues, technology, and inquiry-based instructional practices. M. A. Rose concluded that a systemic inquiry-based instructional approach that included data, technology, and local resources increased teachers' ocean and environmental literacy. This study is important because it demonstrates the importance of including technology and teacher training in inquiry-based science instruction to improve teachers' ocean literacy skills.

Thus, ocean literacy is not confined to a single subject as these research studies indicate. Utilization of web-based programs helps teachers to engage students in local environmental issues and to use technology to illustrate data. The interrelated nature of marine science encourages the dissemination of results to a wide audience, including individuals who are more easily engaged in science education through technology.

Teacher preparation. Teacher training related to ocean literacy enables teachers to incorporate ocean literacy principles into instruction effectively. In a middle school study about the concept of bathymetry, (Michael, 2013) explored the use of high interest topics such as remote operated vehicles (ROVs) that were used to find the Titanic. Michael defined bathymetry as the measure of an object's depth from the surface of the water. Teachers in this study were trained to use computer and lab materials to simulate a search for underwater objects. Teachers used inquiry-based instructional methods to help these middle school students analyze data regarding the potential depth of unseen objects. Michael found that students who successfully completed the instructional module demonstrated a significant increase in their understanding of bathymetry and the tools used to measure it. This study is important because it demonstrates the practical application of inquiry skills related to marine education, technology, and the NGSS.

In relation to their instructional practices concerning ocean literacy, science teachers should consider how student perceptions of marine resources are influenced by their culture. In a study examining student perceptions of relationships with marine organisms, Kim, Anderson, and Scott (2013) explored the impact of cultural influences on Korean elementary students in relation to marine organisms. Kim et al. asked students to rate various organisms based on utilitarian or commercial value as well as aesthetic value. Students from higher socioeconomic backgrounds or who lived in coastal regions rated animals with commercially value higher than students from lower socioeconomic backgrounds s or who lived in interior regions. Kim et al. concluded that this difference was likely due to students' personal interactions with the organisms. This study is important because it demonstrates that the influence of culture on student perceptions of how marine resources are used begins at a young age.

The integration of inquiry-based instruction into cultural contexts often creates a challenge for teachers who may lack preparation. In a study about professional development for Hawaiian teachers in relation to a unique marine and environmental science program, Rivera, Manning, and Krupp (2013) examined the efficacy of place-based features of professional development. The study included middle and high school teachers involved in a four week professional development program about cultural, ocean, and environmental content and place-based inquiry instructional strategies. Experienced university faculty led this professional development program. Rivera et al. found that teachers were more comfortable and knowledgeable teaching ocean science content at the conclusion of the program. Rivera et al. concluded that the inclusion of experts in the ocean science field contributed to increasing teacher understanding of ocean science content and inquiry-based instructional practices. This study is important because the effectiveness of collaboration between ocean science university experts and teachers needs to be considered in professional development related to ocean literacy.

The use of ocean science experts and an emphasis on cultural context are essential components of professional development models. Using large marine ecosystems and cultural responsiveness as the context for the professional development of teachers and scientists, Sigman et al. (2014) examined a professional development program that was modeled to function as a workshop wherein teachers would create and implement lessons during the course of the professional development activity. Participants included K-12 educators from Alaska and 30 scientists of varied affiliations and locations. This professional development program was designed to help teachers integrate ocean sciences into their science classrooms while utilizing networking opportunities with scientists who were experts in their field. The workshop component of the professional development program included cultural connections through a partnership with Alaskan Native communities. The leaders of the workshop provided teachers with the content and the time to develop marine science lessons that they could use in their classrooms after the conclusion of the professional development series. The program participants collaborated on the development of over 30 lesson plans integrating marine science and science content for multiple grade levels. Sigman et al. found that the use of cultural context and expert scientists built communication pathways between teachers and scientists. Sigman et al. also found that teachers developed a deeper understanding of science literacy, ocean literacy, and cultural connections between the environment and humans. In addition, Sigman et al. found that teachers were more likely to include the lessons they developed in their classrooms. This study is important because it demonstrates the need for scientists and teachers to work together to design instructional lessons that improve students' ocean literacy skills.

Bringing teachers together with scientists provides a valuable foundation for developing science courses that emphasize ocean literacy. Teachers who are provided with professional development opportunities to work with experts in marine science content produce a greater understanding of the material and how it can be used in the traditional classroom (Buaraphan, 2011). The use of experts in developing teacher understanding of ocean literacy also enables the incorporation of place-based instruction and the integration of the ocean literacy principle regarding the interconnectivity of humans as an important cultural element (NOAA, 2013)

Instruction related to ocean literacy principles. The NOAA (2016) recommended that ocean literacy principles be aligned with instructional strategies and related resources that teachers use in the classroom and in informal settings like summer camps. Ocean literacy principles were developed to enable citizens to make responsible and informed choices regarding policies for the ocean (Guertin & Clements, 2015). Public awareness campaigns related to these ocean literacy principles strive to connect people to the impact that humans have on the ocean (Gelcich et al., 2014). Instructional strategies and related resources that are aligned with the ocean literacy principles should, therefore, reflect the stewardship of these natural resources. Current research studies in marine science education indicate that teachers need to be provided with background research, materials to use, and learning objectives that they can integrate into their classroom instruction (Houser, Garcia, & Torres, 2015; Kovacs, Curran, & Cox, 2013). These available resources also support a learner centered approach for instructional and assessment purposes while providing relevant content that can be integrated into a science curriculum (Guertin, 2016).

Instructional practices for ocean literacy should reflect progression in student understanding of the content associated with ocean literacy. In a study exploring learning progressions for the use of water in socioeconomic systems, Gunckel, Covitt, Salinas, and Anderson (2012) examined how middle and high school student in Colorado and Michigan learn about the water cycle. Gunckel et al. divided their understanding of the water cycle into three learning levels with the lowest level as cause effect relationship and the highest level including a deeper understanding of how and why water moves through the water cycle. Gunckel et al. found students at higher educational levels need added depth to instruction about the water cycle in addition to supported inquiry and formative assessments. Gunckel et al. also found that the instructional strategy of model-based reasoning provided students with additional insight into the workings of the water cycle. This study is important because it supports teacher use of a learner centered framework for instruction about ocean literacy.

A review of the research also provided examples of how science teachers might provide instruction in relation to the seven ocean literacy principles. The first ocean literacy principle states that "the earth has one big ocean with many features" (NOAA, 2013, p. 7). Instructional strategies for this ocean literacy principle should incorporate inquiry-based and learner centered approaches. This ocean literacy principle includes three main concepts: (a) geological features, (b) properties of ocean water, and (c) ocean circulation. In a study examining the use of science kits as a classroom learning tool, Foley et al. (2013) evaluated the kits that the Center for Microbial Oceanography: Education and Research (C-MORE) developed for use in Grade 6-8 classrooms to teach ocean literacy principles. Foley et al. noted that the kit development process involved integrating these kits into the existing curricula while highlighting ocean literacy principles by including instructional materials and guides for inquiry-based lessons for students. The pilot for this kit development included easy to use lessons, so teachers did not have to become experts in the topics presented in the kits. The kits were tested with students in Grades 6-8 in Hawaii, California, Massachusetts, and Oregon, including the use of a pretest and two posttests. According to Foley et al., students demonstrated growth between the pretest and the first posttest as well as retention based on the second posttest that was administered two weeks after the first one. Foley et al. found the kits were effective models to teach inquiry-based skills to students. This study is significant because it demonstrates the effectiveness of partnerships between teachers and researchers in the development of ocean literacy lessons that are aligned with state science standards.

In a study about enhancing environmental literacy and technology assessment skills, C. M. Rose, Adams, Hinchey, Nestlerode, and Patterson (2013) developed a teacher resource titled *The Incredible Sinking Cup.* The purpose of this instructional activity was to improve science literacy skills such as hypothesis development, understanding of Boyle's law, and understanding of the concepts of ocean depth and pressure through a two-part laboratory experience. Students also communicated with marine science researchers who were exploring these concepts. Students supplied researchers with plastic cups so that they could connect to equipment in the depths of the ocean. Students not only received their cup back in an altered state but also were provided with the environmental data that may have contributed to its change in size and density. C. M. Rose et al. found that this instructional activity improved student understanding of Boyle's law and of ocean depth and pressure. This study is important because it provides teachers with an example of how to improve specific ocean literacy skills and concepts for students.

The second ocean literacy principle states that "the ocean and life in the ocean shape the features of Earth" and focuses on three geological concepts, including (a) geological change, (b) plate tectonics, and (c) the rock cycle (NOAA, 2013, p. 8). Several studies were found that align with this second ocean literacy principle. These studies also demonstrate a learner centered instructional approach. In a study about an online guided inquiry tool for middle and high school geoscience education, (Schifman et al., 2013) evaluated an online inquiry tool, *Sleuthing through the Rock Cycle* designed for teachers to use with students in Grades 5-12 in Rhode Island schools to determine its impact on their overall understanding of the rock cycle and to improve their inquiry skills. Teachers were trained online to use this inquiry-based tool in the classroom. Schifman et al. found that approximately 30 of the 179 teachers participating in the online training had a rudimentary understanding of the rock cycle prior to the training sessions. Schifman et al. also found that students utilized inquiry skills to learn about the rock cycle. The rock cycle units were flexible to allow students to explore concepts and to receive support in mastering concepts related to the rock cycle. Student understanding was assessed through a pretest and a posttest. Schifman et al. found students demonstrated an overall understanding of the rock cycle. This study is important because it demonstrates how online training can be used to help teachers improve their marine science instruction.

In another study that reflected the second ocean literacy principle about how the ocean shapes the Earth's features, Parrish, Curran, and Sajwan (2015) implemented an instructional activity about the creation of sediment through destruction. Teachers were provided with background information about research and standards alignment as well as materials required to conduct the activity. Participants in the pilot of the activity were students in a Grade 6 earth science class in Georgia. Students engaged in an exploratory activity to learn how sediments are created by crushing and sifting cereal through sieves. Students used scientific tools and processes to predict and measure outcomes. Parrish et al. found that students were highly engaged in this inquiry-based and learner centered approach to instruction. This study is important because it also demonstrates how teachers can improve students' inquiry skills through a learner centered instructional activity.

In another study related to the second ocean literacy principle, Caudle and Paine (2016) evaluated data collected in the Texas High School Coastal Monitoring Program (THSCMP) as a methodology for improving students' inquiry skills and understanding of coastal geological changes. The THSCMP was a citizen scientist program that required these high school students to measured beach erosion over a three month period. Students were expected to make predictions about equilibrium between erosion and deposition of sediment. Caudle and Paine found that students' participation in the program increased their overall knowledge of geological processes affecting coastlines. This study is important because it demonstrates how the utilization of research-based methods for data collection can be used to improve students' understanding of ocean literacy principles.

The third ocean literacy principle states that "the ocean is a major influence on weather and climate" and focuses on three main concepts: (a) the water cycle, (b) weather and climate, and (c) global climate change (NOAA, 2013, p. 9). The science of climate change and the understanding of global climate change are the most polarizing topics in relation to the ocean literacy principles (Hoegh-Guldberg & Bruno, 2010). To teach this third ocean literacy standard, teachers need to understand the general public's perspective about climate change and to be prepared to teach and defend the related content.

In a study about climate change attitudes that reflect this third ocean literacy principle, Kelly et al. (2014) examined the climate change literacy of visitors from 10 zoos and five aquariums across the United States. The intent of the study was to compare the general public's view of climate change with the views of visitors from zoos and aquariums. Kelly et al. administered a 15 question survey to randomly selected visitors to zoos and aquariums over 6 weeks. The survey rated attitudes toward climate change from alarmed to dismissive. Kelly et al. found that visitors of both zoos and aquariums rated themselves as concerned regarding climate change. Kelly et al. also found that zoo and aquarium visitors gave supportive responses regarding climate change. In addition, Kelly et al. found that a significant number of the general public were unconcerned or dismissive of climate change. However, the number of concerned and alarmed visitors of zoos and aquariums was greater than the general public. Kelly et al. concluded that science educators could use zoos and aquariums as well as other informal educational settings to support climate change literacy through their existing programs. This study is important because it provides a broad overview of the differences in public opinion on climate change.

In order to provide quality instruction about climate change, Bleicher and Lambert (2013) believed that teachers need to have a deep understanding of the science associated with climate change. Training teachers to provide instruction in ocean literacy principles should begin in preservice science courses by assessing prior knowledge and perceptions about climate change To understand preservice teacher's perspective on global climate change, Bleicher and Lambert evaluated an elementary science methods class that included 154 university students in a university teacher training program located in the southeastern region of the United States. Participants were surveyed and interviewed on their understanding of climate change, the role of the media, and politics as it influences understanding of climate change. Bleicher and Lambert found that preservice teachers had little understanding of climate change prior to the intervention. Bleicher and Lambert also found that preservice understanding of climate change prior to the intervention was heavily influenced by media reports. In addition, Bleicher and Lambert found that participants understood the politicization of public opinion on climate change and its negative effects on current climate policies. They also found that preservice teachers were responsive to the instructional interventions on climate change. This study is important because it supports the need to provide in-depth training to teachers who address challenging science content such as climate change.

In another study about preservice teachers and climate change, Boon (2016) wanted to determine if climate change education included sustainable instructional methods. The 4 year study included 87 preservice teachers in early childhood and primary education courses. In this mixed methods study, Boon found that preservice teachers' understanding of climate change was heavily influenced by the media rather than informed by scientific research. Boon also found that preservice teachers were unprepared to teach ocean literacy topics due to a lack of understanding about climate change. Boon was not able to conclude that instructional interventions were sustainable and recommended further study. This study is important because it demonstrates a need to provide professional development for early childhood and primary teachers in order to prepare them to provide instruction for complex topics in science such as climate change.

In further research regarding preparing teachers to teach climate change, Ratinen, Viiri, Lehesvuori, and Kokkonen (2015) evaluated primary student teachers' practical knowledge and classroom communication of climate change in Finland. Ratinen et al. conducted a content analysis of lesson plans developed by preservice teachers to determine how preservice teachers had integrated climate change into their lessons. Ratinen et al. found that participants did not fully implement inquiry-based learning because they did not support student roles in instruction. Ratinen et al. found that teachers did not activate students' prior knowledge, advance student thinking without direct links made by the teacher, and did not ask students to make connections between learning phases. This study is important because it demonstrates a need for teacher preparation programs to include training in inquiry-based science teaching.

Understanding the complexity of marine ecosystems is addressed in the fourth and fifth ocean literacy principles. The fourth ocean literacy principle states that "the ocean makes the Earth habitable" and focuses on the following concepts: (a) oxygen production and (b) origins of life (NOAA, 2013, p. 9). The fifth ocean literacy principle states that "the ocean supports a great diversity of life and ecosystems" and focuses on the following concepts: (a) primary productivity, (b) diversity of ecosystems and (c) diversity of life (NOAA, 2013, p. 10). A review of the research indicated that studies related to the fifth ocean literacy principle that focused on the diversity of ecosystems and life were more abundant than studies focused on the fourth ocean literacy principle about making the Earth habitable.

In relation to these ocean literacy principles, understanding an animal's role in the ecology of an area can provide students with a model for how an ecological system works. In a study about mollusks, Taubenheim, Curran, and Hoskins-Brown (2016) described an instructional activity for students in Grades 6-8 that was focused on the conservation of eastern oysters. For this instructional activity, Taubenheim et al. provided background research regarding the ecological role of eastern oysters in a salt marsh environment. They also provided research-based information to help teachers and students understand the ecological role of oysters and their contribution to diversity in the ecosystem. Students learned about restoration projects to recover oyster reefs lost to commercial fishing practices. Taubenheim et al. also provided middle grades students with a learning structure for hypothesis development while immersing them in a field work model. Students were able to replicate the oyster reef monitoring process with everyday objects. Teachers were provided with potential modifications and discussion points to support learner centered instruction. This study is important because Taubenheim et al. found that inquiry-based instruction helps students master ocean literacy principles.

Examining the interrelationships between animals in an ecosystem can provide students with a concrete understanding of the diversity of the ocean. In a related study about shrimp, C. Thompson, Ebanks, and Curran (2016) developed and piloted a lesson about shrimp and their parasites for Grade 6-8 students in Georgia. The lesson provided a tactile experience for students as well as estuarine connections to the marsh ecosystems through inquiry-based instruction. Students contaminated shrimp with parasites using pipe cleaners, socks, and beads. Teachers were provided with background research on shrimp, parasitology, and marsh ecology. Students also used lab sheets that reflected cross connections between the NGSS and Common Core State Standards in mathematics. C. Thompson et al. provided modifications for the lesson plan including alternative methods for analyzing student data. C. Thompson et al. found that this lesson produced diverse student products that modeled the diversity of parasitized shrimp found in nature. They also found that the lesson supported inquiry skills instruction through data interpretation and other science process skills. This study is important because it models how to improve inquiry skills as a function of the content when learning about ecological diversity in species.

Learning about defenses in animals also contributes to the fifth ocean literacy principle by focusing on the diversity of a species. In a study about how fish play hide and seek, Hunnewell, Curran, and Sherman (2015) designed a lesson for Grade 6 students about how fish use camouflage to avoid predation in the wild. Students utilized the surrounding classroom to create fish that can blend with the environment. This activity aligned with the fifth ocean literacy principle focused on the diversity of life. Hunnewell et al. designed this inquiry-based lesson so that an individual such as an administrator could be invited into the classroom to observe fish acting as predators. Students also reflected on this camouflage and how quickly the predator was able to find the fish. This instructional activity provided students with an opportunity to explore a complex science concept using inquiry-based skills. The lesson also provided students with a hands-on experience regarding how the environment influences camouflage in animals. This research is important because it demonstrates how teachers can provide instruction about abstract science concepts by using a concrete application with an inquiry-based focus.

Macro organisms and their monitoring programs further immerse students into the complex ecological relationships of each organism in an ecosystem. J. Thompson, Curran, and Cox (2016) designed an instructional activity to teach Grade 6 and 7 students how to estimate dolphin populations. They provided background information about dolphins as abundant predators in the waters near Georgia, South Carolina, and Florida. The lesson defined population estimates based on census data gathered through surveys and tag and release programs. Rather than use radio tag and recapture methods to generate a census of dolphin population, J. Thompson et al. noted that researchers used photo surveys of the dorsal fin. Due to trauma sustained over the course of a dolphin's life, the dorsal fin is unique to each individual. Students were given a bank of photo ID pictures and data sets to answer questions about dolphin population estimates. Students used both quantitative and qualitative data to find population estimates. In the pilot of the lesson plan, J. Thompson et al. found the connection between mathematics and science content to be essential to student understanding of these science concepts. J. Thompson et al. also recommended scaffolding to enhance student comprehension of science concepts. This study is important because J. Thompson et al. used qualitative methods to present scientific data, which is not commonly found in science instruction for middle school students.

In another related study, Ramsden and Curran (2016) developed a research-based instructional activity for Grades 9-12 students about the seasonal patterns of the Atlantic stingray. During this instructional activity, students used mapping skills to integrate technology into data collection and analysis as part of the lesson. Unlike J. Thompson et al.'s (2016) population survey activity, Ramsden and Curran utilized data collected from radio tag surveys. The lesson objective asked students to identify the location of marine animals to inform conservation policies. Student created their own distribution maps by utilizing data sets created from their research about the location of the Atlantic stingray in Georgia saltwater marshes. Ramsden and Curran designed the lesson as a group activity emphasizing the use of inquiry-based skills and real world datasets in order to help students learn about the distribution patterns of stingrays. The lesson was found to encourage specific inquiry skills such as prediction and argumentation. Even though this instructional activity was designed for high school students, Ramsden and Curran found that the activity could be modified for younger students. This study is important because it provides a framework for utilizing technology and real world data sets in ocean literacy lessons.

The sixth ocean literacy principles states that "the ocean and humans are inextricably interconnected" and focuses on the following concepts: (a) how the ocean affects weather and climate, (b) the uses of the ocean, (c) how the ocean affects where people live, (d) the human impact on the ocean and atmosphere, and (e) responsibility and advocacy for the ocean (NOAA, 2013, p. 11). Current research studies related to this sixth principle of ocean literacy were found to focus on the impact of humans on the ocean and their stewardship of the ocean. The following studies provide evidence of how to build students' understanding of the impact of humans on the ocean and about how community change campaigns can improve local marine science environments.

To improve climate education in Chesapeake Bay area, Nuss and Beck (2015) developed a program to teach Grade 9-12 students about rising sea levels in relation to local salt marsh ecosystems. Students participated in an instructional activity using mock transects of salt marsh ecosystems. Each transect was built to represent sea level rise and storm flooding, based on tidal changes. Students observed the differences between each transect and developed conclusions about the differences in water levels. Nuss and Beck found that this inquiry-based activity provided students with the structure to generate and analyze data using a model similar to scientists in the field of climate change. This study is important because it models how teachers can provide instruction to demonstrate the process by which ecosystems change.

Cramer, Sherman, and Curran (2015) conducted a research study about litter on Georgia area beaches. Participants were students in Grades 6-8. Students were introduced to the method of transects in order to collect data about a study area. Transects were predetermined linear distance where measurements are taken along that transect. Cramer et al. asked students to use transects with quadrates to count the trash along a 50 meter section of the beach. Cramer et al.'s lesson included real data from cleanup efforts on the beach to track where the bulk of the litter was found. Cramer et al. found that students were able to predict human behaviors and to learn about the negative impact that marine debris had on the ecosystem in this inquiry-based activity. Cramer et al. recommended extending the lesson to include community communications such as brochures on the impact of litter on marine environments or developing litter reduction programs at their schools. This study is important because it is a foundational instructional activity that teachers can use to help students learn about the impact of humans on a marine science environment by using real world data.

One result of the human impact on ocean waters has been an abundance of marine debris. In a study focused on mitigating micro plastics, Kowalski, Crews, and Rowe (2016) developed and evaluated a science curriculum for Grade 6-8 students in Oregon. This three-part curriculum on microplastics in the water was evaluated in a mixed methods study. Kowalski et al. utilized pre and posttest surveys and summative and formative assessments to evaluate the curriculum. Students were introduced to micro plastics and their impact on the environment through an investigative lesson structure. Kowalski piloted activities that modeled sources of micro plastics and their entry into the water cycle. Additionally, students researched experts in the field of micro plastics and the impact of microplastics on the environment. Kowalski et al. noted that students reported they were more connected to this ecological problem due to the solution-based approach of the curriculum. This study is important because it provides a model for middle school science teachers about how to use continued feedback to enhance and adapt instruction in an investigative ocean literacy activity.

In another study related to the sixth ocean literacy principle, Hernández-Pacheco et al. (2015) developed an instructional lesson for Grade 7-8 students in life or physical science courses. This lesson focused on ocean acidification, which is the result of increased carbon in the water that creates a more acidic environment for plant and animal life because the ocean acts as a carbon sink for atmospheric carbon. This activity scaffolds concepts of acidity, the carbon cycle, and coral reef ecology together in an instructional unit on ocean acidification. Students researched ocean acidification while teachers guided them through the lesson objectives. Students were assessed on their understanding of ocean acidification through their development of solutions for preventing ocean acidification and community connections promoting those solutions. Hernandez-Pacheco et al. found that students needed a more concrete connection between acidification and human impacts and recommended students maintain a daily journal about habits potentially influencing the environment. This study is important because it demonstrates how teachers can integrate research, communication, and data analysis skills into a unit for middle school students.

Cultural connections are another aspect of the sixth ocean literacy principle about how humans and the ocean are linked. In a related study, Luther, Tippins, Bilbao, Tan, and Gelvezon (2013) explored the use of socioscientific cases to improve ocean literacy skills for Grade 6-8 students in the United States. In this study, Luther et al. designed each lesson in the mangrove curriculum so that students could work in small groups. Luther et al. developed lessons with inquiry-based components so that students could explore content about mangrove forests and deforestation. Each lesson built toward understanding the ecological consequences of habitat depletion. Luther et al. found the use of case studies developed a social identity for Philippine students who participated in the lesson plan pilots. The mangrove curriculum is important in developing ocean literacy skills because it incorporates social and cultural influences to foster stewardship of the ocean.

In another study about how the ocean and humans are linked, Williams, Gut, Sherman, and Curran (2016) developed a mock town hall meeting about human induced impacts on the ecosystem for students in Grades 9-12 in Georgia. The science literacy focus of the lesson was on communication, argumentation, and research skills in a town hall format. Instructional design components included class discussion, small group research based on students' assigned group role regarding perspective, and a summative project, which was the town hall meeting. Representatives were selected from each group followed by an open floor discussion. Williams et al. designed this activity to encourage students to build and defend arguments, modify plans, and simulate the policy creation process. In the pilot follow up, Williams et al. found that students learned to prioritize key points based on time constraints. Williams et al. also found students learned that their arguments had to be clear and concise. This study is important because the importance of communication with the public regarding scientific content is modeled. This instructional activity teaches students how policies are created and build a foundation for citizen participation in science programs.

In another study about how humans and the ocean are linked, Widder, Falls, Rohm, and Lloyd (2014) examined behavior changes in high schools students from Florida as a result of their experiences in a stewardship program. The program was developed in response to the deaths of several newborn dolphins where the cause of death was related to human pollution in a Florida lagoon. High school students were recruited to participate in a program to increase communication with the local community and provide solutions to prevent further deaths in the dolphin population. The program had no scripted curriculum but included a focus on local issues designed to create change in the community through blogs, print, and radio media. Widder et al. found that students demonstrated ownership of the project and the research due to the local focus of the program. Widder et al. also found that this citizen science program changed the way students learned because they applied science skills to a real world problem. This study is important because it provides the framework for citizen science programs that promote ocean literacy and science literacy skills.

The seventh ocean literacy principle states that “the ocean is largely unexplored” and focuses on the following concepts: (a) people explore the ocean, (b) ocean exploration requires collaboration, and (c) ocean exploration requires technological innovation (NOAA, 2013, p. 12). Research-based activities that teachers use to teach this ocean literacy principle integrate technology into their lesson design. The following studies present a strong focus on technology use in marine science as the medium to teach ocean literacy principles, particularly in relation to the seventh principle.

Thomas and Raisor (2015) examined the use of real-world learning objects and real time ocean science data in K-12 classrooms. Thomas and Raisor evaluated the following five real world learning objects: (a) the center for innovation in engineering and science education, (b) Journey North, (c) Sea Turtle Conservancy, (d) Global Learning and Observation to Benefit the Environment, and (e) the National Data Buoy Center. Thomas and Raisor evaluated all five resources and found that they had supporting resources for the classroom. The recommended instructional design was the scientific process. Students developed research questions and then answered those questions using data analysis from the recommended real world learning objects. Thomas and Raisor also found that this instructional design provided authentic opportunities for students to model science processes, which is why this study is significant.

In another study demonstrating the link between humans and the ocean, Caldwell, Wiener, Heckman, and Lemus (2015) piloted an instructional lesson on the use of fluorescence to assess the health of coral reefs. As humans continue to explore the oceans, Caldwell et al. contended there is still much is to be learned about the health of reef ecosystems. Currently, scientists are developing technology to assess coral reef health in the field. Caldwell at al. developed a lesson utilizing black lights and fluorescent paint to teach the concept of this new technology to students. They piloted this lesson at a teachers' workshop and a school open house event. The lesson integrated light refraction with coral reef health. Caldwell at al. found the lesson needed to be conducted over 2 days to allow time for the creation of the healthy and unhealthy corals. Caldwell et al. also found the piloted lesson exhibited the most success with students in Grades 5-8. This study is important because it models a framework for how to teach students about a complex technology in an accessible way.

In summary, an analysis of current research on ocean literacy found that no definitions for ocean literacy existed prior to 2005, except as an informal understanding Cava, Schoedinger, Strang, and Tuddenham (2005). The lack of a unified definition of ocean literacy was identified through early research. The accepted definition of ocean literacy is the product of a coalition of marine scientists, educators, and policymakers that occurred in 2005 (Schoedinger et al., 2010). The current NOAA definition of ocean literacy was designed primarily for use by K-12 educators. Ocean literacy researchers and science educators in the United States and several other countries such as Canada, Turkey, and Korea have adopted this definition and the seven related principles. Current research about strategies that science teachers use to provide instruction concerning the definition and principles of ocean literacy support learner centered teaching. As research in ocean literacy continues, additional definitions about ocean literacy may emerge.

Middle School Science Education

Middle school is a time when students often enroll in their first dedicated science class in middle school (Treagust, Jacobowitz, Gallagher, & Parker, 2001). A review of the research literature indicates that curricular, instructional, and assessment trends in middle school science often influence student learning outcomes for summer science camps.

Curricular trends. In earlier research, several curricular trends in middle school science education were found. One of these trends is an emphasis on inquiry-based instruction. *Science for All Americans*, which was a significant national report published in 1991, stated that middle school science instruction was in need of an inquiry-based approach to improve science literacy skills for students (Rutherford & Ahlgren, 1991). In this report, Project 2061 was reassessed to determine the state of science education nationwide and to make recommendations for future improvements in curriculum, instruction, and assessment. Project 2061 defined what all high school students should know in order to be considered science literate by 2061. In this report, science process skills, including an emphasis on inquiry skills, were considered an essential aspect of science education curriculum and included analysis, argumentation, and communication. Science content was defined as topical information related to specific sciences such as earth sciences and ocean sciences. The report suggested that curricular and instructional development in science should support scientific thinking and science as "producing knowledge" (Rutherford & Ahlgren, 1991, p. 2). This report also suggested that curricular design practices in science incorporate problem-based learning and learner centered approaches that support the crosscutting concepts of the NGSS, which bridge connections between science content and science process skills.

Another curricular trend found in the research is that middle school science teachers often perceive ocean literacy as supplemental content, which is not essential in relation to their course curriculum. In a significant meta-analysis, Hart (2010) found that teachers often view environmental topics as added content to the science curriculum. Hart suggested, however, that science education curriculum should be restructured so that environmental topics such as ocean sciences are considered as stand-alone instructional units. Environmental topics, Hart contended, such as climate change and ocean acidification, are charged with political connections and push traditional boundaries in scientific understanding. These topics also align with inquiry-based instructional practices because they include practical applications of learning goals. Hart concluded that inclusion of environmental topics in traditional science curriculum has the potential to lead to significant social change in science education. This study is significant because the inclusion of ocean literacy topics is considered critical to improving science education.

Another curricular trend in middle school science education emphasizes inquiry-based and place-based content. In related research, Gorospe et al. (2013) examined the engagement of 380 high school students in Hawaii in an outreach lesson on ocean acidification. With Hawaii's strong cultural and economic ties to the ocean, Gorospe et al. hypothesized that place-based lessons including inquiry-based instructional strategies would be an effective method for improving ocean literacy skills for participating students. Ocean acidification directly affects Hawaiian residents due to its impact on local coral reef populations and therefore is an ideal topic to integrate into a curriculum utilizing science process skills and inquiry-based instructional practices. Gorospe et al. found that inquiry-based instructional practices encourage students to develop deeper connections to the science content than direct instruction. Students in this study participated in instructional activities that included laboratory modules focused on ocean acidification. Gorospe et al. found that participants demonstrated a better understanding of ocean acidification and the related science behind the phenomenon. Gorospe et al. also found that place-based topics like ocean acidification increased student engagement in curriculum and instruction. Gorospe et al. concluded that students who participated in inquiry-based instruction demonstrate a deeper understanding of science concepts in general. This study is important because the benefits of inquiry-based and place-based instruction on student understanding of science are clearly demonstrated.

Another curricular trend is related to science content at the middle school level through the implementation of science fairs. Dublin, Sigman, Anderson, Barnhardt, and Topkok (2014) explored the Center for Ocean Sciences Education Excellence-Alaska (COSEE-AK) ocean science fairs as a model that anchors student projects in western science and traditional native knowledge. These ocean fairs were open to both middle and high school students. These ocean fairs were used as a medium to link ocean literacy with cultural aspects through learner centered projects. Teachers were given support through COSEE-AK regarding content and resources, which enabled them to support diverse student projects. The central content of the program was ocean sciences, and all student projects needed to demonstrate an understanding of ocean science content. The program design addressed the need to incorporate cultural aspects with self-directed activities to facilitate student-centered learning. Dublin et al. found that the design of these ocean science fairs enabled students to engage more readily in science content due to the cultural and self-guided aspects of the fair. Dublin et al. concluded that student-led projects that are focused on ocean science content enable students to explore and master science content. This study is important because independent project design utilizing ocean science as the content focus can be replicated in other schools.

An additional curricular trend in middle school science education is that science content should be relevant and meaningful to students. Stevenson, Peterson, et al. (2014) examined the role that significant life experiences play in relation to the environmental knowledge of middle school students. Stevenson, Peterson, et al administered the *Middle School Environmental Literacy Survey* (MSELS) to students in Grade 6 and 8 in North Carolina. The results of the survey indicated a correlation between environmental knowledge and proenvironmental behaviors. Students of low socioeconomic status did not spend much time engaged in outdoor activities, and therefore, they reported fewer proenvironmental behaviors. Stevenson, Peterson, et al. also confirmed that the availability of resources impacts students' perceptions of the environment. Stevenson, Peterson, et al recommended further integration of environmental education topics into science education curriculum with an emphasis on related outdoor activities. This study is relevant because understanding the influences on student engagement should be taken into account when designing and implementing an ocean science curriculum.

Thus, curriculum trends in science education indicate that science topics for middle school students need to be relevant and tied to place. High-interest topics such as ocean science should be integrated into general science content to improve overall understanding of science content. To be relevant, environmental education topics such as ocean science need to be woven throughout the curriculum rather than treated as standalone topics. The use of place-based content builds cultural connections between science content and familiar local environments. Relevance and cultural connections are key characteristics of ocean science curriculum because students can make inferences about the importance of these connections to their lives.

Instructional trends. Instructional trends in middle school science need to be aligned with the NGSS. This alignment includes an emphasis on inquiry-based instruction and training middle school science teachers to integrate these practices into their instruction. This section includes an analysis of earlier and current research about inquiry-based, problem-based, and learner centered instructional methods.

In earlier research, Kolodner et al. (2003) explored problem-based learning as an instructional approach to teach science to middle school students**.** Kolodner designed a science education program at the middle school level that focused on a framework of problem-based learning, which was defined as a learner centered approach, which included the design, investigation, and research of a specified problem. The instructor's role was to be a guide while groups of students address a specified challenge. This problem-based instructional design was combined with case-based reasoning to help students develop connections between what they learned and how their learning could be applied as a solution to the problem. This program was piloted for 2 years with middle school students in Georgia. Results indicated that student engagement and understanding of related science content improved as a result of participation in this program. Kolodner et al. concluded that the learner centered focus of this program addressed socialization concerns in an environment that were conducive to improving science literacy. Kolodner et al. recommended the continued use of this program.

Recent instructional trends in science in the United States have also emphasized inquiry-based instruction to teach science content because it relies on a student centered focus to be effective. Inquiry-based instruction in science education also relies on motivated teachers to provide instruction while encouraging student discovery. In a metaanalysis of the role of informal science learning environments in developing a reform-minded science teaching identity, Avraamidou (2014) identified the characteristics of the teacher role in inquiry-based science education. Avraamidou found that teachers require focused and specific preparation to teach inquiry-based science education. Informal science education programs such as outside-of-school programs hosted by local universities and nonprofit organizations offer teachers a way to learn inquiry-based instructional skills through demonstrations. Avraamidou also found that teachers who pursue informal science education activities to develop their instructional skills are more confident in presenting science content. These teachers also embrace a role of guidance during instruction and develop a stronger commitment to inquiry-based science education. Informal science education settings such as summer camps and professional developments also encourage teachers to practice and refine those skills. Avraamidou also found that the use of informal science education settings offered opportunities to motivate teachers to teach science content. This meta-analysis is important because it explores the benefits of informal science programs in providing teachers with the inquiry-based instructional skills needed to change their practices effectively.

Another instructional trend in middle school science education is the emphasis on student motivation and student engagement as key factors that improve student learning. In earlier research, Lee and Anderson (1993) explored task engagement and conceptual change in middle school science classrooms. Lee and Anderson followed 12 Grade 6 students through a traditional science course and found that students generally had a positive attitude toward science content and instruction when the teacher included inquiry-based instructional activities in a lab setting. Lee and Anderson also found that student motivation to pursue science education was linked to these science lab activities. Lee and Anderson concluded that inquiry-based instructional activities promote engagement and achievement in science. This study is important as support for the use of inquiry-based instruction to promote science literacy.

A significant instructional trend in middle school science education is that learner centered instructional approaches are often used to encourage positive attitudes toward science and to increase student achievement in science. In related earlier research, Wolf and Fraser (2008) examined the learning environment, attitudes, and achievement among middle school science students who participated in inquiry-based laboratory activities. Wolf and Fraser focused on the effectiveness of inquiry-based instruction for middle school students in relation to improving science literacy skills as aligned with Project 2061. Wolf and Fraser found inquiry-based instruction was effective as a method for improving student learning because students received additional support from the teacher. Wolf and Fraser concluded that inquiry-based activities are useful to teach data analysis and interpretation skills. This study is important because it demonstrates the effectiveness of inquiry-based activities in improving student learning.

In other research about science instruction at the middle school level, Davis (2014) examined microspiral pedagogies integral to problem-solving and place-based learning to increase science literacy for middle school students. Davis defined microspiral learning as an instructional strategy that helps students to build prior knowledge of a particular content area in order to strengthen their knowledge and understanding of science content. This instructional strategy emphasizes problem solving and the practical application of science content. This instructional strategy also places more emphasis on the student's role in learning science content and supporting the teacher through robust training related to the associated science content. In this study, Grade 6 students participated in both linear physics and microspiral instructional models, and achievement results were compared to determine the effectiveness of these pedagogical approaches. Davis found that students who participated in both pedagogical approaches demonstrated growth in understanding the selected science content, but the microspiral approach yielded significantly better results. Therefore, Davis recommended the use of the microspiral pedagogy to build an understanding of and reinforce science concepts taught over a short period of time. This study is significant because it demonstrates the effectiveness of instructional pedagogies in science education that utilize content in meaningful and practical ways.

Thus, instructional strategies that support inquiry-based learning and student centered learning motivate students to learn science content. Inquiry-based instructional strategies also incorporate cross-cutting science concepts. Inquiry-based instructional practices also support exploratory learning and enable students to become more proficient in doing science.

Assessment trends. Assessment trends in middle school science education are linked to student misconceptions about science concepts and to a lack of teacher knowledge about specific aspects of science. Instructional and curricular trends related to inquiry-based learning and student centered learning provide teachers with opportunities to address these misconceptions about science. Assessments are used to identify these student misconceptions.

One current trend is that teachers often use assessments to help middle school students improve their understanding of science content and avoid related misconceptions. Examining middle school students' misconceptions about science and how they are linked to teacher knowledge of science content was the focus of (P. M. Sadler & Sonnert, 2016) study. Participants included 219 teachers who provided science instruction for students in Grade 6-8. Teachers and students were given pre and posttests to assess their science knowledge. Sadler and Sonnert found that when teachers are educated about the types of misconceptions students have about specific science concepts, student achievement increases. Sadler and Sonnert concluded that training teachers to use assessments to identify and address student misconceptions increase student achievement in science. This study is important because it demonstrates how assessments can be used to identify students' misconceptions in science.

Another assessment trend is that alternative assessments such as class discussions can be used to assess science knowledge for middle school students. In a case study regarding the use of assessments to improve student understanding in science, Treagust et al. (2001) described a science teacher's use of assessments for Grade 8 students who were learning about sound. Treagust et al. found that alternative assessments such as class discussions are effective in identifying students' misconceptions about science and in guiding students to understand these misconceptions. The Grade 8 science teacher of this study included both traditional and alternative assessments, which allowed for flexibility in instruction to address individual student needs while meeting instructional requirements. Treagust et al. found that teacher use of varied assessments in science not only gave feedback to students but also encouraged the teacher to identify student misconceptions about science. Treagust et al. concluded that frequent and purposeful assessments allow teachers to meet the individual needs of students. This study is important because it demonstrates the effectiveness of alternative assessment methods in reducing student misconceptions about science.

In earlier research about assessment trends in middle school science education, Kesidou and Roseman (2002) examined the effectiveness of middle school science programs in relation to findings from a review of Project 2061's curriculum. They evaluated nine middle school programs based on the desired outcomes for Project 2061, which was intended to improve science literacy for students. Kesidou and Roseman found that these middle school science programs did not support student learning in the life, physical and earth sciences. As a result, students did not demonstrate desired performance on associated assessments. Kesidou and Roseman recommended restructuring science programs at the middle school level to support in-depth practice for learning science content. The study is important because it demonstrates how educators can use assessments to evaluate and improve program effectiveness.

Thus, teachers often use assessments in middle school science courses to inform their decisions about curriculum and instruction. By understanding common student misconceptions about science enables teachers to adapt their instructional practices to eliminate those misconceptions held by students. Assessments also provide information regarding the effectiveness of curriculum and instruction in improving science learning for students.

Science Summer Camps

This section includes an analysis of research about curricular, instructional and assessment trends in relation to science summer camps in order to improve science and ocean literacy skills for K-12 students. Summer camps have been sites for recreational and educational activities for 150 years (Garst & Ozier, 2015). Summer camps provide students with opportunities for educational gains due to the traditional calendar schedule that was designed to accommodate the agricultural and industrial economic structure of the late 1800s (Garst & Ozier, 2015). Summer camps also provide a social structure for students to explore their academic interests with peer groups who have similar interests (Hughes, Nzekwe, & Molyneaux, 2013). Current research on science summer camps indicates that inquiry-based and placed-based instructional approaches to science education have influenced curricular, instructional, and assessment trends for science summer camps.

Curricular trends. Summer camps are short-term social or educational opportunities for K-12 students to learn new skills or enhance previous skills. The curricular trends for science summer camps include an emphasis on ecological, inquiry-based, and place-based contexts. These trends are in response to the NGSS that science educators established in 2013 and the foundational report *Science for all Americans* that was published in 1991 (NGSS, 2014; Rutherford & Ahlgren, 1991). Both initiatives called for students to become more science literate.

Instructors of summer programs sponsored by organizations such as 4-H have modified their existing curriculums to address inquiry-based and place-based curricular trends. Many 4-H programs offer both afterschool programs and summer camps in order to teach young people a variety of skills outside of school. Worker and Smith (2014) examined curriculum and professional development for this out-of-school science education program in California. Worker and Smith noted that the California 4-H program underwent significant curricular changes to meet the new NGSS. These 4-H instructors also attended professional development workshops to learn the new science curriculum and how to provide inquiry-based science instruction. Worker and Smith found that students who participated in the new 4-H curriculum demonstrated an increased understanding of science concepts based on pre and postsurvey results. This study is important because out-of-school programs need to follow current curriculum trends in science education in order to improve science learning.

The curriculum focused on specific science topics has also been shown to improve science literacy skills for students. In a study about ecology-based summer programs for primary school students, Erdogan (2011) found that students in Grade 3-7 who participated in an ecology curriculum in Finland's nature schools demonstrated a significant improvement in their understanding of environmental principles after only 12 days. In a study about a summer astronomy camp, Aktamis et al. (2015) found similar results in the pre and posttest results for a summer program focused on improving student understanding of astronomy and science concepts. In a study about middle school students' interests in STEM, Mohr-Schroeder et al. (2014) found that student participation in a one-week intensive STEM program increased their interest in STEM and improved their science literacy through inquiry-based practices. Each of these science camps provided a strong science curriculum that incorporated scientific inquiry, evidence, and argumentation skills needed to master the Next Generation Science Skills (NGSS). These studies are important because they provide examples of how science camps can be used to improve inquiry-based learning through an expansion of science content. These studies are also important as curricular models that provide students with authentic science experiences.

In other related research about curricular trends in summer science camps, Lindner and Kubat (2014) examined the organizational structure of science camps in Europe in terms of their collaboration with companies and participant reflections on their experiences in these camps. They found that teachers at some camps were unaware of their long-term impact on STEM careers. Lindner and Kubat noted that science summer camps are generally resourced by institutions outside the traditional K-12 program. The staff are generally highly motivated individuals who have an interest in science and science education. According to Lindner and Kubat, summer camps occur over a short period of time, generally 1 to 4 weeks, and the focus is on a particular topic or theme in science. This intensive time on content focused on a central theme contributes to increased student understanding of the topic. Lindner and Kubat found students were more likely to have a prior interest in the camp's focus or themes that enabled them to build peer relationships in concert with those interests. Linder and Kubat concluded that educators who are employed in science summer camps are successful in improving student learning because of the available resources, time spent on a specific science topic, and prior student interests. This study is important because summer camps are often used to provide supplemental instruction in a specified science content area.

Thus, curricular trends in science summer camps are often topic specific and aligned to curricula to the NGSS. The topic specific approach to summer camp curricula allows for in-depth learning that is not always possible in traditional classrooms (Worker & Smith, 2014). This intense structure allows students to explore content in an environment that is supported by experts in the content area (Lindner & Kubat, 2014). These trends in science curricula identify summer camps as an appropriate intervention to increase science and ocean literacy.

Instructional trends. Instructional trends in summer camps are often influenced by facilities and resources found in universities and specialized organizations (Leblebicioğlu et al., 2011). These resources provide teachers with the support to teach inquiry-based science skills using the appropriate equipment. These instructional trends also often include a community or place-based focus to help students develop deeper connections to science content.

Teaching students about the nature of science in a nature setting have become a recent instructional trend in the United States (Stevenson, Carrier, & Peterson, 2014). The utilization of nature settings to teach science literacy has also become a popular trend in some European countries. Leblebicioğlu et al. (2011) examined the utilization of a nature summer camp program to address learning gaps in science for Turkish students in Grades 6-8. The study focused on a two-week summer camp designed to improve science literacy for 34 participants. The camp was located in a rural environment that included a lake. Teachers conducted science instruction outside utilizing the natural environment. Leblebicioğlu et al. found that participants' science literacy skills improved between pre and posttests. Leblebicioğlu et al. concluded that a combination of instructional strategies using guided inquiry-based instruction and activities related to explicit instruction about the nature of science enabled students to improve their science literacy skills. This study is important because students were able to experience the connections between science content, ecology, and the natural setting of the camp.

Another instructional trend is that community summer camp programs are often developed as alternatives to traditional classroom instruction in order to improve science and ocean literacy skills for K-12 students. In a study about developing scientific literacy through summer science camps, Foster and Shiel-Rolle (2011) examined strategies for design, implementation, and assessment involving the Young Bahamian Marine Scientist (YBMS) program. Participants included seven male students in Grades 4-12 who experienced limited access to effective science instruction in their communities. The YBMS program was designed as a one-week intensive program emphasizing science and ocean literacy skills with a focus on local ecology. Program participants demonstrated modest increases in science literacy skills in posttest assessments. Foster and Shiel-Rolle concluded that this summer camp program served as a low-cost means to increase science literacy skills for high school students. These findings are important because targeted interventions and access to resources as provided in this summer science camp have been shown to improve science and ocean literacy skills for students.

An additional instructional trend is that science programs are often designed in relation to knowledge gaps that students have demonstrated about ocean and science literacy. In a study about the development of a K-12 geoscience outreach program as a model for universities, Dahl and Droser (2016) found a lack of teacher preparation in the geosciences, a field closely related to ocean literacy. The proposed project was designed to supplement STEM curricula. Program staff recruited graduate and undergraduate students to teach geosciences content in classroom presentations to K-12 students in schools in southern California. Dahl and Droser found student understanding of topics such as global climate change, earth sciences, and fossils improved at four sites. The study is important because this outreach instructional model could be replicated in other school districts to improve ocean and science literacy.

Another instructional trend found in relation to science summer camps concerns student motivation, which contributes to the development of student self-identity as scientists. Summer science camps often provide the environment to achieve that self-identity. In a case study about a science education camp hosted by the Chincoteague Bay field station for Grade 6-8 students, Riedinger (2015) hypothesized that summer science camps provide ideal opportunities for students to develop their identities as potential scientists due to the unique instructional environment of these camps. Riedinger noted that when students identify as scientists, they are motivated to pursue education and careers in science. Riedinger found that teachers in this summer camp provided high-interest topics and inquiry-based instructional activities that supported student interests in science. Riedinger also found that this camp offered diverse instructional opportunities for participants to explore science. Students developed self identity as scientists through engagement in varied instructional activities with their peers. Riedinger concluded that scientist self-identity was linked to peer groups with similar interests and to high engagement in the camp's science content. This study is important because it illustrates the significance of the social aspects of a summer science camp and the contribution of peer groups to developing science literacy in students.

In a qualitative study examining the perception of girls' participation in a STEM camp, Farland-Smith (2016) interviewed nine mothers about their perceptions of their daughters' attitudes about science before and after camp. Farland-Smith explored four categories of perceptions, which included involvement and interest, verbalization of science-related activities, changes in interest levels and participation, and noticeable differences in behavior. Farland-Smith found that summer camp provided a transformative experience for the girls who participated in the camp. The girls participating in the study demonstrated a shift from disinterest to an avid interest in science that parents attributed to their children's interactions with scientists at the camp. Farland-Smith also found that the girls carried their camp experiences into science classrooms during the academic year.

Thus, instructional practices that teachers use in summer camps are often place-based, inquiry-based, and related to the local ecology. These place-based and inquiry-based instructional practices are designed to help students develop a deeper connection to science content and to improve their science literacy skills. Based on this evidence, marine science summer camps that are focused on placed-based and inquiry-based instruction should also improve the ocean literacy skills of participating students.

Assessment trends. Assessment in summer science camps varies based on the objectives or outcomes of the particular camp. Assessments in science summer camps are used to determine camp effectiveness as well as the science career interests of students who have participated in camps (Culen & Mony, 2003). Other assessments used in science summer camps focus on the development of student self-identity as scientists that are aligned with their career goals (Talley et al., 2011). Studies relating to curricular and instructional practices in science often include descriptions of assessments that science educators use to demonstrate improved student achievement in science.

One trend is that many of the assessments that instructors use in summer science camps are associated with assessing student motivation to pursue careers in marine sciences. In a study examining ocean literacy for students in Grades 7-12 in Nova Scotia, Guest et al. (2015) found that participants who completed a survey reported placing a high economic value on jobs and careers related to marine science. Guest et al. concluded that recreational and economical uses of marine environments are a driving factor in the development of marine science education and an ocean literate public. This study is particularly important because determining student motivation in science is important in assessing the effectiveness of science summer camps that emphasize ocean literacy skills.

Another trend is that science educators often use assessments to determine student understanding of basic ocean science knowledge and to inform curricular and instructional choices. In early research about student experiences related to marine knowledge and attitudes, Fortner and Teates (1980) used the *Survey of Oceanic Attitudes and Knowledge* (SOAK) to assess the ocean literacy skills of Grade 10 students from Virginia. Fortner and Teates found coastal students scored significantly higher on the

SOAK than their inland counterparts. Additionally, students with higher economic status were found to be more likely to pursue marine science careers. This study is important because science educators can use assessment tools like the SOAK to establish baseline information regarding students' prior knowledge about ocean science to inform the curricular design of the camp.

Another assessment trend is that teachers at science summer camps often utilize both qualitative and quantitative instruments to assess marine science literacy. Lambert (2006) used three instruments, including the *Science Assessment in Literacy* (SAIL), *Students' Worldviews and Interests in Marine Science* (SWIMS), and *My Attitude toward Science, Technology, and Society* (MASTS), to assess marine science and science literacy for students in Grade 9-12 in Florida. Lambert found the quantitative scores for the SAIL and the qualitative responses for the SWIMS tools demonstrated improvement in science literacy and ocean science understanding. However, the MASTS pre and posttest results presented no significant differences in student attitudes toward science, technology, and society. Lambert also found that the SWIMS results indicated that students developed a better understanding of marine science content and of the social impact of science on their everyday lives. This study is important in relation to assessment trends for science summer camps because qualitative assessments can provide deeper insights into student connections to the science content than quantitative assessments.

In more current research, Gorospe et al. (2013) described how to engage students using an inquiry-based lesson in ocean acidification. Gorospe et al. utilized pre and posttest to measure knowledge about ocean acidification and hypothesis testing for Grade 9-12 students in Hawaii who participated in the Hawaii Institute of Marine Biology outreach program. Gorospe et al. found that students demonstrated a better understanding of both ocean acidification and hypothesis testing. This study is particularly important because pre and posttest results indicate student growth over time when teachers use an inquiry-based approach that supports a deeper understanding of scientific experimentation.

Thus, the assessments that teachers use in summer science camps depend on the camp's objectives. Assessments are often focused on measuring student attitudes about science careers and their identity as potential scientists when the goal of the camp is to recruit students to university degree programs. Pre and posttests are often tailored to the camp's unique curricula and instructional strategies in order to measure the specific content taught during the camp. However, research on assessments that science educators use during science summer camps was limited due to an emphasis on curriculum development and instructional strategies.

Summary and Conclusions

In summary, this chapter was focused on a review of the literature. This chapter included a description of the literature search strategy used to conduct this review and the conceptual framework related to learner centered instruction. The literature review included an analysis of research related to ocean literacy, which included a definition and brief history of ocean literacy as well as an analysis of both early and current research related to ocean literacy. In addition, research related to science summer camps was analyzed, including curricular, instructional and assessment trends. Research about middle school science education was also analyzed in relation to curricular, instructional and assessment trends.

Several themes emerged from this review. The first theme was that the NOAA (2013) defined ocean literacy and its related principles as the human influence on the ocean and the ocean's influence on humans. This definition was born out of research conducted to determine what students knew about the oceanic systems affecting their lives (Fortner & Teates, 1980). Educators and scientists across the United States participated in an ocean literacy campaign to promote ocean literacy nationwide, recognizing that the availability of resources was an indicator of understanding (Fortner & Mayer, 1991).

A second theme that emerged from this review was that science summer camps provide opportunities to improve science learning for K-12 students by continually adjusting and updating curriculum, instruction, and assessment. Science summer camp teachers encourage students to focus on science topics in an immersive environment with dedicated resources to develop an improved understanding of science topics (Aktamis et al., 2015). Science summer camps also encourage students to explore science in-depth and to develop an identity as scientists (Riedinger, 2015). Science summer camps provide students with the opportunities to experience science through inquiry-based instruction (Gorospe et al., 2013).

A third theme was that current trends in curriculum, instruction, and assessment at the middle school level in science education are focused on improving science literacy skills through inquiry-based instruction. This type of instruction has been shown to help middle school students relate science to real-world situations (Rutherford & Ahlgren, 1991). The utilization of high-interest topics with real-world connections may also enable positive social change, particularly in relation to resolving environmental problems (Hart, 2010). Science classrooms at the middle school level also include both traditional and outdoor settings in order that students have meaningful experiences with the content (Sezen Vekli, 2013).

Several research gaps also emerged from this review. Even though foundational studies have been conducted to determine baseline understanding of ocean literacy in the United States, much of the research has taken a broader view of environmental education, which means that few studies have been conducted regarding ocean science in particular (Fortner & Teates, 1980; Hart, 2010). Few studies were also found about the impact of science summer camps on ocean literacy. Additional gaps in the literature were found in relation to curricular trends in science education at the middle school level. In particular, few studies have been conducted on curricular trends that incorporate cross-cutting concepts and teacher training, especially in relation to science summer camps that emphasize ocean literacy. Chapter 3 will describe the research method that has been selected to address these gaps.

Chapter 3: Research Method

The purpose of this study was to describe the impact of a marine science summer enrichment camp on the ocean literacy skills of middle school students who participate in this camp. To accomplish that purpose, this study included a description of the perceptions of teachers, students, and parents about the impact of this camp on the ocean literacy skills of participating middle school students. In addition, this study included a description of teachers and student reflections about a learner centered teaching approach used at this camp. This study also included a description of how camp documents and archival records reflect a learner centered teaching approach in order to improve the ocean literacy skills of middle school students.

This chapter is about the research method. It includes a description of the research design and rationale, the role of the researcher, participant selection logic, and instrumentation. This chapter also includes procedures for recruitment, participation and data collection and the data analysis plan. Issues of trustworthiness and ethical procedures are also discussed in this chapter.

Research Design and Rationale

The research questions were based on the conceptual framework and the literature review for this study. They are as follows:

Central Research Question

How does a marine science summer enrichment camp impact the ocean literacy skills of students in Grades 6-8?

Related Research Questions

- What do teachers believe about the impact of this camp on the ocean literacy skills of middle school students?
- What do parents believe about the impact of this camp on the ocean literacy skills of their children?
- What do students believe about the impact of this camp on their ocean literacy skills?
- What reflections do teachers have about a learner centered teaching approach used at this camp?
- What reflections do students have about a learner centered teaching approach used at this camp?
- What do documents and archival records related to this camp reveal about a learner centered teaching approach to improving students' ocean literacy skills?

The research design selected for this qualitative study is a single case study. Yin (2014) defined case study research as an

> empirical inquiry that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident. (p. 16)

Based on the above definition, Yin contended that a case study examines a current phenomenon in a real-world situation. Yin also noted that a case study is bounded by context. Therefore, the boundaries between the selected phenomenon and the context must be explored to develop a clear understanding of the case itself. Yin also defined case study research as a design that

> copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis. (p. 17)

The collection of data from multiple sources in case study research provides a richer understanding of the boundaries between the selected phenomenon and the context of the real-world situation. These multiple data sources also add clarity to the phenomenon. Yin also noted that theoretical propositions often guide case study data collection and analysis.

A single case study research design was selected for this study to answer the research questions related to the phenomenon or case. The phenomenon or case for this study was a marine science summer camp for students in Grades 6-8, and the real-world context was the learner centered instructional setting for this camp. In order to present a rich picture of this phenomenon or case, multiple data sources were used including interviews with camp instructors, camp students, and parents; reflective journals that teachers and students maintained; and documents and archival records related to instruction, curriculum, and assessment at this summer camp. A theoretical proposition also guided data collection and analysis. The theoretical proposition for this study was that this marine science summer enrichment camp positively impacted the ocean literacy skills of students because a learner centered teaching approach was used to improve these skills.

Other qualitative research designs were considered and rejected, including phenomenology, grounded theory, and ethnography. Phenomenology is a research design that describes a shared phenomenon that participants of a study experience (Creswell, 2013). Phenomenological studies require participants to be carefully selected to develop a rich picture of the central phenomenon. For this study, phenomenology was not chosen as a research design because the purpose of this study was not to describe the lived experiences of teachers and students at this marine science summer camp.

Grounded theory was another qualitative research design considered for this study. It is typified by the generation of theory related to the central research question of the study (Merriam & Tisdell, 2015). Grounded theory involves developing a general explanation for the results that becomes foundational for later research (Creswell, 2013). This type of qualitative design requires a researcher to put aside prevailing theories so that a new theory can emerge from the data analysis. Grounded theory was also considered for the study but was rejected. The conceptual framework for this study about learner centered instructional practice is well-established, and therefore, the purpose of this study was not to develop a new theory to explain the phenomenon.

Ethnography is another qualitative research design that was considered for this study because it examines the culture of a group of individuals over time. Ethnography is a research design typically employed in social sciences such as anthropology to identify the language, behaviors, beliefs, and values of a group (Creswell, 2013). Participants in an ethnographic study also share experiences as well as cultural rules that have developed from this shared experience (Creswell, 2013). Researchers typically engage with participants through emersion into the study group’s culture (Creswell, 2013). This research design was rejected because the purpose of this study was not to describe the shared culture of camp participants over an extended period of time.

A quantitative design was not considered for this study for several reasons. The summer science enrichment camp selected for this study did not include a formalized assessment plan that used a valid and reliable instrument to measure ocean literacy skills for students. Finding or developing an appropriate assessment instrument also did not fit into the time frame of this study. However, the findings from this study have the potential to inform the selection of a formal assessment instrument for future studies that are based on a quantitative research design.

Role of the Researcher

As an individual researcher, I assumed several roles in conducting this study. I was responsible for selecting the research design for this study and the participants. I was also responsible for designing the data collection instruments in addition to recruiting the participants and collecting all data. I was also responsible for the transcription and analysis of all data. Therefore, the potential for researcher bias existed. To address that potential bias, I described specific strategies that I used to increase the trustworthiness of this qualitative research later in this chapter.

At the time of this study, I was the outreach coordinator for K-12 programs at the marine and science department overseeing the Marine Science Summer Enrichment Camp program. My duties included coordinating the camp program with university and community partners. I was responsible for recruiting instructional staff for camp positions. However, the camp director and the human resources director held final approval for hiring staff. Lead instructional staff members with the most camp experience were responsible for supervision and evaluation of all staff and for training new staff. Therefore, I did not have supervisory responsibilities for instructional staff. The summer of 2016 was also the final year that the NOAA sponsored the Marine Science Summer Enrichment Camp. The funding status of Marine Science Enrichment Camp was under review and was not guaranteed for the summer of 2017.

Methodology

For this study, a qualitative method was selected to answer the research questions. This methodology is described in the sections below in relation to participation selection logic, instrumentation, procedures for recruitment and participation, data collection, data analysis, issues of trustworthiness, and ethical procedures.

Participant Selection Logic

Participants included the following: (a) instructional staff at Marine Science Enrichment Camp, consisting of one certified K-12 science teacher, one marine science graduate with a master's degree in marine science, and one undergraduate college intern majoring in marine science, (b) three parents of children who participated in this camp, and (c) four students in Grades 6-8 who participated in the camp. A total of ten participants were included in this study, based on Yin's (2014) recommendations for a limited number of participants due to the collection of data from multiple sources and the in-depth analysis of data required for case study research.

Participants were purposefully selected, according to specific inclusion criteria. Science summer camp teachers were selected according to these criteria: (a) must have been employed at the Marine Science Summer Enrichment Camp from June 2016 to July 2016, (b) must have provided instruction in marine science to students in Grades 6-8 at this camp, and (c) must have received some training related to ocean literacy standards and learner centered teaching such as inquiry-based and place-based instructional strategies prior to providing instruction at the camp. Students in Grades 6-8 were selected according to these criteria: (a) must have participated in the Marine Science Summer Enrichment Camp from June 2016 to July 2016, (b) must have attended the full 4 weeks of the camp, and (c) must have been enrolled in Grades 6-8 at a public or private school or home school program during the 2015-2016 academic year. Parents were selected according to these criteria: (a) must have had a child enrolled in the Marine Science Summer Enrichment Camp from June 2016 to July 2016, (b) must be the legal guardian of a child who participated in the Marine Science Summer Enrichment Camp from June 2016 to July 2016, and (c) must have a child who was enrolled in Grades 6-8 at a public or private school during the during the 2015-2016 academic year.

Instrumentation

For this single case study, I designed three instruments: the interview guide, the participants' reflective journal, and the document and archival records data collection form based on Merriam and Tisdell's (2015) qualitative research guidelines for conducting effective interviews and for conducting a content analysis of documents. An expert panel of two colleagues with advanced degrees in education reviewed these instruments for alignment with the research questions in order to support the reliability and validity of the instruments. Table 1 indicates the alignment of each of these data collection instruments with the research questions

Table 1

Alignment of Research Questions with Data Collection Instruments

	Interview Guide	Reflective Journal	Documents	Artifacts
CRQ	X	X	X	X
RR1	X			
RR2	X			
RR3	X			
RR4		X		
RR5		X		
RR6			X	X

Interview guide. For this study, I designed an interview guide for parents and students, which included a brief script for the beginning and end of the interview as well as 7 open-ended questions for each group (see Appendixes G&H). I also designed an interview guide for teachers, which included a brief script for the beginning and ending of the interview as well as 9 open-ended questions (see Appendix F). According to Merriam and Tisdell (2015), a semi structured interview allows the researcher more flexibility in the interview because open-ended questions are used. Probing questions are also used when needed to gain clarity from unclear responses (Merriam & Tisdell, 2015). The interview questions were based on Merriam and Tisdell's guidelines for conducting effective interviews for qualitative research. These questions included experience and behavior questions and opinion and value questions in addition to a few demographic questions. The questions were structured to be open-ended, which encouraged participants to provide detailed responses about their experience during the ocean literacy summer camp. Table 2 describes the alignment of the research questions with the interview questions.

Table 2

Alignment of Research Questions with Interview Questions

Research Questions	*Interview Questions*
RRQ1: What do teachers believe about the impact of this camp on the ocean literacy skills of middle school students?	1 .Please describe your previous experiences as a marine science teacher.
	2. What curricular materials did you use at the 2016 Camp that you believe improved ocean literacy skills for middle school students?
	3. What instructional strategies did you use at the 2016 Camp that you believe improved ocean literacy skills for middle school students?
	4. What assessment strategies did you use at the 2016 Camp that you believe improved ocean literacy skills for middle school students?
	5. Why or why not do you believe that middle school students who participated in 2016 Camp improved their ocean literacy skills?
	6. Why or why not do you believe that middle school students who participated in 2016 Camp became more responsible for their own learning?
	7. What professional development in ocean literacy skills have you received that you believe improved teaching and learning at 2016 Camp?
	8. What professional development in learner centered teaching have you received that you believe improved teaching and student learning at 2016 Camp?
	9. What else would you like to tell me about this experience?
RRQ2: What do parents believe about the impact of this camp on the ocean literacy skills of their children?	1. Please explain why you enrolled your child at 2016 Camp.
	2. Why or why not do you believe the curricular materials used at 2016 Camp improved your child's ocean literacy skills?
	3. Why or why not do you believe the instruction teachers used at 2016 Camp improved the ocean literacy skills of your child?
	4. Why or why not do you believe the assessments used at 2016 Camp improved the literacy skills of your child?
	5. Why or why not do you believe your child's participation in 2016 Camp improved your child's ocean literacy skills?
	6. Why or why not do you believe your child's participation in 2016 Camp made your child more responsible for his or her learning?
	7. What else would you like to tell me about this experience?

(table continues)

Research Questions	*Interview Questions*
RRQ3: What do students believe about the impact of this camp on their ocean literacy skills?	1. Please explain why you wanted to attend the 2016 Camp. 2. What curricular materials did teachers at 2016 Camp use that you believe improved your ocean literacy skills? 3. What instructional strategies did teachers at 2016 Camp use that you believe improved your ocean literacy skills? 4. What types of assessments did teachers at 2016 Camp use that you believe improved your ocean literacy skills? 5. Why or why not do you believe that your participation in 2016 Camp has improved your ocean literacy skills? 6. Why or why not do you believe that your participation in 2016 Camp has helped you develop more responsibility for your own learning? 7. What else would you like to tell me about this experience?

Reflective journal. For this study, I also designed online reflective journal questions for teachers and students, which included 5 open-ended questions for each group (see Appendices I&J). In these journals, all participants were asked to reflect on the relation of a learner centered teaching approach to their instruction, based on Weimer's research. These journal questions also demonstrate the characteristics of an asynchronous interview because there was a delay in responses returned by email (Merriam & Tisdell, 2015). Table 3 describes the alignment of the research questions with the reflective journal questions.

Table 3

Alignment of Research Questions with Reflective Journal Questions

Research Questions	*Reflective Journal Questions*
RRQ4: What reflections do teachers have about a learner centered teaching approach used at this camp?	1. How would you describe your role as a science teacher during this marine science summer camp experience?
	2. How would you describe the balance of power between you and your students in your marine science classroom this past summer?
	3. How did you present science content to students during this marine science summer camp experience?
	4. How did you encourage students to take responsibility for their own learning during this marine science summer camp experience?
	5. How did you evaluate student learning during this marine science summer camp experience?
RRQ5: What reflections do students have about a learner centered teaching approach used at this camp?	1. How would you describe your role as a camper during this marine science summer camp experience?
	2. How would you describe the balance of power between you and your counselor or camp teacher in your marine science classroom this past summer?
	3. How was science content presented to you during this marine science summer camp experience?
	4. How were you encouraged to take responsibility for your learning during this marine science summer camp experience?
	5. How was your marine science learning evaluated during this marine science summer camp experience?

Document and archival records data collection form. A content analysis was used to describe the documents and archival records related to this marine science summer enrichment camp. The documents included the original grant proposal, teacher handbook, parent handbook, and the NOAA standards and scope and sequence for ocean literacy. Archival records included the teacher training records and records of camp evaluations. The data collection form for documents and archival records was adapted from Merriam and Tisdell's (2015) discussion about conducting a content analysis for qualitative research, which involves describing the purpose, structure, content, and use of each document. The data for each document and archival record was collected in relation to the purpose, structure, content, and use of each document or archival record (see Appendix K). Table 4 indicates the alignment of the research questions with this instrument.

Table 4

Alignment of Research Questions with Document and Archival Data Collection Form

Research Question	*Documents/Archival Records*	*Criteria*
RRQ6: What do documents and archival records related to this camp reveal about a learner centered teaching approach?	original grant proposal	Purpose, Structure, Content, Use
	teacher handbook	Purpose, Structure, Content, Use
	parent handbook	Purpose, Structure, Content, Use
	NOAA standards	Purpose, Structure, Content, Use
	NOAA scope and sequence	Purpose, Structure, Content, Use
	teacher training records	Purpose, Structure, Content, Use

Procedures for Recruitment, Participation, and Data Collection

In relation to recruitment, I first met with the Director of NOAA) Living Marine Research Cooperative Science Center (LMRCSC) at this university to explain the purpose of this study and to seek a signed letter of cooperation (see Appendix A), indicating the willingness of this university to be my research partner. I also asked this individual to provide me with the names and contact information of camp instructors, parents, and students who met the specific inclusion criteria for this study.

Concerning participation, I mailed a letter of invitation (see Appendix B), a consent form, and a self-addressed stamped envelope to three 2016 camp teachers who met the inclusion criteria, inviting them to participate in this study. I selected the first three teachers from this group who returned a signed letter of consent to me. I also sent a letter of invitation (see Appendix D), and a self-addressed stamped envelope to 20 camp parents who enrolled their children in this camp in 2016. In addition, I sent a letter of invitation (see Appendix C), a consent form and an assent form, and a self-addressed stamped envelope to 20 parents and/or guardians of middle school children who attended this camp in 2016, inviting their child to participate in this study. I selected the first three parent participants and four student participants who returned a signed letter of consent or assent to me. Even though both parents and their children were recruited for this study, they were not required to participate jointly, but joint participation also did not bar them from participation in this study.

In relation to data collection, I collected data in March and April 2017. I first conducted individual interviews with students in Grades 6-8. I sent students the reflective journal questions via an email link after I completed their interviews, asking them to return their responses to me within 2 weeks. I then conducted individual interviews with parents. I also conducted individual interviews with camp teachers and sent them the reflective journal questions via an email link after I completed their interviews, asking them to return their responses to me within 2 weeks. Interviews were about 30 to 45 minutes in length and were conducted in the marine science department conference room at this university to ensure privacy for all participants. I also collected documents and archival records from the camp director for the Marine Science Summer Enrichment Camp. These documents and archival records included the original grant proposal, camp parent handbook, camp counselor handbook, the NOAA standards and scope and sequence for ocean literacy, records of teacher training, and records of camp evaluations.

Data Analysis Plan

Data were analyzed at two levels. At the first level, an initial analysis of the interview data and the reflective journal data included using line-by-line coding that Charmaz (2006) recommended for qualitative analysis with support from NVivo qualitative software. A content analysis was used for the documents and archival records (Gall et al., 2007; Merriam & Tisdell, 2015), which involves a description of the purpose, structure, organization, content, and use of each document. Categories were then constructed for all coded data sources, using the constant comparative method that

Merriam and Tisdell (2015) recommended for qualitative research, which involves comparing similarities and differences in the coded data. Summary tables of the constructed categories were presented for all data sources. At the second level, the categorized data was analyzed to determine themes and discrepant data that informed the key findings. These key findings or results were analyzed in relation to the central and related research questions and interpreted in relation to the conceptual framework and literature review. This chapter also includes an analysis of discrepant data, which is defined as any data that challenges the theoretical position for this study. An example of discrepant data would be data that indicates the camp may have had a negative impact on ocean literacy skills for students.

Issues of Trustworthiness

Trustworthiness in qualitative research is important because the results impact people's lives (Merriam & Tisdell, 2015). Individuals who read this research need to be confident that the results are credible, dependable, transferable, and objective. Trustworthiness also means that the researcher carried out the study in an ethical manner with the well-being of the participants considered throughout the course of the study. Therefore, the constructs of credibility, transferability, dependability, and confirmability are discussed in relation to specific strategies that I used to improve the trustworthiness of this qualitative research.

Participant Demographics

Participants for this study included teachers, students, and parents who participated in the 2016 marine science summer enrichment camp. Teachers included one certified K-12 science teacher and two undergraduate college interns majoring in marine science and biology. Three parents of children in Grades 6-8 who enrolled in the 2016 camp also participated in the study. In addition, four students who were in Grades 6-8 at the time of the 2016 camp participated in this study. Pseudonyms were used for all participants in this study.

Teachers

Tina was a female teacher intern of Indian descent. Tina was in her second year of college. Tina had been a camp instructor for 11 to 13 year old students at the camp for 5 years. Before her experience as a camp instructor, she enrolled as a student at the camp for 5 years. Tina was also part of the first student cohort at the camp in 2009.

Tabatha was an African-American female instructor. Tabatha was a certified middle school teacher who taught Grade 8 physical science at a local middle school. She is also an alumna of the Coastal Ocean University where she had completed a bachelor’s degree in marine science and a master’s degree in education. Tabatha had taught 9 to 10 year old students and 11 to 13 year old students at the summer camp for 8 years.

Torrie was an undergraduate student in her fourth year at the Coastal Ocean University. As a camp intern, Torrie planned to complete a degree in marine science. Her first year working at the marine science summer enrichment camp was in 2016. Torrie and her fellow camp instructor supervised the 14 to 18 year old students. Torrie was also a frequent volunteer at other marine science education facilities in the local community.

Students

Stan was a Caucasian male student and was entering Grade 7 in the fall of 2016 at a local middle school. At the time of the 2016 camp, Stan was enrolled as a Grade 6 student at a local middle school. The 2016 camp session was his first experience at the camp. Stan joined the camp because of his interest in marine science.

Stella was a female student who was enrolled in Grade 7 at a local middle school. Stella had participated in the camp since she was 7 years old and she had also encouraged her younger sister to enroll in the camp. During the 2016 summer, Stella was in enrolled in the camp level for 11 to 13 year old students, marking her fifth year in the camp. Stella was also enrolled in the camp due to her interest in marine biology.

Salena was an African-American female student who was enrolled in Grade 9 year at a local high school. Salena was enrolled in the camp level for 14 to 18 year old students, which included Grade 8 students transitioning to high school. Salena had participated in the camp for 5 years. Salena was also one of four siblings who took part in the camp. Salena was interested in pursuing marine biology as a career and was taking high school courses in oceanography. Salena was interested in interning at the Coastal Ocean University to expand her interests in marine biology.

Stacey was an African American female student enrolled in Grade 8 at a local middle school. Stacey had completed Grade 7 at the local school and was enrolled in the camp level for 11 to 13 year old students. She was also one of four siblings who attended the marine science program. Stacey had no initial interest in the summer program during her first year as her career aspirations were in engineering. However, during her first year, the middle school camp experience incorporated engineering and technology activities with marine science, engaging her interest in marine science. Salena and Stacy were also siblings.

Parents

Patricia was a Caucasian female parent. The first year she had enrolled her child in the marine science summer enrichment camp was 2010. Although her child did not return to the camp in 2017, her family offered to sponsor another child to participate in the camp. Patricia was also an elementary school teacher in the local school district.

Peter was a Caucasian male parent. Peter had enrolled family members in the marine science summer enrichment camp for 6 years. Peter had two children who participated in the camp. Both children first enrolled in the camp at age 7. The oldest child was in Grade 7 and had been involved in the camp for 6 years. The youngest child had taken part in the camp for 2 years.

Patience was a female parent of African American descent and a local elementary school teacher. Patience had three children who participated in the camp over the 10 years the camp had been in existence. Her oldest child was part of the first cohort of students who participated in the camp beginning in 2009. Her middle child had been involved in the camp for 5 years. Her third child had taken part in the camp for 4 years.

Credibility

Credibility in qualitative research, Merriam and Tisdell (2015) contended, is defined as validity relative to the purposes and circumstances of the research. Validity is how logical or factual the data is in terms of being a realistic representation of the studied phenomenon. Merriam and Tisdell recommended specific strategies that researchers can use to improve the credibility of qualitative research. These strategies include triangulation, member checks, adequate engagement in data collection, discrepant data, reflexivity, and peer review.

For this study, I used the strategy of triangulation by comparing and contrasting multiple data sources such as interviews with multiple groups of participants, reflective journals maintained by two groups of participants, and archival data in a search for common themes. I also used the strategy of member checks by soliciting feedback from participants about the credibility of the tentative findings (Merriam & Tisdell, 2015).

Transferability

Transferability in qualitative research, Merriam and Tisdell (2015) contended, is defined as the extent to which the study can be applied to other situations. Merriam recommended specific strategies that researchers can use to improve the transferability of qualitative research. These strategies include the use of thick description, maximum variation or typicality of the sample, and modest extrapolation.

For this study, I used the strategy of thick description by describing the setting, participants, data collection and data analysis procedures, and results in detail. I also used the strategy of maximum variation of the sample by seeking three different types of participant populations, including camp teachers, parents, and students. In addition, I used the strategy of modest extrapolation by determining the applicability of the study's findings to similar situations.

Dependability

Dependability in qualitative research, Merriam and Tisdell (2015) contended, occurs when the results are consistent with the data that was collected during the study. Merriam recommended specific strategies that researchers can use to improve the dependability of qualitative research. These strategies include triangulation, peer examination, investigator's position, and the audit trail.

For this study, I used the strategy of an audit trail by including a detailed description of the data collection and data analysis procedures in a researcher's journal that I will maintain during the research process. I also used the strategy of triangulation by comparing and contrasting multiple data sources. In addition, I used the strategy of peer examination by using an expert panel to review the alignment of the data collection instructions with the research questions.

Confirmability

Confirmability in qualitative research, Merriam and Tisdell (2015) contended, is defined as objectivity. For this study, I used the strategy of reflexivity, which involves critical reflection on assumptions and potential biases present during the data collection and analysis process. This reflection was accomplished by maintaining a journal in which I reflected on my assumptions and beliefs about ocean literacy skills and learner centered teaching for middle school students.

Ethical Procedures

Conducting high-quality qualitative research requires adherence to ethical procedures. Merriam and Tisdell (2015) noted that qualitative researchers need to conduct research with integrity that involves their adherence to procedures that protect the participants. Research should be carried out that is ethically sound, always taking the safety of the participants and surrounding community into consideration. Informed consent allows participants to become fully informed about the research study. Providing reliable and valid instrumentation also provides an ethical foundation for data collection and analysis. Additionally, participants should be informed of the researcher’s role and motivation in conducting qualitative research.

For this study, I first submitted an application to conduct this study to the Institutional Review Board (IRB) at Walden University. This application included a signed letter of cooperation from the camp director at the NOAA LMRCSC at this university to indicate their willingness to be my research partner in this study. In addition, this application included signed informed consent and assent forms from participants explaining the purpose of this study and its potential risks and benefits. Participants were informed they could leave the study at any point without consequence. Students were asked to sign an assent form, and their parents were asked to sign a consent form to be sure their children’s responses were represented fairly. Camp teachers who participate in this study were also asked to sign a consent form. Pseudonyms were used for the university, the summer camp, and the participants to protect their privacy. I received IRB approval to conduct the study from Walden University with approval number 03-14-17-0201207 with expiration date March 13, 2018.

Summary

This chapter included a description of the research method for this study. The research design for this qualitative study was a single case study that examined the contemporary phenomenon of a marine science camp that was conducted in southeast Georgia during the summer of 2016. Participants who represented summer camp teachers, students, and parents of camp students at the middle school level were recruited to participate in this study. Documents and archival records were also collected to deepen the understanding of this single case study. Data were analyzed at two levels. At the first level, data from interviews and reflective journals were coded and categorized using the constant comparative method. A content analysis was used for the documents and archival records. At the second level, categorized data were examined to determine themes and discrepancies to inform key findings. The trustworthiness of this study was improved by using specific strategies that enhanced the credibility, transferability, dependability, and confirmability of the research. Chapter 4 includes a description of the results of this study in relation to the single case study research design.

Chapter 4: Results

The purpose of this study was to describe the impact of a marine science summer enrichment camp on the ocean literacy skills of middle school students who participated in this camp. The central research question for this study was: How does a marine science summer enrichment camp impact the ocean literacy skills of students in Grades 6-8? The related research questions were as follows:

- What do teachers believe about the impact of this camp on the ocean literacy skills of middle school students?
- What do parents believe about the impact of this camp on the ocean literacy skills of their children?
- What do students believe about the impact of this camp on their ocean literacy skills?
- What reflections do teachers have about a learner centered teaching approach used at this camp?
- What reflections do students have about a learner centered teaching approach used at this camp?
- What do documents and archival records related to this camp reveal about a learner centered teaching approach to improving students' ocean literacy skills?

This chapter is the results of this study. It includes a description of the setting at the time of the study and the participant demographics. Also, this study presents the details on the data collection and data analysis procedures. This chapter also contains evidence of trustworthiness in relation to the constructs of credibility, transferability, dependability, and confirmability. This study also includes the results of participant interviews, reflective journals, and document analysis.

Setting

The setting for this study was a 2016 marine science summer enrichment camp, located in the southeastern coastal region of the United States that Coastal Ocean University (pseudonym) supported. The purpose of the camp was to introduce local K-12 public school students to marine science and to generate interest in careers in marine science. At the time of this study, the camp had been in operation for 10 years with a mission to increase the ocean literacy of students, with particular emphasis to serve students in underserved populations and students who may not have opportunities to learn marine science at their schools. The camp was funded from 2010 to 2016 by a federal grant from the NOAA. Each year students who participated in the camp completed a pre and posttest on ocean literacy skills as part of an ongoing study that the Coastal Ocean University conducted. The camp facilities included a computer lab, an instructional laboratory, three classrooms, and outdoor access to salt marsh estuarine systems located on the university campus.

The camp was divided into four academic levels based on age and developmental level of the students. The first camp level was designed for 7 to 8 year old students who were in or entering Grades 1-3. The second camp level was designed for 9 to 10 year old students who were in or entering Grades 3-5. The third camp level was designed for 11 to

13 year old students who were in or entering Grades 5-8. The fourth camp level was designed for 14 to 18 year old students who were in or entering Grades 9-12. The third and fourth level of camp typically served a large number of students in Grades 6-8, which was the focus of this study.

Data Collection

Data were collected from multiple sources, including interviews, reflective journals, documents, and archival records. Interviews were conducted with parents, students, and teachers to obtain their perspectives on the impact of the camp on students' ocean literacy skills. Reflective journals were collected from students and teachers to develop an understanding of learner centered teaching practices that teachers used during the 2016 camp. Documents and archival records about the camp were gathered to understand the purpose and structure of the camp, the curriculum, and the instructional practices as they aligned with learner centered teaching practices to improve the ocean literacy skills of participating students.

Interviews

Interviews were scheduled and conducted between March 23, 2017, and April 12, 2017. Participants were given the option of a phone interview in place of an in-person interview to accommodate schedules and transportation barriers. All interviews were recorded with each participant's permission using a Livescribe™ Echo smartpen (2015). The date and length of each interview were recorded. Student interviews were a bit shorter, averaging 20 minutes because they gave less detailed responses to the questions. Table 5 contains a summary of participant interview collection.

Table 5

Summary of Participant Interview Collection

Participant	*Date of Interview*	*Interview Time*	*Length of Interview (min)*	*Location*
Stan	March 23, 2017	1:30 p.m. to 1:50 p.m.	20	private conference room
Patricia	March 23, 2017	2:00 p.m. to 2:20 p.m.	20	private conference room
Tina	March 24, 2017	9:00 a.m. to 9:30 am	30	phone interview
Tabatha	March 24, 2017	4:30 p.m. to 5:00 p.m.	30	phone interview
Stella	March 30, 2017	3:30 p.m. to 4:00 p.m.	30	private conference room
Peter	March 30, 2017	4:00 p.m. to 4:30 p.m.	30	private conference room
Salena	March 31, 2017	5:30 p.m. to 5:45 p.m.	15	private conference room
Stacey	March 31, 2017	5:45 p.m. to 6:00 p.m.	15	private conference room
Torrie	April 5, 2017	9:30 a.m. to 10:00 a.m.	30	private conference room
Patience	April 12, 2017	9:30 a.m. to 10:00 a.m.	30	phone interview

Reflective Journals

In addition to the interview data, reflective journal data was collected from teachers and students. Reflective journal questions were emailed to participants using SurveyMonkey® (2017). SurveyMonkey® was selected because each participant could be sent a private link. SurveyMonkey® also allowed participants to modify responses after submission. In addition, SurveyMonkey® also recorded other data such as the date the survey was initially sent, date of completion, and the length of time participants took to complete the journal questions. Reflective journal questions were sent to students on April 1, 2017, and the last response was received on April 25, 2017. Teachers were sent reflective journal questions on April 10, 2017, and the last response was received on April 26, 2017. The survey site collected each participant's responses which I downloaded to a secure thumb drive and removed from the SurveyMonkey® website. Table 6 is a summary of the reflective journal collection.

Table 6

Summary of Reflective Journal Collection

Participant	*Date sent*	*Date of completion*	*Time Spent (min)*
Salena	April 1, 2017	April 7, 2017	11
Stella	April 1, 2017	April 25, 2017	14
Stan	April 1, 2017	April 25, 2017	4
Tina	April 10, 2017	April 10, 2017	30
Torrie	April 10, 2017	April 17, 2017	31
Tabatha	April 10, 2017	April 26, 2017	41

Documents and Archival Records

The documents and archival records that I collected for this study include *11-13 Camp Curriculum* (2016) for 11 to 13 year old students*, 14-18 Camp Curriculum* (2016) for 14 to 18 year old students*,* the *2016 Counselor Handbook* (2016), the *Parent and Participants Handbook* (2016), and the standards document titled *Ocean Literacy: The Essential Principles and Fundamental Concepts* (2013)*, Ocean Literacy Scope and Sequence for Grades K-12* (2010). I collected the most recent evaluation and archival records for the camp program*,* which was titled *Performance Report for Cooperative Agreement No: NA11SEC4810002 for the Period from September 1, 2015 to February 29, 2016 (Revised)* (Chigbu a, 2016) and the grant award document which was titled *2011-2016 University of Maryland Eastern Shore: NOAA Living Marine Resources Cooperative Science Center: Grant No.NA11SEC4810002* (Chigbu et al., 2010) from the NOAA Living Marine Resources Cooperative Science Center website.

Table 7 contains a summary of the document and archival record collection including date, document or archival record collected and location.

Table 7

Summary of Document and Archival Record Collection

Date	*Document/Archival Record Collected*	*Location*
March 15, 2017	• 11-13 Camp Curriculum • 14-18 Camp Curriculum	camp offices
March 16, 2017	• The 2016 Counselor Handbook • Parent and Participant Handbook	camp offices
April 1, 2017	• Ocean Literacy: The Essential Principles and Fundamental Concepts (2013) • Ocean Literacy Scope and Sequence for Grades K-12 (2010)	Ocean Literacy Network website
April 18, 2017	• 2016Instructor Professional Development Plan (2016) • 2016 Master Schedule: Curriculum Map (2016)	camp offices
April 24, 2017	• Performance Report for Cooperative Agreement No: NA11SEC4810002 for the Period from September 1, 2015 to February 29, 2016 (Revised) (2016)	NOAA LMRCSC
April 28, 2017	• 2011-2016 University of Maryland Eastern Shore: NOAA Living Marine Resources Cooperative Science Center: Grant No.NA11SEC4810002 (2010)	NOAA LMRCSC

Regarding variations in the data collection process, a fourth student was included to add depth to student perspectives about the impact of the summer camp on the improvement of their ocean literacy skills. I was not able to access the original grant proposal. However, I was able to collect the 2011-2016 grant, which included data for the 2016 summer camp. I did not experience any other unusual circumstances in the data collection process.

Data Analysis Process

This section includes a description of the Level 1, and Level 2 data analysis conducted for each data source for this single case. The case was defined as the 2016 Marine Science Summer Enrichment Camp, which was located in the southeastern region of the United States. The interview and reflective journal questions were developed based on the central and related research questions. The alignment between the central and related research questions and the data sources for the study can be found in Tables 2-4. The first level of analysis identified the coding for each data source. The coding from the Level 1 analysis was used to create the categories. The second tier of analysis was informed by the categories developed in the initial analysis. The second level of analysis used the categories to construct 6 emergent themes related to the related research questions.

The first level of analysis was undertaken after interviews were recorded and transcribed, documents were collected, and participants returned the reflective journals through online software. I recorded, transcribed, and reviewed each interview for accuracy. Rather than using software to organize the data, I used the line-by-line coding method that Charmaz (2006) recommended for qualitative research to code the interview and reflective journal transcripts for each participant. Transcriptions were typed into Microsoft Word 2013 (Microsoft Office 365 ProPlus) documents, and the tracking feature was used to conduct the line by line coding. This line-by-line coding involved reviewing each sentence and then constructing a code that begins with an "–ing" word to stay as close to the words of the participant as possible.

From the coded transcripts, the constant comparative method that Merriam and Tisdell (2015) recommended for constructing categories from the coded transcripts for each data source was used to construct the initial analysis. The coded transcripts and reflective journal responses were moved to a Microsoft Excel 2013 (Microsoft Office 365 ProPlus) workbook to organize the data. The document was organized by interview or reflective journal question, and coded sections from each participant interview and reflective journal were placed in individual columns under corresponding questions. The coded sections were then grouped together utilizing the constant comparative method by comparing similarities and differences between the data segments (Merriam & Tisdell, 2015). Content analysis was used to describe the purpose, structure, content, and use of each document that I collected about the camp program. Repeated patterns found in the content analysis were used to construct the categories for the documents and archival records. The similarities and differences in the content analysis informed the emergent themes for the case study. A summary table of categories was constructed for each data source after the first level of analysis.

The resulting patterns in the data were utilized to create the categories used to develop the emergent themes in the second level of analysis. The Level 2 data analysis for this single case study constructed 6 themes that were selected from the Level 1 data analysis for all sources for this single case in relation to the central and related research questions. The emergent themes were constructed using Merriam and Tisdell's (2015) constant comparative method in connection the central and related research questions. The following 6 themes emerged from the analysis:

- Teachers believed that the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students.
- Students believed the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students.
- Parents believed that the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students.
- Teachers believed that they used a learner centered teaching approach at the 2016 marine science summer enrichment camp to improve the ocean literacy skills of students, which included their beliefs about the role of the teacher, the balance of power between students and teacher, the function of content, responsibility for learning, and the purposes of evaluation.

- Students believed that they experienced a learner centered teaching approach at the 2016 marine science summer enrichment camp, which included their beliefs about the role of the teacher and the student, the balance of power between students and the teacher, the function of content, responsibility for learning, and the purpose of evaluation.
- Documents and archival records related to the marine science summer enrichment camp were used to improve students' ocean literacy skills but did not indicate a learner centered teaching approach was used to achieve this improvement.

Also, discrepant data that emerged from the Level 1 data analysis to challenge the theoretical proposition for this study is also discussed. Both the emergent themes and discrepant data are the basis for the findings or results of this study and will be discussed in the next section.

Emergent Themes

Six emergent themes related to the research questions emerged from the data analysis. Each theme is supported by data from the interviews, reflective journals and document analysis based on the categories developed from the constant comparative method used while coding each data source. Each theme is presented with data and categories from the two part data analysis.

Theme 1: Teacher Beliefs

The first theme emerged from the teacher interviews. This theme was teachers believed that the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students. During the face to face and phone interviews, teachers consistently provided responses indicating the summer camp program positively impacted ocean literacy in middle school students. These responses consisted largely of the teacher's opinions regarding curricular materials, instructional strategies, assessments, student participation, and responsibility for learning and professional development which they felt contributed to the positive impact of the camp on ocean literacy. Participants were asked questions regarding their background and experience in teaching marine science. Each interview question is presented with summaries of teacher responses supporting this emergent theme.

Teacher interview data. The first teacher interview question asked, "*Please describe your previous experiences as a marine science teacher*." All three teachers for the marine science summer camp program described their prior experience in marine science education, either through the camp itself or other organizations. Tabatha and Torrie had earned or were earning a bachelor's degree in marine science. Tina's marine science teaching experience was primarily in the camp program. In addition to the camp program, Torrie volunteered at several of marine science educational organizations, such as the local marine science center, a charter school with a marine science focus and with marine science department at the university. Tabatha reported that she enjoyed teaching marine science because she had earned a degree in marine science.

The second teacher interview question asked, "*What curricular materials did you use at the 2016 marine science summer enrichment camp that you believe improved ocean literacy skills for middle school students?*" Tabatha and Torrie were similar in their responses to this question, citing a variety of curricular materials that they used to improve ocean literacy skills for middle school students, including computer resources, modified college labs, and field trips. Tina described her use of group work and independent work with students to improve their ocean literacy skills. Torrie also reported using the counselor notebook as a guide for providing more challenging activities to increase student engagement because many of the camp participants had attended camp the previous year.

The third teacher interview question asked, "*What instructional strategies did you use at the 2016 marine science summer enrichment camp that you believe improved ocean literacy skills for middle school students?*" Tabatha and Torrie both described specific instructional strategies that they used to improve the ocean literacy skills of middle school campers. Torrie shared a conversational instructional strategy, in which camp instructors talked with students about their interests in marine science and then built upon those interests by guiding students toward content and activities that reflected their interests about the ocean. Tabatha reported using the activities in the camp curriculum notebook along with supplementary materials such as games and instructional strategies that included placing students into pairs or groups. Another instructional strategy that Tabatha reported using was the KWL charts to determine students' previous knowledge about a topic. Tabatha also described placing students into groups or pairs to help them complete camp labs and activities. Tabatha added that she differentiated instruction by identifying camper academic strengths and weaknesses and prior knowledge of ocean literacy before she began instruction. Tabatha's identified student abilities through assessments such as the journals and quizzes according to her interview response. Students were then placed in flexible groups to develop academic and ocean literacy skills. Tabatha noted the camp curriculum included the integration of art into daily lessons. Tina's answers differed from the other teachers' responses because she described using different resources including videos and online activities before and during the activities.

The fourth teacher interview question asked, *"What assessment strategies did you use at the 2016 marine science summer enrichment camp that you believe improved ocean literacy skills for middle school students?"* All three teachers described specific assessment strategies that they used at camp to improve the ocean literacy skills of middle school campers. Tabatha and Tina noted that they asked students to summarize the lessons and what students learned from each camp day in their journals. Torrie described using self-assessment as a strategy to check student understanding of the day's marine science content. Tina reported that she asked students questions about what they learned about marine science and talked with students about what they learned each day at camp. Torrie also described using observations of student use of laboratory tools and equipment as an assessment strategy. Tabatha used pre and posttests, quizzes, and student products as assessments to improve ocean literacy skills for students.

The fifth teacher interview question asked, *"Why or why not do you believe that middle school students who participated in 2016 marine science summer enrichment camp improved their ocean literacy skills?"* All three teachers felt participating in the marine science camp program improved ocean literacy skills for middle school students. Tabatha indicated ocean literacy skills improved because the camp program included life and earth sciences as well as physics and chemistry. Tina expressed the opinion students improved their ocean literacy skills because students were motivated and interested in learning. Torrie felt student learning improved when they understood marine science terms and how to use the equipment. Torrie also noted that some students were not excited to be back at camp because they thought they would be repeating instructional activities such as the starfish lesson. Also, Tabatha felt the camp program introduced marine science as a STEM career pathway to many of the campers who had never been to the ocean before their camp experience.

The sixth teacher interview question asked, *"Why or why not do you believe that middle school students who participated in 2016 marine science summer enrichment camp became more responsible for their learning?"* All three teachers believed the camp program made students more responsible for their learning. Tina noted that instructors gave students more opportunities to be creative. Torrie reported that she asked students what they wanted to do in relation to marine science and placed them in leadership roles. Torrie gave students tasks to complete and asked them to figure out how to complete them, using problem solving skills and their knowledge of the marine science equipment. Tabatha held the opinion students were in control of the lab or activity for the day because they did the work themselves, which made them more responsible for their learning. Tabatha held the opinion that students who experienced inquiry activities such as labs about the oil spill made them more responsible for their learning.

The seventh teacher interview question asked, *"What professional development in ocean literacy skills have you received that you believe improved teaching and learning at the 2016 marine science summer enrichment camp?"* All three teachers reported that high school and college classes related to marine science were part of their professional development as teachers for the 2016 summer camp. Tabatha and Torrie reported using college courses that focused on marine science as the basis for their professional development. Tabatha was of the opinion her degree in marine science enabled her to teach curricular materials related to marine science more effectively. Torrie modified curricular materials from her college labs as the basis for instructional activities at camp. Tina felt her high school classes such as AP Chemistry and AP biology also helped her to teach marine science more effectively to camp students.

The eighth teacher interview question asked, *"What professional development in learner centered teaching have you received that you believe improved teaching and student learning at the 2016 marine science summer enrichment camp?"* Each teacher indicated they had participated in professional development in learner centered teaching. Each teacher received this training in different ways. Tina held the opinion her experience as a camper was a learner centered experience that helped her improve her teaching and learning. Tina reflected on her previous camp experience and emulated her favorite camp instructors. Tabatha had received professional development on differentiated instruction, teaching inner city students, and how to integrate mathematics and art into the classroom from the school district. Tabatha also trained in using Prometheus boards and Google docs as well as integrating writing into science instruction. Torrie believed that her experiences helping younger siblings with school work and life skills and participating in gymnastics classes improved her learner centered teaching because she was able to identify individual student learning needs and to provide guidance and opportunities for students to direct their learning.

The ninth teacher interview question asked, "*What else would you like to tell me about this experience?*" Each teacher reported different additional information about the summer camp program. Tina felt the camp was an amazing experience for the students in that they learned about marine science, loved the activities, and made friends. Torrie shared her observations the activities for middle school students transitioning to high school needed more challenge, particularly in relation to opportunities to put their knowledge to use by teaching younger students and developing leadership skills. Tabatha felt students needed the camp because they had not been to the beach or knew little about marshes and state ecology. Tabatha held the opinion the camp experience helped minorities and women become involved in STEM fields. Tabatha felt the camp offered students an opportunity to get involved in marine science and to develop their passions for marine science. Tabatha shared her opinion that the community did not always place education at the forefront, so the camp experience helped students work toward what they wanted to be.

Categories were generated from the interview responses based on similarities and differences using the constant comparative method recommended by Merriam and Tisdell (2015) in relation to interview and research questions. Table 8 is a summary of the categories constructed from the analysis of the teacher interview data. These categories were used to identify the first emergent theme which stated the teachers' belief the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students. These categories were used to identify the first theme in relation to the fifth related research question. The related research question and the first theme are discussed in the results section.

Table 8

Summary of Categories from Teacher Interview Data Analysis

Interview Questions	*Categories*
1. Please describe your previous experiences as a marine science teacher.	--Earning a degree in marine science --Volunteering for marine science organizations
2. What curricular materials did you use at the 2016 camp that you believe improved ocean literacy skills for middle school students?	-- Citing field trips -- Citing online resources -- Using the camp notebook
3. What instructional strategies did you use at the 2016 camp that you believe improved ocean literacy skills for middle school students?	-- Using small group instruction -- Using preassessments to modify content -- Using camp curriculum activities
4. What assessment strategies did you use at the 2016 camp that you believe improved ocean literacy skills for middle school students?	-- Believing assessment improved ocean literacy skills -- Using journal summaries -- Using self-assessment -- Using formative assessments -- Using observation of skills in use -- Using pre and post- assessments
5. Why or why not do you believe that middle school students who participated in the 2016 camp improved their ocean literacy skills?	-- Believing participation improved ocean literacy -- Believing participation improved science literacy -- Believing students were motivated to learn
6. Why or why not do you believe that middle school students who participated in the 2016 camp became more responsible for their own learning?	-- Believing camp experience made students responsible -- Believing students controlled their learning -- Believing students completed their own work
7. What professional development in ocean literacy skills have you received that you believe improved teaching and learning at the 2016 camp?	-- Citing college science courses improved teaching and learning -- Emphasizing high school AP science courses --Citing professional development from camp personnel
8. What professional development in learner centered teaching have you received that you believe improved teaching and student learning at the 2016 camp?	-- Receiving professional development on instructional strategies from the school district -- Using firsthand experiences as camper -- Using previous experiences working with children
9. What else would you like to tell me about this experience?	-- Believing camp provided a new experience to campers -- Believing camp provided leadership opportunity -- Believing camp connected campers with outdoor environment --Believing camp provided science instruction not found in local schools

Theme 2: Student Beliefs

The second theme to emerge from the data was the student's belief that the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students. During the face to face interviews, students provided responses to seven open-ended questions supporting this theme. Student participants offered the opinion the summer camp program improved their ocean literacy skills through curricular materials, instructional strategies, and assessments. Students reported the camp improved their responsibility for learning as well due to their participation in camp. Each interview question is presented with summaries of the students' responses which were used to inform the categories used to inform the second theme.

Student interview data. The first student interview question asked, "*Please explain why you wanted to attend the 2016 marine science summer enrichment camp.*" Students' answers were similar in that they all wanted to participate in the summer camp program because they were interested in marine science. Stan, Stella, and Salena indicated they wanted to be marine biologists. Stacy was not initially interested in the camp, but she wanted to attend camp again because many of the marine science activities were related to engineering, the field she wanted to pursue as a career.

The second student interview question asked, "*What curricular materials did teachers at the 2016 marine science summer enrichment camp use that you believe improved your ocean literacy skills?*" Stella and Salena shared the opinion curricular materials that emphasized hands-on activities and experiential learning, such as the marsh walks, improved their ocean literacy skills because they were able to observe the content that teachers presented in a real world context. Stan felt curricular materials, including tools such as a refractometer and Secchi disk, improved his ocean literacy skills because he learned the tool's function and was able to use the tool. Stan also believed that curricular materials that emphasized hands-on activities, such as looking at sharks' teeth and dissecting starfish, improved his ocean literacy skills because he was able to identify the species of sharks based on their teeth and anatomy of a starfish through guided instruction. Stacey also noted that curricular materials that emphasized field trips and the use of the microscope improved her ocean literacy skills because she was able to use the content to identify plankton under the microscope.

The third student interview question asked, "*What instructional strategies did teachers at the 2016 marine science summer enrichment camp use that you believe improved your ocean literacy skills?"* All of the students described different instructional strategies that teachers used to enhance their ocean literacy skills. Stan believed that playing games such as fish hangman improved his ocean literacy skills because it improved his marine science terminology. Stella held the opinion that teachers helped her improve her ocean literacy skills by answering her questions and helping her understand how marine science can impact engineering design. Salena felt the instructional strategies that teachers used to improve her ocean literacy skills included a mock debate about a local river dredging that enabled larger container ships to travel to various ports. This debate forced Salena to think about the impact of the river dredging on the environment and the economy. Stacey noted that teachers reduced paper and pencil activities by asking them to complete hands-on inquiry activities, which she believed improved her ocean literacy skills.

The fourth student interview question asked, "*What types of assessments did teachers at the 2016 marine science summer enrichment camp use that you believe improved your ocean literacy skills?"* All of the students believed that the assessments teachers used at camp improved their ocean literacy skills. Two of the students, Stan and Stella, thought that exit tickets were an assessment that developed their ocean literacy skill because teachers asked them what they had learned for the day. Salena and Stacey described the camp group project as an evaluation that improved their ocean literacy skills because they were required to present this project in front of the class. Stella noted that teachers also used pre and posttests to improve her ocean literacy skills.

The fifth student interview question asked, "*Why or why not do you believe that your participation in the 2016 marine science summer enrichment camp has improved your ocean literacy skills?"* All of the students agreed their participation in the camp experience improved their ocean literacy skills. Stan believed his camp participation improved his ocean literacy skills because he learned information about the ocean that he did not know and that there was still more to learn. Stella was of the opinion the camp experience improved her ocean literacy skills because she learned more about marine science than she knew before she enrolled in the camp. Salena felt her ocean literacy skills improved because these skills were not taught in school. Stacey held the opinion the information about marine science that teachers presented at camp prepared her for the Grade 7 academic year because the content was presented in camp the summer before Grade 7. Stacey added that she used her camp journals to help her study for her Grade 7 science tests. Salena felt she could use what she learned in camp to help her perform better on state assessments in science and other science content tests in high school.

The sixth student interview question asked, "*Why or why not do you believe that your participation in the 2016 marine science summer enrichment camp has helped you develop more responsibility for your own learning?* All of the students believed their participation in the camp improved their responsibility for learning. Two of the students, Stella and Stacey, shared similar responses about how their participation in the camp helped them develop responsibility for their learning, particularly in improving their teamwork skills. However, Salena thought involvement in the camp only helped students to become responsible for their learning if they were motivated to learn. Stella also felt the camp experience made her a more responsible learner because she learned how to manage the completion of several projects. Also, Stella felt the camp experience helped her learn information about marine science that she previously believed was not interesting. Stan thought he took more responsibility for his learning because the camp experience was well organized and planned.

The seventh student interview question asked, "*What else would you like to tell me about this experience?"* Stan and Stella reported that they made friends at camp who were interested in similar facets of marine science. Stacey and Salena's responses focused on the camp teachers. Stacey felt more connected with the younger camp teachers. Salena felt she was ready to become a camp teacher.

Student interview data was used to create categories based on the constant comparative method to identify similarities and differences between the 4 interview participants. Students repeatedly identified the camp as having a positive impact on their ocean literacy skills. Table 9 is a summary of the categories constructed from the analysis of the student interview data. The second theme, students believed that the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students, is based on the evidence from the student interviews and resulting categories. The second theme will be discussed further as to how this finding answers the second related research question.

Table 9

Summary of Categories from Analysis of Student Interview Data

Interview Questions	*Categories*
1. Please explain why you wanted to attend the 2016 camp.	--Having an interest in marine science --Wanting a career in marine science
2. What curricular materials did teachers at the 2016 camp use that you believe improved your ocean literacy skills?	-- Participating in hands-on inquiry activities improved ocean literacy skills -- Using marine science tools improved ocean literacy skills -- Noting curricular materials emphasizing field trips improved ocean literacy skills
3. What instructional strategies did teachers at the 2016 camp use that you believe improved your ocean literacy skills?	-- Believing games improved ocean literacy skills -- Getting individual help from instructors
4. What types of assessments did teachers at the 2016 camp use that you believe improved your ocean literacy skills?	-- Believing exit slips improved ocean literacy skills -- Working on final camp project improved ocean literacy skills -- Noting pre and posttests improved ocean literacy skills
5. Why or why not do you believe that your participation in the 2016 camp has improved your ocean literacy skills?	-- Learning new information about marine science -- Using information from camp in academic year science courses -- Believing camp prepared students for state tests
6. Why or why not do you believe that your participation in the 2016 camp has helped you develop more responsibility for your own learning?	-- Improving teamwork skills -- Learning to manage projects -- Increasing interest in topics students did not select
7. What else would you like to tell me about this experience?	-- Making friends at camp -- Connecting with instructors

Theme 3: Parent Beliefs

The third theme emerged from the parent interviews regarding the 2016 summer camp program which was, parents believed that the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students. Parents repeatedly shared the opinion the summer camp program improved ocean literacy through curricular materials, instructional activities and assessments. Parents also expressed the opinion the summer camp improved their student's responsibility for learning through participation in the summer camp. The parent interview questions with response summaries are presented below. Responses were compared for similarities and differences to generate categories.

Parent interview data. The first parent interview question asked, "*Please explain why you enrolled your child in the 2016 marine science summer enrichment camp.*" Two of the parents, Peter and Patricia, reported that both their children had an interest in marine science. The third parent, Patience, enrolled her child in the camp because of his love for science. Patricia thought the program would be good for her son. Peter noted the camp experience included many outdoor activities, and he expressed the opinion the camp experience helped his daughter develop her knowledge about marine science. Patience pointed out that teachers did not emphasize science during the school year and that the camp experience was different from traditional sports camps as the camp focused on improving academic skills rather than athletic skills.

The second parent interview question asked, *"Why or why not do you believe the curricular materials used at the 2016 marine science summer enrichment camp improved your child's ocean literacy skills?"* All parents were of the opinion the curricular materials used at this camp improved their children's ocean literacy skills. Peter thought the curricular materials used at the camp improved his child's ocean literacy skills because his child learned about how animals interact with the ocean. Patience also believed that the curricular materials used at the camp improved her child's ocean literacy skills because her child was aware of the alignment of the camp curriculum to the curriculum taught during the school year. Patricia felt her child already had good ocean literacy skills but noted that her child could use those skills in hands-on inquiry activities at camp rather than memorizing facts from independent reading.

The third parent interview question asked, "*Why or why not do you believe the instruction teachers used at the 2016 marine science summer enrichment camp improved the ocean literacy skills of your child?"* All three parents felt the instruction that teachers provided at this camp improved the ocean literacy skills of their children. Patience felt camp instruction improved the ocean literacy of her child because camp instructors demonstrated knowledge about and backgrounds in marine science. Patricia noted that camp teachers used hands-on inquiry activities, such as exploring the marsh and the ocean, to improve her child's ocean literacy skills. Peter pointed out that his child had participated in this camp for 4 or 5 years, and she wanted to take part in camp again next summer. Patience noted that camp teachers had developed a unique relationship with students because they had been camp teachers for several years, and she believed these relationships helped teachers to know how to teach campers. Peter also noted that his child wanted to participate in the camp again because his child thought the instruction made learning exciting. Patricia reported that the camp experience gave her children a hands-on and real life experience in marine science.

The fourth parent interview question asked, *"Why or why not do you believe the assessments used at the 2016 marine science summer enrichment camp improved the literacy skills of your child?"* All three parents held the opinion the assessments used at the camp improved the ocean literacy skills of their children. Patricia felt the exit slips were effective assessments because teachers learned what students were interested in or engaged in in relation to marine science. Peter thought assessments helped his child establish goals to improve his ocean literacy skills. Patience added that she believed assessments built a foundation for learning beyond the summer camp experience.

The fifth parent interview question asked, *"Why or why not do you believe your child's participation in the 2016 marine science summer enrichment camp improved your child's ocean literacy skills?"* All three parents believed their children's participation in the camp program developed their ocean literacy skills. Patricia felt her child learned information about marine science that he did not know, even though he already had many experiences with the ocean. Peter noted that his child made an effort to use her ocean literacy skills after camp by utilizing strategies to minimize the impact on the environment and to teach her family ocean literacy principles. Patience believed that participation in the camp improved her son's social skills and helped him put more effort into learning.

The sixth parent interview question asked, *"Why or why not do you believe your child's participation in the 2016 marine science summer enrichment camp made your child more responsible for his or her learning?"* All three parents felt their child's involvement in the camp made their children more accountable for their learning. Patricia thought her child was interested in marine science, wanted to know more about marine science, and loved to participate in the camp experience, which made her more responsible for her learning. Peter felt his child wanted to get as much out of the camp experience as possible so she could use the learning for school and family activities related to the ocean. Patience noted that her child was more responsible for his learning because camp teachers expected him to be on time and to be prepared as well as to be a team player and leader.

The seventh parent interview question asked, *"What else would you like to tell me about this experience?"* Parents differed in their responses to this question. Patricia believed the closing program was robust, especially the videos. Peter like the fact that he had an opportunity to view the products that students made during the camp experience. Patricia felt the camp was a positive experience for her child because the staff worked well with him. Peter thought that a benefit of the camp experience was that a variety of instructors taught outdoor skills. Patience repeated the notion that the teachers did not focus enough on science during the academic year, and therefore, the camp experience gave her child an additional opportunity to have fun and to learn science.

The codes and summaries of the parent interviews were used to create categories regarding the parent's opinions about the summer camp's impact on their student's learning and ocean literacy. Table 10 is a summary of the categories constructed from the analysis of the parent interview data. The categories were used to inform the third theme regarding parent perceptions the camp positively impact the ocean literacy skills in middle school students. These categories were used to identify the third theme in relation to the fifth related research question. The related research question and the third theme are discussed in the results section.

Table 10

Summary of Categories from Analysis of Parent Interview Data

Interview Questions	*Categories*
1. Please explain why you enrolled your child in the 2016 camp.	-- Noting child was interested in marine science -- Noting child was interested in science -- Noting teachers did not emphasize science during academic year
2. Why or why not do you believe the curricular materials used at the 2016 camp improved your child's ocean literacy skills?	-- Believing curricular materials improved ocean literacy skills -- Believing child learned about marine science -- Seeing alignment between camp and state science standards -- Noting child learned to use marine science knowledge in hands on activities during camp
3. Why or why not do you believe the instruction teachers used at the 2016 camp improved the ocean literacy skills of your child?	-- Believing instruction improved ocean literacy skills -- Noting teachers used hands-on instruction -- Noting child wanted to participate in camp again -- Noting real life experience with marine science improved ocean literacy skills
4. Why or why not do you believe the assessments used at the 2016 camp improved the literacy skills of your child?	-- Believing assessments improved ocean literacy skills -- Believing assessments set goals for learning -- Believing assessments informed instruction
5. Why or why not do you believe your child's participation in the 2016 camp improved your child's ocean literacy skills?	-- Believing participation in camp improved ocean literacy skills -- Believing participation improved understanding of marine science content -- Believing camp improved social skills -- Noting child used content outside of camp to minimize human impact on the environment
6. Why or why not do you believe your child's participation in the 2016 camp made your child more responsible for his or her learning?	-- Believing participation in camp made child more responsible for learning -- Believing child wanted to learn more -- Noting child was expected to be prepared to learn each day
7. What else would you like to tell me about this experience?	-- Noting end of camp program showed what child learned in camp -- Noting instructors worked well with child -- Noting teachers did not adequately emphasize science during academic year

Theme 4: Teacher Reflections

The fourth theme was teachers believed that they used a learner centered teaching approach at the 2016 marine science summer enrichment camp to improve the ocean literacy skills of students, which included their beliefs about the role of the teacher, the balance of power between students and teacher, the function of content, responsibility for learning, and the purposes of evaluation. This theme is supported by data and categories from the teacher's reflective journal responses. The teacher's responses are summarized and divided by journal questions below.

Teacher reflective journal data. The first teacher reflective journal question asked, *"How would you describe your role as a science teacher during this 2016 marine science summer enrichment camp experience?"* Torrie and Tabatha presented similar responses. Torrie described her role as directing the learning by keeping campers on task and encouraging them to decide what they wanted to learn about marine science. Tabatha described her role as enhancing campers' knowledge of marine ecology and oceanography. Tina's answer was different from the other teachers in that she believed her role was as a role model and moral compass for students.

The second teacher reflective journal question asked, *"How would you describe the balance of power between you and your students in your marine science summer enrichment classroom this past summer?"* In describing the balance of power in the classroom, all three teachers described some degree of shared power. Teachers also described the amount of power students had in the classroom differently. Tina believed the balance of power between herself and her students was equal because she learned from the students as they did from her. Torrie encouraged campers to help her in determining what they were interested in learning. Tabatha believed that she had 60% of the power and students had 40% of the power in the classroom because students chose the labs they did for the day. Tabatha and Tina both believed that they learned from their students. For example, Tabatha learned that students enjoyed making decisions in the classroom. In addition, Torrie and Tina both described challenging students. Torrie encouraged students to have fun while learning. Tina noted that students helped her view marine science concepts in different ways through a variety of products that students created during camp.

The third teacher reflective journal question asked, *"How did you present science content to students during this marine science summer enrichment camp experience?"* All three teachers reported that they presented marine science content at camp using a variety of instructional methods. Tina presented the content by integrating marine science concepts into activities that she believed campers enjoyed. Torrie designed hands-on activities such as requiring students to work with different types of equipment in the marine science building. Tabatha reported that she presented marine science content through labs, field trips, power point presentations, and classroom instruction.

The fourth teacher reflective journal question asked, *"How did you encourage students to take responsibility for their own learning during this marine science summer* *enrichment camp experience?"* Both Torrie and Tina presented similar responses to this question. They believed that they placed students in charge of their learning. Tina encouraged students to take responsibility for their own learning by giving them flexibility in how they completed instructional activities. Tina gave students a few guidelines they had to follow but told them to be as creative as they wished according to those guidelines. Torrie assigned students to leadership roles such as putting them in charge of helping younger students during field trips. Torrie also required students to become more familiar with the marine science equipment such as a Secchi disk, a dissolved oxygen meter, and a salinity refractometer and trusted them to get help using the tools when needed instead of relying on instructors to use the equipment. Tabatha's response was different from Tina's or Torrie's response. Tabatha noted that some of the labs were designed to be competitive, which helped students be more responsible for their learning by increasing their engagement in the lab. Tabatha also noted that some of the activities involved arts and crafts that required students to be responsible for their individual product.

The fifth teacher reflective journal question asked, *"How did you evaluate student learning during this marine science summer enrichment camp experience?"* Tina and Tabatha presented similar responses regarding evaluations of student learning during the camp program. Both teachers cited journals as a method of evaluation. Tina evaluated student learning by asking students what they learned at the end of the day, and she read their journals to evaluate their learning. Tabatha also cited daily journal writing as an evaluation of student learning. Tabatha also used quiz bowl competitions and summative assessments of ocean literacy principles to measure student learning. Torrie evaluated student learning by asking students questions as they completed different marine science activities.

The reflective journal question responses coded and grouped into categories using Merriam and Tisdell's (2015) constant comparative method. The similarities and differences in the responses created categories which informed the theme from the participants' responses to the reflective journal questions. Table 11 is a summary of the categories constructed from an analysis of the reflective journal questions for teachers. The theme, teachers believed that they used a learner centered teaching approach at the 2016 marine science summer enrichment camp to improve the ocean literacy skills of students, was based on the repetitions in the written responses from the teachers. This theme's relationship to the related research question will be discussed in the results section.

Table 11

Summary of Categories from Analysis of Teacher Reflective Journal Data

Reflective Journal Questions	*Categories*
1. How would you describe your role as a science teacher during this marine science summer enrichment camp experience?	--Directing student learning --Encouraging students to make decisions about their learning --Enhancing student knowledge about marine science --Serving as a role model and moral compass for students
2. How would you describe the balance of power between you and your students in your marine science summer enrichment classroom this past summer?	-- Believing teachers learned from students -- Encouraging campers to decide what content to learn -- Believing power in the classroom was shared
3. How did you present science content to students during this marine science summer enrichment camp experience?	-- Presenting marine science using a variety of curricular materials -- Designing activities related to different marine science tools -- Using familiar activities to teach new content
4. How did you encourage students to take responsibility for their own learning during this marine science summer enrichment camp experience?	-- Giving students flexibility in what and how they learned -- Encouraging students to complete creative projects with guidance -- Requiring students to become familiar with marine science tools -- Integrating arts and crafts into instruction -- Increasing student engagement through competitive activities
5. How did you evaluate student learning during this marine science summer enrichment camp experience?	-- Using student journals to evaluate learning -- Using self-assessments -- Asking questions about student learning -- Using alternative assessments such as quiz bowls

Theme 5: Student Reflections

The fifth theme is students believed that they experienced a learner centered teaching approach at the 2016 marine science summer enrichment camp, which included their beliefs about the role of the teacher and the student, the balance of power between students and the teacher, the function of content, responsibility for learning, and the purpose of evaluation. This theme is supported by the data from the student reflective journal and categories created from the coding using Merriam and Tisdell's (2015) constant comparative method. Student responses to the reflective journal questions are summarized in the next section according to each question from the reflective journal.

Student reflective journal data. The first student reflective journal question asked, *"How would you describe your role as a camper during this marine science summer enrichment camp experience?"* Two of the student participants described their role as campers during the marine science camp. Salena described her role as a student researcher as she learned specific research skills during the camp. Stella also identified as a researcher, which made her camp experience enjoyable. Stan noted he liked the camp but did not describe his role as a camper.

The second student reflective journal question asked, *"How would you describe the balance of power between you and your counselor or camp teacher in your marine science summer enrichment classroom this past summer?"* Students presented similar responses in describing the balance of power between students and educators in their marine science classrooms at camp. Stan believed that teachers listened to students and students listened to teachers, so the balance of power was equal. Stella believed that camp instructors had the authority to teach the content, but teachers allowed students to determine content based on students' interests. Salena believed the balance of power in her marine science classroom between students and the teacher was neutral. Salena noted that students and teachers respected each other and tried to resolve problems at camp by talking about the issues.

The third student reflective journal question asked, *"How science content was presented to you during this marine science summer enrichment camp experience?"* Stella and Salena presented similar responses about how teachers presented science content during the camp. Stella believed the content was presented in different ways, including hands-on activities, presentations, lectures, and debates, to meet the needs of students who learn in different ways. Salena also believed that teachers presented science content in various forms, such as hands-on inquiry activities, interactions with other campers, and technology. Stan did not address the question.

The fourth student reflective journal question asked, *"How were you encouraged to take responsibility for your learning during this marine science summer enrichment camp experience?"* Each student gave varied responses about how they were invited to take responsibility for their learning at camp. Stan felt teachers supported students and helped them during classroom activities. Stella thought camp teachers taught them that it was their responsibility to learn about marine science by creating projects and completing labs. Salena had the opinion the research skills that teachers taught made students more responsible and increased their engagement in the camp experience.

The fifth student reflective journal question asked, *"How was your marine science learning evaluated during this marine science summer enrichment camp experience?"* All three students agreed that teachers evaluated their marine science learning by using pre and posttests. Stella had the opinion these tests helped students to understand how much they knew about marine science before and after the camp experience. Stella added that teachers asked them about their previous knowledge of marine science and how that knowledge had changed over time. Salena noted that teachers evaluated their marine science learning through group projects. Stan noted that teachers used pre and posttests to evaluate his marine science learning.

Categories were formed from similarities and differences found through coding student responses. Table 12 is a summary of the categories constructed from an analysis of the reflective journal questions for students. These categories were used to identify the fifth theme in relation to the fifth related research question. The related research question and the fifth theme are discussed in the results section.

Table 12

Summary of Categories from Analysis of Student Reflective Journal Data

Reflective Journal Questions	*Categories*
1. How would you describe your role as a camper during this marine science summer enrichment camp experience?	--Noting role as student researcher --Learning specific research skills
2. How would you describe the balance of power between you and your counselor or camp teacher in your marine science summer enrichment classroom this past summer?	-- Believing two-way communication existed -- Believing power was shared between teachers and students -- Noting mutual respect between teachers and students
3. How was science content presented to you during this marine science summer enrichment camp experience?	-- Believing content was presented through hands-on activities, presentations, lectures, and debates -- Believing content was presented through interactions with other students and technology
4. How were you encouraged to take responsibility for your learning during this marine science summer enrichment camp experience?	-- Encouraging responsibility for learning -- Supporting students in lab activities -- Providing guidance in completing group/individual projects -- Teaching research skills
5. How was your marine science learning evaluated during this marine science summer enrichment camp experience?	-- Using pre and posttests to evaluate learning -- Evaluating learning through group projects -- Assessing prior knowledge

Theme 6: Documents and Archival Records

The sixth theme to emerge from the data was documents and archival records related to the marine science summer enrichment camp proved a structure to improve students' ocean literacy skills. The documents and archival records did not indicate a learner centered teaching approach was used to achieve improvement in ocean literacy. Each document and archival record underwent a content analysis examining content, purpose, structure, and use. Summary data from the documents and archival records are described in the next sections.

Documents. The documents that were collected for this case study included the grant, ocean literacy principles, curricular scope and sequence, camp curriculum documents, and handbooks for the camp. These documents could be applied to any camp year during the camp program's operation. In the document analysis, I have described the purpose, structure, content, and use of each document.

Grant. The first document collected was titled *University of Maryland Eastern Shore: NOAA Living Marine Resources Cooperative Science Center: Grant No. NA11SEC4810002* (Chigbu et al., 2010). The purpose of the grant was to report the science plan for the grant awarded for marine science programs and projects between 2011 and 2016. The science plan provided the approved programming from the grant proposal that was submitted to fund programs provided from university partnerships. Another purpose of the document was to inform the public about how NOAA Educational Partnership Program funds were to be used. The 26-page document was divided into five main sections with three to six subsections each. Each section was organized according to the following topics: overview, goals, strategies and approach, performance metrics, and risks for scientific research. The document contained tables and diagrams in support of related content. The content of the document included descriptions of projects, programs, and research for the cooperative center. The document also contained the organizational and reporting structure for funding. Each section contained content related to an introduction, the center for scientific management, research activities at the LMRCSC, education, and outreach, and appendices. Program objectives for the 2011-2016 award included (a) recruiting and retaining students from underrepresented minorities in marine science academic tracks and careers and (b) developing scientific collaborations among partner institutions. Education and outreach activities for the grant award included seminars, presentations, and K-12 programs. The K-12 programs included a kayak camp, the marine science enrichment camp, and a high school mentorship program. The marine science summer enrichment camp for this study was intended to serve as a national model to train youth and undergraduate and graduate students in ocean literacy. The document was used to outline a five-year plan for the grant awarded for 2011-2016. The document was also used to report the intent and objectives of education, research, and programming for the cooperative science center. In addition, this document was used to understand the objectives, research goals, and program targets for cooperative center research and programs.

Ocean literacy principles. The second document collected was titled *Ocean Literacy: The Essential Principles and Fundamental Concepts of Ocean Sciences for Learners of All Ages Version 2 (2013).* The purpose of this document was to present the definition of ocean literacy principles and the intended use of these principles. This document was a partner to the document titled *Ocean Literacy Scope and Sequences for Grades K-12 (2010).* This 13-page document was divided into two sections. The first section contained content related to the development of the ocean literacy definition, using the ocean as a teaching tool, the ocean literacy framework, and the ocean literacy campaign. The second section contained the seven ocean literacy principles and 45 fundamental concepts. The fundamental concepts were aligned with the ocean literacy principles based on content. The first ocean literacy principle was supported by eight fundamental concepts, including (a) the ocean is the defining feature of Earth, (b) ocean basins are the sea floors and their geographical features, (c) one interconnected circulation system is powered by the wind, tides, the Earth's rotation, the Sun and water density differences, (d) sea level is the height of the ocean relative to land, (e) 97% of the Earth's water is in the ocean, (f) the ocean is an integral part of the water cycle, (g) all major watersheds on Earth drain to the ocean, and (h) the ocean's resources are limited. The second ocean literacy principle was supported by five fundamental concepts, including (a) many of the Earth's materials and biogeochemical cycles originate in the ocean, (b) sea level changes over time shape the surface of the lands, (c) erosion deposition occurs, (d) the ocean is the largest reservoir of cycling carbon, and (e) tectonic activity, sea level changes and force of waves shape the coastlines. The third ocean literacy was supported by seven fundamental concepts, including, (a) interaction between the atmosphere and ocean controls weather and climate, (b) the ocean moderates global warming, (c) the heat exchange between the ocean and atmosphere can result in weather phenomena, (d) water evaporated from warm seas provides the energy for hurricanes, (e) the ocean dominates the Earth's carbon cycle, (f) the ocean has a significant influence on climate by absorbing heat, carbon, and water, and (g) changes in the ocean atmosphere system can result in changes to the climate. The fourth ocean literacy principle was supported by three fundamental concepts, including (a) most of the oxygen in the atmosphere comes from photosynthetic organisms in the ocean, (b) the ocean is the cradle of life, and (c) the ocean provides water, oxygen, and nutrients to sustain life on earth. The fifth ocean literacy principle was supported by nine fundamental concepts, including (a) life in the ocean ranges in size from the smallest to the largest living organisms on Earth, (b) most of the life in the ocean are microbes, (c) organism diversity is greater in the ocean than on land, (d) ocean biology provide unique examples of life, (e) the ocean provides vast and diverse habitats and ecosystems for organisms to thrive, (f) ocean ecosystems are defined environmental factors and organism communities, (g) deep ocean ecosystems use chemosynthetic organisms to support life, (h) zonation in the ocean influences organisms' distribution and diversity, and (i) estuaries provide nursery areas for many marine species. The sixth ocean literacy concept was supported by seven fundamental concepts, including (a) the ocean affects every human life, (b) the ocean provides food, medicines, minerals and energy resources, (c) the ocean is a source of recreation and discovery, (d) humans affect the ocean in a variety of ways, (e) changes to the ocean temperature and pH due to human activity can affect the survival of organisms in the ocean, (f) much of the world's population live in coastal areas, and (g) everyone is responsible for caring for the ocean. The seventh ocean literacy principle was supported by six fundamental concepts, including (a) the ocean is the largest unexplored place on Earth, (b) exploration is required to understand better the ocean systems, (c) use of ocean resources has increased over the last 50 years, (d) new technologies are created to explore the ocean, (e) use of mathematical models is essential to understanding ocean systems, and (f) ocean exploration is interdisciplinary. This document was used by the camp instructors to understand the history and content of the ocean literacy principles. Teachers were encouraged to use this guide to enhance their instruction as it related to ocean science. Teachers could use this document to select content related to marine and ocean science to improve the ocean literacy skills of students.

Ocean literacy scope and sequence. The third document collected was titled *Ocean Literacy Scope and Sequences for Grades K-12(2010).* The purpose of this document was to guide teachers related to the integration of ocean literacy principles by grade level into marine science instruction at the camp. The document was a partner to the document titled *Ocean Literacy: The Essential Principles and Fundamental Concepts of Ocean Sciences for Learners of All Ages Version 2(2013).* The structure and content of the document included seven flow charts for each of the seven ocean literacy principles.

The flow charts were divided into four grade-level groups. The grade level groups were K-2, 3-5, 6-8, and 9-12. The fundamental concepts for each environmental principle were presented as recommended instructional sequences. The content was presented as branch topics, major concepts to the branch topic, and supporting ideas for further discussion related to the branch topic. The content of the document included each of the ocean literacy principles and their related fundamental concepts. The main ocean literacy principles were the branch topics. The fundamental concepts were aligned to their ocean literacy principles as the major concepts to the branch topic. Supporting ideas were grade level specific topics for discussion about the ocean literacy principles. The camp coordinator used this document to help camp instructors align their lessons and activities to the ocean literacy principles. The camp instructors also used this scope and sequence in selecting curriculum content at an appropriate depth for each grade level. In addition, camp instructors used this document to develop or select lessons, activities, and other instructional materials appropriate to each camp level.

Camp curriculum. The first curriculum document that I collected was titled the *11-13 Camp Curriculum (2016)*, which was designed for 11 to 13 year old students. The purpose of this document was to provide a description of the curriculum and instruction that teachers should use for camp students enrolled in Grades 6-8. This document served as a teacher's guide to the content, instruction, and inquiry skills to be taught in each camp module. In addition, the purpose of this document was to provide instructional activities that were aligned with the ocean literacy principles and Next Generation

Science Standards. The document's structure and content were organized into seven chapters. Chapter 1 included descriptions of the ocean literacy principles. Chapter 2 included activities that teachers could conduct for the parent day presentations for the 2016 camp. Chapter 3 was devoted to hurricane awareness. Chapter 4 contained camp activities for such events as the annual trip to the local beach. Chapter 5 included activities that teachers could use at all camp levels. Chapter 6 contained lesson plans specific to the camp level for students in Grades 6-8. Chapter 7 included electronic resources for the camp program. The document concluded with a list of references and sample lesson plans that teachers could use. This document was used by camp teachers to prepare for each camp day and to guide their instruction. The document was used as a reference tool for instructors because the lesson plans also included background science information for each instructional activity. Camp instructors were also encouraged to use these lesson plans in their science classrooms.

The second curriculum document collected was titled the *14-18 Camp Curriculum (2016)*, which was designed for 14 to 18 year old students. The document's purpose was to provide instructional materials for camp instructors that were aligned with the ocean literacy principles and the Next Generation Science Standards. This document also contained the curriculum activities used students at this level. The document was also designed as a guide for camp teachers relative to the content, instruction, and inquiry skills to be taught in each camp module. The document structure included a list of references for the marine science information and lesson plans referenced in this document. In relation to the structure and content of this document, Chapter 1 contained descriptions of the ocean literacy principles. Chapter 2 contained the activities that teachers could use for the parent day presentations for the 2016 Marine Science Summer Enrichment Camp program. Chapter 3 was devoted to hurricane awareness. Chapter 4 contained camp activities such as the annual trip to the local beach. Chapter 5 included activities used at all camp levels. Chapter 6 contained the lesson plans specific to this group of students. Chapter 7 contained the electronic resources that teachers could use. Chapters 1-5 and 7 included the same information as found in the curriculum document designed for 11 to 13 year old students. Chapter 6, however, included age appropriate activities for 14 to 18 year old students. Instructors used this document to prepare their instruction for each camp day. Similar to the other curriculum document, camp instructors used this document to inform themselves about the content and assessment practices for the 2016 marine science summer enrichment camp program. The document was also used as a reference tool for instructors because it included marine science information for each lesson plan. Camp instructors were also encouraged to use these lesson plans in their science classrooms during the academic year.

Camp counselor manual. The sixth document collected was titled the *Counselor (Teacher) Manual (2016).* The purpose of the manual was to provide a set of guidelines for camp counselors or teachers relative to instruction and behavior expectations for students. The manual also provided information about camp policies, procedures, curriculum, and developmentally appropriate interventions to provide a stimulating educational experience for camp participants. In relation to structure, the manual was organized into 32 topics. Examples of topics included basic camp information, expectations of camp counselors, dress code, cell phone usage, work schedule, curriculum overview, field trips, campers' basic needs, behavioral interventions, and discovery-based learning. The content of the document was divided into categories with similar themes. Information applying to all levels of the camp such as dress code and employee policies was presented in the first nine pages of the document. Camp instructors were given important dates during the camp program, appropriate dress for camp, and an example of a daily schedule. The next section of the manual focused on the expectations for a summer enrichment experience. Instructors were introduced to expectations for behavior by age level. Each developmental section included a list of the developmental characteristics of campers based on their age and their meaning to the teacher. The next section focused on behaviors, interventions, and support strategies that teachers should keep in mind for their camp levels. This section was divided by age, gender, and academic levels. The next section included the discipline policy for the camp. Expectations for camper behavior were detailed in the next two sections. The first section described camp procedures for handling discipline problems. The next section focused on group instruction strategies such as how to develop clear communication between instructor and students. This section was followed by content regarding camp safety and general first aid. According to these sections, each instructor was provided with America's Red Cross First Aid and CPR training at their developmental level. The final sections of the manual focused on discovery-based learning as an instructional strategy. Marine science summer enrichment camp personnel used this document to train new instructors. The instructors used the document over the summer camp as a reference tool for understanding the camp policy and instructional expectations for students. The document was also used to inform camp staff about employment responsibilities and developmentally appropriate strategies for behavior interventions for camp participants.

Parent handbook. The seventh document that I collected was titled *Parent & Participant Handbook (2016).* This document was designed to provide parents and camp participants with written procedures and expectations for the camp experience. The purpose of the document was to also describe the policies of the hosting university regarding youth safety and an overview of the camp's structure and mission. In relation to structure and content, this nineteen-page document contained nine main sections with corresponding topics about the summer camp program. These nine sections included basic information, registration policies, camp information, camp program, camper development, camp counselors, child abuse policy, first aid, medicine, emergencies and the campus map. The basic information sections included the camp location, central office location and contact information, and camp hours. The registration policy section included the registration and selection procedures for the camp program. The section called camp information included drop off and pick up times for campers. The handbook section contained the camp schedule as well as protocols for parent volunteers. The camp schedule was divided into the daily schedule and monthly calendar. The section on camper development focused on the development of self-esteem and appropriate behaviors in camp. Content included inclusive policies for students with special needs. Disruptive behavior and zero tolerance policies for camper safety were outlined in this section as well. The camp counselor section defined the camp instructors' qualifications and expected behaviors. This section defined staff duties as well as protocols regarding information sharing during camp. The section containing first aid, medication, and emergency procedures included the camp's policies and procedures for medical situations. This document was distributed to parents through the hosting university's website so that parents could reference expected behaviors, appropriate dress, and behavioral intervention strategies. The document was also used to inform potential camp participants about the program structure and registration policies.

The document content analysis informed the categories used to support the sixth theme. Table 13 is a summary of the categories from the documents' content analysis. These categories were combined with the data from the archival records to inform the sixth theme for the case study as it relates to the related research question. The results of the document analysis and the sixth related research question are discussed in the results section.

Table 13

Summary of Categories for Documents Content Analysis

Documents	*Categories*
Camp curriculum	-- Providing a description of curriculum -- Segmenting activities and labs to be taught -- Including curriculum aligned with ocean literacy principles -- Containing background information to inform teaching -- Preparing instructors for each camp day
Parent handbook	-- Providing camp policies and procedures -- Structuring information into sections -- Containing information about the camp -- Containing information about behavior expectations -- Containing information about staff -- Informing potential participants about camp policies
Camp counselor handbook	-- Providing camp policies and procedures -- Containing basic camp information -- Containing instructional strategies -- Serving as a training manual for camp teachers -- Serving as a reference guide for camp teachers
Ocean literacy principles	-- Describing the ocean literacy principles -- Describing fundamental concepts related to ocean literacy principles -- Enhancing science education
Ocean literacy scope and sequence	-- Providing instructional guidance -- Partnering with ocean literacy principles -- Presenting appropriate content depth -- Being used to select or develop lessons
Grant	-- Outlining grant programs -- Providing funding for research and K-12 programs -- Informing public about intended programs -- Outlining five-year plan objectives

Archival Records. The archival records that I collected included a curriculum map, the professional development plan for the 2016 summer and the grant program evaluations. These records were specific to the 2016 summer camp whereas the documents could be applied to any camp. In the archival record analysis, I have described the purpose, structure, content, and use of each archival record.

Curriculum map. The first archival record collected was titled *2016 Master Schedule: Curriculum Map (2016).* The purpose of this archival record was to provide a curriculum map for the 2016 camp. The curriculum map also acted as a pacing guide for camp instructors in relation to teaching ocean literacy skills. The structure of the curriculum map was based on a four-week calendar. This archival record was organized according to each camp level. Each day's schedule and camp instructional modules were organized and color coded by event type. Field trips away from campus were coded in green font. Regular camp modules were coded in black font. Guest speakers and their topics were coded in red font. Locations of camp modules such as docks, dry lab, and computer labs were included in this record. The content of this archival record included lessons from the curriculum notebooks to be taught during the 2016 summer camp. Each lesson was assigned a time slot and date. This archival record also contained locations associated with lessons, such as the marsh walk lesson that was conducted in the open space behind the marine science instructional building. The purpose of this archival record was to prevent overlap between different camp levels for rooms and resources. The camp instructors used the curriculum map as a pacing guide for instruction to ensure all ocean literacy principles were taught over the course of the summer. The camp director and coordinator also used this curriculum map to communicate the camp schedule, including locations, field trips, and special speakers, to camp staff.

Performance reports. The second archival document collected was titled *Performance Report for Cooperative Agreement No: NA11SEC4810002 for the Period from September 1, 2015 to February 29, 2016 (Revised) (Chigbu and Stevens, 2016).* The purpose of this record was to report the progress of programs from the cooperative science center. The report included evaluation of programs under the cooperative science center and its partner institutions for the grant awarded for 2011-2016. The 63-page document was structured according to the goals of the grant award. Each goal was divided into specific objectives outlined in the grant award. The record included sections on performance related to education and outreach activities, success stories, and amendments to the award. The contents included the most recent annual evaluation of the progress of the 2011-2016 grant award. The education and outreach activities were evaluated according to the number of students supported, impact on community members, and the success of K-12 modules piloted at the camp. The cooperative science center supervisors used the annual report to evaluate the cooperative science center programs for undergraduates and graduate students, research projects, and K-12 education and outreach programs. The cooperative science center supervisors also used this archival record to inform the public about progress related to the 2011-2016 grant award. The marine science camp staff used this record to evaluate their progress as a part of the cooperative science center and to make adjustments to meet the 2011-2016 grant award goals for education and outreach program objectives.

Professional development plan. The third archival record collected was titled the *2016 [Marine Science Summer Enrichment Camp] Instructor Professional Development Plan (2016).* The purpose of this archival record was to provide the timeline and content of professional development for the camp instructors. The purpose of this record was to serve as a curriculum map to train camp staff in the ocean literacy principles and content to be taught at the camp. The structure of this record was based on a timeline for professional development, which was arranged in a daily format with learning objectives aligned with each training day's content and the ocean literacy principles. The document was designed to partner with the [*Marine Science Summer Enrichment] Camp Curriculum* documents for instructors. The content of this archival record was a schedule and description of the content for each professional development session, which included Red Cross First Aid and CPR training, classroom management for new instructors, and camp instructional units. This archival record contained the locations of each professional development session as well as the associated instructional events for camp instructors. The lead camp instructors used this archival record to train camp instructors in marine science education. The camp coordinator also used this archival record to inform camp instructors of mandatory professional development sessions such as the youth risk assessment training and to provide the professional development schedule to camp instructors, informing them of the content and location of instruction. Camp instructors also used this archival record to track their professional development.

The archival records content analysis informed the categories used to support the sixth theme. Table 14 is a summary of the categories from the archival records' content analysis. These categories were combined with the data from the documents to inform the sixth theme for the case study. The results of the archival record content analysis as they pertain to the sixth related research question are discussed in the results section.

Table 14

Summary of Categories for Archival Record Content Analysis

Archival records	*Categories*
Curriculum map	-- Providing pacing guide for camp -- Outlining camp calendar -- Including lessons, field trips, and guest speakers -- Ensuring instruction of ocean literacy principles
Performance reports	-- Evaluating grant programs -- Describing how grant objectives are met -- Evaluating success of K-12 programs -- Evaluating progress as part of cooperative science center
Professional development plan	-- Providing content of professional development -- Using timeline format -- Containing learning objectives -- Containing lessons from camp curriculum -- Tracking professional development

Discrepant Data

Discrepant data is defined as data that challenges the theoretical proposition (Yin, 2014). For this single case study, the theoretical proposition was that the 2016 marine science summer enrichment camp had a positive impact on the ocean literacy skills of middle school students who attended this camp. The only challenge to the theoretical proposition of the study was that some of the documents and archival records did not support a learner centered teaching approach. In particular, I anticipated that the parent handbook and the camp counselor manual would provide evidence of a learner centered teaching approach, but they provided no evidence.

Evidence of Trustworthiness

Trustworthiness in qualitative research is important because the results impact people's lives (Merriam & Tisdell, 2015). Results from a study should be obtained in an ethical manner in order to be considered valid and reliable. The rigor of a qualitative study, therefore, impacts the trustworthiness of the results, and this rigor can be achieved through the consistent use of strategies related to the constructs of credibility, transferability, dependability, and confirmability. The strategies I used to address credibility, transferability, dependability, and confirmability are discussed below in relation to the results of the study.

Credibility

Merriam and Tisdell (2015) defined credibility or internal validity as "how the research findings match reality" (p.242). To improve the credibility of this study, I used the strategy of triangulation by comparing and contrasting multiple data sources in a search for common themes, including interviews with teachers, students, and parents; reflective journals that teachers and students maintained, and documents and archival data. I also used the strategy of member checks by soliciting feedback from participants about the credibility of the tentative findings (Merriam & Tisdell, 2015). The results of the study were distributed to participants for review in May 2017. Participants reported the "analysis of the interviews are thorough and reflect the positive impact of the [camp] from various perspectives (teachers, parents, and campers.)."

Transferability

Transferability in qualitative research, according to Merriam and Tisdell (2015), is defined as the extent to which the study can be applied to other situations. To improve the transferability for this study, I used the strategy of "thick description"(Merriam & Tisdell, 2015, p. 256) by describing in detail the setting of this single case study, which was the camp and the university, as well as teacher, student, and parent participants, and the data collection and data analysis procedures that I used to obtain the results. I also used the strategy of maximum variation of the sample by seeking three different types of participant populations, including camp teachers, parents, and students. In addition, I used the strategy of modest extrapolation by determining the applicability of the study's findings to similar situations.

Dependability

Dependability, according to Merriam and Tisdell (2015), occurs when the results are consistent with the data that was collected during the study. To improve the dependability of this study, I used the strategy of an "audit trail" by including a detailed description of the data collection and data analysis procedures that I followed in a researcher's journal that I maintained during the research process (Merriam & Tisdell, 2015, p. 251). I also used the strategy of triangulation by comparing and contrasting multiple data sources, as I indicated earlier. In addition, I used the strategy of peer examination by using an expert panel of two colleagues with advanced degrees in education to review the alignment of the data collection instructions with the research questions.

Confirmability

Confirmability in qualitative research, Merriam and Tisdell (2015) contended, is defined as objectivity. For this study, I used the strategy of "reflexivity" which involves a critical reflection about my assumptions and potential biases that might be present during the data collection and analysis process (Merriam & Tisdell, 2015, p. 249). I accomplished this critical reflection by maintaining a journal in which I reflected on my assumptions and beliefs about ocean literacy skills and learner centered teaching for middle school students. Initially, I made the assumption that the 2016 camp documents and archival records would provide support for learner centered instruction. However, after a detailed examination of the documents and archival records, I found no evidence of a learner centered teaching approach. In addition, I made an assumption that participants would respond to the interview questions and reflective journal questions about learner centered teaching and ocean literacy principles in that they would provide more detailed initial responses to these questions. To address this assumption, I could have used more probing questions to encourage participants to respond in more detail to these questions.

Results

This section is about the results of this single case study, based on an analysis of the interview and reflective journal data and a content review of 2016 camp documents and archival records. The results of the study are presented in relation to the research questions. The central research question with supporting data is discussed first. Other relevant information related to the central research question will be discussed under the related research questions.

Central Research Question: Impact of Camp on Students' Ocean Literacy Skills

The central research question asked, "*How does a marine science summer enrichment camp impact the ocean literacy skills of students in Grades 6-8?*" The key finding was that this camp had a positive impact on the ocean literacy skills of students in Grades 6-8 who were enrolled in this camp in 2016.

All data sources supported this finding. Concerning the interview data, teachers, students and parents believed the 2016 marine science summer enrichment camp program positively improved the ocean literacy skills of middle school students. Tabatha, a camp teacher, held the summer camp "was an opportunity to get kids intrigued and involved in the STEM field." Tina, another camp teacher, noted that "students loved the [marine science] activities" and demonstrated growth in their understanding of ocean literacy during the duration of the camp. Patience, a parent, had confidence in that "teachers knew how to teach" marine science to students based on their backgrounds in marine science. Peter viewed the camp as a way for his child to "grow her intelligence" in marine science. Patricia believed that "[the camp] would be a good program for [her child] to be involved in" to develop his interest in marine science further. Stella, a student, noted that "before I came to [camp], I did not know as much as I do." Stacey, also a student, added that "the activities were fun, and I did not exactly have to be a marine biologist, [because] I [could] use that information in a different career." Stan, another student, stated that he would recommend the marine science camp program to other students as a way to improve their ocean literacy skills. Thus, teachers, parents, and students believed that the 2016 marine science summer enrichment camp improved students' ocean literacy skills.

In relation to the reflective journal data, teachers and students believed a learner centered teaching approach at the 2016 marine science summer enrichment camp improved the ocean literacy skills of students, which included their beliefs about the role of the teacher, the balance of power between students and teacher, the function of content, responsibility for learning, and the purposes of evaluation. Concerning the role of the teacher, Tina, a camp instructor, reported they encouraged students to take responsibility for their learning during the camp experience by "by giving leeway in the activities they did." Torrie, another camp teacher, described her role at camp as a guide "by allowing [students] to lead in what they wanted to learn [about the ocean]." Tabatha said her instructional role was "to enhance campers' knowledge of marine ecology and oceanography."

Concerning the balance of power in the classroom, students believed that this power was shared between students and teachers. Stella, a camper, thought teachers "taught [us] a lot about marine ecosystem" by guiding students through camp activities. Stan believed the power between student and teacher was shared because "the [teachers] listened to [him] and [he] listened to the [camp teachers]." Salena thought the power between student and teacher was shared because she was able to "talk out problems" and concerns with her camp instructors as well as identifying mutual respect between camp teachers and students by stating, "we both respected each other." Tina, a teacher, had confidence the balance of power was shared because "[students] had to do what we told them, but they could change how they completed a project." Torrie, another teacher, noted that she "kept activities challenging" while taking student interests into consideration when teaching at the camp. Tabatha noted students were given "full power over how they wanted to present what they learned to the parents" and choice of "the labs [the students] did for the day," but she determined the content student would learn each camp day.

Concerning the function of content, teachers and students both reported multiple resources were used to present marine science content, which made the content more interesting. Tabatha noted using the online game "Kahoot" and field trips to "aquariums and the beach" to present marine science content. Torrie, another teacher, noted using "college oceanography labs" to engage students in more challenging marine science content. Salena, a student, noted that teachers used hands-on activities to follow-up lessons on marine science content they had taught the previous day.

Concerning responsibility for learning, both teachers and students believed the camp experience made students more responsible for their learning. Teachers thought students were more responsible for their learning due to the flexibility they had established in relation to their instructional methods. Torrie said she and her co-teacher "put [the students] in leadership roles of working with other middle schoolers" made students more responsible for their learning. Tabatha noted that an emphasis on "creativity through arts and crafts activities, competitive activities and [students had to write daily in their journals about what they learned" in the classroom motivated students to be more responsible for their learning. Tina, another camp instructor, had confidence they encouraged students to be more responsible for their learning by giving students a choice in how projects and labs were completed by stating:

> We gave them more independence than what they had in the [regular] classroom. We would just present it to them, and then we would let them take it over from there. They had to do what we told them, but they could change it up if they wanted, so they had more freedom to do their own thing.

Students also reported that teachers guided them in becoming more responsible for their learning. Stacey stated, "working in a small group made me more responsible for my learning." Salena identified the guided research process as a source of her excitement "to find out more about the [marine science] topics," which she understood improved her responsibility for learning. Stella thought the end-of-camp project fostered responsibility for her learning because she was required to present this project to her parents.

Concerning the purposes and processes of evaluation, teachers and students both believed that the purpose of the evaluation was to improve students' ocean literacy skills and that a variety of assessments were used to accomplish that purpose. Tina, a camp teacher, evaluated student learning daily by "asking them what they learned at the end of the day and reading the [students'] journals." Tabatha identified journals, pre and post-tests, quizzes, and student products as types of assessment she used to evaluate improved ocean literacy. Torrie reported using observations, oral presentations, and use of marine science equipment to determine mastery of students' ocean literacy skills. Salena, a student, noted that teachers used pre and posttests to improve her ocean literacy skills. Stan, another student, pointed out that teachers used "a worksheet on different fish, and where they are, where they live, what ocean they are in and what type of animals they prey on" to assess his ocean literacy skills. Stella also noted that teachers used pre and posttests to evaluate her ocean literacy skills and that the results of these tests encouraged her to continue to improve her skills.

Documents and archival records from the 2016 marine science summer enrichment camp were also used to improve the ocean literacy skills of middle school students who participate in this camp. In relation to the documents, teachers used the camp curriculum guide in combination with the ocean literacy principles and the scope and sequence documents to inform the marine science content for the 2016 summer camp. In relation to archival records, the curriculum map and the professional development plan provided instructional guidance for marine science instructors at the 2016 summer camp. The curriculum map provided the timeline for teachers in relation to when they should teach specific marine science concepts and skills to students at the camp experience. Camp administrators, including the camp coordinator and the camp director, used the professional development plan to train camp teachers about best practices in marine science instruction. The grant provided the framework for recruitment of camp students, and the performance records included an evaluation of the camp experience. These performance records were used to report the number of students engaged in outreach each year of the grant and to make adjustments to camp curriculum and recruitment procedures to improve the diversity of camp participation. The handbooks provided information to teachers and parents about camp procedures and behavior expectations for students, but they did not contribute to an understanding of how to improve their ocean literacy skills.

Related Research Question 1: Teacher Beliefs

The first related research question asked, *"What do teachers believe about the impact of this camp on the ocean literacy skills of middle school students?"* The key finding was that teachers believed the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students.

Interview data supported this finding. All three of the camp instructors believed that students who participated in the 2016 camp improved their ocean literacy skills. Tina stated, “I know they improved their ocean literacy skills.” To support this statement, Tina described how students often discussed camp activities they liked and what they learned from these activities during noninstructional times such as the daily recess. Torrie also expressed that her students improved their ocean literacy skills due to the instructional approach she and her co-instructor used to increase student engagement. Torrie noted, “We let them pick what we were going to learn about,” using the curriculum guide to inform their instruction. As an example, Torrie described the buoyancy egg lab in which students learned about the challenges of neutral buoyancy and how fish utilize this buoyancy to sink and rise in the water. By the end of camp, Torrie believed her students improved their ocean literacy because:

> from the beginning to the end, [students] were understanding more of the [marine science] terms that we were using and they knew all the different equipment [used in marine science], and what the equipment does and [the students] were enjoying it a little more by the end.

Tabatha thought the camp program offered students an experience that they had never had before as well as a possible career pathway. Tabatha noted:

> A lot of [the students in the community] have never been to the ocean, or the marsh and [the summer camp] provided [an] opportunity to learn about the ocean, and [marine science] can be something they are possibly interested [in].

All of the camp instructors expressed that students were motivated to learn because the labs and hands-on marine science activities required students to do the work. Torrie noted that students “used all the different tools from the [marine science] wet lab,” such as learning to throw a casting net to collect marine animals from the marsh for identification and reporting.

Camp instructors shared the instructional strategies they used to improve ocean literacy in their students. Tina tried:

> to get them to do more group work instead of independent work because [she] felt [the students] did better with other people to bounce off each other’s ideas and help each other instead of going to [her] and learned more from each other.

Tabatha also encouraged group work for her students during the marine science camp to improve their ocean literacy stating, “most of the time we put them in groups or pairs.” Torrie and her co-teacher’s instructional strategy utilized student interests to enhance engagement to improve ocean literacy. She says “we sort of had a lot of conversations” which for her and her co-teacher, “as long as it was geared toward the ocean we went towards [those topics] and sort of guided [the} conversations with the ocean.” In this way, she incorporated student interests into the lessons and activities for the 2016 summer. Based on this evidence, teachers utilized instructional strategies to improve ocean literacy.

The camp instructors shared the opinion the curricular materials they used during the 2016 camp improved students ocean literacy. Torrie and her co-instructor “used a lot of [her] oceanography labs so sort of that entry to college labs, [they] modified them for leaving middle school to high school where it was more challenging them.” She cited "some of the things in the binder were too young for her" campers as many of them "have seen it before in the previous year." Tabatha utilized the camp curriculum book' activities as well as other resources to improve her student's ocean literacy. She said, "all of the activities had a reading part that explained what the kids should be learning. I used United Streaming a couple of times; I used Kahoot a couple of times." Additional curricular materials Tabatha cited to improve ocean literacy included

> field trips to the beach and aquariums, fishing at the fishery observed the fins dorsal fins and pectoral fins, trips to the marsh. [In the early years of] the camp. we took the boat out to collect the different animals and [the students] could see the animal up close.

Based on this evidence, the variety of curricular materials available to the students during the four week summer program contribute the students' improved ocean literacy according to the camp instructors.

Camp instructors also believed that their use of assessments, including journals, summative assessments such as the pre and post- tests, and self-assessments, helped students to improve their ocean literacy skills. Torrie added that students demonstrated a better understanding of the marine science terms and tools teachers used during the camps because she observed students using these terms with the tools during the instructional activities. She stated:

> I think giving them a chance to use the equipment on multiple occasions. As being like, go and grab this you know where it is at and they grabbed the

> equipment and went out and did it on their own. And sort of watching and seeing if they remembered everything and how to use it.

Tina reported that she asked students to "summarize their day in their journals," which encouraged them to reflect on what they had learned during the camp. The assessment strategies Tabatha felt improved ocean literacy were

> the journaling is of course one, then the pre and post assessment, the activities when they produced a product was a type of assessment, we did little quizzes sometimes with three questions and who ever got the question right would receive a reward.

Through the use of instructional strategies, a variety of curricular materials and a variety of assessment strategies student improved their ocean literacy according to the camp instructors. Thus, teachers believed the marine science summer enrichment camp positively improved students' ocean literacy skills.

Related Research Question 2: Parent Beliefs

The second related research question asked, "*What do parents believe about the impact of this camp on the ocean literacy skills of their children?*" The key finding was parents believed that the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students.

Interview data supported this finding. All parents deemed the curricular materials teachers and students used at this camp improved their children's ocean literacy skills. Patricia noted that camp instructors "did hands-on activities, actually exploring in the marsh," which improved her child's ocean literacy skills. Patricia held that field trips improved her child's ocean literacy skills because her child was able to apply the content that she learned on the field trip to improve her performance on the state tests in science. She said, "the day [the school] did science, he came come, he was very excited because he said "Mama, I remember something," something was on the test he learned during [camp] about oceans, about sea animals." Peter added that he assumed his child's ocean literacy skills improved because "she actually learned a lot, especially about environmental safety." Based on this evidence the curricular materials improved student ocean literacy from the parents' perspectives.

The parents felt the instruction during the 2016 camp improved the ocean literacy of their children. Patricia felt "actually exploring the marsh, in the ocean and all the places [the students] went gave them hands on real life experience instead of watching it on TV or a video." Peter stated his child "had a really good time; she wanted to do it again." He goes on to say it was her fourth or fifth time at camp because "she asks to do it again" Patience felt the instruction teachers used improved her child's ocean literacy because the camp teachers "have a lot of knowledge for ocean literacy and a lot of background from it." While the parents did not cite specific instructional practices in their responses, the parents attribute the positive change in ocean literacy to instruction from the camp teachers.

All three parents also assumed the assessments teachers used at the camp improved the ocean literacy skills of their children. Peter noted that his child's ocean literacy skills improved because these assessments “gave her something to strive for” during the camp. Patricia had confidence that assessments such as exit slips were also effective in improving her child’s ocean literacy skills because the exit slips allowed students give the camp instructors feedback on content and instruction. Patience noted:

> [instructors] need assessments to assess both prior knowledge and what students learned from [the camp] because [students] don’t know the correct terms or correct language for what goes on in marine science, [and the assessment] helps them, not just during the summer.

In addition, all three parents expressed the opinion their children’s participation in the camp program improved their ocean literacy skills. Patricia noted that her child already had prior experience with the ocean, but she believed the camp “built on the experiences he already had, and he was able to enjoy the curriculum.” Peter noted his child used her knowledge of the ocean on family trips, adding that “whether its aquariums or beaches, she looks out for the flags, danger zones, [and] turtle nests” and understands the need for environmental protection of ocean resources. Patience felt the camp:

> didn’t just improve his ocean literacy, it improved his social skills because science is his thing. His science is earth science; this ocean science was different. He did learn from it, and he wanted to do it. You know if a child likes something they are going to put more effort into it.

Parents provided evidence the camp's instruction, curricular materials and assessments improved their child's ocean literacy. They repeatedly provided positive evidence of the camp's ability to increase ocean literacy. Thus, parents believed the camp improved the ocean literacy skills of their children.

Related Research Question 3: Student Beliefs

The third related research question asked, "*What do students believe about the impact of this camp on their ocean literacy skills?"* The key finding was that students believed the 2016 marine science summer enrichment camp positively improved their ocean literacy skills.

Interview data supported this finding. Students believed their participation in hands-on inquiry activities during the camp experience improved their ocean literacy skills. Salena thought that the "strategies [the instructors] used would force us to think about issues in today's society with marine animals and marine life." Stella also noted, "We did a few marsh walks, and that was a more hands-on experience for me. [The marsh walk] helped me learn [marine science] better because I liked doing more hands-on [activities] than doing diagrams and watching videos." Stacey added that "we were able to go the boats and catch stuff in the marsh," which believed helped her improve her ocean literacy skills. Students also said assessments, such as exit tickets, journals, and pre and post- tests, improved their ocean literacy skills. Stella noted that the exit tickets "helped me kind of summarize what we did." Stan pointed out that the daily exit ticket asked "questions such as 'What did you learn today?' and "Did you like it?" Stacey identified the “end of year project we did as a group” as an assessment. Stella noted that pre and posttests and exit slips involved “remembering everything” she did during camp. Students also believed that using marine science tools also improved their ocean literacy skills. Stan noted:

> I used the refractometer; we dissected starfish, [I used] the Secchi disk, and we also looked at different shark’s teeth and compared them to charts and learned about [them] just by looking at the shark’s teeth [to identify] what kind of shark’s teeth it was.

Salena added that “we might be cleaning up in the marsh or working on slides shows or making ROV’s or using real marine science materials they would use in the marsh.” Students also believed that the summer camp experience prepared them for the state tests and other assessments in science that were administered during the academic year. In describing how the summer camp experience improved her ocean literacy skills, Salena noted: “I can now use [what I learned] for GMAS or other science tests I have.” Stacey also noted that she used notebooks that she maintained during the camp experience to support her science learning during the school year. She said

> in [Grade 7] I was like I know what this is, I don’t have to look at this book. I don’t to read this because I remember this. I kept the notebooks, so I looked back in the notebooks, and it was right there.

Three of the four students also asserted the 2016 camp supported their interests in marine science as a possible career pathway. Stan noted, “I want to be a marine biologist when I grow up," which he imagined had a positive impact on his camp participation. Stella reported that "[the camp] was really interesting to me because I have always been interested in sea creatures and the ocean." Salena echoed Stan's response by stating, "I want to be a marine biologist." Stacey enjoyed the camp, but stated, "I didn't want a career in marine biology; I want to do engineering." However, Stacey added the remotely operated vehicle (ROV) activities from camp connected marine science to her interest in engineering.

Students shared their experiences with hands on learning activities as well as connections to their regular education experiences which they felt impacted their ocean literacy. Their responses provided evidence the 2016 camp improved their ocean literacy skills. Thus, students believed their participation in the marine science summer enrichment camp improved their ocean literacy skills.

Related Research Question 4: Teacher Reflections

The fourth related research question asked, "*What reflections do teachers have about a learner centered teaching approach used at this camp?"* The key finding was teachers thought they used a learner centered teaching approach at the 2016 marine science summer enrichment camp to improve the ocean literacy skills of students, which included their beliefs about the role of the teacher, the balance of power between students and teacher, the function of content, responsibility for learning, and the purposes of evaluation.

Reflective journal and interview question data supported this finding. In relation to their beliefs about the role of teachers, camp instructors believed a learner centered approach was reflected in their role as teachers. Tina felt that as a camp instructor, she was a "role model" for students because she had been a camper before being a camp instructor. Teachers also believed that their role as teachers was to learn from students during the camp experience. Tina noted, "I presented them with the material they had to know, but with their help, I was able to view the concepts in many other different ways." Torrie stated, "We had a lot of conversations [with students] so whatever was interesting to them is what we went toward" regarding instruction. Thus, teachers identified their role during the summer camp as both a moral guide and as a learner.

In relation to power in the classroom between teachers and students, camp teachers believed this power was shared. Tabatha stated, "I have learned as a teacher [that] students enjoy making decisions in the classroom." Torrie reinforced Tabatha's statement by stating that "we allowed the campers to help direct what they were interested in learning" to keep them engaged in the camp activities. Tina described how power was distributed in her classroom by stating that "we would present [the lesson objective] to them and then we would let them take over from there." Teachers expected students to meet the marine science objectives so they provided them with more freedom in how they met those targets.

Regarding the function of content, camp teachers believed that they taught marine science content by designing activities related to different marine science tools that supported instruction about the content. Torrie noted that "we made all of the science very hands-on by allowing the student to work with the different equipment in the marine science building." The equipment students used during the camp program included the Secchi disk to teach how turbidity, or the cloudiness of the water, is measured when learning about characteristics of the local salt marshes. Tabatha reported that she used videos on planet life and the water cycle to present information related to ocean literacy principles before students engaged in laboratory activities. Tabatha described the immersive experience of fishing at the fish hatchery where students "observed dorsal fins and pectoral fins" on the fish they caught during the excursion. Tina also used videos and other resources to present the content, adding:

> We used more outside resources, read[ing] a little bit on the computer or letting them watch a video of someone else talking about the activity. [For example,] when we did the *Carbon Cycle* poster, we let them watch a video on how the carbon cycle goes, and then we let them see [examples of the carbon cycle] before they drew it themselves.

Camp teachers also believed that students needed to be responsible for their learning. To develop this responsibility for learning, teachers felt they needed to give students flexibility in what and how they learned. Tina asserted the students were more responsible for their learning because "we gave them more independence." Tabatha believed that "if they have to do the work themselves, it makes them responsible for doing the work." Torrie added that "we allowed the campers to help direct what they were interested in learning." The result, teachers believed, was increased student engagement to learn marine science content and improved student responsibility for learning.

In relation to the purposes and processes of evaluation, camp teachers believed that the assessments they used during the camp experience improved students' ocean literacy skills. Teachers reported using a variety of assessments to evaluate student learning and inform instruction, which included formative and summative assessments, such as journals and quiz bowls. In relation to formative assessments, Tabatha noted that students were required "to write journals daily about what they learned for the day." Tina asked questions such as "What did you learn today?" to facilitate summaries that students wrote in their journals. Torrie used observations of students using the marine science equipment to assess student learning in addition to using self-assessments to check understanding. Thus, teachers deemed the purpose of evaluation at this camp was to improve student learning, and therefore, teachers used a variety of assessments to inform instruction to improve students' ocean literacy skills.

Related Research Question 5: Student Reflections

The fifth related research question asked, "*What reflections do students have about a learner centered teaching approach used at this camp?"* The key finding was students believed that they experienced a learner centered teaching approach at the 2016 marine science summer enrichment camp, which included their beliefs about the role of the teacher and the student, the balance of power between students and the teacher, the function of content, responsibility for learning, and the purpose of evaluation.

Reflective journal and interview question data supported this finding. Students were asked in the reflective journals to define their role as students rather than their teacher's role during the camp experience. Students felt their role during camp was as researchers who learned specific research skills related to marine science. Salena noted that she "got to experience, research and explain every activity" she completed during the camp. Stella identified herself as a researcher by stating that she was "more of a researcher than a big project person." Stan did not comment on his role, only indicating that he enjoyed the 2016 camp experience.

In relation to the balance of power between teachers and students, students also judged this power was shared during the 2016 camp experience. Salena noted, "We respected each other." Stella believed power was shared because the "camp teacher had just enough authority to teach us what we need to know but not so much [authority that] they took control [of student learning]. Students determined two-way communication between students and teachers contributed to shared power. Stan added, "[Camp] counselors supported me and helped me the whole time." `Salena added, "[Camp instructors] would give us an article and ask us a lot of questions," which she noted would often "turn into a conversation." Stella noted, "[The laboratory activities] weren't just here [for] you [to] go figure it out yourself; [the camp] instructors would walk you through it." Thus, shared power between students and teachers in the classroom was supported by two-way communication that they believed improved their ocean literacy skills.

Concerning the function of content, students reported teachers presented content through hands-on activities, presentations, lectures, and debates. Salena added, “My excitement [about marine science] urged me to find out more about topics we would talk about in class.” Stan described his ocean debate experience as a meaningful one because he was selected as one of four students to observe the debate. In describing how participation in the camp improved her ocean literacy skills, Stella stated, “I could read books about [the ocean], but [reading about the ocean] wasn’t as much [fun] as looking [at the ocean], coming to [camp] to see different things [related to the ocean].” Students also thought to learn marine science content through interactions with other students and technology improved their ocean literacy skills. Stella noted that hands-on activities such as the marsh walk helped her to learn marine science content better than “doing diagrams and watching videos.” Stacey reported using nets to collect organisms from the marsh and then using microscopes to identify the organisms. Salena also described how their group used microscopes to identify samples that they collected from the marsh and then “present[ing] their findings in front of the class as a group.” Stella reported that her teachers “taught us about how to learn more about marine science” by teaching research skills through activities such as *Introduction to the Ocean Zones* from the camp curriculum guide. Stan said his ocean literacy skills improved as a result of his participation in fun activities such as fish hangman. Stan added, “All the words you have to guess are ocean related words." Thus, students believed that because camp teachers presented the content using a variety of methods, their ocean literacy skills improved.

Students thought camp teachers encouraged them to take responsibility for their learning. Salena stated, "every topic we researched always had new findings. My excitement encouraged me to find out more about topics we would talk about in class." Stella felt the teachers "taught us how to learn more about marine science and that it would be our responsibility to do that." Stan said, "the [camp instructors] supported me and helped me the whole time." Based on this evidence, students felt camp instructors supported students to take responsibility for their learning.

Students reported working together in groups and learning time management skills made students more responsible for their learning. Stella noted that students "made projects that were due at certain times," which encouraged them to work together and to present their marine science learning to their camp group. Salena added:

> I think this camp encourages you to want to push yourself to learn more because you can do something one day and then learn something totally new the next day. That made you want to learn because it is a totally different topic every time.

Students also reported they were required to learn to work as a team and to be responsible for the products they produced. Stella added that "[the camp experience] also taught me teamwork." Stacey provided a more in-depth description of teamwork by stating:

> I think it made it easier for you to work in a group. There are new kids every year, and [camp instructors] make you pair up with someone you don't know. You have

> to understand yourself, and you have to try to work together. If they are new and you are not, you have to teach [the content] to them.

Thus, students thought to work in groups helped them assume responsibility for their learning.

Concerning the purposes and processes of evaluation, students reported teachers and students used a variety of formative and summative assessments to evaluate their learning as well as their prior knowledge about marine science. Stella noted, “We did pre and posttests to see how much we knew then and how much we knew of the course.” Salena understood that “my marine science learning was evaluated through the pre and posttest and group activities.” Stan also identified the pre and posttests as an assessment method that teachers used to assess student learning during the camp. According to the evidence provided by the students, the 2016 camp program provided a learner centered approach to improve ocean literacy.

Related Research Question 6: Documents and Archival Records

The sixth related research question asked, “*What do documents and archival records related to this camp reveal about a learner centered teaching approach to improving students’ ocean literacy skills?”* The key finding was documents and archival records related to the 2016 marine science summer enrichment camp were used to improve students’ ocean literacy skills, but they did not indicate a learner centered teaching approach was used to achieve this improvement.

Data collected from documents and archival records supported this finding. Documents such as the camp curriculum guide and archival records such as the curriculum map were aligned with the ocean literacy principles to ensure instruction of the ocean literacy principles. The scope and sequence presented guidelines for camp teachers about the appropriate depth for teaching content related to the ocean literacy principles for middle school students. The grant document provided the objectives for increased ocean literacy by outlining the structure of the K-12 programs to recruit students. Archival performance reports included evaluations of the K-12 programs; these evaluations included the number of students who participated in each camp program and educators trained in ocean literacy principles as an outreach activity. The performance report measured the number of participants engaged in outreach programs aligned with the NOAA mission relevant learning opportunities but did not measure individual student or teacher growth in learning the ocean literacy principles.

Concerning documents such as the parent handbook and camp counselor or teacher manual, I had anticipated that they would contain information about learner centered teaching, but they did not provide evidence of Weimer's (2013) five characteristics of learner centered teaching, including the role of the teacher, balance of power, function of the content, responsibility for learning, and the processes and purposes of evaluation. Instead, these documents primarily focused on procedures and behavior expectations for students enrolled in the summer camp program.

Discrepant Data

Regarding discrepant data, one teacher participant, one parent participant, and one student participant alleged that the camp experience improved student performance on state tests in science that were administered during the academic year. Patience, a parent, said her child's results on state tests in science improved as a result of this experience, adding that "[camp instructors] made sure it aligns with the curriculum in the school system." Tabatha, a teacher, also noted, "we don't just cover marine biology. We also cover life science, earth science, and a little bit of physical science and chemistry." Salena, a student, had confidence she could use the marine science content that she learned during the camp experience to improve her performance on state tests in science. However, further research would need to be conducted to determine if the camp experience improved student performance on the state science assessments. Table 15 provides a summary of the results of this study as the findings related to the central and related research questions.

Table 15

Summary of Results

Research Question	*Findings*
RRQ 1 What do teachers believe about the impact of this camp on the ocean literacy skills of middle school students?	-- Believing participation in summer camp improved ocean literacy skills -- Believing students were motivated to learn marine science -- Believing assessments improved ocean literacy skills
RRQ2 What do parents believe about the impact of this camp on the ocean literacy skills of their children?	-- Believing curricular materials improved children's ocean literacy skills -- Believing instruction improved children's ocean literacy skills -- Believing assessments improved children's ocean literacy skills -- Believing camp experience improved science literacy skills -- Believing camp experience improved children's performance on state tests
RRQ3 What do students believe about the impact of this camp on their ocean literacy skills?	-- Believing hands-on inquiry activities improved ocean literacy skills -- Believing assessments improved ocean literacy skills -- Believing using marine science tools improved ocean literacy skills -- Believing camp experience prepared students for state science tests
RRQ4 What reflections do teachers have about a learner centered teaching approach used at this camp?	-- Believing teachers learned from students during camp experience -- Believing power in classroom was shared between teachers and students -- Designing activities related to different marine science tools -- Improving student engagement to learn marine science content -- Using variety of assessments to evaluate learning and inform instruction
RRQ5 What reflections do students have about a learner centered teaching approach used at this camp?	-- Defining their role as researchers learning specific research skills -- Believing power was shared between teachers and students -- Believing two-way communication between students and teachers existed -- Believing content was presented through interactions with other students and technology -- Believing they were encouraged to take responsibility for their learning -- Believing assessments were used to evaluate learning and prior knowledge
RRQ6 What do documents and archival records related to this camp reveal about a learner centered teaching approach to improving students' ocean literacy skills?	-- Aligning instruction with ocean literacy principles -- Ensuring instruction of ocean literacy principles -- Using scope and sequence to provide appropriate depth for content -- Describing K-12 programs that emphasize ocean literacy skills -- Evaluating K-12 programs in relation to improving ocean literacy skills -- Focusing on procedures and behavior expectations for camp experience

(*table continues)*

Research Question	*Findings*
CRQ How does a marine science summer enrichment camp impact the ocean literacy skills of students in Grades 6-8?	-- Believing 2016 camp experience improved students' ocean literacy skills -- Believing learner centered teaching approach improved students' skills -- Believing role of teacher was to model learning and to be a moral guide -- Believing role of student was as a researcher -- Believing power in the classroom between students and teacher was shared -- Believing function of content was to motivate students to learn by integrating content into variety of enjoyable instructional activities -- Believing students assumed responsibility for their learning at camp -- Believing purpose of evaluation was to improve student learning by using variety of formative and summative assessments -- Using documents/ archival records to improve students' ocean literacy skills -- Believing 2016 camp experience improved *science* literacy skills

Summary

Chapter 5 was about the results of this study and included a description of the setting, participant demographics, and data collection methods for the interviews, reflective journals, documents and archival data. This chapter included data analysis process for the Level 1 and Level 2 analysis for each data source. Also included are the emergent themes, supporting data with corresponding data tables and discrepant data that informed the key findings or results for this study. The chapter included a discussion of the strategies that were used to improve the trustworthiness of this qualitative research in relation to the constructs of credibility, transferability, dependability, and confirmability. Results were presented in relation to the related research questions and the central research question. Based on these results, Chapter 5 included an interpretation of the results, recommendations, and conclusions for this single case study.

Chapter 5: Discussion, Recommendations, and Conclusion

The purpose of this study was to describe the impact of a marine science summer enrichment camp on the ocean literacy skills of middle school students who participated in this camp. Therefore, a case study research design was selected to answer the central research question: How does a marine science summer enrichment camp impact the ocean literacy skills of students in Grades 6-8? This study was conducted as little research had been conducted on the impact of marine science summer enrichment camps on the ocean literacy skills of middle school students.

Several key findings emerged from this study. According to the interview data, teachers, students, and parents believed that participation in the 2016 marine science summer enrichment camp improved the ocean literacy skills of middle school students. Also through reflective journal data, teachers and students both reported that a learner centered teaching approach was used to improve students' ocean literacy skills, particularly in relation to the role of the teacher, balance of power, the function of content, responsibility for learning and purpose and process of evaluation. Another key finding was that documents and archival records related to the 2016 marine science summer enrichment camp were used to improve students' ocean literacy skills, but they did not indicate a learner centered teaching approach was used to achieve this improvement. Therefore, I determined that the 2016 marine science summer enrichment camp had a positive impact on the ocean literacy skills of middle school students because data analysis and triangulation from multiple sources supported this finding.

Interpretation of Findings

The interpretation of findings is presented in relation to the literature review for this study and the conceptual framework. This interpretation is presented in relation to the findings of teacher beliefs, student beliefs, and parent beliefs that emerged from the interview data. In addition, this interpretation is presented in relation to the findings of teacher reflections and student reflections that emerged from the reflective journal data. Interpreted data presented here also includes a discussion of the findings in relation to the conceptual framework.

Teacher Beliefs

The key finding was that teachers believed the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students. Based on the interview data, teachers held the opinion the summer camp program improved ocean literacy for the students participating in the program. The literature review supports this finding.

According to the teachers, students demonstrated an increased understanding and interest in ocean literacy. This is similar to Lindner and Kubat's (2014) exploration into the long term impact of summer science camps on learning in Finland. Lindner and Kubat found that students demonstrated an increased interest in the camp's themes, which included ecology, as a result of their participation. According to the teachers' perspectives, students demonstrated increased interest marine ecology due to the exposure the camp environment. Teachers from the 2016 marine science enrichment camp program also cited the activities and lessons used to improve the ocean literacy in the students. Thompson et al. (2016) found the connections between mathematics and science content to be essential to improving ocean literacy. The participating teachers also described cross-disciplinary approaches to teach ocean literacy by incorporating art, math and writing in the lesson activities for the students. Haley and Dyhrman (2009) found that the utilization of cross discipline instruction in an oceanography program increased science literacy. Teachers from the 2016 marine science enrichment camp program reported professional development, such as college courses, were used to inform their instruction during the summer camp program. Michael (2013) recommended training teachers in the tools and technology used in marine education activities to support improved ocean literacy. Teachers from the 2016 summer camp program identified that journals and pre and posttests, as well as student products, were used to identify misconceptions as well as enhance learning for individual students. Treagust et al.(2001) found the use of frequent and meaningful assessments at the individual student level to improve their science literacy skills. Based on the teacher responses and review of the literature, the 2016 marine science enrichment camp improved ocean literacy due to the utilization of assessments, professional development and cross discipline instructional strategies used during the camp program.

Student Beliefs

The key finding was that students believed the 2016 marine science summer enrichment camp positively improved their ocean literacy skills. Students provided repeated evidence in their interviews regarding the summer camp's impact on their ocean literacy. The literature review supports this finding.

Students remarked on the authentic experiences they had during the summer camp program which included the use of research skills and field trips. According to the students, they were more engaged in learning due to the authentic science activities during camp to improve their ocean literacy. Gold et al. (2015) recommended the use of authentic science data to increase student engagement in science and ocean science content. The students from the 2016 camp commented on the personal experience the program provided. Beaulieu (2015) recommended personal experiences with ocean science content for students, such as technological simulations, to increase ocean literacy. Students commented on exploring the local salt marsh as well as local factors impacting the salt marsh, thus the camp utilized local marine environments as recommended by Cummins and Snively (2000) and Gill et al. (2014) to increase ocean literacy. Students commented on the peer connections they made during the summer camp citing those connections improved their understanding of the marine science content. In similar research, Wiener and Matsumoto (2014) explored the personal experiences of Grade 4 and 5 students who participated in the Ecosystem Pen Pals program to develop their understanding of and connections to local waterways. Wiener and Matsumoto found that students developed positive peer relationships and improved their understanding of the human impact on the ocean as a result of participating in this pen pal program. The students' responses regarding increased ocean literacy are supported by the literature due to the authentic science experiences and peer relationships formed during the 2016 camp.

Parent Beliefs

The key finding related to the parents' belief indicated the 2016 marine science summer enrichment camp positively improved the ocean literacy skills of middle school students. The parent interviews shared responses regarding the positive impact on student ocean literacy. The literature review supports this finding. Parents from the 2016 marine science enrichment camp shared the perspective that their student increased science literacy as well as ocean literacy. Farland-Smith's (2016) study found parents thought that their child had developed a self-identity as a scientist as a result of participation in the camp. The camp parents related the significant life experiences through field trips and learning activities they felt improved their children's ocean literacy. In related research, Stevenson, Peterson, et al. (2014) explored the role significant life experiences played in relation to the environmental knowledge of middle school students. Based on the evidence from parent interviews and the literature, students improved their ocean literacy through personal experiences with the camp's content.

Teacher Reflections

The key finding was teachers believed they used a learner centered teaching approach at the 2016 marine science summer enrichment camp to improve the ocean literacy skills of students. This finding was supported by their reflections about the role of the teacher, the balance of power between students and teacher, the function of content, responsibility for learning, and the purposes of evaluation. The teacher's reflective journal responses described instructional, curricular, and assessment strategies emphasizing learner centered teaching to improve ocean literacy. The literature review supports this finding. The teachers utilized formative and summative assessments during the 2016 summer to provide meaningful feedback to provide students with deeper content connections. Gunckel et al. (2012) found the utilization of frequent evaluations enabled teachers to assess the progression toward ocean literacy. In their study, Kowalski et al. (2016) found the use of continuous feedback to enhance and adapt instruction to improve ocean literacy for middle school students. Teachers reported the hands on learning opportunities provided by the curriculum increased ocean literacy for students. In related research, Worker and Smith (2014) found that teachers who participated in the inquiry-based curriculum training believed that they improved student science literacy skills. According to the teachers, the natural setting of the 2016 camp was used to supplement instructional practices as students could see and explore the environment. Leblebicioğlu et al. (2011) explored the use of a nature summer camp to address learning gaps in science for Turkish students and found that a combination of instructional strategies using guided inquiry-based instruction and activities related to explicit instruction about the nature of science enabled students to improve their science literacy skills. Teachers from the 2016 camp utilized group settings to support a learner centered focus and to support peer relationships which is similar to Kolodner et al.' s (2003) findings regarding increased science literacy in middle school students through problem based learning. Therefore, the use of group settings, frequent assessments, content specific training and hands on science instruction contributed to learner centered instructional environment to improve ocean literacy.

Student Reflections

The key finding was that students believed they experienced a learner centered teaching approach at the 2016 marine science summer enrichment camp, which included their beliefs about the role of the teacher and the student, the balance of power between students and the teacher, the function of content, responsibility for learning, and the purpose of evaluation. The literature review supports this finding. Students from the 2016 marine science enrichment camp reported building peer relationships improved their ocean literacy. Riedinger (2015) found science summer camps were an environment where students have opportunities to engage with supportive peer groups who have similar interests in order to improve their science literacy. The 2016 students held the opinion the summer camp program allowed them to develop research and science inquiry skills during the camp. Gorospe et al. (2013) found that students demonstrated a better understanding of ocean acidification and hypothesis testing after their participation in a summer camp program focused on ocean acidification. In other similar research, Foster and Shiel-Rolle (2011) explored summer camps as an alternative to traditional classrooms for students in the Bahamas who had limited access to effective science instruction in their communities and found that students demonstrated an increase in science literacy after participation in the one-week ecology science camp. Students identified hands-on or inquiry-based instructional strategies increased their ocean and science literacy. In another similar study, Davis (2014) found problem solving and practical application significantly improved science literacy for participating students. Access to scientific equipment, development of research skills and problem solving strategies and high interest topics contributed to the learner centered instruction at the 2016 camp improved ocean literacy according to the students and relevant literature.

Documents and Archival Records

The key finding was that the documents and archival records related to the 2016 marine science summer enrichment camp were used to improve students' ocean literacy skills, but they did not indicate a learner centered teaching approach was used to achieve this improvement. The literature review supports this finding. The documents and archival records indicated ocean and environmental science topics were integrated throughout the summer camp program. Hart (2010) explored the integration of environmental education in science curriculum and recommended the inclusion of environmental and ocean literacy topics in science curriculum to lead to significant social change in science education. The documents and archival records described the utilization of inquiry based activities to support the development of ocean literacy skills. Boyle et al. (2014) reported a decrease in understanding of ocean literacy topics and recommended inquiry and place-based activities to improve science and ocean literacy. The camp's design included a structure to engage students in actively using the marine science content to develop better ocean and science literacy skills. Wiener et al. (2015) found when individuals use the ocean and their background knowledge of the ocean it impacted their attitudes toward ocean conservation. The documents and archival records did not indicate a positive correlation between learner centered instruction and increased ocean literacy. According to Aavard's (2009) description of learner centered teaching in summer camp programs, the 2016 marine science enrichment camp has inquiry-based activities, group discussions, and a variety of assessments. However these characteristics were articulated through the interviews and reflective journals, not in the documents or archival records.

Impact of Camp on Ocean Literacy Skills

The key finding was that this camp had a positive impact on the ocean literacy skills of students in Grades 6-8 who were enrolled in this camp in 2016. The literature review supports this finding. Teachers, parents, and students reported in interviews that the 2016 summer camp program increased ocean literacy. Teachers shared similar responses regarding the utilization of content training they received prior to the camp to increase ocean literacy in students. M. A. Rose (2010) explored professional development programs for Grade 9-12 teachers utilizing technology and local resources and found teachers and students made significant gains in their understanding of environmental issues, technology, and inquiry-based instructional practices. In related research, Bleicher and Lambert (2013) found in depth teacher training in ocean literacy concepts enabled teachers to address challenging content. Based on the reflective journals and interview, the 2016 camp program integrated local resources and cultural influences through field trips to increase ocean literacy which includes the impact of the ocean on economy and local culture. Luther et al. (2013) explored the use of socioscientific cases to improve ocean literacy skills for Grade 6-8 students in the United States and found the use of social and cultural influences foster stewardship of the ocean. Teachers, parents, and students shared similar responses stating the camp utilized hands-on laboratory activities, scientific tools, and research skills to teach ocean literacy. Caudle and Payne (2016) found that research-based methods for data collection improve students' understanding of the ocean literacy principles in a study about the Texas High School Coastal Monitoring Program (THSCMP) citizen science program. The camp's positive impact on ocean literacy is supported both by participants and by literature related to ocean literacy.

Conceptual Framework

Weimer's (2013) learner centered teaching model is comprised of five components; (a) role of the teacher, (b) balance of power, (c) function of content, (d) responsibility for learning, and (e) the purpose and the process of evaluation. The role of the teacher is described as a guide to student learning rather than a dispenser of knowledge. The balance of power for learning is equally distributed between the student and teacher. The function of content in a learner centered approach is to increase student engagement in learning. In the learner centered teaching model, students demonstrate more responsibility for their learning. Evaluations are used to inform progress in learning while supporting a positive learning environment. Weimer's model was designed to facilitate problem solving, cooperative learning, and research skills. Current research also supports these five changes to instruction for teachers to implement a learner centered teaching approach in their classrooms.

Role of the teacher. Current research supports the finding of this study that camp teachers believed that the role of teachers was to be facilitators of the learning process rather than dispensers of knowledge. In the study, teachers and students described the role of the teacher as a guide or facilitator. The responses from the study described an inquiry-based learning environment which allows for students to discover the content as described by Weimer (2013). Lee and Anderson (1993) explored student motivation and engagement in science education and found students generally have a positive attitude toward science and science content when teacher include inquiry-based instructional activities. Students defined their role as researchers learning specific research skills thus allowing students to lead in more learning tasks as recommended by Weimer. Kolodner et al. (2003) explored problem-based learning as an instructional approach and found students developed connections between what they learned and how their learning could be applied in developing solutions to problems students researched in a science course. Teachers indicated that they learned from students during camp experience thus allowing student's prior knowledge to inform instruction. Avraamidou (2014) explored the teacher's role in inquiry-based education in teaching science content and found teachers who pursue informal science education activities to develop their instructional skills are more confident in presenting science content, guiding students during instruction and developed a stronger commitment to inquiry-based science education. During the study, students and teachers reported individual student interventions made students more aware of their learning.

Balance of power. Current research supports the finding of this study that power would be distributed equally between teachers and students in the camp classrooms. The documents such as the curriculum documents and curriculum map indicated camp teachers still retained control of content presented during the camp. Teachers stated that power in the classroom was shared between teachers and students. Interview data from the teachers indicated students had input into when topics were taught or the direction of assigned lessons. Sigman et al. (2014) explored teachers as learners in an ocean literacy workshop and found the communication between the teachers as learners and the science experts as instructors developed deeper science and ocean literacy among the workshop participants. Students suggested power was shared between teachers and students in regards to how they presented final products from lessons. Students also stated two-way communication between students and teachers existed during the 2016 camp. The communication between teachers and students allowed students input but also provided the structure for teachers to provide guidance and lesson objectives. Widder et al. (2014) explored the behavior changes in high school students from Florida in a stewardship program and found students demonstrated ownership of the project by producing blogs, news and print media for the stewardship program. The teachers and students also identified collaborative work in the classroom environment. Ramsden and Curran (2016) explored collaborative instructional strategies in a research-based instructional activity utilizing authentic scientific data and found the collaborative setting encouraged science inquiry skills such as prediction and argumentation. This strategy allowed students to self-regulate as well as self-direct the inquiry-based lessons presented during the camp. Thus, the balance of power was distributed equally among the students and teachers.

The function of content. Current research supports the finding of this study that camp teachers would utilize an instructional pedagogy that engages participating students in learning marine science content rather than in obtaining a grade was another proposition of the theoretical framework. Students credited hands-on inquiry activities to improving ocean literacy skills during the 2016 camp. Dublin et al. (2014) explored the integration of ocean science in science fair projects and found student-led projects that are focused on ocean science content enabled students to explore and master science content. Students deemed using marine science tools improved ocean literacy skills during the 2016 camp. Weimer recommended regular, repeated opportunities to use skills allowed students to access the content and the repeated use of marine science tools provided students with an opportunity to access marine science content. The 2016 camp teachers designed activities related to different marine science instruments. Riedinger (2015) explored the instructional environments of summer science camps and found science summer camps provide opportunities for students to develop self-identities as potential scientists due to the unique instructional environment. In addition to science skills and ocean content, teachers improved student engagement to learn marine science content through field trips, hands-on activities, and supplemental materials. Students stated content was presented through interactions with other students and technology. Similarly, Gold et al. (2015) explored the use of authentic scientific data into the classroom and found science teachers who used data related to high-interest topics such as the Arctic ecosystem to improve ocean literacy in classrooms helped students understand how scientists acquire and analyze data. Thus the marine science camp instructors utilized a pedagogy that engaged students in learning marine science content through skill process and practice, relevant data and authentic experiences during the 2016 camp.

Responsibility for learning. Current research supports the finding of this study that students would be given opportunities to demonstrate responsibility for their learning at the study site. Teachers thought students were motivated to learn marine science and supported a classroom environment to promote this responsibility. Students were given autonomy for projects and creative license for products students produced during the camp which embodied Weimer's recommendations for fostering responsibility for learning. Hunnewell et al. (2015) explored abstract marine science content utilizing familiar environments and found students improved their understanding of camouflage through student-made representations of environmental blending. Students reasoned they were encouraged to take responsibility for their learning through hands-on lesson which allowed them to participate in classroom activities.   Hernandez-Pacheco et al. (2015) explored ocean acidification in a lesson designed for life or physical science and found students developed concrete connections to understanding human impacts on the environment through student-developed solutions for preventing ocean acidification. The documents focused on procedures and behavior expectations for camp experience to support an inclusive environment. Hughes et al. (2013) explored peer relationships in science summer camps and found an inclusive environment with a supported peer network support increased science literacy. Thus, students were given opportunities to demonstrate responsibility for their learning at the study site.

Purpose and process of evaluation. Current research supports the finding of this study that evaluation would include the use of summative and formative assessments to foster a positive learning environment. Teachers accepted assessments improved ocean literacy skills in middle school students through varied summative and formative assessments. Assessments teachers cited using in the marine summer camp included student journal, pre and post- tests and observations of appropriate tool use. Lambert (2006) explored the use of assessments to evaluate developed ocean literacy and found summative assessments demonstrate growth in ocean literacy. Students claimed assessments improved ocean literacy skills through projects created in camp, journals and pre and post- tests. The variety of assessments during the 2016 camp allowed camp teachers and students evaluate learning in the marine science camp. Kowalski et al. (2016) explored instructional strategies related to marine debris and found the use of continuous feedback enhance and adapt instruction in inquiry-based ocean literacy activities. Students contended assessments were used to evaluate new learning and prior knowledge. Bleicher and Lambert (2013) explored instruction related to climate change and found assessing prior knowledge about politicized topics such as climate change supported interventions to address knowledge gaps for challenging science content. Parents asserted assessments improved children's ocean literacy skills through the use of exit slips which allowed students to self-assess each day's learning. Parents identified the pre and post- tests as mediums for students to benchmark their progress and learning during the camp. The use of assessments allowed for formative feedback enabling students to learn from what they learned each day. Parents also claimed camp experience improved science literacy skills and the camp experience improved children's performance on state tests. This observation demonstrates long-term learning of the material as state tests were administered several months after the camp concluded for the summer. Thus formative and summative assessments were used to foster a positive learning environment. Table 16 is a summary of the interpretation of findings as they relate to the conceptual framework for the study.

Table 16

Summary of Interpretation of Findings

	Teacher	*Student*	*Parent*	*Documents*	*Archival Records*
Ocean Literacy-Curriculum	✓	✓	✓	✓	✓
Ocean literacy – Instruction	✓	✓	✓	✓	✓
Ocean Literacy – Assessment	✓	✓	✓	✓	✓
Role of the teacher	✓	✓	✓		
Balance of Power	✓	✓	✓		
Function of Content	✓	✓	✓		
Responsibility for learning	✓	✓	✓		
Purpose and Process of Evaluation	✓	✓	✓		

Limitations of the Study

Limitations of this study are related to the case study design. The first limitation is related to the number of cases. This study was a single case study, and Yin (2014) noted that both literal and theoretical replications are limited for single case studies. The single case study is limited in literal replication because it cannot be compared to another study with potentially similar findings. Theoretical replication is also limited because a single case study cannot be compared to a case with potentially contrasting findings (Yin, 2014). This limitation could mean that results might be difficult to replicate through other studies.

The second limitation is related to the number of participants. The sample size of three teachers, three parents, and four students may have limited the findings of this study. Four student participants and three parent participants may not reflect the beliefs of the typical marine science summer camp participant or the typical parent. Three camp teachers may also not represent the beliefs of all teachers who provide instruction at marine science summer camps for middle school students. However, this limitation was addressed by collecting data from multiple sources. Documents were collected in relation to the camp curriculum and related content standards, instructional guidelines, and recommended assessments. Archival records such as the original grant proposal were examined regarding curriculum implementation and assessment goals. These multiple data sources provided a rich description of the case

The third limitation is related to data collection. Only one initial interview was conducted for each participant. Participants were also asked to review the tentative findings of this study for their credibility. Richer findings might have resulted if additional interviews were conducted for each participant. However, individuals may also have been unwilling to participate in multiple interviews, limiting the data for analysis. This limitation was addressed by using the strategy of member checks to solicit feedback from participants as well as collecting data from multiple sources. This limitation was also addressed through a reflective journal for teachers and student participants to collect further data related to the camp and the theoretical framework.

Recommendations

The recommendations for this study are related to the results. The first recommendation is to conduct an additional study regarding the marine science camp's impact on state science test scores. A study into the marine science camp's impact on state science test scores would benefit schools in determining the efficacy of a local-focused science program on science literacy. Students would benefit from the study as it would determine the effectiveness of inquiry-based instruction in summer camp programs to develop science literacy.

The second recommendation is to evaluate the camp based on pre and post test results to determine the extent of increased ocean literacy in middle grades students. This evaluation would benefit the camp administration in determining curricular, instructional and assessment strategies to improve ocean literacy. The camp program would benefit from the evaluation as the results could be potentially used to develop stronger community support of the marine science camp program.

The third recommendation is to conduct a longitudinal study of camp participants to determine the long-term learning of ocean literacy skills. The study would determine the impact of ocean literacy skills on the community. This study would benefit schools and community partners seeking to implement ocean literacy education programs.

Implications for Social Change

This study may contribute to social change at the individual, family, organizational, and societal level. Concerning individual students, this study may contribute to positive social change by providing students with a deeper understanding of the principles of ocean literacy. Students who develop this deeper understanding have the potential to demonstrate improved stewardship of local marine resources. Instead of being passively affected by changing technologies and climates, students who participate in marine science summer enrichment camps may be able to influence these changes as they become contributing members of their communities.

Concerning families, this study may contribute to positive social change by providing parents in these families with a deeper understanding of how the principles of ocean literacy can be integrated into improved science education for their children. Capra (2007) contended that improved science literacy for all individuals provides increased stewardship for environmental resources. Therefore, parents may also contribute to positive social change by supporting their family's interests in place-based marine science summer enrichment programs that incorporate local resources and environmental problems through inquiry-based practices.

Concerning schools, this study may also contribute to positive social change by providing educators with a deeper understanding of the principles of ocean literacy and the importance of learner centered teaching approaches to science education. Summer camp experiences have the potential build student engagement in learning content and topics supported by resources that are not available in traditional classrooms (Lambert, 2006). Through these summer camp, teachers may have the opportunity to develop and implement instructional and assessment strategies using a learner centered teaching approach that they can integrate into their traditional classrooms during the academic year. Principals may develop a better understanding of the need for place-based, inquiry lessons incorporating local resources and addressing community issues.

Concerning society, this study may contribute to positive social change by developing ocean literate citizens. The ocean is a resource for economic, cultural, and recreational activities, but those resources are finite and in need of preservation (NOAA, 2013; Weiner et al., 2015). Ocean literate citizens have the potential to inform policies to preserve ocean resources for future generations. Ocean literate citizens also have the potential to educate other members of society about the impacts of the ocean on society and society's impact on the ocean.

Conclusion

Teachers, students, and parents who participated in this study believed that the 2016 marine science summer enrichment camp positively impacted the ocean literacy skills of middle school students. Teachers at this camp used a learner centered teaching approach that included inquiry-based and hands-on instructional activities to improve ocean literacy and science literacy for these students. The instructional activities of this camp also included an emphasis on the importance of local science content and resources to reinforce marine science content.

Participation in this 2016 marine science summer enrichment camp gave students the opportunity to experience marine science content in-depth with the guidance of instructors who were experts in the content they presented. In this study, two of the three teachers had earned a degree in marine science, and the third teacher had participated in the camp for several years before becoming a camp instructor. Instructors who have a strong background in marine science have the ability to address student misconceptions in their understanding of controversial issues in marine science, such as climate change. Students who receive reliable feedback from these knowledgeable teachers are more likely to develop an improved understanding of marine science content. Teachers at this camp helped students to acquire deep content knowledge that they believed improved their ocean literacy skills.

Teachers at the 2016 marine science summer enrichment camp also used local resources to enhance student learning. Students and teachers identified this use of local resources as an important component in improving ocean literacy for students. Teacher use of locally-based resources has been found to increase student engagement in conservation practices. Student engagement in learning has also improved when science content is connected to local ecology. One of the camp teachers reported that many students in the local school district had not been to the beach or had few connections with the local ocean ecology. One parent reported that his child used the camp field trips to local oceanic sites as a vehicle to teach the family about the ocean and its resources. The use of locally-based resources has the potential to connect students to the cultural influences of the ocean, including economic ties, music, and art. The camp was located in a community on the eastern coast of the United States with a distinctive social, cultural, and economic dependence on the ocean. Developing ocean literate citizens in this area may mean increased stewardship of the marine environment so that the ocean can continue to be an integral part of the economy and culture of the area.

On a global scale, students need to become informed citizens of the world in relation to marine science policies and related resource use. Resources need to be used in ways that benefit society and are protected over time because ocean resources are becoming limited worldwide. Politicized marine science issues such as climate change need citizens who are ocean and science literate so that they can implement changes that positively impact the environment, particularly in sustaining the earth's oceans.

References

**References marked with an asterisk indicate studies included in meta-analyses.*

Aktamis, H., Acar, E., & Unal Coban, G. (2015). A summer camp experience of primary student: Let's learn astronomy, explore the space summer camp. *Asia-Pacific Forum on Science Learning and Teaching*, *16*(1), 24. Retrieved from https://www.eduhk.hk/apfslt/

*Avard, M. (2009). Student-centered learning in an earth science, preservice, teacher-education course. Journal of College Science Teaching, 38(6), 24–29. Retrieved from www.nsta.org

Avraamidou, L. (2014). Developing a reform-minded science teaching identity: The role of informal science environments. *Journal of Science Teacher Education*, *25*(7), 823–843. doi:10.1007/s10972-014-9395-y

Bas, M., Teksoz, G. T., & Ertepinar, H. (2011). Emphasizing local features for effective environmental education: Environmental attitudes of elementary school students living in ancient Halicarnassus (Turkey). *Science Education International*, *22*(2), 119–132. Retrieved from http://icaseonline.net

Beaulieu, S. E., Emery, M., Brickley, A., Spargo, A., Patterson, K., Joyce, K., … Madin, K. (2015). Using digital globes to explore the deep sea and advance public literacy in earth system science. *Journal of Geoscience Education*, *63*(4), 332–343. doi:10.5408/14-067.1

Bischoff, P. J., Castendyk, D., Gallagher, H., Schaumloffel, J., & Labroo, S. (2008). A science summer camp as an effective say to recruit high school students to major in the physical sciences and science education. *International Journal of Environmental & Science Education*, *3*(3), 131–141. Retrieved from http://www.ijese.com

Bleicher, R., & Lambert, J. (2013). Preservice teachers' perspectives on global climate change. *International Journal of Climate Change: Impacts & Responses*, *4*(1), 65–72. doi:10.18848/1835-7156/CGP/v04i01/37152

Boon, H. J. (2016). PreService teachers and climate change: A stalemate? *Australian Journal of Teacher Education*, *41*(4), 3. doi:10.14221/ajte.2016v41n4.3

Boyle, P., Breslin, V., Brisson, L. C., Fraser, J., Friedman, A. J., Gardner, K., … Yalowitz, S. (2014). *COSEE OCEAN inquiry group report: Opportunities for creating lifelong ocean science literacy* (p. 124). Boston,MA: School for the Environment, University of Massachusetts, Boston. Retrieved from http://scholarworks.umb.edu/environment_pubs/1/.

Brody, M. J., & Koch, H. (1990). An assessment of 4th-, 8th-, and 11th-grade students' knowledge related to marine science and natural resource issues. *Journal of Environmental Education*, *21*(2), 16–26. doi:10.1080/00958964.1990.9941927

Buaraphan, K. (2011). The impact of the standard-based science teacher preparation program on preservice science teachers' attitudes toward science teaching.

Journal of Turkish Science Education (TUSED), *8*(1), 61–78. Retrieved from http://www.tused.org/internet/tused/default13.asp

Caldwell, J. M., Wiener, C., Heckman, M., & Lemus, J. D. (2015). The essence of fluorescence. *Current: The Journal of Marine Education*, *29*(3), 22–29. Retrieved from http://www.marine-ed.org/

Canadian network for ocean education. (2014). *Journal of Ocean Technology*, *9*(3), 102–103. Retrieved from http://www.thejot.net/

Capra, F. (2007). Sustainable living, ecological literacy, and the breath of life. *Canadian Journal of Environmental Education*, *12*(1), 9–18. Retrieved from https://cjee.lakeheadu.ca/

Carneval, A. p., Smith, N., & Melton, M. (2011). *STEM* (p. 112). Washington, D.C: Georgetown University Center on Education and the Workforce. Retrieved from https://cew.georgetown.edu/report/stem/

Carrier, S. J. (2009). The effects of outdoor science lessons with elementary school students on preservice teachers' self-efficacy. *Journal of Elementary Science Education*, *21*(2), 35–48. doi:10.1007/BF03173683

Caudle, T. L., & Paine, J. G. (2016). Applications of coastal data collected in the Texas high school coastal monitoring program (THSCMP). *Journal of Coastal Research*, *33*(3). doi:10.2112/JCOASTRES-D-16-00033.1

Cava, F., Schoedinger, S., Strang, C., & Tuddenham, P. (2005). *Science content and standards for ocean literacy: A report on ocean literacy*. College of Exploration

Berkeley. Retrieved from http://www.cosee-se.org/files/coseeca/OLit04-05FinalReport.pdf

Cavanagh, S. (2007). Science camp: Just for the girls. *Education Week*, *26*(45), 26–28. Retrieved from www.edweek.org

Charmaz, K. (2006). *Constructing grounded theory*. London ; Thousand Oaks, Calif: Sage Publications.

Chigbu, P., & Stevens, B. G. (2016a). *Performance Report for Cooperative Agreement No: NA11SEC4810002 for the Period from September 1, 2015 to February 29, 2016 (Revised)* (p. 26). Princess Anne, MD: University of Maryland Eastern Shore: NOAA Living Marine Resources Cooperative Science Center. Retrieved from https://www.umes.edu/uploadedFiles/_DEPARTMENTS/LMRCSC/Content/LMRCSC%20Semi-Annual%20Report%20Sept%202015-Feb%202016%20(web%20revised).pdf

Chigbu, P., & Stevens, B. G. (2016b). *University of Maryland Eastern Shore: NOAA Living Marine Resources Cooperative Science Center: Grant No. NA11SEC4810002* (LMRCSC SCIENCE PLAN (Revised)) (p. 26). Princess Anne, MD: University of Maryland Eastern Shore: NOAA Living Marine Resources Cooperative Science Center. Retrieved from https://www.umes.edu/cms300uploadedFiles/LMRCSC%20Science%20Plan%20-%20Final.pdf

Chigbu, P., Stevens, B. G., Smith, S., Gibson, D., & Hoskins, D. (2011). *LMRCSC Science Plan* (No. 2011–2016) (p. 26). Princess Anne, MD: University of Maryland, Eastern Shore. Retrieved from https://www.umes.edu/cms300uploadedFiles/LMRCSC%20Science%20Plan%20-%20Final.pdf

Clark, B., & Button, C. (2011). Sustainability transdisciplinary education model: Interface of arts, science, and community (STEM). *International Journal of Sustainability in Higher Education*, *12*(1), 41–54. doi:10.1108/14676371111098294

Cramer, K. R., Sherman, M. B., & Curran, M. C. (2015). Litter isn't glitter: Beaches should be clean. *Current: The Journal of Marine Education*, *29*(3), 5–15. Retrieved from http://www.marine-ed.org/

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed). Los Angeles: SAGE Publications.

Culen, G. R., & Mony, P. R. S. (2003). Assessing environmental literacy in a nonformal youth program. *Journal of Environmental Education*, *34*(4), 26–28. doi:10.1080/00958960309603484

Cummins, S., & Snively, G. (2000). The effect of instruction on children's knowledge of marine ecology, attitudes toward the ocean, and stances toward marine resource issues. *Canadian Journal of Environmental Education (CJEE)*, *5*(1), 305–326. Retrieved from cjee.lakeheadu.ca

Dahl, R. M., & Droser, M. L. (2016). Building an effective and affordable K-12 geoscience outreach program from the ground up: A simple model for universities. *Journal of Geoscience Education*, *64*(1), 5–16. doi:10.5408/15-100.1

Davis, E. G. (2014). Micro pedagogies: Implementing a micro-spiral science curriculum for preservice teachers and middle school children science summer camp. *International Journal of Science in Society*, *5*(2), 9–27. Retrieved from http://www.commongroundpublishing.com/

Dublin, R., Sigman, M., Anderson, A., Barnhardt, R., & Topkok, S. A. (2014). COSEE-AK ocean science fairs: A science fair model that grounds student projects in both western science and traditional native knowledge. *Journal of Geoscience Education*, *62*(2), 166–176. doi:10.5408/12-411.1

Erdogan, M. (2011). The effects of ecology-based summer nature education program on primary school students' environmental knowledge, environmental affect and responsible environmental behavior. *Educational Sciences: Theory and Practice*, *11*(4), 2233–2237. Retrieved from http://www.edam.com.tr/estp.asp

Erinosho, S. (2015). Engaging girls in "learn science by doing" as strategy for enhanced learning at the junior high school level: A study in Nigeria. *International Journal of Educational Studies*, *2*(2), 101–107. Retrieved from http://escijournals.net

Farland-Smith, D. (2016). My Daughter the Scientist? Mothers' Perceptions of the Shift in Their Daughter's Personal Science Identities. *Journal of Educational Issues*, *2*(1), 1–21. doi:10.5296/jei.v2i1.8670

Foley, J., Bruno, B., Tolman, R., Kagami, R., Hsia, M., Mayer, B., & Inazu, J. (2013). C-MORE science kits as a classroom learning tool. *Journal of Geoscience Education*, *61*(3), 256–267. doi:10.5408/12-336.1

Fortner, R. W., & Mayer, V. J. (1983). Ohio students' knowledge and attitudes about the oceans and Great Lakes. *Ohio Journal of Science*, *83*(5), 218–224. Retrieved from http://hdl.handle.net/1811/22959

Fortner, R. W., & Teates, T. G. (1980). Baseline studies for marine education: Experiences related to marine knowledge and attitudes. *Journal of Environmental Education*, *11*(4), 11–19. doi:10.1080/00958964.1980.9941385

Foster, J. S., & Shiel-Rolle, N. (2011). Building scientific literacy through summer science camps: A strategy for design, implementation and assessment. *Science Education International*, *22*(2), 85–98. Retrieved from http://www.eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=EJ941663

Fraser, B. J., Treagust, D. F., & Dennis, N. C. (1986). Development of an instrument for assessing classroom psychosocial environment at universities and colleges. *Studies in Higher Education*, *11*(1), 43–53. doi:10.1080/03075078612331378451

Gall, M., Gall, J., & Borg, W. (2007). Collecting research data with questionnaires and interviews. In *Educational research: An introduction* (8th ed., pp. 227–261). Pearson/Allyn & Bacon.

Garst, B. A., & Ozier, L. W. (2015). Enhancing youth outcomes and organizational practices through a camp-based reading program. *Journal of Experiential Education*, *38*(4), 324–338. doi:10.1177/1053825915578914

Gelcich, S., Buckley, P., Pinnegar, J. K., Chilvers, J., Lorenzoni, I., Terry, G., … Duarte, C. M. (2014). Public awareness, concerns, and priorities about anthropogenic impacts on marine environments. *Proceedings of the National Academy of Sciences*, *111*(42), 15042–15047. doi:10.1073/pnas.1417344111

Gill, S. E., Marcum-Dietrich, N., & Becker-Klein, R. (2014). Model my watershed: Connecting students' conceptual understanding of watersheds to real-world decision making. *Journal of Geoscience Education*, *62*(1), 61–73. doi:10.5408/12-395.1

Gold, A. U., Kirk, K., Morrison, D., Lynds, S., Sullivan, S. B., Grachev, A., & Persson, O. (2015). Arctic climate connections curriculum: A model for bringing authentic data into the classroom. *Journal of Geoscience Education*, *63*(3), 185–197. doi:10.5408/14-030.1

Gorospe, K. D., Fox, B. K., Haverkort-Yeh, R. D., Tamaru, C. S., & Rivera, M. A. J. (2013). Engaging students in the pacific and beyond using an inquiry-based lesson in ocean acidification. *Journal of Geoscience Education*, *61*(4), 396–404. doi:10.5408/12-390.1

Guertin, L. (2016). Starting students on the pathway to ocean literacy with a first day class activity. *Current: The Journal of Marine Education*, *30*(2), 20–24. Retrieved from http://www.marine-ed.org/

Guertin, L., & Clements, N. (2015). Ocean literacy: Can students learn the essential principles? *Current: The Journal of Marine Education*, *29*(3), 35–38. Retrieved from http://www.marine-ed.org/

Guest, H., Lotze, H. K., & Wallace, D. (2015). Youth and the sea: Ocean literacy in Nova Scotia, Canada. *Marine Policy*, *58*, 98–107. doi:10.1016/j.marpol.2015.04.007

Gunckel, K. L., Covitt, B. A., Salinas, I., & Anderson, C. W. (2012). A learning progression for water in socio-ecological systems. *Journal of Research in Science Teaching*, *49*(7), 843–868. doi:10.1002/tea.21024

Haley, S. T., & Dyhrman, S. T. (2009). The artistic oceanographer program. *Science and Children*, *46*(8), 31–35. Retrieved from http://www.nsta.org

Hart, P. (2010). No longer a "little added frill": The transformative potential of environmental education for educational change. *Teacher Education Quarterly*, *37*(4), 155–177. Retrieved from http://www.jstor.org/stable/23479465

Hernández-Pacheco, R., Bárbara Casañas-Montes, Morales-Figueroa, A., López, M. E., Mayol, A.-R., & Díaz-Vázquez, L. M. (2015). Let me grow! *Current: The Journal of Marine Education*, *29*(2), 18–21. Retrieved from http://www.marine-ed.org/

Hine, A., & Medvecky, F. (2015). Unfinished science in museums: A push for critical science literacy. *Journal of Science Communication*, *14*(2), 1–14. Retrieved from https://espace.library.uq.edu.au/view/UQ:362585

Hoegh-Guldberg, O., & Bruno, J. F. (2010). The impact of climate change on the world's marine ecosystems. *Science*, *328*(5985), 1523–1528. doi:10.1126/science.1189930

Houser, C., Garcia, S., & Torres, J. (2015). Effectiveness of geosciences exploration summer program (GeoX) for increasing awareness and knowledge of geosciences. *Journal of Geoscience Education*, *63*(2), 116–126. doi:10.5408/14-016.1

Hughes, R., Nzekwe, B., & Molyneaux, K. (2013). The single sex debate for girls in science: A comparison between two informal science programs on middle school students' STEM identity formation. *Research in Science Education*, *43*(5), 1979–2007. doi:10.1007/s11165-012-9345-7

Hunnewell, M. C., Curran, M. C., & Sherman, M. B. (2015). Do you see me now? How fish play hide and seek. *Current: The Journal of Marine Education*, *29*(2), 2–6. Retrieved from http://www.marine-ed.org/

Hymer, V. (2005). Bitten by the science "BUG." *Science and Children*, *42*(8), 26–29. Retrieved from http://www.nsta.org

Ismail, N. S., Suandi, T., Muda, A., Rashid, N. A., & Yusof, M. M. (2011). Environmental literacy of trainees from Malaysian Teacher Education institute: The affective and behavior component. *OIDA International Journal of*

Sustainable Development, (6), 77–88. Retrieved from http://www.ontariointernational.org

Jeronen, E., Jeronen, J., & Raustia, H. (2009). Environmental education in Finland--A case study of environmental education in nature schools. *International Journal of Environmental and Science Education*, *4*(1), 1–23. Retrieved from http://www.ijese.com

Johnson, E., & Catley, K. (2009). Urban soil ecology as a focal point for environmental education. *Urban Ecosystems*, *12*(1), 79–93. doi:10.1007/s11252-008-0080-9

*Kardash, C. M., & Wallace, M. L. (2001). The perceptions of science classes survey: What undergraduate science reform efforts really need to address. Journal of Educational Psychology, 93(1), 199–210. doi:10.1037/0022-0663.93.1.199

Kelly, L.-A. D., Luebke, J. F., Clayton, S., Saunders, C. D., Matiasek, J., & Grajal, A. (2014). Climate change attitudes of zoo and aquarium visitors: Implications for climate literacy education. *Journal of Geoscience Education*, *62*(3), 502–510. doi:10.5408/13-078.1

Kesidou, S., & Roseman, J. E. (2002). How well do middle school science programs measure up? Findings from Project 2061's curriculum review. *Journal of Research in Science Teaching*, *39*(6), 522–549. doi:10.1002/tea.10035

Kim, J.-M. (2012). 30 Years of marine educational research in North America: A review of methodologies. *Journal of Fisheries and Marine Sciences Education*, *24*(6), 950–962. doi:10.13000/JFMSE.2012.24.6.950

Kim, J.-M., Anderson, D., & Scott, S. (2013). Korean elementary school students' perceptions of relationship with marine organisms. *Asia-Pacific Forum on Science Learning and Teaching*, *14*(2). Retrieved from http://www.eduhk.hk/apfslt/

Kolodner, J. L., Camp, P. J., Crismond, D., Fasse, B., Gray, J., Holbrook, J., … Ryan, M. (2003). Problem-based learning meets case-based reasoning in the middle-school science classroom: Putting learning by design (tm) into practice. *Journal of the Learning Sciences*, *12*(4), 495–547. doi:10.1207/S15327809JLS1204_2

Kovacs, C., Curran, M. C., & Cox, T. (2013). Where's that dolphin? Using bottlenose dolphin sightings to study spatial patterns. *Science Teacher*, *80*(9), 24. Retrieved from www.nsta.org

Kowalski, M., Crews, T., & Rowe, S. (2016). Mitigating microplastics: Development and evaluation of a middle school curriculum. *Current: The Journal of Marine Education*, *30*(2), 34–40. Retrieved from http://www.marine-ed.org/

Kurtz-Costes, B., Rowley, S. J., Harris-Britt, A., & Woods, T. A. (2008). Gender stereotypes about mathematics and science and self-perceptions of ability in late childhood and early adolescence. *Merrill-Palmer Quarterly*, *54*(3), 386–409. doi:10.1353/mpq.0.0001

Lambert, J. (2006). High school marine science and scientific literacy: The promise of an integrated science course. *International Journal of Science Education*, *28*(6), 633–654. doi:10.1080/09500690500339795

Leaper, C., Farkas, T., & Brown, C. S. (2012). Adolescent girls' experiences and gender-related beliefs in relation to their motivation in math/science and English. *Journal of Youth and Adolescence*, *41*(3), 268–282. doi:10.1007/s10964-011-9693-z

Leblebicioğlu, G., Metin, D., Yardımcı, E., & Berkyürek, İ. (2011). Teaching the nature of science in the nature: A summer science camp. *Ilkogretim Online*, *10*(3), 1037–1054. Retrieved from http://dergipark.ulakbim.gov.tr/ilkonline/

Lee, O., & Anderson, C. W. (1993). Task engagement and conceptual change in middle school science classrooms. *American Educational Research Journal*, *30*(3), 585–610. doi:10.3102/00028312030003585

Lindner, M., & Kubat, C. (2014). Science camps in Europe - Collaboration with companies and school, implications and results on scientific literacy. *Science Education International*, *25*(1), 79–85. Retrieved from http://icaseonline.net

Livescribe[TM] Echo smartpen. (2015). (Version Smartpen Firmware 2.9.9) [Window 3.0]. Livescribe Inc. Retrieved from https://www.livescribe.com/

Luther, R. A., Tippins, D. J., Bilbao, P. P., Tan, A., & Gelvezon, R. L. (2013). The story of mangrove depletion: Using socioscientific cases to promote ocean literacy. *Science Activities: Classroom Projects and Curriculum Ideas*, *50*(1), 9–20. doi:10.1080/00368121.2013.768952

*Macaskill, A., & Taylor, E. (2010). The development of a brief measure of learner autonomy in university students. Studies in Higher Education, 35(2), 351–359. doi:10.1080/03075070903502703

Madden, L., Bedward, J. C., Wiebe, E. N., & Benitez-Nelson, C. R. (2014). Lessons learned in summer camp: A case study of the learning paths of three campers. *Electronic Journal of Science Education*, *16*(3). Retrieved from http://ejse.southwestern.edu

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation* (4th ed.). San Francisco, CA: Jossey-Bass. Retrieved from www.wiley.com

Michael, K. Y. (2013). Bathymetry in the classroom. *Technology and Engineering Teacher*, *73*(1), 14–18. Retrieved from http://www.iteaconnect.org

Mohr-Schroeder, M. J., Jackson, C., Miller, M., Walcott, B., Little, D. L., Speler, L., … Schroeder, D. C. (2014). Developing middle school students' interests in STEM via summer learning experiences: See blue STEM camp. *School Science and Mathematics*, *114*(6), 291–301. doi:10.1111/ssm.12079

National Research Council (U.S.). (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, D.C: The National Academies Press.

Nelson, A. (2010). Environmental education & ecology in a life science course for preservice K-8 teachers using project wildlife in learning design. *American Biology Teacher*, *72*(3), 156–160. doi:10.1525/abt.2010.72.3.6

Next generation science standards. (2014). Retrieved October 31, 2014, from http://www.nextgenscience.org/

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education*, *31*(2), 199–218. doi:10.1080/03075070600572090

NOAA. (2013). *Ocean literacy : The essential principles of ocean sciences for learners of all ages* (p. 13). Retrieved from http://oceanliteracy.wp2.coexploration.org/

Nuss, S., & Beck, J. (2015). Enhancing climate education for a changing Chesapeake Bay. *Current: The Journal of Marine Education*, *29*(2), 7–11. Retrieved from http://www.marine-ed.org/

Parrish, C. L., Curran, M. C., & Sajwan, K. S. (2015). We're gonna crush it! Sediment creation through destruction. *Science Activities: Classroom Projects and Curriculum Ideas*, *52*(4), 75–91. doi:10.1080/00368121.2015.1083523

Plankis, B. J., & Marrero, M. E. (2010). Recent ocean literacy research in United States public schools: Results and implications. *International Electronic Journal of Environmental Education*, *1*(1). Retrieved from http://dergipark.ulakbim.gov.tr/iejeegreen/article/view/1087000027/1087000008

*Pollio, H. R., & Beck, H. P. (2000). When the tail wags the dog: Perceptions of learning and grade orientation in and by contemporary college students and faculty. Journal of Higher Education, 71(1), 84–102. doi:10.2307/2649283

Ramos, A., & Ramos, R. (2011). Ecoliteracy through imagery: A close reading of two wordless picture books. *Children's Literature in Education*, *42*(4), 325–339. doi:10.1007/s10583-011-9142-3

Ramsden, S., & Curran, M. C. (2016). One ray, two ray, spring ray, fall ray. *Current: The Journal of Marine Education*, *30*(2), 41–48. Retrieved from http://www.marine-ed.org

Ratinen, I., Viiri, J., Lehesvuori, S., & Kokkonen, T. (2015). Primary student-teachers' practical knowledge of inquiry-based science teaching and classroom communication of climate change. *International Journal of Environmental and Science Education*, *10*(5), 649–670. doi:10.12973/ijese.2015.259a

Riedinger, K. (2015). Identity development of youth during participation at an informal science education camp. *International Journal of Environmental and Science Education*, *10*(3), 453–475. doi:10.12973/ijese.2015.254a

Rivera, M. A. J., Manning, M. M., & Krupp, D. A. (2013). A unique marine and environmental science program for high school teachers in Hawaii: Professional development, teacher confidence, and lessons learned. *International Journal of Environmental and Science Education*, *8*(2), 217–239. Retrieved from http://files.eric.ed.gov/fulltext/EJ1008602.pdf

Roberts, J. (2007). Education, eco-progressivism and the nature of school reform. *Educational Studies: Journal of the American Educational Studies Association*, *41*(3), 212–229. doi:10.1080/00131940701325688

Rose, C. M., Adams, J. M., Hinchey, E. K., Nestlerode, J. A., & Patterson, M. R. (2013). The incredible shrinking cup lab: Connecting with ocean and great lakes scientists to investigate the effect of depth and water pressure on polystyrene. *Science*

Activities: Classroom Projects and Curriculum Ideas, *50*(1), 1–8. doi:10.1080/00368121.2012.727754

Rose, M. A. (2010). Envirotech: Enhancing environmental literacy and technology assessment Skills. *Journal of Technology Education*, *22*(1), 43–57. doi:10.21061/jte.v22i1.a.3

Rutherford, F. J., & Ahlgren, A. (1991). *Science for all Americans*. Oxford university press.

*Sadler, D. R. (2010). Beyond feedback: Developing student capability in complex appraisal. Assessment and Evaluation in Higher Education, 35(5), 535–550. doi:10.1080/02602930903541015

Sadler, P. M., & Sonnert, G. (2016). Understanding misconceptions: Teaching and learning in middle school physical science. *American Educator*, *40*(1), 26–32.

Schifman, L., Cardace, D., Kortz, K., Saul, K., Gilfert, A., Veeger, A. I., & Murray, D. P. (2013). Sleuthing through the rock cycle: An online guided inquiry tool for middle and high school geoscience education. *Journal of Geoscience Education*, *61*(3), 268–279. doi:10.5408/12-326.1

Schoedinger, S., Cava, F., & Jewell, B. (2006). The need for ocean literacy in the classroom: Part 1. *Science Teacher*, *73*(6), 44. Retrieved from http://www.nsta.org

Schoedinger, S., Tran, L. U., & Whitley, L. (2010). From the principles to the scope and sequence: A brief history of the ocean literacy campaign. *NMEA Special Report*, *3*, 3–7. Retrieved from http://www.coexploration.org/oceanliteracy/NMEA_Report_3/NMEA_2010-2-History.pdf

Schusler, T. M., & Krasny, M. E. (2010). Environmental action as context for youth development. *Journal of Environmental Education*, *41*(4), 208–223. doi:10.1080/00958960903479803

Sezen Vekli, G. (2013). Summer science camp for middle school students: A Turkish experience. *Asia-Pacific Forum on Science Learning & Teaching*, *14*(1), 1–26. Retrieved from https://www.eduhk.hk/apfslt/download/v14_issue1_files/vekli.pdf

Sigman, M., Dublin, R., Anderson, A., Deans, N., Warburton, J., Matsumoto, G. I., … Harcharek, J. (2014). Using large marine ecosystems and cultural responsiveness as the context for professional development of teachers and scientists in ocean sciences. *Journal of Geoscience Education*, *62*(1), 25–40. doi:10.5408/12-403.1

Stanger-Hall, K. F. (2012). Multiple-choice exams: An obstacle for higher-level thinking in introductory science classes. *CBE-Life Sciences Education*, *11*(3), 294–306. doi:10.1187/cbe.11-11-0100

Sterling, D. R., Matkins, J. J., Frazier, W. M., & Logerwell, M. G. (2007). Science camp as a transformative experience for students, parents, and teachers in the urban setting. *School Science & Mathematics*, *107*(4), 134–148. doi:10.1111/j.1949-8594.2007.tb17928.x

Stevenson, K. T., Carrier, S. J., & Peterson, M. N. (2014). Evaluating strategies for inclusion of environmental literacy in the elementary school classroom. *Electronic Journal of Science Education*, *18*(8). Retrieved from http://ejse.southwestern.edu/article/view/13940

Stevenson, K. T., Peterson, M. N., Carrier, S. J., Strnad, R. L., Bondell, H. D., Kirby-Hathaway, T., & Moore, S. E. (2014). Role of significant life experiences in building environmental knowledge and behavior among middle school students. *Journal of Environmental Education*, *45*(3), 163–177. doi:10.1080/00958964.2014.901935

Strand, S. (2002). Supporting an educational marine science camp for urban youth. *California Sea Grant College Program*. Retrieved from http://www-scgs.uscd.edu

SurveyMonkey Inc. (2017). *SurveyMonkey ® : Free online survey software & questionnaire tool*. San Mateo, California, USA. Retrieved from www.surveymonkey.com

Talley, D., Goodwin, L., Ruzic, R., & Fisler, S. (2011). Marine ecology as a framework for preparing the next generation of scientific leaders. *Marine Ecology*, *32*(3), 268–277. doi:10.1111/j.1439-0485.2011.00468.x

Taubenheim, T., Curran, M. C., & Hoskins-Brown, D. (2016). Mollusk mania. *Current: The Journal of Marine Education*, *30*(2), 5–11. Retrieved from http://www.marine-ed.org/

Thomas, J., & Raisor, J. M. (2015). Reel in students: Using real world learning objects (RWLO) and real-time data in ocean science. *Current: The Journal of Marine Education*, *29*(3), 16–21. Retrieved from http://www.marine-ed.org/

Thompson, C., Ebanks, S. C., & Curran, M. C. (2016). Shrimp socktail: The shrimp you feel instead of peel. *Current: The Journal of Marine Education*, *30*(1), 35–47. Retrieved from http://www.marine-ed.org/

Thompson, J., Curran, M. C., & Cox, T. (2016). "Capture" me if you can: Estimating abundance of dolphin populations. *Science Activities: Classroom Projects and Curriculum Ideas*, *53*(2), 49–67. doi:10.1080/00368121.2015.1135863

Treagust, D. F., Jacobowitz, R., Gallagher, J. L., & Parker, J. (2001). Using assessment as a guide in teaching for understanding: A case study of a middle school science class learning about sound. *Science Education*, *85*(2), 137–157. doi:10.1002/1098-237X(200103)85:2%3C137::AID-SCE30%3E3.0.CO;2-B

*Walczyk, J. J., & Ramsey, L. L. (2003). Use of learner centered instruction in college science and mathematics classrooms. Journal of Research in Science Teaching, 40(6), 566–584. doi:10.1002/tea.10098

Weimer, M. (2013). *Learner centered teaching: Five key changes to practice* (2nd ed.). San Francisco, CA: Jossey-Bass.

Widder, E., Falls, B., Rohm, R., & Lloyd, C. (2014). Save the water babies: High school students as citizen scientists. *Current: The Journal of Marine Education*, *29*(1), 16–21. Retrieved from http://www.marine-ed.org/

Wiener, C. S., Manset, G., & Lemus, J. D. (2015). Ocean use in Hawaii as a predictor of marine conservation interests, beliefs, and willingness to participate: an exploratory study. *Journal of Environmental Studies and Sciences*, 1–12. doi:10.1007/s13412-015-0272-6

Wiener, C. S., & Matsumoto, K. (2014). Ecosystem pen pals: Using place-based marine science and culture to connect students. *Journal of Geoscience Education*, *62*(1), 41–48. doi:10.5408/12-401.1

*Wiggins, G., & McTighe, J. (2005). Understanding by Design (2nd ed.). Saddle River, NJ: Pearson Education.

Williams, J. T., Gut, J. A., Sherman, M. B., & Curran, M. C. (2016). Hear ye, hear ye: Mock town hall meeting on human-induced impacts on the ecosystem. *Current: The Journal of Marine Education*, *30*(1), 13–24. Retrieved from http://www.marine-ed.org/

Wolf, S., & Fraser, B. (2008). Learning environment, attitudes and achievement among middle-school science students using inquiry-based laboratory activities. *Research in Science Education*, *38*(3), 321–341. doi:10.1007/s11165-007-9052-y

Worker, S. M., & Smith, M. H. (2014). Curriculum and professional development for OST science education: Lessons learned from California 4-H. *Afterschool Matters*, (20), 21–27. Retrieved from http://www.niost.org

Yin, R. K. (2014). *Case study research: Design and methods* (Fifth edition). Los Angeles: SAGE.

Appendix A: Letter of Cooperation

Victoria Young
[redacted]

March 2017

Dear Victoria Young,

Based on my review of your research proposal, I give permission for you to conduct the study entitled *Impact of a Marine Science Summer Enrichment Camp on Ocean Literacy Skills for Middle School Students*. As part of this study, I authorize you to recruit [redacted] instructors and parents and their middle school children who attended this summer camp in 2016. In addition, I authorize you to collect data from multiple sources, including (a) individual interviews with selected teachers, parents, and students, (b) reflective journals maintained by teachers and students, and (c) documents and archival records related to the [redacted] summer experience. Individuals' participation will be voluntary and at their own discretion.

We understand that our organization's responsibilities include providing a private conference room at NOAA LMRCSC at [redacted] to conduct the individual interviews with teachers, parents, and students. We reserve the right to withdraw from the study at any time if our circumstances change.

I confirm that I am authorized to approve research in this setting and that this plan complies with the organization's policies.

I understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student's supervising faculty/staff without permission from the Institutional Review Board (IRB) at Walden University.

Sincerely,

[redacted]

Appendix B: Invitational Letter for Teachers

March 2017

Dear Teacher,

My name is Victoria Young, and I am a doctoral student at Walden University, which is an accredited institution of higher education. I am inviting you to participate in my research study titled *Impact of a Marine Science Summer Enrichment Camp on Ocean Literacy Skills for Middle School Students* because you were a teacher or an intern who provided instruction in marine science for middle school students at [redacted] in 2016. The purpose of my study is to describe the impact of [redacted] on the ocean literacy skills of middle school students who participated in the camp.

Please review the enclosed consent form, which includes an explanation of the data collection procedures. If you are interested in participating in this study, please sign and return the consent form in the enclosed self-addressed stamped envelope to me as soon as possible. I will select the first three teachers who return signed consent forms to me as participants, and I will contact you about scheduling the interview.

Thank you for your time.

Sincerely,

Victoria Young

Appendix C: Invitational Letter for Students

March 2017

Dear Student,

My name is Victoria Young, and I am a doctoral student at Walden University, which is an accredited institution of higher education. I am inviting you to participate in my research study titled *Impact of a Marine Science Summer Enrichment Camp on Ocean Literacy Skills for Middle School Students* because you were a student who participated in the 2016 [redacted] for middle school students. The purpose of my study is to describe the impact of [redacted] on the ocean literacy skills of middle school students who participated in this camp.

Please review the enclosed consent form and assent form, which include an explanation of the data collection procedures. If you are interested in participating in this study, please sign and return the assent form in the enclosed self-addressed stamped envelope to me as soon as possible. You will also need to enclose a signed consent form from your parent, indicating his or her approval for your participation. I will select the first three students who return signed assent and consent forms to me as participants, and I will contact you about scheduling the interview. Thank you for your time.

Sincerely,

Victoria Young

Appendix D: Invitational Letter for Parents

March 2017

Dear Parent,

My name is Victoria Young, and I am a doctoral student at Walden University, which is an accredited institution of higher education. I am inviting you to participate in my research study titled *Impact of a Marine Science Summer Enrichment Camp on Ocean Literacy Skills for Middle School Students* because you were a parent who enrolled your child in the 2016 [redacted]. The purpose of my study is to describe the impact of this camp on the ocean literacy skills of middle school students who participated in this camp.

Please review the enclosed consent form, which includes an explanation of the data collection procedures. If you are interested in participating in this study, please sign and return the consent form in the enclosed self-addressed stamped envelope to me as soon as possible. I will select the first three parents who return signed consent forms to me as participants, and I will contact you about scheduling the interview.

Thank you for your time.

Sincerely,

Victoria Young

Appendix F: Interview Guide for Teachers

Introduction

Thank you for your participation. This interview should be about 30 to 45 minutes, and I will ask you nine questions. The purpose of this study is to gain a better understanding of how [redacted] has impacted the ocean literacy skills of middle school students who participated in this camp. Here are the interview questions that I will ask you. On the back side are the definitions of terms that I would like to discuss with you briefly before we begin the interview.

Interview Questions

1. Please describe your previous experiences as a marine science teacher.
2. What curricular materials did you use at the 2016 [redacted] that you believe improved ocean literacy skills for middle school students?
3. What instructional strategies did you use at the 2016 [redacted] that you believe improved ocean literacy skills for middle school students?
4. What assessment strategies did you use at the 2016 [redacted] that you believe improved ocean literacy skills for middle school students?
5. Why or why not do you believe that middle school students who participated in 2016 [redacted] improved their ocean literacy skills?
6. Why or why not do you believe that middle school students who participated in 2016 [redacted] became more responsible for their own learning?

7. What professional development in ocean literacy skills have you received that you believe improved teaching and learning at 2016 [redacted]?
8. What professional development in learner centered teaching have you received that you believe improved teaching and student learning at 2016 [redacted]?
9. What else would you like to tell me about this experience?

Conclusion

Thank you for your time and cooperation. In the next two weeks, I will send you five reflective journal questions as an email link attachment. It should take you about 30 minutes to answer these questions. Please complete these reflective journal questions by (insert date). I will email you the results of the study in the spring of 2017. If you have any questions, please contact me at [redacted].

Definition of Terms

Ocean literacy: understanding the ocean's influence on humans and the influence of humans on the ocean (NOAA, 2013) which includes the following principles: (a) the Earth has one big ocean with many features, (b) the ocean and life in the ocean shape the features of the Earth, (c) the ocean is a major influence on weather and climate, (d) the ocean makes Earth habitable, (e) the ocean supports a great diversity of life and ecosystems, (f) the ocean and humans are connected, and (g) the ocean is largely unexplored.

Learner centered teaching: An instructional approach that fosters an inquiry-based learning environment (Weimer, 2013). This approach is divided into the following five components related to key changes in instructional practice: (a) role of the teacher, (b) balance of power, (c) function of content, (d) responsibility for learning, and (e) purpose and processes of evaluation.

Curricular materials related to ocean literacy:

[redacted] *Learning Activities Binder*, which includes such topics as fish body, climate change, ocean debate, and ecology of the marsh, including coring in marsh mud, conducting a marsh walk, and making marsh stew.

Instructional strategies related to ocean literacy:

In the structured inquiry, the camp teacher presented a question and data collection procedures such as catch, tag, and release, requiring students to identify strategies to measure population densities in the ocean.

Assessments related to ocean literacy:

Summative assessments: pre and posttests on marine ecology and ocean science

Formative assessments: Daily exit slip asking students to describe what they learned in camp that day

Appendix G: Interview Guide for Parents

Introduction:

Thank you for your participation. This interview should be about 30 to 45 minutes, and I will ask you seven questions. The purpose of this study is to gain a better understanding of how [redacted] has impacted the ocean literacy skills of middle school students who participated in this camp. Here are the interview questions that I will ask you. On the back side are the definitions of terms that I would like to discuss with you briefly before we begin the interview.

Interview Questions:

1. Please explain why you enrolled your child at 2016 [redacted]

2. Why or why not do you believe the curricular materials used at 2016 [redacted] improved your child's ocean literacy skills?

3. Why or why not do you believe the instruction teachers used at 2016 [redacted] improved the ocean literacy skills of your child?

4. Why or why not do you believe the assessments used at 2016 [redacted] improved the literacy skills of your child?

5. Why or why not do you believe your child's participation in 2016 [redacted] improved your child's ocean literacy skills?

6. Why or why not do you believe your child's participation in 2016 [redacted] made your child more responsible for his or her learning?

7. What else would you like to tell me about this experience?

Conclusion:

Thank you for your time and cooperation. I will email you the results of the study in the spring of 2017. If you have any questions, please contact me at.

Definition of Terms

Ocean literacy: understanding the ocean's influence on humans and the influence of humans on the ocean (NOAA, 2013)which includes the following principles: (a) the Earth has one big ocean with many features, (b) the ocean and life in the ocean shape the features of the Earth, (c) the ocean is a major influence on weather and climate, (d) the ocean makes Earth habitable, (e) the ocean supports a great diversity of life and ecosystems, (f) the ocean and humans are inextricably interconnected, and (g) the ocean is largely unexplored.

Learner centered teaching: An instructional approach that fosters an inquiry-based learning environment (Weimer, 2013). This approach is divided into the following five components related to key changes in instructional practice: (a) role of the teacher, (b) balance of power, (c) function of content, (d) responsibility for learning, and (e) purpose and processes of evaluation.

Curricular materials related to ocean literacy:

[redacted] *Learning Activities Binder*, which includes such topics as fish morphology, climate change, ocean debate, and ecology of the marsh, including coring in marsh mud, conducting a marsh walk, and making marsh stew.

Instructional strategies related to ocean literacy:

In the structured inquiry, the camp teacher presented a question and data collection procedures such as catch, tag, and release, requiring students to identify strategies to measure population densities in the ocean.

Assessments related to ocean literacy:

Summative assessments: pre and posttests on marine ecology and ocean science

Formative assessments: Daily exit slip asking students to describe what they learned in camp that day

Appendix H: Interview Guide for Students

Introduction:

Thank you for your participation. This interview should be about 30 to 45 minutes, and I will ask you seven questions. The purpose of this study is to gain a better understanding of how [redacted] has impacted the ocean literacy skills of middle school students who participated in this camp. Here are the interview questions that I will ask you. On the back side are the definitions of terms that I would like to discuss with you briefly before we begin the interview.

Interview Questions:

1. Please explain why you wanted to attend the 2016 [redacted].

2. What curricular materials did teachers at 2016 [redacted] use that you believe improved your ocean literacy skills?

3. What instructional strategies did teachers at 2016 [redacted] use that you believe improved your ocean literacy skills?

4. What types of assessments did teachers at 2016 [redacted] use that you believe improved your ocean literacy skills?

5. Why or why not do you believe that your participation in 2016 [redacted] has improved your ocean literacy skills?

6. Why or why not do you believe that your participation in 2016 [redacted] has helped you develop more responsibility for your own learning?

7. What else would you like to tell me about this experience?

Conclusion:

Thank you for your time and cooperation. In the next two weeks, I will send you five reflective journal questions as an email link attachment. It should take you about 30 minutes to answer these questions. Please complete these reflective journal questions by April, 2016. I will email you the results of the study in the spring of 2017. If you have any questions, please contact me at [redacted]

Definition of Terms

Ocean literacy: understanding the ocean's influence on humans and the influence of humans on the ocean (NOAA, 2013)which includes the following principles: (a) the Earth has one big ocean with many features, (b) the ocean and life in the ocean shape the features of the Earth, (c) the ocean is a major influence on weather and climate, (d) the ocean makes Earth habitable, (e) the ocean supports a great diversity of life and ecosystems, (f) the ocean and humans are inextricably interconnected, and (g) the ocean is largely unexplored.

Learner centered teaching: An instructional approach that fosters an inquiry-based learning environment (Weimer, 2013). This approach is divided into the following five components related to key changes in instructional practice: (a) role of the teacher, (b) balance of power, (c) function of content, (d) responsibility for learning, and (e) purpose and processes of evaluation.

Curricular materials related to ocean literacy:

[redacted] *Learning Activities Binder*, which includes such topics as fish morphology, climate change, ocean debate, and ecology of the marsh, including coring in marsh mud, conducting a marsh walk, and making marsh stew.

Instructional strategies related to ocean literacy:

In the structured inquiry, the camp teacher presented a question and data collection procedures such as catch, tag, and release, requiring students to identify strategies to measure population densities in the ocean.

Assessments related to ocean literacy:

Summative assessments: pre and posttests on marine ecology and ocean science

Formative assessments: Daily exit slip asking students to describe what they learned in camp that day

Appendix I: Reflective Journal Questions for Teachers

Directions:

For each question, please write a paragraph reflecting on your experiences during the 2016 [redacted] summer program. Please submit your responses to me at [redacted] within 2 weeks of receipt of this reflective journal.

Reflective Journal Questions:

1. How would you describe your role as a science teacher during this marine science summer camp experience?

2. How would you describe the balance of power between you and your students in your marine science classroom this past summer?

3. How did you present science content to students during this marine science summer camp experience?

4. How did you encourage students to take responsibility for their own learning during this marine science summer camp experience?

5. How did you evaluate student learning during this marine science summer camp experience?

Appendix J: Reflective Journal Questions for Students

Directions:

For each question, please write a paragraph reflecting on your experiences during the 2016 [redacted] summer program. Please submit responses to me at [redacted] within 2 weeks of receipt of this reflective journal.

Reflective Journal Questions:

1. How would you describe your role as a camper during this marine science summer camp experience?

2. How would you describe the balance of power between you and your counselor or camp teacher in your marine science classroom this past summer?

3. How was science content presented to you during this marine science summer camp experience?

4. How were you encouraged to take responsibility for your learning during this marine science summer camp experience?

5. How was your marine science learning evaluated during this marine science summer camp experience?

Appendix K: Document Data Collection Form

Document Title:

Date Collected:

Source:

Purpose

Structure

Content

Use
