Understanding Scientific Inquiry: A Study of Seventh Grade Student Engagement

By:

Leah Moore

A Thesis Submitted to the Graduate Faculty
In Partial Fulfillment
Of the Requirements for the Degree
Master of Science in Education

University of Wisconsin – Superior

May 2016

Major Professor

Chair of the Department

Dean of Faculties and Graduate Studies

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Dedication

I dedicate this paper to my parents, Nan and Bob Ladehoff who fostered my scientific inquiry from the beginning. When I asked the question "What will happen if we plant this sprouted acorn?" without pause, you showed me not only how to perform my first scientific inquiry, but also how to teach and inspire others to ask questions. I would not be where I am today without your love, guidance, and endless hours of babysitting.

Abstract

Increasingly, there have been calls for science educators to teach science through scientific inquiry as research has shown that students who learn via scientific inquiry better understand how to practice science as well as science content (Eslinger, White, Frederiksen & Brobst, 2008; Peffer, Beckler, Schunn, Renken & Revak, 2015). However, science educators face barriers in teaching scientific inquiry such as curriculum that provides little if any scientific inquiry components and lack of resources. The purpose of this study explored if the Raptor Lab, a set of two scaffolded, inquiry based modules, had an impact on students' achievement of scientific inquiry. Upon completion of the two Raptor Lab modules, students applied their scientific inquiry skills to a Stream Study lab, in which students written lab report grades from 2015, a year without the Raptor Lab, were compared to lab report grades from 2016, the year with the Raptor Lab. Students on average Agreed or Strongly Agreed they learned components of scientific inquiry after completing the two Raptor Lab Modules. However, there was not a statistical significance found between lab report grades from 2015 (the year with no change) to 2016 (the year with change.)

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Chapter One

Introduction

Increasingly, the field of science is changing (Hurd, 1998). As a result, there is a continued emphasis on science education curriculum in schools to prepare students to understand the process of science in order to be scientifically literate and therefore to be an active citizen in society (Hurd, 1998). While there is some debate as to what it means to be scientifically literate, DeBour, (2000) suggested science curriculum should aim to provide students with opportunities that spark their interest and thus give students the opportunity to apply science to their lives in a meaningful way. In doing so, he alludes to the idea that students will then be able to be an active participant in society.

Policies implemented in science education over the last fifteen years have defined scientific inquiry as a component of scientific literacy (Barrow, 2006). As such, research suggested for scientific inquiry to be taught as a process and not a structured set of steps (Tang, Coffey, Elby, Levin, 2009). By teaching scientific inquiry as a process, researchers have shown a link from learning science through scientific inquiry to better understanding of the scientific process (Tamir, Stavy & Ratner, 1998), while other researchers have found a link between scientific inquiry and increased academic scores on standardized testing (Blanchard, M. R., Southerland, S. A., & Granger, E. M., 2009).

Classroom teachers have the task of carrying out educational policies. While research has shown the benefits of inquiry teaching (Anderson, 2002), there is also much discussion about barriers that educators must overcome when implementing scientific inquiry. These barriers cover a wide range of issues from extended, content specific professional development (Smith, Desimone, Zeidner, Dunn and Rumyantseva (2007), to those that are political and cultural barriers (Johnson, 2006).

Sandoval and Reiser (2004) argued that it is not enough for students to do science; they must have an understanding of how science is practiced in order to understand the scientific process. Several researchers have specifically looked at the impact of scaffolding scientific inquiry through computer software programs on student's understanding of how science is practiced (Eslinger, White, Frederiksen & Brobst, 2008, Peffer, Beckler, Schunn, Renken & Revak, 2015) showed the positive effects of scaffolding a computer program to provide cognitive support for middle school students to learn scientific inquiry, or the process of practicing science.

In light of the different issues surrounding the teaching science of inquiry, there are several questions to be examined. As mentioned previously there are barriers to teaching scientific inquiry (Johnson, 2006). She suggested lack of resources and teacher commitment to the textbook are two common barriers. If textbooks offer little to no inquiry experiences (Chin & Malhotra, 2002), then what other free or low cost curriculum is there for teaching science inquiry? Can scaffolding successfully occur without a computer programed curriculum? What other components of inquiry should curriculum include to have the greatest impact on student learning?

Problem Statement

According to Anderson (2002) external and internal barriers exist for teachers trying to teach scientific inquiry. The research showed that an example of an external barrier to the educator is teacher commitment to a textbook. Chinn and Malhorta (2002) developed a framework for evaluating inquiry tasks. According to their study, textbooks provide little in the way of inquiry tasks. The researchers suggest when students engaged in scientific tasks with little or no inquiry value, the experience promotes a false understanding of the process of science and therefore true scientific knowledge is not built. Another example of an external barrier is lack of resources (Johnson, 2006). The researcher explains that science educator often do not have resources, money and supplies to properly teach scientific inquiry. Since the Raptor Lab is a free program, it removes this barrier.

Peffer et al. (2015), Eslinger et al. (2008) and Manlove, Lazonder and De Jong (2007) studied the effects of learning scientific inquiry through scaffolded computer programs. These studies showed a positive correlation between experiencing these programs with learning outcomes. While these researchers have shown that scaffolding helps students learn about scientific inquiry, what happens when students are given the opportunity to learn via a scaffolded hybrid platform instead of a completely on-line version? In other words, what is the impact of the Raptor Lab curriculum on student learning? This study aims to look at the effect of a scaffolded; inquiry based Raptor Lab on student achievement on scientific inquiry.

Rationale of Study

This study aims to explore the impact on learning of students experiencing scientific inquiry in a hybrid, scaffolded setting. Student achievement and perception of the experience will be measured by pre-assessments and post-assessments, Likert scale and the Stream Study paper. The results will be assessed to see what impact learning in a scaffolded, teamed approach makes in learning scientific inquiry skills. This study intends to inform other 7th grade science teachers about the impacts of the Raptor Lab program on learning scientific inquiry.

Assumptions

For the purposes of this study, it is assumed that students will answer honestly to survey and pre-assessments and post-assessments. For all assessments, the anonymity of the participants will be protected. It is assumed that the Raptor Lab curriculum will cover the standards it states the material will cover.

Limitations of the Study

This study will be limited to two modules of the Raptor Lab and thus, there will be no long-term assumptions made. Another limitation to this study is that one school in northern Minnesota will be involved. This school is mainly comprised of students of Caucasian, 94%, Black 1.3%, Hispanic 2.2%, Asian 0.9% and Native American Indian 1.1% according to http://rc.education.state.mn.us/#demographics/orgId--10704002000__p--1. Therefore, the students in this study do not reflect national and state diversity and thus, findings of this study will be limited.

Delimitations

There are several delimitations that are present in this study. This study does not account for gender or race with in the student population. This study does not intend to evaluate teacher performance or motivation. This study does not intend to look at long-term impacts on study learning, as it will span one unit.

Definitions

Scientific Method- a set of steps taught to students in a typical science classroom

Scientific Inquiry – the process of learning science that parallels how professional scientists practice science

Raptor Lab Modules – Two modules that will be presented to students in a scaffolded format. This structure will be presented through videos in which students will watch and then work through the problems as a group. In their groups, students will work together to solve a real life scientific problem based on evidence.

Scaffolding: - An educational technique where the student is fully supported in the beginning, but as student proves mastery the support is faded so that the student is taking the responsibility of the learning.

Hybrid Approach – A portion of course work is presented through the internet program and the other portion of the classroom experience for students the tradition experience.

Summary

This study aims to look at the connection between learning scientific inquiry through a scaffolded hybrid approach (Raptor Lab) and the impact on student learning. The focus of this study is on seventh grade students at this point in their science education career. The scores of this aggregate group will be compared to seventh grade students from the 2014-2015 school year. This study intends to offer insights to other science teachers looking to implement scientific inquiry into their classrooms. Findings of this study will be shared with the Proctor science department and administration at A.I Jedklica Middle School and Proctor High School.

Chapter 2

Literature Review

“Inquiry is a pervasive theme of the National Science Education Standards, where inquiry is portrayed as not only a method that scientist use to study the world, but a means of engaging students in actively learning about both science content and nature of science” (Eslinger et al., 2008, p. 611). While seemingly simple and straight forward, teaching inquiry in the science classroom has unique challenges. Benefits of learning through scientific inquiry (Tamir et al., 1998), barriers educators experience in implementing inquiry instruction (Anderson, 2002), and scaffolded inquiry technology based programs that help overcome barriers to classroom instruction are current issues that surround teaching scientific inquiry in the science classroom.

This study proposes to examine the impact of the Raptor Lab Modules on student achievement of learning scientific inquiry. To that end, the articles presented are a sample of relevant research. Three predominant areas are addressed in this literature review. The first section of the literature review addresses research that studied the potential benefits of teaching scientific inquiry as a process.

The second section of the literature review describes research that examined the process and possible barriers that educators face when trying to implement scientific inquiry in the classroom. This section looks at what studies have found to be barriers, both internal and external to the teacher, which may play a role in preventing teachers from successfully implementing scientific inquiry.

The final section of the literature review focuses on research that looked at computer software that scaffolds scientific inquiry. This section describes research examining the impact of three different programs which have been applied and studied in the science classroom.

Scientific Inquiry as a Process

According to Tang et al., (2009), the term scientific method came in to science education more than one hundred years ago. They explained at the time John Dewey proposed his thoughts on “reflective thinking” but these were incorrectly implemented by science educators into a series of steps that were taught via science curriculum and easily followed in the lab. More recently, according to Tang et al., there have been increased calls for science inquiry. The researchers explain these calls for scientific inquiry mean practicing science they way scientists do; not by following rigid steps, otherwise known as the scientific method.

Tang et al. (2009) studied the impact between teaching scientific method as rigid steps and teaching the scientific method while encouraging students to practice scientific inquiry. The researchers acknowledged that while the aim of scientific inquiry is to practice science like scientists do, schools cannot offer students this exact experience. They suggested that student can, however, engage in scientific inquiry, which they defined as the “pursuit of coherent, mechanistic accounts of natural phenomena” (Tang et al., p.32).

In their study, twenty five teachers were involved in a three year long professional development project (Tang et al., 2007). During the summers, teachers participated in a professional development workshop which focused on the nature of scientific inquiry. To collect data, researchers employed a method of videotaping lessons and conducting teacher interviews to analyze the content of interactions. The researchers also required the teachers to collaborate together to discuss videos, in which the conversations were recorded and also contributed to the data.

In analyzing the data, Tang et al. (2009) looked at the discourse of what took place in the classroom. From this point they looked for student engagement in scientific inquiry as well as classroom situations where students could have engaged in scientific inquiry but data collected did not show any evidence of them doing so. At this point, the researchers interviewed the teachers to further understand the dynamics of the lesson. Through this process the researchers looked at the impact of scientific method had on student's engagement in scientific inquiry.

Tang et al. (2009) found that the twenty five teachers in their study confirm what other studies have shown: teachers typically teach the scientific method as a series of steps that are to be followed in order. Two specific scenarios emerged from this study. First, the researchers noted that when students were taught the scientific method in rigid steps it clouded the scientific inquiry process. The authors hypothesized that because students were so fixated on the steps of the scientific method they missed opportunities to refine their thinking pattern, a hallmark of scientific inquiry. The researchers argued that the issue was that the scientific processes was ignored and therefore not learned. The other scenario the researchers noted emerging from this study was students, when they were engaged in the process scientific inquiry, did not appear to follow the rigid steps of scientific method. The researchers argued that these results showed teaching the scientific method in rigid steps did not appear to contribute to students understands of the process of science. Tang et al., concluded the scientific method should be taught as a process to promote understanding of the scientific inquiry.

In conclusion, a vast majority of teachers teach the scientific method as a prescribed way of doing science (Tang et al., 2009). According to the authors, this process is a set of steps that are followed in order. However, this is in conflict of engaging students in the process of scientific inquiry or practicing science as professional scientists do. The researchers suggested that if the goal is to engage students in true scientific inquiry, the scientific method should not be taught.

In an earlier study, Tamir et al. (1998) studied the effects of student's experiencing science in three different formats; no inquiry, inquiry orientated, and explicit inquiry. The authors did so to answer the question: in which scientific inquiry format do high school students learn the best? Their experiment included three groups, Group A received physics curriculum that did not include inquiry. The researchers noted that this group had the highest academic achievement. For the second group, Group B, the researchers had the students receiving biology curriculum with inquiry orientated curriculum. The researchers noted Group B had a lower academic achievement rate than Group A, but a higher achievement rate than Group C. The third group, Group C, received inquiry orientated biology curriculum that included explicit inquiry instruction. Group C had the lowest academic achievement of the three groups, according to the researchers. Upon completion of the course, the researchers had the participants take the same test which consisted of inquiry Task X and inquiry Task Y. For both tasks researchers chose to assess inquiry skills including "identifying and defining research problem, formulating a hypothesis, planning a relevant experimental design, data collection and presentation, explanation of results and drawing conclusions, application of conclusions" (p. 28).

Tamir et al. (1998) explained the results of this exam. They found Group A, the group that did not receive any type of inquiry curriculum, scored the lowest out of the three groups on the inquiry tasks. The group that received the explicit inquiry biology instruction (Group C) and had the lowest academic achievement the researchers found performed better than the regular inquiry biology group. The authors reported specific skills that showed the greatest increase included planning investigations and explaining the process. Tamir et al. hypothesizes that explicit inquiry instruction teaches the process of inquiry as well as relationships between science content and process of doing science which allows for lower achieving students to make academic gains.

In conclusion, Tamir et al. (1998) compared the outcomes of teaching science through explicit inquiry, inquiry, and non-inquiry settings. The authors found that lowest academic achieving group showed the most academic growth through experiencing the explicit inquiry method. In addition, the researchers concluded that students that are taught through explicit inquiry are better able to understand the connections between the concepts and the process of science, thus allowing for greater academic achievement.

In a related study, Blanchard et al. (2010) found that when scientific inquiry is taught as a process it can help students be successful in showing achievement on standardized tests. The researchers explained that states are requiring school districts to teach standards and administer assessments based on state standards. According to Blanchard et al., there has been an emphasis for teachers to teach to the test and not on the formative process of developing student's learning leading up to the test. The researcher noted that science standards required teachers to teach scientific inquiry as a way to help students better understand science content and the process of scientific inquiry. They also pointed out the idea was that the students would develop a more meaningful knowledge base. However, the common thought amongst teachers has been that standardized testing and teaching scientific inquiry were at odds with each other, according the authors.

Blanchard et al. (2010) tested the impact of learning science content through scientific inquiry on student achievement on standardized testing. They defined four different levels of inquiry. They defined #0 inquiry situation where the teacher provided the question, the methods, and a way to use the results to come to a conclusion. They defined #1 as "structured" inquiry where the teacher provided the question and the method, but the students were to use the results to come to a conclusion. They defined #2 as "guided" inquiry where the teacher provided the question but the student comes up with the method and how to use data to come to a conclusion as defined by the researchers. They defined #3 as "open" inquiry where it was student centered where the student went through the three steps of the inquiry process without the framework given by the teacher. Blanchard et al. stated "there is no optimal form of inquiry that extends across all content or context" (p. 582). In other words, the researchers suggested teachers assess their students and other classroom factors to determine the type of inquiry to implement in their specific setting.

Given that teachers are to prepare students for standardized testing while also having the demand of teaching scientific inquiry, the researchers compared the outcomes of students learning via the traditional lab and via scientific inquiry (level two) methods as assessed by standardized testing (Blanchard et al., 2010). The researchers employed 1,063 students in twelve classes in three high schools and four middle schools from various socio-economic backgrounds and both rural and urban locations. Results from pre and posttests were employed by the researchers.

Blanchard et al. (2010) set up their study by developing a forensics unit for both the traditional lab group (level 0) and scientific inquiry group (level 2) to experience. They provided all necessary equipment. Teachers in the traditional lab group (level 0) were instructed by the researchers to be teacher-centered; to instruct students at every step of the way, giving feedback to students right/wrong answers. Teachers in the scientific inquiry group (level 2) where instructed by the researchers to have students refer to the materials they had developed and to answer student questions with guiding questions.

Blanchard et al. (2010) noted results of this study indicated, in general, students in the scientific inquiry (level 2) group outperformed the traditional lab (level 0) group. The researchers looked at differences between high and middle school students, socio-economic status, and teacher ability. The researchers found high school students outperformed middle school students in regards to content learned. They speculated this was due to more refined content knowledge and skill level of high school students. Researchers hypothesized that a lower level inquiry (level one) is more appropriate for younger learners. When taking into account socioeconomic status, Blanchard et al. found that students in the guided inquiry (level two) group outperformed those in the traditional lab (level 0). The researchers suggested the scientific inquiry format was more interesting to a wider range of students. Another finding of this study they concluded showed that if the teacher had a strong skill set in teaching scientific inquiry then guided inquiry (level two) students scored better than students in the traditional lab group. However, if the teacher was not skillful in delivering scientific inquiry, then in those instances the traditional lab (level 0) did better. The researchers hypothesized prolonged professional development could be a factor in a teacher's skill level.

In conclusion, Blanchard et al. pointed to the results of their study to illustrate that over all their participants showed academic gains on standardized tests when taught through scientific inquiry methods. Depending on the group of students, the authors argued different types of inquiry can be appropriate at different stages of learning. Last, Blanchard et al. suggested professional development was a factor in teacher implementation of scientific inquiry.

Barriers to implementing inquiry instruction

According to Smith et al. (2007), a result of No Child Left Behind Act (NCLB) was the development of science standards. They suggested these standards were developed with the idea to improve science education. While the standards include inquiry, there is great disagreement in what this actually means for classroom applications according to Smith et al. They pointed out while it is not a definition; the National Research Council lists the eight components of classroom inquiry at the middle level:

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation
- Use appropriate tools and techniques to gather, analyze and interpret data
- Develop descriptions, explanations, predictions and models using evidence.
- Think critically and logically to make relationships between evidence and explanations
- Recognize and analyze alternative explanations and predictions
- Communicate scientific procedures and explanations
- Use mathematics in all aspects of scientific inquiry (p.171)

Smith et al. (2007) looked into teacher training and the impact that had on instructional strategies as well as the impact of professional development on using instructional strategies. To explore their questions, Smith et al. (2007) employed a teacher questionnaire through the National Assessment of Educational Progress, NAEP. The researchers chose this questionnaire as it provided nationwide data on teacher certification, instructional strategies, and professional development. The researchers noted a limitation to this study was the sample that was chosen was done so based on the population of the school which meant the smaller the school the least likely it was to be included in the sample.

Smith et al. (2007) used the questionnaire to examine four categories: procedural activities (types of assignments students were required to complete), writing activities, hands on activities, and conceptual objectives (applying the science). Procedural activities were found by the authors to be used more frequently by beginning teachers. They noted professional development did not have a significant impact on this category. However, data collected on teachers with a science background combined with professional development did show a strong correlation with incorporating more writing and hands on activities as well as conceptual objectives according, to the authors.

When looking specifically at only teachers with a science background and the extent of professional development, Smith et al. (2007) found a connection between the two categories. The more science education professional development that the teachers had, the higher the frequency of writing activities, hands-on activities, and conceptual objectives occurred in their classrooms. They suggested the three categories were associated with the increased teaching of scientific inquiry standards.

In conclusion, Smith et al. (2007) suggested a barrier to teaching scientific inquiry was teacher preparation and continued content professional development. They found a result of this study was that teachers with science degrees who also participate in continued professional development had an association with implementing inquiry standards in the classroom. In addition they noted the professional development, however, had to be science content related over an extended time period.

Capps and Crawford (2013) also looked at barriers to teaching scientific inquiry in the classroom and came to similar findings as Smith et al. (2007). According to Capps and Crawford, scientific inquiry has shown many benefits; it can help the learner to understand the process of science, to better understand science content, and to help develop critical thinking skills. The authors suggested there was much in the way of antidotal evidence that science teachers do not teach scientific inquiry in the classrooms. Thus they aimed to study this issue: what teachers actually taught, teacher views on inquiry and if the two were aligned.

For their study, Capps and Crawford (2013) first analyzed teacher views on scientific inquiry. Then they had all of the participants take part in a professional development experience. The researchers used mixed methods to gather both quantitative and qualitative data from written lesson plans, videotapes, observations of classrooms, interviews and a questionnaire in order to include the multifaceted ways of teaching scientific inquiry. They chose twenty six teachers based on a set of criteria that included factors of experience and high motivation to teach scientific inquiry.

Capps and Crawford (2013) found four out of the twenty-six highly motivated teachers implemented scientific inquiry in the classroom. They pointed to common themes amongst these teachers including longevity as teacher and teacher involvement in either science professional development or in research experience. According to the authors, the remaining twenty-two teachers believed they were teaching scientific inquiry, but in reality they were not. The data collected by the researchers showed that teachers held naïve views and misunderstandings of scientific inquiry. For example, “many of these teachers believed that scientists follow a uniform series of steps that are experimental in nature, allowing little or no room for creativity” (p. 521). In addition, the researchers found the majority of the twenty-two teachers could not accurately describe what it meant to teach scientific inquiry. The researchers argued that in order to teach true scientific inquiry, teachers must have an understanding of scientific inquiry in order to explicitly teach it successfully. Development of a common definition of inquiry, a way to assess if inquiry is occurring, and professional development specific to teaching inquiry were all suggestions Capps and Crawford had for addressing this barrier to teaching inquiry in the science classroom.

In conclusion, Capps and Crawford (2013) research showed that scientific inquiry was a topic that was misunderstood by many educators and as a result, it was not actually being taught in the science classroom. Since their study specifically focused on motivated teachers, there is even more of a chance that this group would teach scientific inquiry than a group of non-motivated teachers. The authors suggested in the general population of science educators, the number of teachers actually teaching scientific inquiry was very low. Last, Capps and Crawford also suggest that science educators should be exposed to professional development that allowed teachers to learn about scientific inquiry in order to be able to have a better understanding of what the process was in order to be able to teach it.

Johnson (2006) looked deeper into the issue of the impact on the barrier of professional development. Even though teachers are required to teach inquiry standards set forth by their state research, Johnson found that most are not teaching scientific inquiry. One reason, Johnson suggested, was that while teachers attend professional development opportunities, these experiences are short in duration, which does not provide the teacher with what they need to implement inquiry in the classroom.

According to Johnson (2006) there were three dimensions that defined barriers to teaching scientific inquiry. They included technical, political, and cultural. For her research, Johnson focused on the political and cultural dimensions. Political issues, or those external to the teacher, were identified as lack of support by administration and lack of resources. Lack of support by administration was considered to be issues such as lack of common planning time to collaborate and lack of opportunities to observe scientific inquiry teaching, according to the author. Johnson defined the term resources to mean the time, the space, and materials needed to perform scientific inquiry. The author pointed to the cultural dimension to be defined as the teacher's existing beliefs and values, or those dimensions internal to the teacher. In this category, it was the belief of the teacher that preparing the student for the state assessment or the next grade was the focus, not teaching scientific inquiry.

Johnson (2006) studied two different schools. The researcher required the educators to take part in an extended professional development program called the Model School Initiative. The author explored the impact of extended professional development on barriers to teaching scientific inquiry. The two schools were partnered with universities; a long term professional development plan was created and put in to practice. The researcher designed the training according to teachers' needs and included pairing up of teachers. The researcher gathered data for this study through classroom observations and interviews.

Johnson (2006) found even though the two schools had slightly different structures, they experienced common barriers to teaching scientific inquiry. At both schools, teachers experienced both political and cultural barriers, according to the author. She found cultural barriers at both schools to include lack of teacher belief in using scientific inquiry to teach science. According to Johnson, both schools also had teachers that did not believe teaching scientific inquiry was compatible with preparing students to take standardized tests. Johnson found teachers at both schools experienced political barriers. She explained these barriers included lack of time to meet and to discuss inquiry based practices as well as lack of resources to be able to effectively teach scientific inquiry. Johnson concluded that while teachers needed continued professional content development, they also needed external support from administration and resources in order to remove barriers to teaching scientific inquiry.

Johnson (2006) showed that while professional development was an important aspect of removing barriers to teaching scientific inquiry, there are other barriers that also needed to be addressed. Political issues such as time for collaboration between teachers, scheduling and money for resources were barriers that are out of the control of teachers and were difficult to remove. The study also showed that cultural issues, such as teacher beliefs, could be altered by giving the teacher experiences that showed scientific inquiry could be taught in an effective manner in the classroom.

Teaching scientific inquiry with software

According to Eslinger et al. (2008), scientific inquiry should be taught in a manner scaffolded. They proposed one way to do this was to use an interactive learning environment computer program. In their study, the researchers looked at the impact of the science classroom inquiry (SCI) simulation on student inquiry skills.

Eslinger et al. (2008) noted the idea of inquiry has been around for many decades. However, recently there has been a renewed push to teach scientific inquiry as a way for students to better understand science content through understanding how science is practiced. The authors noted other studies have shown that students who are taught by scientific inquiry methods show increased understanding of scientific concepts and how to practice science better than those who are not taught via inquiry based methods. Although benefits of learning via scientific inquiry are noted, there are many challenges in successfully teaching scientific inquiry, according to the researchers. They pointed out that teachers face several challenges in implementing scientific inquiry into the classroom such as pressure to use the provided curriculum which typically does not adequately teach scientific inquiry. Another challenge the researchers mentioned can also include the lack of the educator knowing how to teach scientific inquiry.

According Eslinger et al. (2008) there are two parts to teaching scientific inquiry; the understanding of the process of practicing science and the science content. The researchers argued that these two pieces, process and content, should be taught simultaneously. In addition, they suggested that in order for students to learn scientific inquiry, their metacognition needs must be met. The researchers defined scaffolding as providing structure in the beginning and then as students are able to perform tasks giving them less and less structure. They argued that interactive learning environments (ILE) can offer specific structure as needed to individual students. In creating this ILE, it was the author's aim to create an inquiry tool that could be used across different domains and varied curriculums.

Eslinger et al. (2008) developed the program by leading students through The Inquiry Cycle which incorporated scaffolding of cognitive, metacognitive, and socio-cognitive goals. They defined the Inquiry Cycle as an abstract method that included the stages of questioning, hypothesizing, investigating, analyzing, modeling, and evaluating. The authors designed the system to allow for participants to track their progress, log work, complete assessments, and analysis of their work as they completed the Inquiry Cycle. The domain specifics of the program identified by Eslinger et al. were developed and scaffolded the progress: initially the program provided the research question for the students as they worked through the process in pairs. The researchers required the participants to come up with their own questions as the pair progressed through the Inquiry Cycle. At the end of the project, the researchers had the participants presented their findings to the class and were given The Inquiry Test to assess their inquiry skills.

Eslinger et al. (2008) found significant improvement in student scores. An important note the authors made was that the test was not on the subject (genetics) the students were taught but was a transfer test. As a result, the researchers were able to note what students knew about the process of scientific inquiry and not the specific science content.   In this study, the researchers reported hypothesis, model, and evaluate steps had the most amount of gains. Researchers speculated that this was due to the amount of instructional time spent on these steps. In addition, significant improvement in students' scores supported prior findings when Inquiry Island was applied with a different grade level thereby adding weight to the program's success, according to the researchers.

In conclusion, Eslinger et al. (2008) suggested that teaching scientific inquiry to students can increase scientific knowledge. They recommended teaching scientific inquiry in a manner that is scaffolded; that is to lessen the amount of support given to students so that they can cognitively perform tasks. According to the authors, the program, Inquiry Island, has shown that it can be an effective scaffolding tool to help teach scientific inquiry.

Peffer et al. (2015) also studied the impacts of learning scientific method through the use of a different type of scaffolded computer program. The researchers opined that textbooks did not provide students with authentic scientific tasks. Not experiencing authentic scientific tasks was thought to lead to misunderstandings of the scientific process, according to the researchers. They argued that by allowing students to understand authentic scientific processes the students developed a deeper understanding of the scientific process. In addition, Peffer et al. pointed out that since scientific process can be abstract students needed scaffolding to be able to be able to complete science tasks. The authors explained that this gave students cognitive support when dealing with abstract concepts. In this study, they looked at the impact of providing students with a simulation of authentic science in a scaffolded manner and then assessed student perception of the experience.

To explore the impact of authentic science experience on student learning, Peffer et al., (2015) they created the Science Classroom Inquiry Simulator, a computer program, to scaffold the scientific inquiry process and to allow students to experience scientific inquiry without obstacles due to classroom constraints. In addition, the authors designed the simulations to allow for students to be the scientist: to try an idea to gather evidence on the outcome while having access to current scientific literature and websites. The researchers had the students complete one of three specific simulations. In completing a simulation, the researchers gave students the background information on the topic. Then the students worked in groups to complete the simulation while reflecting on the process as they completed tasks. The researchers gave the students a Likert scale to assess the students' perceptions of their experience.

The scale allowed Peffer et al. (2015) to look at student perceptions. They found students perceived the simulations to be moderately difficult. The researchers also found students perceived the simulations to be helpful. The researchers reported that 64% of the students thought that the simulations changed how they thought about the scientific process. The researchers concluded that these findings supported the idea that by experiencing these simulations students' perceptions of authentic science practices were changed and this helped them to develop how they knew about the process of science.

In conclusion, Peffer et al. (2015) developed a scaffolded computer software program to scaffold authentic scientific inquiry for middle school and high school students. They argued it was important for students to experience authentic scientific inquiry in order for them to develop their ideas about how science works as a process. They found that students perceived the simulations to be helpful in learning scientific inquiry and that the simulations changed how they thought about the scientific process, which the researchers suggested was the goal of science education.

Manlove et al. (2007) looked at the impact of regulation scaffolding through a software program on students' learning. The researchers explained that computer software programs provided an opportunity for students to learn about the process of science by being able to practice the process themselves. In prior settings, Manlove et al. noted other researchers have found students who used strategies such as planning, monitoring and evaluating learned better than those students who do not use those strategies. Given this, the researchers sought to look at the potentials of a regulatory design curriculum to support students understanding of scientific inquiry.

Manlove et al. (2007) explained there were three parts (planning, monitoring and evaluation) to self-regulation in a learning environment. They defined the planning aspect of self-regulation as the student creating goals based on the phases of inquiry and for the student to refine goals as needed. They defined monitoring as the second stage where students compared their prior knowledge to the goal they were trying to obtain. They defined the third task as evaluation, which focused on the quality of the overall task. The authors noted that monitoring and evaluation were different; monitoring happened during the smaller tasks that made up the overall task while evaluation came at the end when students reflected on the learning process.

According to Manlove et al. high school students generally had poor self-regulation skills of planning, monitoring, and evaluating mainly because they did not understand gaps in their knowledge. However, Manlove et al. suggested a process model be given to the students. This model allowed students to see what practicing scientists did and would scaffold the scientific inquiry process for them by giving them a way to monitor their own learning. In addition, the authors noted other researchers had found that software prompts and feedback can help students develop these skills as they are practicing the process of scientific inquiry. These two pieces, providing a model and prompts, led to the end product where students wrote up their results in a lab report which, according to Manlove et al., were a typical way students presented their findings in the science classroom.

In their study, Manlove et al. (2007) aimed to look at the impact of the Process Coordinator (PC) on students' regulatory process while learning scientific inquiry skills. The researchers gave half the students the PC+ version, or the version with prompts to assist in regulating learning. The researchers gave the other half of the students the PC- version, or the version that did not have any regulatory prompts. Instead, those students were to record their thought process (goals, notes, completion of work) as they thought appropriate. The researchers hypothesized that the PC+ group would demonstrate greater gains given the regulatory supports they would receive.

Manlove et al. (2007) had 70 participates from ages 16-18 from three international secondary schools in the Netherlands. The researchers organized the students' academic achievement to ensure each pair consisted of either a high and average or an average and a low achiever. The researchers randomly assigned pairs of students to either the experimental group with software prompts or to the control group with no software prompts. The researchers then had students work through the scientific inquiry process on a specific topic, fluid dynamics. The researchers assessed learning by students' end result: models and lab reports.

Manlove et al. (2007) found that the PC+ group for both achievement levels (high and low) produced higher quality lab reports. They hypothesized this to be due to the self-regulating scaffolding for writing the lab report. On the other hand, an unexpected result showed that the PC- group produced better models than the PC+ group. The researchers surmised this to be due to a function of the help files, which provided content specific information. Since the PC- group did not receive any scaffolding on self-regulating their thinking, the authors deduced they spent more time with the help files which may have given the students more useful content information in building their models.

Manlove et al. (2007) concluded that generally high school students struggled with regulating their thought process as they go through tasks. The researchers found that with regulatory prompts, students of all ability levels were able to write better lab reports. However, the researchers also found that without the prompts, but with specific domain information that students of all abilities were able to build better models. The authors suggested that educators who chose to use technology-enhanced inquiry learning environments could use it to benefit students that have self-regulation and domain needs. Teachers, the authors suggested, should be aware of both components of the software and facilitate their students' needs as appropriate.

Conclusion

Standards that 7th grade science teachers are required to teach include scientific inquiry. This review of the literature has shown the benefits of teaching scientific inquiry as a process shown by Tamir et al. (1998), Blanchard et al. (2010), and Tang et al. (2009). Although teachers are required to teach scientific inquiry there are barriers teachers face in doing so as addressed by Smith et al. (2007), Capps and Crawford (2013) and Johnson (2006). An important consideration when trying to implement scientific inquiry is scaffolding software programs as the literature has showing the positive impact on student learning as suggested by Eslinger et al. (2008), Peffer et al. (2015) and Manlove et al. (2007). Although these studies provide the arguments for teaching scientific inquiry, the removal of barriers, and a scaffolded method to implement scientific inquiry, they do not address the impact of the Raptor Lab, a scientific inquiry based module, on 7th grade student achievement, as the Raptor Lab is a pilot program. This study attempts to gauge to what extent the Raptor Lab addresses scientific inquiry as demonstrated by student achievement (or lack of) on a transfer assignment.

Chapter Three

Methodology

Research has shown the academic benefits of scientific inquiry on student's understanding of the process and content of science (Blanchard et al., 2010). These benefits have shown increases in student achievement when students have used scaffolded computer software programs (Peffer et al., 2015). The purpose of this study was to investigate what impact the Raptor Lab modules, a scaffolded, inquiry, and technology based program, had on academic achievement on seventh graders at A. I. Jedlicka Middle School. The hypothesis presented in this study was that seventh grade students would show an improvement in achievement after experiencing the Raptor Lab curriculum. This study attempted to answer the following questions: (1) through completing the Raptor Lab modules do students show improvement in their ability to practice scientific inquiry in a real-life setting? (2) on average, did students perceive that they were practicing scientific inquiry?

Setting and Participants

The participants in this study were seventh grade life science students at A. I. Jedlicka Middle School during the 2015-2016 school year. There were a total of 150 students enrolled in the life science course. All students participated in the Raptor Lab as part of the 7th grade Life Science curriculum. The participants were comprised of 80 male and 60 female students with a variety of academic ability levels. Seventeen percent of students were on an individual education plan (IEP) and were receiving special education services. This school's enrollment was mainly compromised of students of who are Caucasian, (95.3%) with small percentages of other ethnicities (Hispanic 2.3%, Black 0.7%, American Indian/Alaskan Native 1.4%, Asian/Pacific Islander 0.5%), according to the MN Department of Education (http://rc.education.state.mn.us/#demographics/orgId--10704002000__p--1). In addition, 15.4% of the students qualify for free lunch and 9.8% of students qualify for reduced lunch according to the school district website (http://www.proctor.k12.mn.us/.)

Instrumentation

The researcher used a quantitative approach to examine what, if any, impact the Raptor Lab had on student achievement in regards to student understanding the process of scientific inquiry. Data was gathered through student scores on the Stream Study paper. Students used their scientific inquiry skills to perform a Stream Study lab. After the lab, students had to write up their experiences in a lab report format. (This assignment is given in Appendix D). The Raptor Lab Modules introduced students to the concept of scientific inquiry and how professional scientists employ scientific inquiry. Therefore, it was hypothesized that if students were posed with a real world problem, "is Keene Creek healthy?" then the students would be able to use the skills and knowledge they learned in the Raptor Lab Modules and apply them to the Stream Study Lab. In order to increase the validity of this study, a second measure was employed. The second measure was a Likert scale. Students filled out the survey upon completion of the Raptor Lab. (The Likert Scale is given in Appendix C.)

There were six primary objectives of the Raptor Lab. These six primary objectives were broken down into eleven statements for students to give their opinion. The survey was set up this way to see if the students' perception of the Raptor Lab was matched to the intent of the Raptor Lab. The intention of this study was to inform future teaching practices of scientific inquiry to seventh grade students at A. I. Jedlicka Middle School and to improve the student's educational experience.

Procedure

Approval for the study was obtained from the UW-Superior Institutional Review Board (IRB) and from the Building Principal before the start of the study. Upon approval, a letter was sent home to parents explaining the program. The letter stated the only difference in this year's curriculum as compared to prior years would be the implementation of the Raptor Lab. Parents were given an option to exclude their child's anonymous scores from the study. Other than the implementation of the Raptor Lab, the classroom was conducted the same as in prior school years.

The participants in this study were seventh grade life science students at A. I. Jedlicka Middle School during the 2015-2016 school year. All students took part in the Raptor Lab as part of the Life Science curriculum. The Raptor Lab was comprised of three modules, each module ranging in a week to two weeks in duration. The first Raptor Lab module was comprised of a series of videos in which the students are the veterinarian technician, "helping" to collect evidence on an injured raptor. At the end of the module, students were given the task of coming up with a research question based on the videos. These were recorded and uploaded to a website, FlipGrid, for students at other participating schools to view. The second Raptor Lab module had the students split into teams. Teams worked together to read and analyze real world scientific data. This data came from the data the Raptor Center has gathered through their research. Students worked together through a scaffolded set of steps to come to an evidence-based conclusion on how the bald eagle came to have lead in its system. Students were responsible for writing a lab report that mirrored what professional scientists do when they go through the process of scientific inquiry. In the third Raptor Lab the students came up with their own research question to perform scientific inquiry as they have learned in the prior two modules. Upon completion of the Raptor Lab modules one and two, the students were given a Likert scale survey.

Once the Raptor Lab modules were complete, students learned about water quality. Students were taught the content knowledge and skills needed to perform the Stream Study lab, a lab which asks the question: "Is Keene Creek healthy?" Through examining the physical, chemical, and biological attributes of Keene Creek, students worked together in groups to write a lab report. This lab report was then graded and compared to the grades that were earned from the 2014-2015 7th grade science Stream Study lab reports.

Data Analysis

The proposal suggested that the data would be analyzed by looking at two sources of data. First, data in the form of grades on the Stream Study paper from the 2014-2015 school year, written by 132 students, would be compared to the 2015-2016 school year, written by 140 students, in order to understand the potential academic impact of the Raptor Lab. Students' scores were run through a t-test for difference to help answer if there is a difference and if there is, is it significant. Only students whose parents gave consent were to be included in the comparison of data. The results of the grades were aggregated and kept confidential and anonymous.

Second, in addition to the Stream Study paper grades, a Likert scale was to be completed by Raptor Lab participants. The purpose of the Likert scale was to assess if, from the students' perspective, the objectives of the Raptor Lab program were or were not met. The objectives of the Raptor Lab (with the exception of items 6, 7 and 8) are parts of practicing or understanding scientific inquiry. The data will be interpreted by percentage of students who disagreed or agreed with a particular objective. The survey was given upon the completion of Raptor Lab modules one and two. (The Likert Scale is included in Appendix C.)

Chapter Four

Results

It is broadly believed that in order to be able to understand science, students must have an authentic opportunity to practice the process of science. Expectations are for teachers to implement the Next Generation Science standards which include scientific inquiry in one of their three categories (Peffer et al., 2015). As teachers aim to follow these guidelines and to prepare students to be scientists, what classroom strategies work to implement scientific inquiry? This study sought to find out if the Raptor lab modules improve student's abilities to practice scientific inquiry in a real-life setting. In addition, it asked if, from the student's perspective, they perceived that they were practicing scientific inquiry.

The sample for this study included 132 7th grade Life Science students. Students took part in two Raptor Lab modules. After the second Raptor Lab Module, students were given a Likert scale based on Raptor Lab objectives to measure student perception of the Raptor Lab. Students then took part in a Stream Study lab and were required to write a lab report based on their findings. Scores for 7th grade students in 2015-2016 school year were compared to scores for 7th grade students in the 2014-2015 school year to see what, if any, impact the Raptor Lab had on student understanding of scientific inquiry. The students in 2014-2015 did not use the Raptor Lab modules but the course had the same objectives.

Results

This section first lays out the results from the Likert Scale and then the results from the Stream Study grades. An eleven question Likert Scale was developed based on the objectives of the Raptor Lab to assess student perception of their experience practicing scientific inquiry. The data is presented by average and range. The Stream Study paper data is presented as a statistical analysis. The grades Stream Study papers from the 2014-2015 school year and the 2015-2016 school years were run through a t-test to assess this data.

Analysis of Data: Likert Scale

The Likert Scale was developed based on the objectives of the Raptor Lab. Module One starts with Dr. Julia Ponder, senior veterinarian at The Raptor Center, explaining to students what The Raptor Center is and the three steps of scientific investigation (ask a question, gather evidence, analyze evidence to make an evidence based conclusion). In the next video, an injured raptor is brought to The Raptor Center. Dr. Ponder asks students to become the veterinarian technician. While Dr. Ponder walks through the procedure of asking a question (why is this raptor sick/injured?) and gathering evidence. At the same time, students are to fill out the Patient Medical Record. Over the next few videos, students are led through the process of analyzing the data gathered. The conclusion is that the evidence shows the bald eagle has lead poisoning. Based on the evidence, Dr. Ponder leads the students through detoxifying the eagle of lead. The series of six videos ends stating that eagles are sentinels, or a species that points to the health or lack of health in the environment. Dr. Ponder explains the link between environmental health and human health.

Module Two is similar to module one. Instead of being led through the process, it is scaffolded to allow for the students to take the active role in asking the question, gathering evidence and analyzing the said evidence to come to an evidence based conclusion. The first video in Module Two reminds students of their work in module one. Dr. Ponder continues to explain that bald eagles are not naturally exposed to lead, and thus the amount of eagles with lead poisoning treated by The Raptor Center is an indication that eagles are somehow exposed to lead in the environment. Students were reminded that environmental health and human health are connected. The next video, introduces students to the field of wildlife biology and Dr. Paul Redig, veterinarian and co-founder of The Raptor Center. Dr. Redig introduces data The Raptor Center has gathered on the number of bald eagles admitted to the facility. This data was reviewed by the US Fish and Wildlife Service, an organization who is responsible for managing bald eagle population. Dr. Redig continues to explain that the US Fish and Wildlife Service has asked him to write an update covering the time span of 2010-2014 to pin point the source of lead. Dr. Redig tells the students that they will be the investigator and that he will help the students through the process. The videos continue to lead students through the process. Students work in groups to decide if bald eagles are exposed to lead through hunting ammunition or lead fishing tackle. The process is for the students to pose a question (hypothesis), to read through articles and graphs and to come to evidence based conclusion. After these two modules, students were given the Likert scale.

As previously mentioned, this Likert scale was developed based on Raptor Lab objectives. For the purposes for this paper questions that are of high importance include 2, 3, 8, 9, 10 and 11 (see Table 1). Eslinger et al. (2008) stated that "Students in inquiry-based classrooms generate better explanations, understand more content, are more able to back up their claims with appropriate evidence, collaborate more productively and effectively with one another." Questions 2, 3, 8, 9, and 10 directly relate to aspects of this statement. Question 9 refers to the process the student went through. This question is also of higher importance as Tang et al. (2009) notes inquiry is to focus on how students think through a scientific problem and construct scientific ideas. Thus, this question shows correlates this idea with the Raptor Lab the students experienced. Question 11 is important because Peffer et al. (2015) noted that the process scientists use to practice is scientific inquiry and thus authentic scientific inquiry needs to model this skill. Question 11 states "I believe that I got to experience what scientists do when they solve problems using scientific inquiry". Answers to this question will explain the student perspective.

Questions 4, 5, 6, and 7 are important to a lesser extent in this study. Since these questions were part of the Raptor Lab objectives, they were included for instructional purposes other than this paper and for feedback to the Raptor Lab.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1. I feel like I was asked to use information to come up with my own ideas for possible solutions to a scientific problem.	3.55%	7.09%	30.50%	46.81%	12.06%
2. I feel like I can look at a graph and explain what information the graph is showing.	1.42%	7.80%	14.18%	45.39%	31.21%
3. I feel like I can better explain my reasoning behind the answer I chose.	2.13%	7.09%	21.28%	45.39%	24.11%
4. After finishing the Raptor Lab, I do not have a higher interest in science.	10.64%	21.99%	24.11%	24.11%	19.15%
5. I feel like I have new ideas about jobs and careers that I could have as a scientist.	24.11%	25.53%	26.24%	19.86%	4.26%
6. I want to learn more about raptors.	24.82%	16.31%	35.46%	14.89%	8.51%
7. I do not want to learn more about environmental issues that affect raptors.	10.95%	33.58%	27.74%	16.06%	11.66%

8. Though the Raptor Lab, we shared our solutions with other students in the class.	4.26%	9.93%	20.57%	43.26%	21.99%
9. I feel like I could explain the process that we used to come to a conclusion in Raptor Lab.	8.51%	16.31%	22.70%	36.17%	16.31%
10. I feel like I can work better with my peers after the Raptor Lab.	9.22%	12.06%	29.08%	29.79%	19.86%
11. I believe that I got to experience what scientists do when they solve problems using scientific inquiry.	10.64%	10.64%	28.37%	34.04%	16.31%

Table 1. Percentages of student responses

The data from the Likert scale showed several trends based on the percentages of student responses. The following statements present the questions with which students more Strongly Agreed/Agreed. The second set of statements presents questions with which students more Strongly Disagreed/Disagreed. The third set of statements present questions with which Undecided received the highest number of percentages.

There were several questions in which students responded more Strongly Agreed and Agreed. These include statements 1, 2, 3, 4, 8, 9, 10. In Question 1, 58.87% of students Strongly Agreed or Agreed that they could come up with solutions to a scientific problem. In Question 2, 76.60% of students Strongly Agreed or Agreed that they could explain information presented in a graph. In Question 3, 43.26% of students Strongly Agreed or Agreed they could better explain the reasoning for their answers. In Question 4, the same percentage occurred between Agreed and Undecided (24.11%) that students do not have a higher interest in science. This question was also the question with reversed scoring. In Question 8, 65.25% of students

Strongly Agreed or Agreed they shared their solutions with other students in the class. In Question 9, 52.48% of students Strongly Agreed or Agreed they could explain the process of coming to a conclusion for the Raptor Lab. In Question 10, 49.65% of students Strongly Agreed or Agreed they could do better work with their peers after the Raptor Lab. In addition, nearly the same reported that they Agreed (29.79%) and Undecided (29.08%). In Question 11, 50.35% of students Strongly Agreed or Agreed they got to experience what scientists do when they solve problems using scientific inquiry.

Three questions had students that more Strongly Disagreed or Disagreed. They include statements 5, and 7. In Question 5, 49.64% of students Strongly Disagreed or Disagreed that they felt that they had new ideas about jobs and careers in the science field. In Question 7, 44.53% of students Strongly Disagreed and Disagreed they did not want to learn more about environmental issues that affect raptors. This is also a question using revered scoring.

One question, Question 6, fell in to the Undecided category. Question 6 asked the students "I want to learn more about raptors." 35.46% of students were Undecided. However, 41.13% either Strongly Disagreed or Disagreed while 23.4% either Agreed or Strongly Agreed.

Two questions, 4 and 7, used reverse scoring. In Question 4, 24.11% of students responded Undecided. The same percentage, 24.11% also Agreed with Question 4. In addition, 21.99% of the students Disagreed with Question 4. In Question 7, which also used reverse scoring, 33.58% of students Disagreed while 27.74% of students were Undecided.

Stream Study

The Stream Study project is utilized as an end of the year assessment for many of the 7th grade Life Science topics, such as matter, evolution, ecology, human impact on the environment, and scientific inquiry as set forth by the Minnesota State Science Standards. Additionally, writing the lab reports meets College and Career Readiness Anchor Standards for Writing. Manlove et al. (2007) also notes that lab reports are a common way for students to report their conclusions in the science classroom. Given this information and since the Stream Study lab report has been used as such in the past, it was chosen as an assessment for the purposes of this paper to measure the effect of the Raptor Lab on student learning.

Students were introduced to the idea of water pollution through classroom discussion and the activity A Drop in the Bucket. This activity points to how little clean, freshwater there is on Earth. Then students looked at the local Keene Creek watershed to gather background knowledge about their local environment. The question was posed "How DO we know if Keene Creek has water pollution?" Through this discussion three categories to test were developed: Biology, Chemistry, and Physical. Students took notes on each of the three categories to build their background knowledge. Since this is a project that has taken place at Keene Creek for the last two years, the data was presented to students to help them develop their hypothesis. Once students had their hypothesis, they were trained on how to perform each of the following tests: Macroinvertebrates (Biotic Index), pH, phosphate, dissolved oxygen, stream flow, turbidity and temperature. Students then went to Keene Creek to run the experiments and gather the data. With their data, students created their graphs and wrote their formal lab report. The lab report was then graded by a rubric (see Appendix D).

As previously mentioned, a t-test of significance was run to assess the data (see Appendix E). Grades from 2015 lab reports and grades from 2016 lab reports were analyzed. Descriptives, Frequencies, Histograms and Levene's Test for Equality of Variances are discussed below.

The Descriptive Statistics and Frequencies show a range of 0 to 98 in 2015 and 0-90 in 2016. The statistical mean is 79.55 in 2015 and 76.28 in 2016. The Standard Deviation around the Mean is 11.925 in 2015 and 17.525 in 2016. The Variance of the two years is far apart at, 142.217 in 2015 and 307.129 and 2016 respectively. This data points to a violation of the assumption needed for a t-test that the distribution are both equally distributed. Since this is not the case, it is necessary to use the second line of the T-Test which in equal variance is not assumed. (A Levene's Test for Equality of Variances was also run. The analysis from this test states $t(237.162) = 1.779$, $p = 0.077$. The findings remained the same.) Thus, there is not a significant difference between the two scores since 0.077 > 0.05. However, some statistical manuals mention that this is considered to be "approaching" a significant difference.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Grade15	128	98	0	98	79.55	11.925	142.217	-2.860	.214	14.996	.425
Grade16	135	90	0	90	76.28	17.525	307.129	-2.448	.209	7.150	.414
Valid N (listwise)	128										

T-Test

Group Statistics

	Year	N	Mean	Std. Deviation	Std. Error Mean
Score	2015.00	128	79.5547	11.92550	1.05407
	2016.00	135	76.2815	17.52510	1.50832

Independent Samples Test

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95%	
									Lower	Upper
Score	Equal variances assumed	7.611	.006	1.761	261	.079	3.27321	1.85827	-.38590	6.93231
	Equal variances not assumed			1.779	237.162	.077	3.27321	1.84014	-.35190	6.89831

Levene's Test

Group Statistics

	Year	N	Mean	Std. Deviation	Std. Error Mean
Zscore(Score) Score	2015.00	128	.1110997	.78856607	.06970005
	2016.00	135	-.1053390	1.15883642	.09973676

		Levene's		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence	
									Lower	Upper
Zscore(Score) Score	Equal variances assumed	7.611	.006	1.761	261	.079	.21643873	.12287691	-.02551755	.45839501
	Equal variances not assumed			1.779	237.162	.077	.21643873	.12167793	-.02326887	.45614633

The histogram Grade 15 and histogram Grade 16 illustrate the differences between the 2015 and 2016 grade distribution. Grade 16 scores are shifted to the right of the bell curve whereas Grade 15 scores are closer to the bell curve.

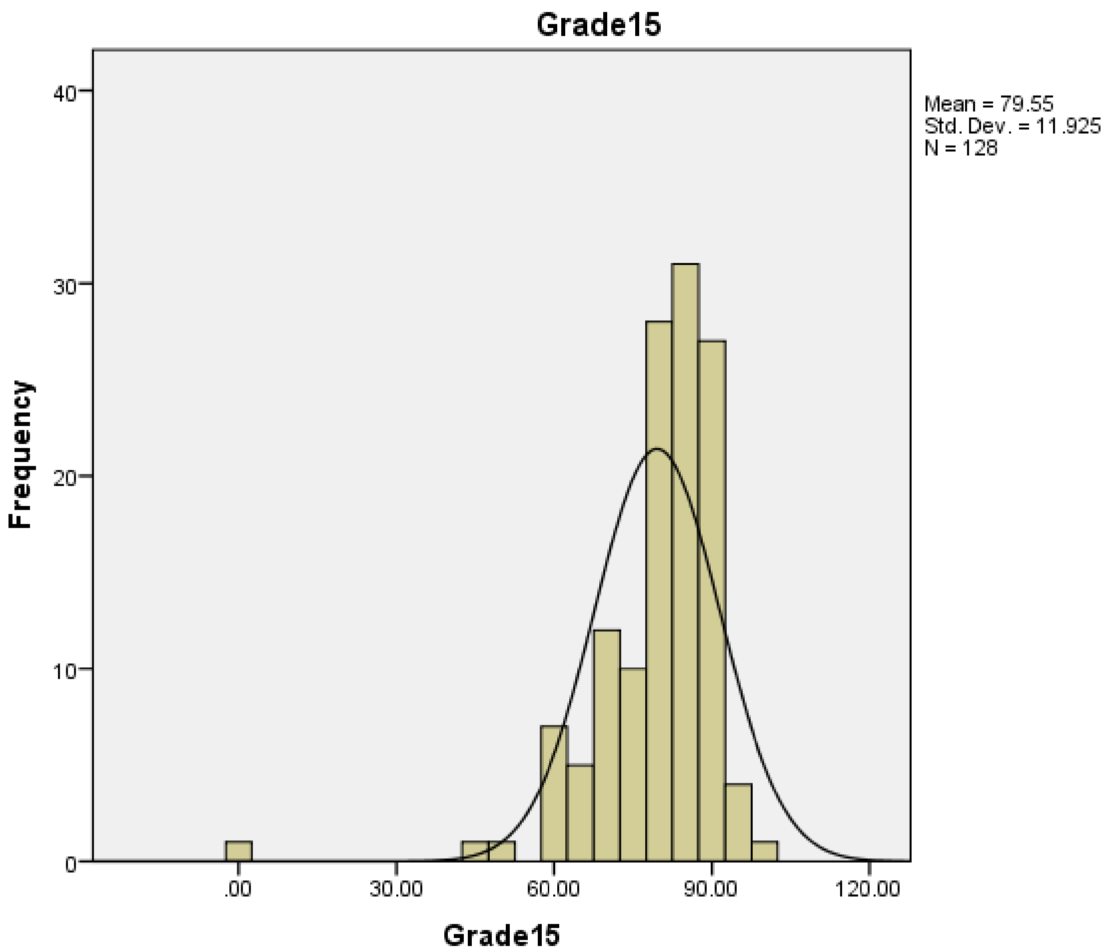

Table 2. Grade distribution of 2015 Stream Study Lab Report Scores

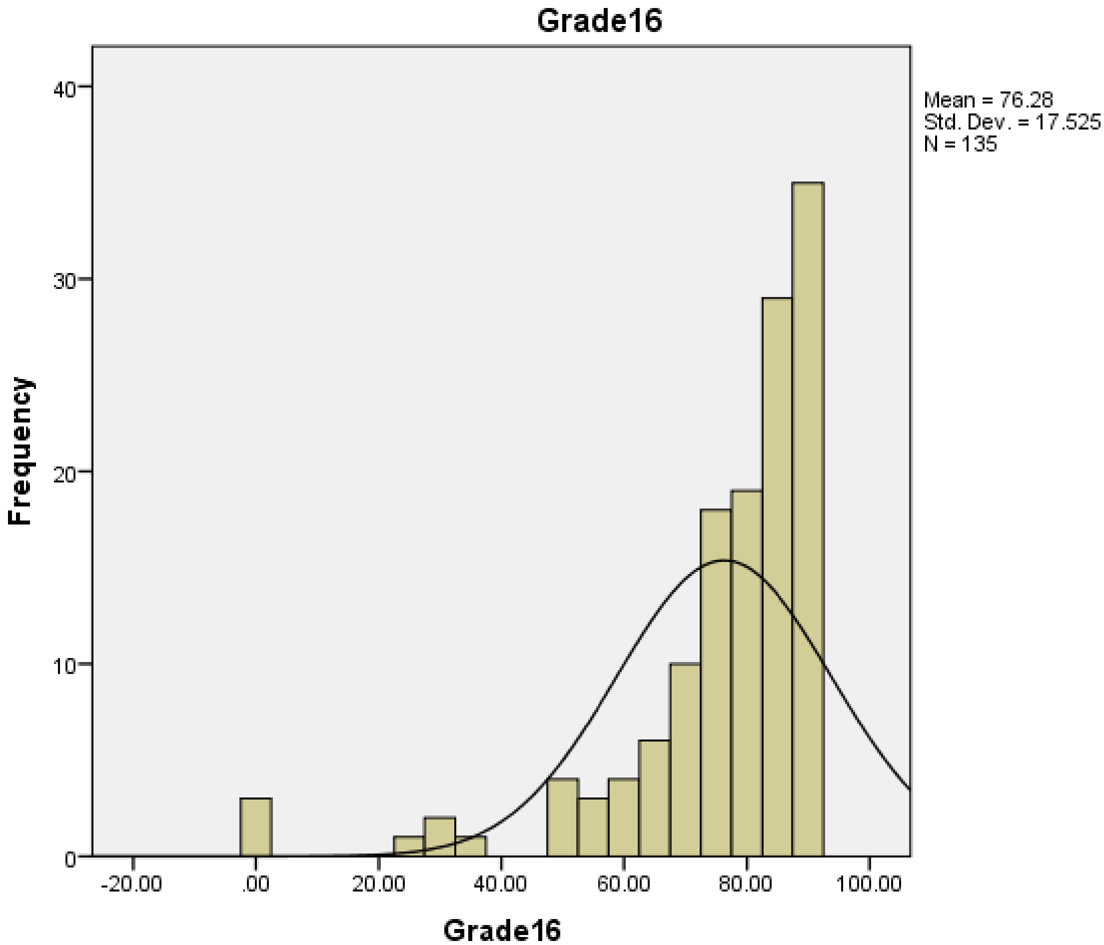

Table 3. Grade distribution of 2016 Stream Study Lab Report Scores

Summary

Students were asked their perspective on experiencing the Raptor Lab Modules One and Two through a Likert-like Survey. Questions that were of high importance to this student were 2, 3, 8, 9, 10 and 11. In Question 2, 45.39% of students Agreed that they could look at a graph and explain what information the graph is showing. In Question 3, 45.39% of students Agreed that they felt like they could better explain their reasoning behind the answer they chose. In Question 8, 43.26% of students Agreed that though the Raptor Lab, they shared their solutions with other students in the class. In Question 9, 36.17% of students Agreed that they felt like they could explain the process that was used to come to a conclusion in Raptor Lab. In Question 10, 29%.79 of students Agreed that they felt like they could work better with their peers after completing the Raptor Lab. In Question 11, 34.04% of students Agreed that they believe that they got to experience what scientists do when they solve problems using scientific inquiry.

In addition to the Likert scale a t-Test of significance was run to look at potential differences between the Stream Study results of 2015 (no Raptor Lab modules) and 2016 (two Raptor Lab modules). This t-Test indicated a variance in the grades between 2015 and 2016 are approaching significance. The analysis from this test states $t(237.162) = 1.779$, $p = 0.077$. Thus, while it is approaching significance, there is not a significant difference between the scores from 2015 and 2016.

CHAPTER 5.

DISCUSSION

Research has shown that students who learn via scientific inquiry methods are better able to understand science content. In order to do this in the science classroom, studies suggested that in addition to learning through scientific inquiry, students benefit when the scientific inquiry is scaffolded. This study attempted to examine the impact of the Raptor Lab Modules, a scaffolded, inquiry based program, on student achievement of learning scientific inquiry. This study asked the following questions. Through completing the Raptor Lab modules do students show improvement in their ability to practice scientific inquiry in a real-life setting? On average, did students perceive that they were practicing scientific inquiry? To asses these questions, this study looked at the impact of the Raptor Lab experience on the academic achievement of 7th graders through analyzing Stream Study grades from 2015 and 2016 as well as student perception measured through a Likert-Like scale.

Findings and Interpretations

Overall results

Upon completion of the Raptor Lab Modules, students were given a Likert-like scale in an attempt to understand student perception of their scientific inquiry experience. In analyzing the results of the Likert-like scale, it was found that more students responded Strongly Agreed and Agreed to Questions 1, 2, 3, 4, 8, 9, 10 and 11. See Table 5 below.) However, the direct implications of Questions 2, 3, 8, 9, 10 and 11 indicate that students perceived that they learned the different aspects directly related scientific inquiry as presented in the Raptor Lab modules.

In Question 2, 76.60% of students Strongly Agreed or Agreed that they could explain information presented in a graph. In Question 3, 43.26% of students Strongly Agreed or Agreed they could better explain the reasoning for their answers. In Question 8, 65.25% of students Strongly Agreed or Agreed they shared their solutions with other students in the class. In Question 9, 52.48% of students Strongly Agreed or Agreed they could explain the process of coming to a conclusion for the Raptor Lab. In Question 10, 49.65% of students Strongly Agreed or Agreed they could do better work with their peers after the Raptor Lab. In Question 11, 50.35% of students Strongly Agreed or Agreed they got to experience what scientists do when they solve problems using scientific inquiry.

	Strongly Disagree/Disagree	Undecided	Agree/Strongly Agree
1. I feel like I was asked to use information to come up with my own ideas for possible solutions to a scientific problem	10.64%	30.50%	58.87%
2. I feel like I can look at a graph and explain what information the graph is showing	9.22%	14.18%	76.60%
3. I feel like I can better explain my reasoning behind the answer I chose.	9.22%	21.28%	69.50%
4. After finishing the Raptor Lab, I do not have a higher interest in science.	32.63%	24.11%	43.26%
5. I feel like I have new ideas about jobs and careers that I could have as a scientist.	49.64%	26.24%	24.46%
6. I want to learn more about raptors	41.13%	35.46%	23.40%
7. I do not want to learn more about environmental issues that affect raptors.	44.53%	27.74%	27.72%

8. Though the Raptor Lab, we shared our solutions with other students in the class.	14.19%	20.57%	65.25%
9. I feel like I could explain the process that we used to come to a conclusion in Raptor Lab.	24.82%	22.70%	52.48%
10. I feel like I can work better with my peers after the Raptor Lab.	21.28%	29.08%	49.65%
11. I believe that I got to experience what scientists do when the solve problems using the scientific inquiry.	21.28%	28.37%	50.35%

Table 4. Percentages of student responses

As noted by Peffer et al. (2015), there is little research in the way of student perceptions on scientific inquiry simulations. In their study, the authors assessed student perception via a Likert scale over three simulations. This differs from this study where students took part in one simulation, the Raptor Lab. However, Peffer et al. (2015) found that students answered in the positive that they found the unit helpful in their learning. The results from this Raptor Lab study indicated Questions 2, 3, 8, 9, 10 and 11 students, on average, more Strongly Agreed and Agreed thus saying that they found these aspects of the Raptor Lab to be effective. This could mean that since students had a positive perception, it helped them develop their ideas of how to practice science. This appears to support the body of previous research that suggests students benefit from learning via a scaffolded, scientific inquiry approach. Specifically, Eslinger et al. (2008) showed through their study on Inquiry Island students made significant gains when learning from a scaffolded, scientific inquiry approach.

After the Raptor Lab was completed, the 7th grade students took part in the Stream Study Lab, described in Chapter 4. The Stream Study grades from 2015 and 2016 were compared and a t-Test utilized. The results were not significant at the $p < 0.05$ but it may indicate that a variance in the grades between 2015 and 2016 are "approaching" significance. The analysis from this test states $t(237.162) = 1.779$, $p = 0.077$. Thus, while it is "approaching significance", there is not a significant difference between the scores from 2015 and 2016.

Even though it did not show a significant gain, it is important to note that once run through the t-test of significance the histograms between 2015 and 2016 show that more students scored higher and scores skewed to the higher end.

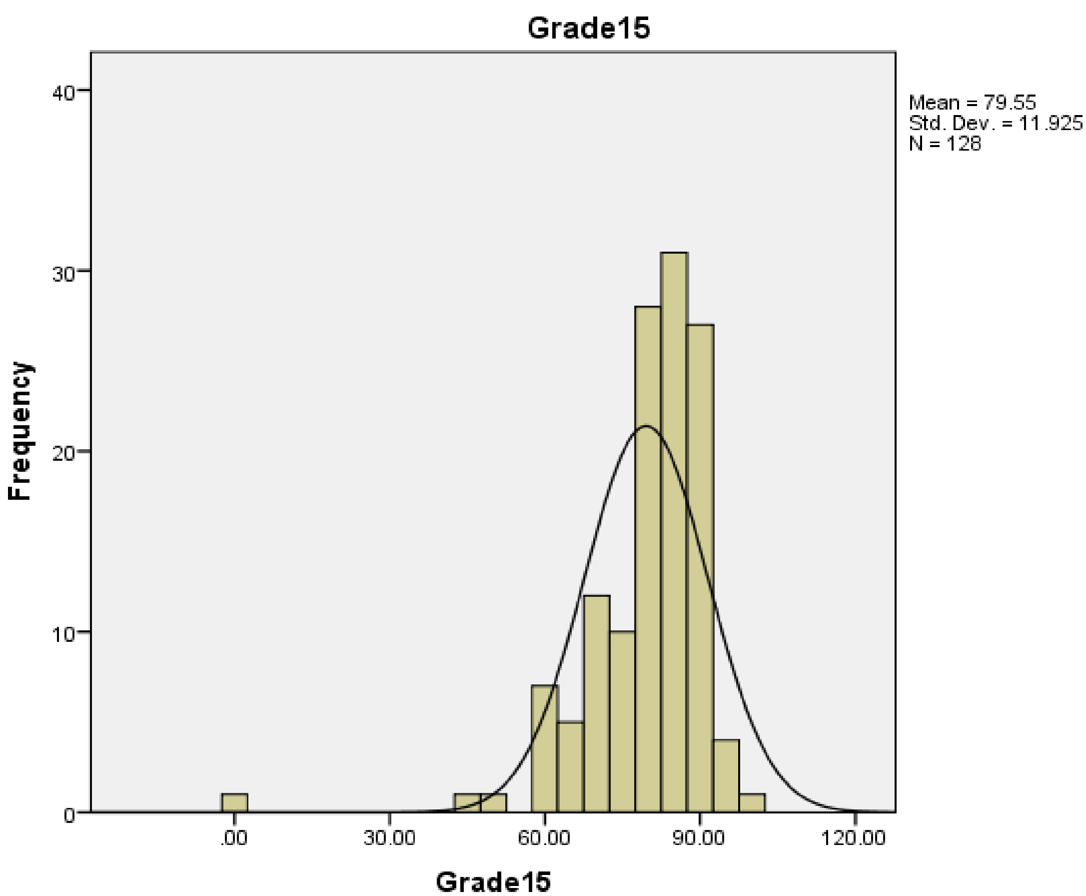

Table 5. Grade distribution of 2015 Stream Study Lab Report Scores

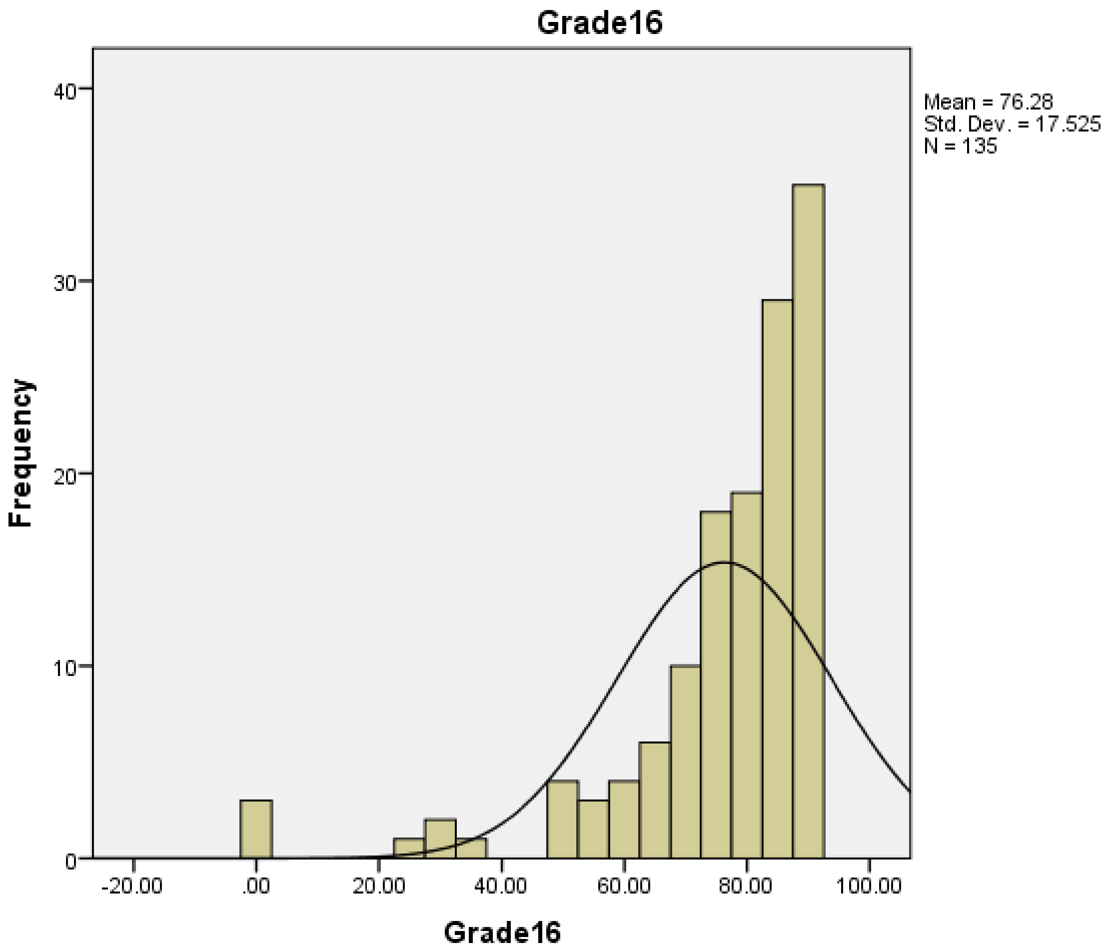

Table 6. Grade distribution of 2016 Stream Study Lab Report Scores

It is important to note that the Stream Study Lab report assessment is a transfer test. Eslinger et al. (2008) studied the impact of a scaffolded, scientific inquiry, technology based program called Inquiry Island. In their study, they also used a transfer test. Students learned the scientific inquiry process while learning genetics but the test they were given to assess their knowledge was not on the subject of genetics. Eslinger et al. (2008) results indicated that students showed a significant gain. In this Raptor Lab study, while it was a transfer test, it did not show a significant gain.

Results of the Stream Study papers could have been a result of student's lack of monitoring their thinking process. Manlove et al. (2007) stated that high school student's lack ability to monitor their learning and evaluating their learning are similar. Specifically, the authors note that high school students have a hard time explaining results that go against what the students think they should have gotten. Given that the Raptor Lab study included middle school students, there is even a higher possibility this occurred since these students are less experienced with the process of scientific inquiry and meta-cognition.

In correcting the Stream Study papers, it was noted that some students struggled to explain "bad" results. One example is how students explained a pH reading. Some groups got a pH result of 7.7. It is generally accepted that most species of stoneflies, mayflies and caddisflies need water with a pH range of 6.5-7.5, thus a reading of 7.7 would be outside of that range and could be an indication of water pollution. One response was "The pH is 7.7, 0.2 high to support trout and macroinvertebrates, which shows that the water is a little basic but not to be worried about." This response is interesting because the student clearly understands it is outside of the given range and thus a sign of pollution, but then decides "not to worry" about this pollution. Another student responded by saying "Our pH measurement was 7.7. This means that Keene Creek is a neutral stream, not too acidic or basic." Since a pH of 7 is considered neutral, the student is showing some understanding of the pH scale. The question this example raises is: is this student trying to explain the from a perspective that would have made it a "healthy" reading so that he or she would not have to deal with the possibility of pollution existing in the creek or did the student really not realize that a pH of 7.7 is different than a pH of 7? It should also be noted that there was one student did attempt to deal the pH reading of 7.7 as a sign of pollution. This student said “The pH tests ended with a pH of 7.7, this means that the water is too basic to support the life we found in the stream. This could mean that there was a mistake in some of the tests or there was something to cause the spike in pH in some parts of the stream but not others due to it being up river from the things that caused it.” Thus this student’s response does show it is possible for middle school students to explain why a stream could be polluted. In addition, it should be noted that the Raptor Lab did deal with lead ammunition and fishing tackle issues that also have a “good” and “bad” notation for students as many of them have the opportunity to hunt and fish. Thus some 7th graders did experience evaluating statements with data that went against their beliefs (students had a choice between which two possible lead exposures they though led to lead poising in bald eagles).

Future Needs

Peffer et al. (2015) looked at student perception of their learning experience through scaffolded, scientific inquiry simulations. In this study, the author’s found that students responded positively that they thought the simulations helped them understand the science content. The Raptor Lab study also found that students responded in the positive of their learning perceptions. However, the Likert-like scale was given to students after they had completed Module Two. One recommendation would be to give a Likert-like scale at the end of each module to assess student perception. This feedback could be useful in pinpointing specific areas of each module that students found to be helpful or adversely, not helpful.

While the t-test of significance did not show a significant difference, the histogram illustrates that more students did score higher. For the purposes of this paper, the Stream Study lab was moved up a few weeks in the school year. This put the time frame for writing the Stream Study lab at the end of testing and during a time when that was very busy for students (choir concert and field trips for other classes) and thus some students were absent from class. My future recommendation would be for the Stream Study to be pushed back to its regular place in the curriculum, thus allowing for more class time for students to complete their work.

Manlove et al. (2007) suggested that students can struggle when data does not align with what they were expecting to get for their data. Written portions in the Stream Study Lab reports showed this even though some experienced this situation in the Raptor Lab Modules. A future consideration would be how to better model for the students how to deal with data that could be different than what they are expecting it to be, even if that data may have a negative environmental impact. In addition, it is unclear if making the lab report writing process the same between the Raptor Lab and Stream Study would have a beneficial impact on student achievement. In the future, based on this study, it is also suggested that the rubric should be broken down in smaller segments and tallied so that it can be seen exactly where students are failing or exceeding within the written lab report. For example, are more students graphing incorrectly or are more students having issues with writing the conclusion? This would allow the educator to make more specific adjustments accordingly.

Limitations

This study had several limitations. As explained in Chapter 1, a limitation was that it included one class in northern Minnesota and thus not a sample of the national average. One other limitation is that this year is the pilot year for the Raptor Lab, only Raptor Lab Modules One and Two were included in this study, instead of all three Modules. Another limitation to this study was the questions of reverse scoring. The responses to these questions were very close together, unlike the rest of the survey questions. It is possible that the students did not understand how to respond to the reverse questioning and thus giving inaccurate results. In addition, one more limitation of this study was that during the writing process students missed class due to state testing and field trips and thus missed out on class time to work on their lab report. Another limitation was scores for the Stream Study lab report from two years were used when the practices were not identical. In addition, Stream Study lab report scores from 2015 appear to be somewhat inflated as they violated the t-test assumption that scores have a normal distribution.

Conclusion

This study was a quantitative study that aimed to look at the effect of the Raptor Lab on student achievement in learning scientific inquiry. In addition, it also looked at student perception of practicing scientific inquiry. The basic conclusions on this study indicate that there was no significant difference through employing the Raptor Lab. However, there the results can be considered to "approaching" a significant difference. The student perceptions of the Raptor Lab indicated that, on average, students responded that the Agreed or Strongly Agreed that they learned or experienced scientific inquiry concepts. Given these results, it is recommended that if the Raptor Lab is to be employed again, the researcher should make several adjustments. First, all three modules should be implemented to measure the full effect of the program. Once three modules are implemented, the researcher should allow for the rubric to be broken down into parts to see where students are exceeding or failing in order to be able to better facilitate achievement. Lastly, it should be considered that students may have a hard time explaining data that goes against their expectations (Manlove et al., 2007). The researcher should be aware of this issue and account for it accordingly.

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Appendix A

IRB Approval Letter

September 9, 2015

TO: Leah Moore
Student Researcher

FROM: Eric Edwards, Chair
Institutional Review Board for Human Subjects

Institutional Review Board (IRB) Full Board Review Status Determination for Research Involving Human Subjects: *Understanding Scientific Inquiry: A Study of Seventh Grade Student Engagement.*

Your research proposal, IRB protocol #1176, has been determined to meet the guidelines for full board review status. The readers were Eric Edwards, Lynn Goerdt, Yvonne Rutford, Andrew Breckenridge, and Vanessa Hettinger. Data collection is approved from today until one year from yesterday. Should collection need to extend beyond that date, you will need to resubmit your protocol to the IRB for an extension.

The purpose of the Institutional Review Board is to review research projects conducted by UW-Superior students, faculty, and staff to ensure that ethical practices and protocols with regards to use of human subjects are followed. Retain this memorandum with your research protocols. Please note that you must follow the proposal submitted to and agreed upon by this committee. If you change protocols or practices, or if data collection is expected to extend beyond the approved date, you must return to the committee for review of the modifications or extension.

Good luck in your research endeavor.

Cc: Dean of Faculties
Suzanne Griffith
IRB Committee members
Eric Edwards
Lynn Goerdt
Yvonne Rutford
Andrew Breckenridge
Vanessa Hettinger

Appendix B Letter of Consent

Life Science COURSE SYLLABUS
Mrs. Moore, Room M204 lmoore@proctor.k12.mn.us 218-628-4926 ext 1053

Explore! Learn! Soar!

Welcome to 7th Grade Life Science!
This year we will explore science as it relates to living things. Expect to explore questions you have about science, learn the answers to these questions and to soar with the knowledge.

Course Objectives
Students will be able to:

1. Understand the scientific process and be able to use the scientific knowledge and skills real life settings
2. Demonstrate an understanding of matter and the periodic table of elements
3. Identify the differences between living organisms and non-living things
4. Demonstrate knowledge of the components of the ecology of Minnesota
5. Describe human impact on ecosystem
6. Understand the life processes plant and animal cells.
7. Demonstrate an understanding of mitosis and meiosis
8. Show an understanding of the components of DNA
9. Illustrate knowledge of how traits are inherited by offspring
10. Understand the key components of evolution

Assessments
Students will be assessed in a variety of ways over the course of the year. Quizzes, labs, unit tests, projects and written work are all examples of how 7th grade students can expect to demonstrate skills and knowledge of science objectives. Assignments and assessments will be posted on my website.

Textbook: Life Science by McGraw Hill
Middle School Grade Scale
90-91 A-
88-89 B+

82-87 B

80-81 B-
78-79 C+
72-77 C
70-71 C-

68-69 D+
62-67 D
60-61 D-
Below 59%

Gradebook Codes

0.01 – assignment is late, but still can be turned in
0 means that the assignment is late and cannot be turned in
EX means that the student is excused from the assignment. Neither helps nor hinders the student's grade

Course Policies: Grades

1. Students should expect to complete daily assignments. Work that is not completed in class needs to be completed as homework.

2. Daily assignments and other important information will be posted in Canvas. Students are expected to enter Canvas on a daily basis.

3. Any assignment that is turned in without a name will be thrown away.

4. Work that is not turned in during the class period it is due is considered late.

If a student does not turn in the assignment, then the grade book will read: 0.01.

After one week, the grade will read 0. As stated above, this means that the assignment is late and cannot be turned in.

1. Students that have been absent will be given an extension equal to the number of days absent to turn in assignments. Assignment slip **must** be turned in with the assignment.

2. Students with special needs will need to make special arrangements with Mrs. Moore in advance of the assignment due date.

Extra Credit Policy: Students should expect very few extra credit possibilities.

Items needed for each class: Pencil, 1.5-inch three ring binder with loose-leaf paper, assigned science textbook and **charged** iPad.

1.5-inch three ring binder: Students will be required to use a three ring binder to keep organized. Every effort will be made to hand out copies that are three hole punched for students. Any item that is not three hole punched will be the responsibility of the student to punch (can use class room three hole punch).

Pencil ***(no pens)***: Unless otherwise noted, all work is to be done in pencil. If work is completed in pen (or other writing utensil), the work will be returned to student to re-do and turn back in. Work will be counted as late.)

Attention Parents If you cannot afford to provide your learner with a daily pencil, I require oral/written communication from you, the guardian, requesting the school to provide a pencil.

iPad: All 7th grade students will be issued an iPad in the beginning of the 2015-2016 school year. It is the expectation that students will bring their iPad to class each day. In addition, the iPad will need to be charged. Otherwise, students can expect to do an alternate assignment, but will still be held accountable for all work done on the iPad.

Science textbook: This year we will have digital textbooks. Students will be able to access this via their iPads. The expectation is that they come to class with a working, charged iPad in order to access their textbook. There are two ways students can access their textbook. One way is through the CINCH application and the other is through the website. Students should expect that they will use both formats.

Classroom Devices

As mentioned above, students are assigned an iPad and expected to bring their charged iPad to class. iPads are to be used for educational purposes only. Any misuse of iPads during class may result in loss of privileges. **All other devices should be left at home or in lockers. It is unacceptable for students to use other devices to do science work.**

Course Policies: Students Expectations

Academic Conduct Policy: Students are to do their best work. Cheating and plagiarism will not be tolerated. Students who are caught cheating and/or plagiarizing will receive a 0 for the assignment/test.

Behavioral Conduct Policy: It is expect that students in the science classroom follow classroom rules as set by the class. It is also expected that students follow all directions given by the teacher. Due to the nature of the science classroom, it is important that directions are followed for the safety of all of the students.

Any student that is not following directions and/or is disrupting the learning environment should expect to have a conversation with Mrs. Moore. Appropriate consequences will be given for each offense.

Students will not be allowed to bring backpacks, food or drinks into the Mrs. Moore's classroom. Students are assigned a locker and backpacks need to remain in the locker. Due to the number of students and the lack of space in the science classroom, backpacks pose a safety risk to students, this are not allowed in Mrs. Moore's classroom. In addition, food and drink will not be allowed in Mrs. Moore's class also due to safety concerns.

Dear Parents and Students,

This year's 7^{th} grade science students will be taking part in the Raptor Lab curriculum as provided by the University of Minnesota's Raptor Center. The Raptor Lab will consist of three modules. These modules will be part of the class and will require students to watch videos, work, and communicate with peers and complete assignments using real life scientific knowledge and skills.

As a teacher of 7^{th} grade science my goal is for students to gain a better understanding of science. My personal goal for my teaching is to provide the best learning experience I can for my students. To meet both of these goals, I am in the process of completing my master's degree.

To help my students gain a better understanding of science, it is important that they know how to practice science through scientific inquiry while using critical thinking and problem solving skills. The Raptor Lab is an exciting opportunity to provide students with three modules that will help them learn and practice these skills. In return, the Raptor Lab is asking that I share the outcome of student learning. As a teacher, I want to know if this study is a good method for supporting student learning.

Any student work utilized in these studies will be anonymous. In other words, names will not be associated with grades. Before any results are used the scores will be averaged in with the data from all 7th graders and will not be identifiable in my study. At the end of the study, I will provide written results to the school, students, and any interested parents.

In some ways, what I am doing is no different than what I do every year. What is different is the more rigorous study and reflection on how well this curriculum is working and the formal writing up of the result, in an anonymous format, to share with others.

If you have any further questions, please feel free to contact me (see the front page of the syllabus). Results of the study can be shared with you upon request.

If you have any concerns about your child's treatment as a participant in this study, please call or write:

Professor Eric Edwards
Chair, Institutional Review Board
Dept of Sociology
Telephone: *(715) 394-8283*
Email: irb@uwsuper.edu

Professor Suzanne Griffith
Thesis advisor
Chair Educational Leadership
715 394 8316
sgriffit@uwsuper.edu

Please keep this sheet for your records. Another copy can be found on my website.

I have read the above information. I understand that all 7th grade students will be participating in Raptor Lab modules as part of the 7th grade science course. I willingly consent that my 7th grader's scores and outcomes on Raptor Lab modules will be used in the Raptor Lab Study.

Name of 7th grade
Student:____

Parent Signature: ____

Date:________________________

Life Science
COURSE SYLLABUS
Mrs. Moore, Room M204
lmoore@proctor.k12.mn.us
218-628-4926 ext 1053

Students, this must be completed and signed by you and at least one parent. This assignment is due on **Friday, September 11th**. Please detach the last **two** sheets and hand in.

Parents, please read over the syllabus and keep it for your records. Your student should return this form as indicated above. Refer to this document as questions arise this school year before you contact me. I will also have this posted on my school website.

____
Student Signature (make sure it is readable – otherwise no credit will be given)

____
Parent Date

____
Parent Date

Parents,

If there is anything you would like me know about your student, please do use this space. It can be anything from academic concerns to extra-curricular activities to personal interests. Thanks for sharing!

Appendix C

Survey Instrument

Dear Students,

Congratulations on working your way through Modules 1 and 2 of the Raptor Lab. Before you are completely finished, I will be asking you a series of questions about your experience. Please be honest about your feelings. You will NOT be sharing your name, so your answers will be anonymous, meaning I will not know which paper belongs to any student. Before I ask you the questions, it is important for you to understand how to answer the questions. Take a moment and fill out the two questions below. When you are finished, please stop and wait for directions from me.

Circle your response to the statement based on your likes.

1 – strongly disagree, 2- disagree, 3– undecided, 4– agree, 5- strongly agree

1. I like pizza.

   1 2 3 4 5

1. I like candy.

   1 2 3 4 5

Please read each statement very carefully! Circle your response to the statement based on your experience through the Raptor Lab.

1 – strongly disagree, 2 - disagree, 3 - undecided, 4 - agree, 5 - strongly agree

1. I feel like I was asked to use information to come up with my own ideas for possible solutions to a scientific problem.

   1 2 3 4 5

2. I feel like I can look at a graph and explain what information the graph is showing.

   1 2 3 4 5

3. I feel like I can better explain my reasoning behind the answer I chose.

   1 2 3 4 5

4. After finishing the Raptor Lab, I do not have a higher interest in science

   1 2 3 4 5

5. I feel like I have new ideas about jobs and careers that I could have as a scientist.

   1 2 3 4 5

6. I want to learn more about raptors.

   1 2 3 4 5

7. I do not want to learn more about environmental issues that affect raptors.

   1 2 3 4 5

8. Through the Raptor Lab, we shared our solutions with other students in the class.

   1 2 3 4 5

9. I feel like I could explain the process that we used to come to a conclusion in the Raptor Lab.

1 2 3 4 5

10. I feel like I can work better with my peers after the Raptor Lab.

1 2 3 4 5

11. I believe that I got to experience what scientists do when they solve problems using scientific inquiry.

1 2 3 4 5

Thank you. Look over your answers. Did you see the trick questions?

Appendix D

Rubric for Grading Stream Study Lab Reports

	Included in report?	Clearly written?	Grammar/punctuation correct/no mistakes?
Hypothesis Is hypothesis testable?	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Procedure/Materials			
Stream flow	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Turbidity	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Temperature	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Dissolved Oxygen	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
pH	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Phosphate	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Biological Index	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Results (Data Sentences)			
Stream flow	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Temperature	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Turbidity	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Dissolved Oxygen	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
pH	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Phosphate	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Biological Index	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)

Graphs			
	Lables	Accurate Graphing	Accurate Data For Graph
Stream flow	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Temperature	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Turbidity	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Dissolved Oxygen	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
pH	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Phosphate	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Biological Index	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Conclusion	Included in report?	Clearly written?	Explains the Data
Provided written explaination of results.			
Stream flow	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Temperature	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Turbidity	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Dissolved Oxygen	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
pH	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Phosphate	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Biological Index	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)
Conclusion includes: Stream is healthy/is not healthy	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)	Yes (1pt) No (0 pt)

Appendix E

t-test Results

```
GET
  FILE='C:\Users\MBUNCHER\Desktop\thesistry1.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
DESCRIPTIVES VARIABLES=Grade15 Grade16
  /STATISTICS=MEAN STDDEV VARIANCE RANGE MIN MAX KURTOSIS SKEWNESS.
```

Descriptives

Notes

Output Created		20-MAY-2016 13:28:09
Comments		
Input	Data	C:\Users\MBUNCHER\Desktop\thesistry 1.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	272
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=Grade15 Grade16 /STATISTICS=MEAN STDDEV VARIANCE RANGE MIN MAX KURTOSIS SKEWNESS.
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00

```
[DataSet1] C:\Users\MBUNCHER\Desktop\thesistry1.sav
```

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance				
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic				
Grade15	128	98.00	.00	98.00	79.5547	11.92550	142.217				
Grade16	135	90.00	.00	90.00	76.2815	17.52510	307.129				
Valid N (listwise)	128										

Descriptive Statistics

	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
Grade15	-2.860	.214	14.996	.425
Grade16	-2.448	.209	7.150	.414
Valid N (listwise)				

```
FREQUENCIES VARIABLES=Grade15 Grade16
  /STATISTICS=STDDEV VARIANCE RANGE MINIMUM MAXIMUM SEMEAN MEAN MEDIAN MODE
SKEWNESS SESKEW
    KURTOSIS SEKURT
  /HISTOGRAM NORMAL
  /ORDER=ANALYSIS.
```

Frequencies

Notes

Output Created		20-MAY-2016 13:29:08
Comments		
Input	Data	C:\Users\MBUNCHER\Desktop\thesistry 1.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	272
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.

	Cases Used	Statistics are based on all cases with valid data.
Syntax		FREQUENCIES VARIABLES=Grade15 Grade16 /STATISTICS=STDDEV VARIANCE RANGE MINIMUM MAXIMUM SEMEAN MEAN MEDIAN MODE SKEWNESS SESKEW KURTOSIS SEKURT /HISTOGRAM NORMAL /ORDER=ANALYSIS.
Resources	Processor Time	00:00:01.56
	Elapsed Time	00:00:00.99

Statistics

		Grade15	Grade16
N	Valid	128	135
	Missing	144	137
Mean		79.5547	76.2815
Std. Error of Mean		1.05407	1.50832
Median		82.0000	82.0000
Mode		84.00	90.00
Std. Deviation		11.92550	17.52510
Variance		142.217	307.129
Skewness		-2.860	-2.448
Std. Error of Skewness		.214	.209
Kurtosis		14.996	7.150
Std. Error of Kurtosis		.425	.414
Range		98.00	90.00
Minimum		.00	.00
Maximum		98.00	90.00

Frequency Table

Grade15

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	1	.4	.8	.8
	45.00	1	.4	.8	1.6
	50.00	1	.4	.8	2.3
	58.00	2	.7	1.6	3.9
	59.00	1	.4	.8	4.7
	60.00	2	.7	1.6	6.3
	62.00	2	.7	1.6	7.8
	64.00	4	1.5	3.1	10.9
	66.00	1	.4	.8	11.7
	68.00	2	.7	1.6	13.3
	70.00	5	1.8	3.9	17.2
	71.00	1	.4	.8	18.0
	72.00	4	1.5	3.1	21.1
	74.00	6	2.2	4.7	25.8
	75.00	1	.4	.8	26.6
	76.00	3	1.1	2.3	28.9
	78.00	2	.7	1.6	30.5
	79.00	2	.7	1.6	32.0
	80.00	12	4.4	9.4	41.4
	82.00	12	4.4	9.4	50.8
	83.00	1	.4	.8	51.6
	84.00	22	8.1	17.2	68.8
	85.00	1	.4	.8	69.5
	86.00	7	2.6	5.5	75.0
	88.00	13	4.8	10.2	85.2
	89.00	2	.7	1.6	86.7
	90.00	11	4.0	8.6	95.3
	92.00	1	.4	.8	96.1
	94.00	3	1.1	2.3	98.4
	95.00	1	.4	.8	99.2

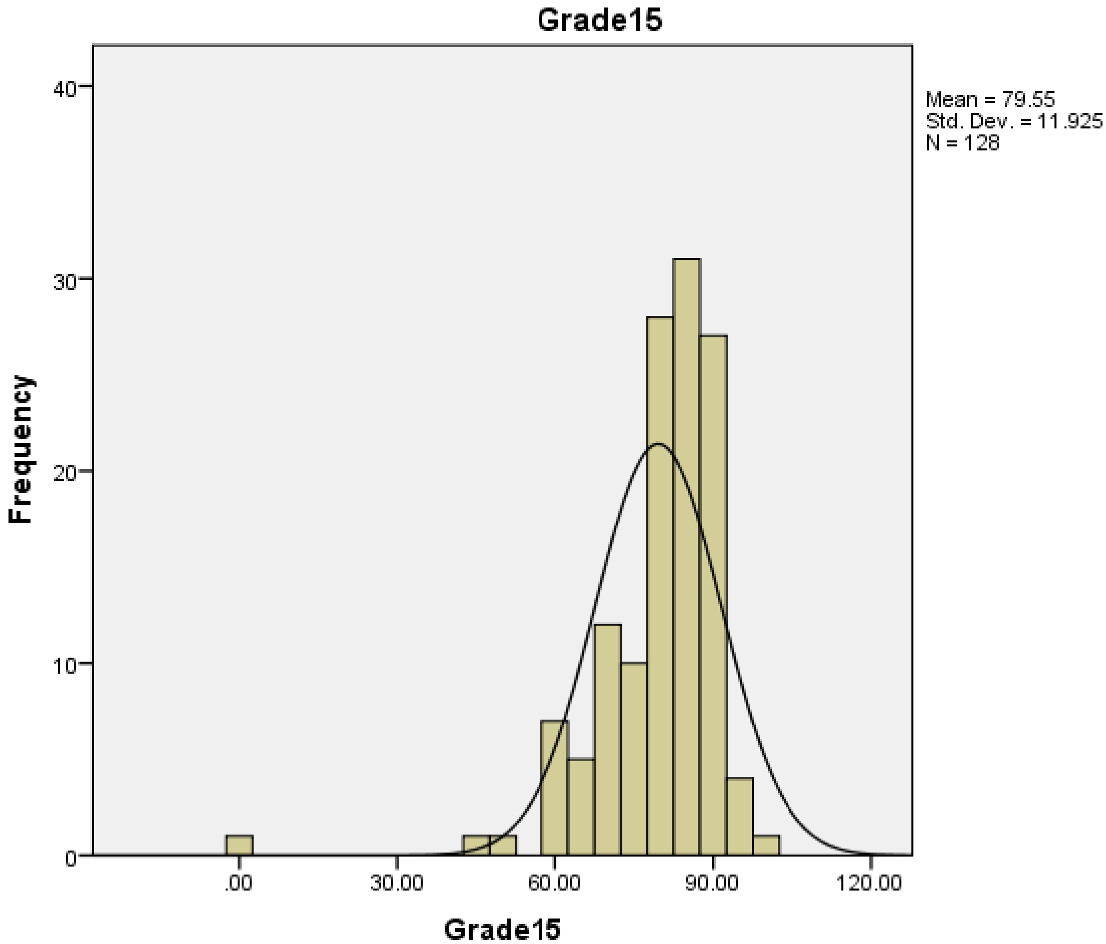
	98.00	1	.4	.8	100.0
	Total	128	47.1	100.0	
Missing	System	144	52.9		
Total		272	100.0		

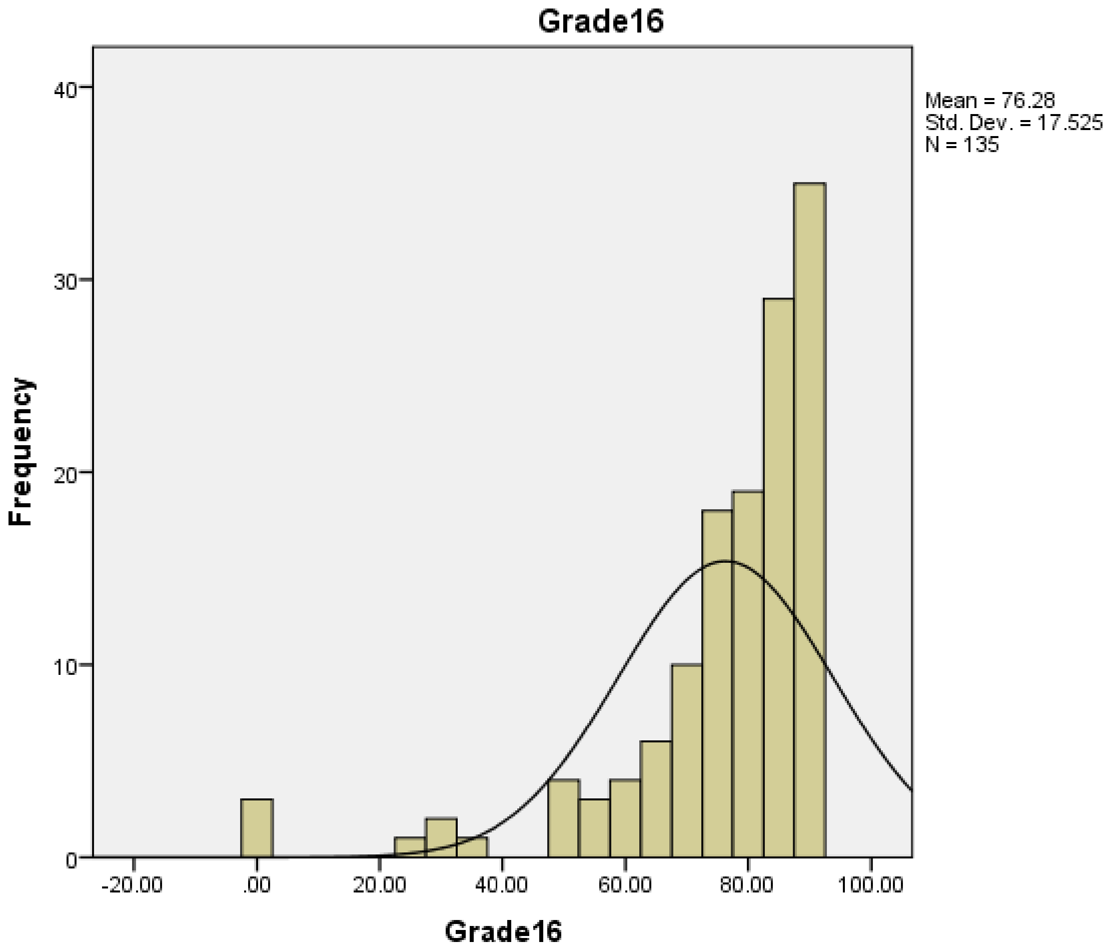
Grade16

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	3	1.1	2.2	2.2
	27.00	1	.4	.7	3.0
	28.00	1	.4	.7	3.7
	32.00	1	.4	.7	4.4
	37.00	1	.4	.7	5.2
	48.00	1	.4	.7	5.9
	49.00	1	.4	.7	6.7
	51.00	2	.7	1.5	8.1
	55.00	2	.7	1.5	9.6
	56.00	1	.4	.7	10.4
	58.00	1	.4	.7	11.1
	59.00	1	.4	.7	11.9
	60.00	1	.4	.7	12.6
	61.00	1	.4	.7	13.3
	63.00	2	.7	1.5	14.8
	64.00	1	.4	.7	15.6
	67.00	3	1.1	2.2	17.8
	68.00	2	.7	1.5	19.3
	69.00	4	1.5	3.0	22.2
	71.00	2	.7	1.5	23.7
	72.00	2	.7	1.5	25.2
	73.00	2	.7	1.5	26.7
	74.00	5	1.8	3.7	30.4
	75.00	4	1.5	3.0	33.3
	76.00	3	1.1	2.2	35.6
	77.00	4	1.5	3.0	38.5

	78.00	4	1.5	3.0	41.5
	79.00	3	1.1	2.2	43.7
	80.00	4	1.5	3.0	46.7
	81.00	4	1.5	3.0	49.6
	82.00	4	1.5	3.0	52.6
	83.00	5	1.8	3.7	56.3
	84.00	3	1.1	2.2	58.5
	85.00	6	2.2	4.4	63.0
	86.00	3	1.1	2.2	65.2
	87.00	12	4.4	8.9	74.1
	88.00	7	2.6	5.2	79.3
	89.00	6	2.2	4.4	83.7
	90.00	22	8.1	16.3	100.0
	Total	135	49.6	100.0	
Missing	System	137	50.4		
Total		272	100.0		

Histogram


Grade15
Mean = 79.55
Std. Dev. = 11.925
N = 128
Frequency
40
30
20
10
0
.00
30.00
60.00
90.00
120.00
Grade15




```
T-TEST GROUPS=Year(2015 2016)
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  /VARIABLES=Score
  /CRITERIA=CI(.95).
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T-Test

Notes

Output Created		20-MAY-2016 13:29:39
Comments		
Input	Data	C:\Users\MBUNCHER\Desktop\thesistry 1.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	272
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=Year(2015 2016) /MISSING=ANALYSIS /VARIABLES=Score /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.16

Group Statistics

	Year	N	Mean	Std. Deviation	Std. Error Mean
Score	2015.00	128	79.5547	11.92550	1.05407
	2016.00	135	76.2815	17.52510	1.50832

Independent Samples Test

	Levene's Test for Equality of Variances	t-test for Equality of Means					

		F	Sig.	t	df					
Score	Equal variances assumed	7.611	.006	1.761	261					
	Equal variances not assumed			1.779	237.162					

Independent Samples Test

		t-test for Equality of Means				
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	
Score	Equal variances assumed	.079	3.27321	1.85827	-.38590	
	Equal variances not assumed	.077	3.27321	1.84014	-.35190	

Independent Samples Test

		t-test for Equality of Means
		95% Confidence Interval of the Difference
		Upper
Score	Equal variances assumed	6.93231
	Equal variances not assumed	6.89831