

THE IMPACT HANDS-ON EXPERIENCES HAVE ON
INTEREST AND ATTITUDES OF MIDDLE SCHOOL
SCIENCE LEARNERS

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The Impact Hands-On Experiences Have on the Interest and Attitudes of Middle School Science Learners

I. Introduction

Science is observing the world, asking questions, and making discoveries. It is about developing experiments and increasing one's knowledge and sharing that knowledge with others. Understanding science can be a powerful thing because it can change one's view of the world (Archer et al., 2010).

Unfortunately, most students do not have an accurate perception of science (Skamp & Logan, 2005). In their eyes science is associated with memorizing facts and completing lab sheets. Despite the excitement that science can bring into one's life, a majority of middle school students do not have a passion for science. Too many students enter a science classroom with the idea that science is boring and irrelevant to their world (Skamp & Logan, 2005). A majority of students view science as something that is unexciting, just boring facts that scientists know, and that students are required to learn (Pickens & Eick, 2009). Because of this negative perception, middle school students are showing a decreased interest in science class (Skamp, 2007). Previous research has shown that young children enjoy science class, but when students reach the age of 10, that interest and enjoyment declines radically. By the age of 14, students' attitudes about science have already been established, and are difficult to change (Archer et. al, 2010). This is of concern because in the next decade demand for professions involving knowledge of science and technology are predicted to increase by 47%, with the labor force increasing by only 15%. With such low interest in science students are choosing other fields of study. Presently the United States is a world leader scientific and technological enterprises, but that may not last for long (Gokhale et. al, 2009). Without properly educated people to work in this field, what may happen?

A lack of student interest may begin in elementary school. There is an increasing concern that due to No Child Left Behind legislation, class time devoted to science has decreased and when science is taught the time is spent focusing on a "narrow set of scientific facts and information needed for short-term success on tests" (Marx & Harris, 2006, p. 471). Teachers are feeling the pressure to "teach to the test" which often results

in more standardized teaching strategies and less time spent with hands-on activities and outdoor experiences. Many teachers are being encouraged to spend more class time on math and reading, which limits class time focused on science. Students may also be feeling the testing crunch and mistakenly associate a subject that is full of excitement and discovery with regurgitating facts. Many “fun” aspects of science class, such as field trips, have been put on hold in order for students to spend time preparing for “the test” (Marx & Harris, 2006).

Funds allocated for experiential learning are diminishing, due to economic woes and federal funding through No Child Left Behind restrictions. According to a *Los Angeles Times* article, over 60% of teachers nationwide have reported decreasing funds for field trips. The fact is simple- field trips are being cancelled due to inadequate funding. Plus, field trips are accused of taking valuable teaching time away from the classroom (Mehta, 2008).

Unfortunately, due to a concentration on state testing, and school limitations on field trips, one of the most hands-on science learning opportunities in which students can participate has been restricted by many school districts. Outdoor experiences, such as a trip to a park, or even having science class outside the school door, have been replaced by focusing class time on preparing for state content exams. Yet Ramey-Gassert (1997) states that “informal science learning environments allow students to observe and investigate natural objects and phenomena and live specimens in ways that textbooks cannot” (p. 436). Students seeing and experiencing scientific content first-hand will help provoke students’ curiosity about the topic and create connections to the natural world. Carrier (2009) described her experiences with outdoor science lessons as a way to “help illustrate the ubiquity of science and the relationships of science to students’ lives” (p. 44).

Providing middle school students with hands-on activities that directly involve them in the learning process have been shown to improve students’ science learning and achievement as well as improve their attitudes towards science (Satterthwait, 2010). Not only do hands-on lessons increase student interest, these lessons provide opportunities for students to see and experience an event for themselves, test predictions based on their (or others’) ideas, and to experience doing “real” science (Skamp, 2007). Tying together

content and middle school students' lives have shown to be effective. Studies have reported that middle school students need to be cognitively engaged in the lesson before they will learn effectively. Teachers need to remember that a hands-on activity is "useless if students' hands are on, but their heads are out" (Skamp 2007). When instructing students on a hands-on activity, it is important for teachers to draw on real-world experiences and help students find ways to connect content with their lives (Ramey-Gassert, 1997). Discovering personal meaning in a topic will most likely increase student interest and motivation to learn (Skamp, 2007). Students need to have the opportunity to experience what real science is, not just hear about it.

Research Question

Even considering the fact that budget cuts are preventing students from taking field trips, there is still an opportunity to teach hands-on, experiential lessons that will interest middle school students, or in the very least, provide them with real-world scientific experiences that follow state content curriculum. The purpose of this study is to answer the question: What impact do hands-on science activities have on the interest and attitudes of middle school science learners?

II. Literature Review

Introduction

Previous studies have documented a decrease in student interest in science, beginning at the end of elementary school. This decrease is most likely due to numerous issues, including an increase in classroom testing, class time being strictly focused on specific curriculum, and gender and socio-economic differences in attitudes about science. Science teachers have struggled to develop strategies and techniques that will greatly involve their students and increase student interest in the content. Strategies that help students better comprehend science content by making topics more relevant to students' lives have been shown to improve student achievement and interest in science (Skamp & Logan, 2005). In order for teachers to increase student interest in science at the middle school level we must be aware of techniques and strategies that engage students and make science more relevant to their daily lives. When middle school students show an increase in comprehension of content, they will more likely show an increase in achievement, which may lead to an overall increase in interest in science.

Decline of Interest in Science

The issue of middle school students' decrease in interest in science is not new. For over three decades, the science community has expressed concern over the issue of student involvement and engagement in science (Archer et al., 2010). Evidence has shown that by third grade, many students lose their sense of curiosity, and their explorative natures, and the routine of classroom learning takes over (Ramey-Gassert, 2009). Previous research has shown that students have a positive image of science until around the age of the end of elementary school, when interest levels start to decrease. By the time students are freshman in high school, their image of science has largely already been formed (Archer et al., 2010). Kanter & Konstantopoulos (2010) found that students' attitudes continue to decline as they progress through middle school and high school. There is even evidence that college students are steering away from the sciences, and choosing majors that do not involve a large science course load (Yang, 2010). Students' attitudes towards a subject are one of the major factors in guiding student choice for a future career (Gokhale, 2009).

Possible Explanations for Declining Interest in Science

An explanation as to why students are showing a declining interest in science is that they do not personally identify with it; students do not see how science benefits them. Whether it is due to social issues, such as gender roles, ethnicity, or socio-economic status students are having a challenging time relating science to their lives (Archer et al., 2010). This section looks into these issues more in-depth as to discover possible social explanations for declining interest. Students' lack of exposure to science in the elementary years and certain instructional strategies may also play a role in interest level.

Gender Roles in Science

For several decades there has been a large push to promote science to females due to their overall lack of interest. Generally speaking, males' attitudes towards science have been positive. It has been consistently found that males have a stronger interest in the physical sciences, whereas females have a stronger interest in biological sciences. Females prefer to participate in observational and life sciences, whereas males are more involved with the manipulation of objects and interactions with machines (Wiens et al., 2003). The female lack of interest in physical sciences most likely prevents females from proceeding with a career in the physical sciences, such as physics, and can limit females from many technological careers (Dawson, 2000). Certain aspects of science may appear to be "too feminized" for many males, and "too masculine" for many females (Archer et al., 2010). It may take many generations to overcome historical interpretations of science as a male career (Ramsay et al., 2005). In order to "close the gender gap" in the sciences Cotner et. al (2011) surveyed female student confidence in using and comprehending science content with a female instructor versus a male instructor. Female students reported significant improvements in their confidence with a female instructor, whereas female students who had a male instructor failed to make significant gains in their confidence. In fact, female students with a male instructor actually lost confidence in their ability to comprehend the scientific content in the class (Cotner et. al, 2011).

However, Skamp & Logan (2005) suggested that gender may have a lesser impact on interest and attitudes in science than previously thought due to the influence of other factors. Gender may be a contributing factor to the decline in interest along with a

combination of other variables, including ethnicity and socio-economic factors (Skamp & Logan, 2005).

Ethnicity/ Socio-Economic Factors

Science is not attracting minority groups. This may be due to the lack of engaging instruction students face in middle school, and the unfortunate perception that science is for white males. African Americans, Hispanic Americans, and American Indians are less likely to pursue a science-related career than their European American peers (Kanter & Konstantopoulos, 2010). When asked “What does a scientist look like?” most students perceived a scientist as being a white male, in a lab coat, surrounded by test tubes and Bunsen burners. This is a problem, especially for minorities and women who tend to choose non-science oriented career fields. If a person does not envision himself or herself fitting into the science community, they will be less likely to choose a science oriented career (Painter et al., 2006). Attention to students’ perceptions of scientists needs to be given, starting in the elementary years, when students are forming their opinions of science that will guide them throughout their education (Skamp, 2007).

There is evidence that suggests urban students’ negative attitudes toward science and their lack of interest begins in the middle grades. There are cross-cultural barriers due to the type of science instruction in many urban schools, where many minority students attend. In many urban schools science instruction focuses on memorization of facts and theories. A hands-on approach is lacking (Kanter & Konstantopoulos, 2010). A well taught, rigorous, motivating science curriculum that properly prepares elementary and middle school science learners may improve student achievement and attitudes towards science (Ruby, 2006).

The differences in instruction are reflected in middle grades’ student achievement in science. Ruby (2006) explains that the U.S. National Assessment of Educational Progress (1996-2000) results show student achievement in science significantly worsens under inner-city middle school conditions. However, middle schools cannot take the all the blame for this. High-poverty elementary students are also showing a decline in achievement in science (Ruby, 2006).

There is a worldwide documented decline in science performance of middle grade students attending schools with high concentrations of students with lower socio-

economic status (Ruby, 2006). Haberman (1991) coined the term “Pedagogy of Poverty” which refers to the teaching styles many minority students face in urban districts: lecture, reading out of the textbook, and memorization of facts. This type of instruction ultimately reduces students’ attitudes towards science, as well as decreases their achievement (Kanter & Konstantopoulos, 2010).

Students who demonstrate below-average science competency are not prepared for the more rigorous science content and expectations in high school. Students are less likely to make adequate progress. As a result, students form a negative attitude of science, and choose other courses of study (Ruby, 2006). Science education reform must address students who are already considered behind (Ruby, 2006).

Lewis, Menzies, Najera and Page (2009) found that as students continue their education through college, minority groups that have been traditionally unrepresented in the biological sciences continue to remain so. This level of misrepresentation increases as minorities move through academia. The numbers of minorities represented in the biological science is similar to the number 15 years ago (Lewis et al., 2009).

Attitudes towards science start forming in the early elementary years, and by middle school have solidified. These attitudes follow the students throughout their education. Ethnicity and socio-economic factors play a role in how students can relate science to their everyday lives (Kanter & Konstantopoulos, 2010). If students were introduced to applicable science early-on, they may feel more connected to this subject, and continue to study science throughout higher education (Lewis et al., 2009). The next section explores reasons why science may not be a focus during the elementary years.

Lack of Science Focus in Elementary Years

Elementary science teachers’ training is not traditionally focused on science, which can often lead to apprehension and lack of self-confidence in this content area (Carrier, 2009). Many teachers do not feel qualified to teach middle school science. Teachers’ lack of science background often leads them to reduce coverage of content that is seen as difficult (Ruby, 2006). The 2000 National Survey of the State of Science and Mathematics Education found that only 25% of elementary teachers surveyed thought of themselves as well qualified to teach science. Close to two thirds of elementary school

teachers revealed that they were not familiar with state science standards (Marx & Harris, 2006).

In most elementary schools class time was spent on reading and mathematics, with diminished time for science. Science was taught if there was time for it. However, due to a 2007 revision in No Child Left Behind legislation, NCLB now requires that states measure students' progress in science at a minimum of once each year for grades 3-5. Some school districts are now giving instructional time for science a higher priority (Marx & Harris, 2006).

Skamp and Logan (2005) found that there was a decline in interest in science as students completed elementary school and moved onto secondary school. Their results found that this may be due to the fact that primary school teachers can make science instruction more relevant to students whereas secondary teachers are restricted by time. (Skamp & Logan, 2005).

Ruby (2006) revealed that the lack of consistency within a school is the primary science constraint for science. The taught science curriculum varied between teachers in the same grade. Students in the same grade learned different science content, which led to problems in future grades. Upper grade teachers were unaware of what students had learned. As a result, upper grade teachers did not build upon what their students had learned in previous years. Often, the same content was covered in several grades (Ruby, 2006). More attention needs to be focused on student transition into secondary school science classes (Skamp & Logan, 2005).

Mandatory Testing

Mandatory testing has impacted instructional strategies and the organization of class time. In many students' eyes, the reason why they are learning something is not because it is relevant to their life, but because that topic is on the test. Testing has unfortunately become a focus of the middle school classroom (Longo, 2010).

In 2008, state science standardized tests were first implemented in the elementary and middle grades as part of a federal mandate, No Child Left Behind. The hope is that through assessment, schools will be held accountable for their students' education and eventually close the learning achievement gap. Science content tests are based on inquiry learning associated with science, and often the test questions model real-life applications.

Despite this fact, the reality is that schools are feeling the push to deliver facts and information that will help prepare students for “the test” and are not focusing on the real-life applications of science. State assessments can guide even the most experienced and skilled teachers down the wrong path (Longo, 2010).

High stakes testing has dictated the way many educators deliver instruction (Longo, 2010). There is a concern that schools must make the choice between students learning through scientific inquiry or preparing students to perform well on high-stakes state testing. Science teachers feel pressure trying to balance mandatory state testing requirements and delivering creative and meaningful curricula (Longo, 2010). Schools are also feeling pressure, and many may feel the need to spend instructional time focused on the memorization of scientific facts and information for short-term success, such as passing state tests (Marx & Harris, 2006). However, how well students perform on tests is not as important as their overall understanding of scientific concepts and their attitudes towards science. Hands-on lessons, labs, and inquiry all are important components of good science classes. All of these factors play a role in students’ attitudes about science (Ornstein, 2006).

Instructional Strategies

Teachers need to be aware of effective ways to implement science instruction, all while preparing students for testing. One way to do this is through inquiry-based learning, which involves students going through the process of constructing understanding for themselves. Unfortunately, the technique that best promotes scientific literacy is becoming lost in the science classroom due to time restrictions and a focus on state assessments (Longo, 2010).

Teachers’ instructional strategies play a part in forming students’ attitudes towards science. Archer et al. (2010) interviewed 10 and 11 year old students and found that children may enjoy science, but reported that it is “not for them” and chose not to study it at a higher level. In Yang’s study (2010) analyzing college student interest in science, students who reportedly were not interested in science felt so because science involved “lectures and book work...worksheets, tests, memorization of facts” (p.73). College students who were uninterested in science felt so mainly because their school experiences involved memorization of facts and concepts, and being forced to learn

certain topics, not being able “do” science. Students mentioned they had a higher interest in science when they were able to experience it as opposed to being told about it (Yang, 2010). Ramey-Gassert (1997) favors the revitalization of the science education process:

Much of what needs to take place is a radical re-thinking of what society and schools in the United States have traditionally thought of as science. Science education reform documents call for the elimination of the so-called layer cake approach to the science disciplines- chemistry, physics, geology, biology- in favor of a more integrated, conceptual teaching approach. (p. 444)

An integrated approach to teaching science would allow content to blend together, and become more “real” for the students (Ramey-Gassert, 1997). However, there are often limitations to creativity in the classroom. High-stakes testing can often cause educators to limit the creativity involved in their science instruction, causing instruction time to take on a lecture, note-taking, and memorization format. Pickens and Eick (2009) found that students had a much more favorable view of science when their teacher used inquiry based instruction through scientific investigation. When teachers fail to convey the true meaning of science to their students, they dampen the student’s natural curiosity and extinguish enthusiasm (Pickens & Eick, 2009).

Strategies that Could Increase Interest and Achievement

Many studies have concluded that when considering interest levels, the most important factor is the kind of science teaching students experience. Student interest and motivation is affected by making science content relevant to students’ lives, by the teacher’s enthusiasm for the subject, providing students a positive classroom climate, enabling students to better comprehend science, and by encouraging students to “experience” science (Pickens & Eick, 2009). The impact that science teachers have on student interest can not be ignored (Skamp & Logan, 2005). The following section shares literature and research that have helped teachers encourage interest and achievement in science amongst their students.

Making Science Relevant

Students often question science because it has little relevance to their everyday lives (Beeman-Cadwallader et al., 2010). When students see science as something that is “real” and they see a scientist as someone who is a real person, then they can begin to think of science as something that they might be able to do (Painter et al., 2006).

Teaching scientific concepts while integrating them with relevant applications to society can motivate students. If a lesson is applicable to students’ everyday lives, they may see value in it. Even reluctant learners have become engaged in activities once they see the value it holds (Pickens & Eick, 2009).

Teachers can make opportunities for students to be exposed to different occupations in science. This may help students overcome the biases they have about science and scientists (Ramsay et al., 2005). Educators can increase students’ curiosity and motivation in science by using real-world lessons and assessments. Students can also learn important life-skills with this process (Longo, 2010). As scientists’ work often deals with people, management, and team-work; therefore, being introduced to these skills early on can help successfully guide a student to a rewarding science career (Ramsay et al., 2005). Wiens et al. (2003) surveyed college students to determine the most frequently cited factors for initiating and increasing student interest in science. The results show that the most important factors were the course experiences they had in school and teacher influence. Students explained that they had teachers that made the science something the students felt was important in their lives, and that their teachers encouraged them to learn more about science and had confidence in their success. Teachers play an important role in encouraging students to explore the sciences (Wiens et. al, 2003).

Darby (2007) describes four pedagogical approaches that were found to represent what teachers thought of as meaningful and relevant ways to portray curriculum to students. Category One describes “Illustrations of relevance” which refers to stories teachers would use to relate the subject matter to the students’ lives. Category Two is the “Explorations of contexts” where teachers build the context around student’ interests, and challenge students to think more deeply about the subject matter. This enables the teachers to replace regurgitating questions with scenarios that are connected to students’

backgrounds. Category Three includes “Humanizing stories of historical and contemporary heroes” by including stories used to humanize scientific discoveries. Examples would include stories that connect a human with an invention, such as Benjamin Franklin’s discovery of static electricity. Category Four is titled “Representations of the human endeavor.” This may be the most important category because this is when teachers explain how science is involved in our daily lives. Teachers may include personal encounters with science making science seem a bit more real to students (Darby, 2007).

Beeman-Cadwaller et al. (2010) suggests that teachers differentiate science instruction by valuing students’ questions and life experiences. Several strategies were modeled in order to learn more about one’s students. The first strategy was on the first day of school have students complete their own business card. The business card was required to contain a design and title of a career they hope to have in the future as well as two brief statements on the back of the card describing how that career relates to science and where their interest in that career originated. Students taped their cards to the wall in the science room in order to refer to them throughout the year. This allowed the teachers and students to make connections with school science and possible careers.

Questionnaires were distributed throughout the year to identify student interests. There were three questionnaires: the first was to determine what students identified as science outside of school, the second was related to science and the work of scientists, and the third was to determine if students’ interests had changed or grown throughout the year (Beeman-Cadwallader et al., 2010).

Many successful school programs have drawn upon real-world situations with outside-of-school leaning to help students find personal meaning in science (Ramey-Gassert, 1997). Science is everywhere- outdoors, at a museum, and at the grocery store. Enabling students to participate in real science, that has meaning, will provide them to see science through a different perspective (Carrier, 2009). When students realize that science is a profession that involves diverse people and fields, they may be more accepting in learning about it. Improved science achievement and attitudes may result from instruction that provides real-world interests (Kanter & Konstantopoulos, 2010).

Increasing Scientific Literacy

Students who struggle in order to understand complex scientific content can develop a negative attitude towards science. Educators can help students comprehend science texts by providing them with reading strategies while teaching content. Increasing students' scientific literacy and motivation may increase student confidence in science and promote higher achievement (LoGiudici & Ende, 2010).

The National Science Education Standards describe scientific literacy as “the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity” (National Research Council, 1996, p. 22). In order to be scientifically literate, students need to be able to read and understand a variety of science texts and participate in meaningful conversations about science (Zmack et al., 2007). However, understanding scientific texts is only a part of being scientifically literate. LoGiudici and Ende (2010) suggest that “an important skill for all scientifically literate citizens is skepticism” (p. 58). Skeptical people think critically and demand evidence. By teaching our students to be critical thinkers and to look at the world with an unbiased eye we are also preparing them to be scientifically literate (LoGiudici & Ende, 2010).

The transition from elementary school to middle school can be challenging in itself, but the challenge is even greater for struggling readers (Olson & Mokhtari, 2010). Too many middle school students are having difficulty reading their textbooks and understanding how scientific information is organized through figures, diagrams, and graphs (Zmack et al., 2007). Secondary science textbooks have the reputation for being dense and technical, which can lead to frustration from their readers attempting to use them. Student frustration through reading can lead to disinterest in a topic, and a lack of motivation (Zmack et al., 2007). Research has found that students participate in very little reading from their texts in secondary classrooms. Consequently, teachers should not rely on the textbook as the primary source of knowledge in the class (Olson & Mokhtari, 2010).

One way to alleviate student frustration with science texts is the need for content area teachers to see teaching reading skills not as something extra, but as an essential part of students' science comprehension. Teachers can provide science literature (such as

trade books) that students can enjoy and feel successful in reading, as well as help students develop reading strategies. Without the ability to learn from textbooks, the range of scientific knowledge diminishes (Zmack et al., 2007).

Content-area teachers can insert reading strategies into their content instruction (Olson & Mokhtari, 2010). In 15-20 minutes a week, teachers can explain and model a reading strategy (Zmack et al., 2007). Instead of memorizing science vocabulary, students should learn fundamental concepts, or “big ideas” while doing science. Olson & Mokhtari (2010) describe a popular technique that is being used to increase student achievement in science reading, called concrete/abstract/concrete sequence, or the learning cycle. There are three stages in the learning cycle: 1) Exploration- students have a challenge question they are to explore. 2) Concept Development- students discuss their observations, questions, explanations. 3) Application- students use their ideas in a more complex setting- to try and solve another challenge. Each stage may be repeated throughout the process, gradually growing more complex and building upon an understanding of a big idea in science (Olson & Mokhtari, 2010).

Successful science programs take on a comprehensive approach to teaching that not only includes the teaching of investigative skills, but also includes direct instruction of reading and confidence in understanding scientific texts (Baker et al., 2010). Science teachers can help their students improve reading skills. Science instruction that focuses on memorization is associated with students’ lack of conceptual understanding, and a decreased interest in science-related activities and careers (Olson & Mokhtari, 2010).

Reading should be used to support the scientific process of thinking through important ideas, testing thoughts, and working with data. Reading and writing are the primary means of communication between scientists, and therefore are important skills for students to master (Olson & Mokhtari, 2010).

One must not confuse reading and scientific literacy. Reading skills are an important part of being scientifically literate. The National Science Education Standards continue to define scientific literacy as “the capacity to pose and evaluate arguments and to apply conclusions from such arguments appropriately.” A scientifically literate person is one “that can ask, find, or determine answers to questions derived from curiosity about everyday experiences” (National Research Council, 1996, p. 22). Teaching students the

importance of being able to look at everyday experiences through a scientific lens and how to look at the world with a critical eye all contribute to scientific literacy and overall comprehension of science (LoGiudici & Ende, 2010).

Effective Writing in Science

Writing in science class has been traditionally looked upon by students in a negative light. Lab notes and reports are dreaded, and become another task students must memorize and complete. Encouraging students' problem solving and creative thinking assess student knowledge at a greater value than memorizing (Skamp & Logan, 2005). Writing not only enables students to reflect on their prior knowledge and experiences, but it also allows students to develop new understandings. It is a technique, that when used effectively, can allow students to connect science in the classroom to the real world (Baker et. al., 2008). Learning how to read and write in science is an important part of scientific literacy due to the fact that it can help students comprehend important science content (Dlugokienski & Sampson, 2008).

Scientific writing is best learned in the context of doing real science. Students learn best when they "do" science as opposed to hearing about science, and learning the skills involved in scientific writing go hand in hand with experiential learning (Moskovitz & Kellogg, 2011). By increasing students' scientific writing skills students will be better prepared to learn about science on their own and become lifelong science learners. All students need to be able to read and write about science so "they can make educated decisions and participate in a democratic society" (Dlugokienski & Sampson, 2008, p.15). Students who have scientific reading and writing skills are more likely to learn and understand concepts, theories and laws of science than those students who do not have these skills (Dlugokienski & Sampson, 2008).

Devick-Fry and LeSage (2010) describe science literacy circles as a way to increase student achievement in both science and literacy. Science literacy circles contain three components: science notebook organization, science literacy circle roles, and the student-generated artifacts and big ideas data chart. All three components are interrelated and occur simultaneously. The goal is to construct meaning and understanding of the science concept through discussion and the creation of personal writing activities, graphs, charts, and illustrations.

The teacher's role in science literacy circles is to introduce a new concept, review any prior knowledge, introduce the materials and procedure, and act as a facilitator.

There are six main roles students hold during science literacy circles:

1. Inquiry Organizer- provides prompts for each part of the notebook
2. Word Explorer- selects new and interesting words
3. Visionary- creates charts, diagrams and illustrations for the group
4. Thinking Connector- makes connections to everyday life
5. Webmaster- searches websites for information about the concept
6. Big Idea Developer- prepares the Big Ideas Chart for the group

Students are given a topic or question, and in the context of their roles discuss ideas and plan steps in conducting an investigation. Graphic organizers and concept maps are used to help guide students through this process. To conclude, students contribute through discussion and create a conclusion journal, reflecting whether or not their hypothesis is supported, and why (Devick-Fry & LeSage, 2010).

Dlugokienski and Sampson (2008) suggest using refutable texts as a way to encourage scientific writing. "A refutable text introduces a common concept, idea, or theory; refutes it; offers an alternative concept, idea, or theory; and then attempt to show that this alternative way of thinking is more valid or acceptable" (p.16). By providing students with an idea or misconception about science and asking them to write an alternative way of thinking with supporting evidence can improve students' scientific writing skills (Dlugokienski & Sampson, 2008). Using writing prompts is another strategy for improving scientific writing. A well-designed writing assignment provides a purpose for writing, motivates students to want to written, and helps students plan and structure their writing. Scientific writing is a way that encourages student understanding of the content (Dlugokienski & Sampson, 2008).

The blend of science and literacy allows students to engage in critical thinking and helps them understand scientific concepts in a more interactive and meaningful way (Devick-Fry & LeSage, 2010). When students understand scientific content, and feel confident in this subject, then their motivation to learn increases (Baker et al., 2008).

Being “Hands-On” in Science

While there are many factors that influence students’ interest and attitudes towards science (including the personality and teaching styles of their teacher, the students’ home environment, age, and social influences) hands-on activities have a critical influence (Ornstein, 2006). Hands-on activities have been shown to improve students’ science learning and achievement, as well as their attitudes towards science (Satterthwait, 2010).

Satterthwait (2010) identified three factors that play a significant role in hands-on teaching. The first is the influence of cooperative learning and social constructivist understandings, which identifies the importance of cooperative group work for learning to occur. The second part of hands-on teaching is object-mediated learning. Some of the most productive science activities are those that involve the manipulation of objects. This type of activity triggers curiosity in students, and students are more likely to remember things in which they are engaged. The third factor is embodiment. This is linked to object-mediated learning, and is a way students gain understanding and make meaning out of their experiences (Satterthwait, 2010).

Inquiry allows students to be hands-on, relevant, and application-based. Using inquiry, students have the opportunity to become creative (Longo, 2010). Students that are involved in project-based science are immersed in scientific inquiry in the classroom, and are also motivated by the need to find a solution to a real problem (Kanter & Konstantopoulos, 2010). Classrooms that have more challenging inquiry teaching methods used (such as through hands-on experimentation) have produced more positive student attitudes toward science (Ornstein, 2006).

Ramey-Gassert (1997) explores the benefits of out-of-school learning. In-school learning tends to be based on the abstract, and not relating to students’ real-world experiences. Out-of-school learning, such as through trips to a museum, involves students interacting with real elements, that takes learning on to a greater meaning. Learners in an informal setting are more motivated to learn, and their learning takes on more meaning, as opposed to memorizing facts or doing well on a test (Ramey-Gassert, 1997). Carrier (2009) found that providing students outdoor experiences helps connect

science to students' lives, since there are numerous outdoor connections with physical, life, and Earth sciences.

By allowing students to control the direction of their investigations, and by enabling them to do "real" science, students not only discover valuable scientific concepts, but they also have fun. When teachers do not help the students to experience what true science is the students' natural curiosity and motivation diminishes (Pickens & Eick, 2009).

Conclusion

There are many factors that contribute to middle school students' decline of interest in science. However, some of these factors can be removed by teachers making science more relevant and exciting to students. Students often are challenged by complex scientific concepts and text. Providing students with strategies that can better prepare them for being scientifically literate may increase student achievement. Research has shown that increased achievement leads to improvement in students' engagement, motivation, and conceptual understanding of science (Pickens & Eick, 2009).

In order for middle school student interest in science to increase, there needs to be a change in teaching strategies. The purpose of this project is to determine the impact hands-on activities have on the interest and attitudes of middle school science learners.

III. Methods

There are numerous studies that support the use of hands-on, inquiry based activities in the science classroom. However, due to many factors these types of activities are often not being used to their full potential in many traditional classrooms. In order to support hands-on, inquiry based lessons one needs to understand the important role these types of lessons may play in the classroom. Becoming aware of the factors that define hands-on teaching and their great potential to enhance student learning will enable teachers to strengthen and encourage such learning opportunities (Satterthwait, 2010).

In order to measure the impact of hands-on activities on student interest, achievement and comprehension, one must have a thorough understanding of students' thoughts towards science, preferences of learning styles, and what types of lessons best encourage student involvement. This section explains how surveys, student observations, and interviews will be used to help measure the minds-on impact of hands-on learning.

Setting

All research and observations were conducted in a rural Appalachian middle school 8th grade science classroom. The middle school consists of 6-8th grades, serving 354 students. The school is located outside of town, situated amongst the hills on a 40 acre campus with both the elementary and high schools located in different wings on the building.

Of the students enrolled in the middle school, 97.6 percent of them were Caucasian. Over half of the students were considered economically disadvantaged (51.1 percent). Of the total student population, 22.4 percent were classified as students with disabilities.

In 2011, the school was designated as "Effective" according to Ohio Department of Education standards (http://webapp2.ode.state.oh.us/reportcard/archives/rc_county.asp?county=Athens). The 8th grade achievement level for reading was 82.1 percent; well over the state requirement of 75 percent. The state average for reading was 80.9 percent. However, the 8th grade achievement for both mathematics and science was below the state requirement, and below the state average, at 67.6 percent and 63.2

percent, respectively. The state average for mathematics is 69.2 percent, and the state average for science is 64.2 percent.

The 10th grade Ohio Graduation Tests listed the district at 78.1 percent achievement in science, the lowest percentage of the five tested subjects. This percentage increased to 86.7 percent in the 11th grade, and was the second lowest score, next to social studies. These scores showed that science is not students' strong point, considering that science is continually one of the lowest scores in grade-level achievement tests. Possible reasons for low-level achievement in science may be due to numerous factors described in Chapter Two.

Participants

There were 142 8th graders who participated in this study. There were six periods of science class per day, and science is a requirement of all 8th graders. Of the total 8th grade student population, one student was African-American, one student was Asian-American, and one student was of mixed race. The rest of the students were Caucasian. Although this school's 8th grade student body did not represent much in terms of ethnic diversity, the students were very diverse in the types of backgrounds they possessed. There were students representing all types of socio-economic, family, and academic backgrounds. In the 8th grade science classes, there were a total of 20 students with Individual Education Plans. There were 75 females in the 8th grade, consisting of 52.8 percent of the students, and 67 males that represented the remaining 47.2 percent of the student population.

Classes were heterogeneously grouped. Each science class period consisted of students at all academic levels. Every class period had students with IEPs, except one. There was one class period that had several students with IEPs and that class had an aide. Nearing the end of the 8th grade, students took the Ohio Academic Assessment in science. In addition to the topics covered during the 8th grade (the Scientific Method, Heredity, Evolution, Plate Tectonics, Earth's Surface, the Universe, and Waves) much review and preparation for the test occurred.

All 142 students were asked to participate in taking surveys. Three students per period were chosen based on their academic level (above average, average, below

average) for observations, for a total of 18 students. Three different students per period, also representing different academic levels, were asked to participate in an interview, for a total of 18 interviews. Students were chosen by various academic levels to provide a more accurate view into students' thoughts. Further details on the instruments used during this research are included in the following pages.

The Instructor

The researcher co-taught these students and participants throughout the entire school year, both in science and in social studies. She knew each of the students and had learned about their personalities and backgrounds. In the spring she completed her student teaching in science, where she was the primary instructor for the quarter. During this time most of the research was conducted, since the researcher was able to develop and monitor the types of lessons in which students participated. Because of the relationship the researcher had with her students, careful attention was paid to the fact that the students understood that their opinions and thoughts would not affect their science grade or their relationship with their teacher in any way.

Instruments

Three different types of instruments were used by the researcher to collect and analyze data. The instruments were used to analyze students' responses about interest in science, lesson and learning styles students prefer, and how they felt about their overall understanding of science. Two surveys were given, one during the first week of the fourth grading period and one during the final week of the fourth grading period. Observations were made of student behavior during different styles of lessons. Students were selected for interviews to allow for more open-ended answers. All instruments were used by the researcher during class time. The following are instruments that were used during this study.

Surveys

There were two surveys that were distributed to the students. The first survey, or the pre-survey, was distributed to students during the first week of the fourth grading

period. The post-survey was distributed to the students during the final week of school. Students were given a brief introduction to the research project prior to the distribution of surveys. Care was taken to not bias student answers in any way, and students were told their grade would not be affected based on their answers of this survey. Surveys were coded with a number for student identification in order to properly distribute pre and post surveys. The code identification sheet was promptly destroyed after the post survey distribution in order to ensure student anonymity.

Each student was asked to complete the surveys, but had the option not to participate. All students asked to participate were willing. The surveys consisted of 11 close-ended questions, where students were asked to circle the answer that best describes how they felt. The choices were Strongly Disagree, Disagree, Slightly Disagree, Slightly Agree, Agree, and Strongly Agree. Questions 12-15 were open-ended questions asking the students to provide a short response. The questions focused on student thoughts towards their overall interest in science. These questions were based off the major factors described in the Literature Review as ways to increase student interest. Question topics included: reading comprehension, making science relevant, lesson format preferences, teacher enthusiasm, and interest level in science.

The surveys contained identical questions in order to compare pre and post answers. The post-survey was distributed after students had completed units that were focused on interactive and hands-on lessons. Student responses from the pre-survey were compared to the post-survey and analyzed to determine differences in trends. The results provided the researcher with information of student opinions of science, and how they had evolved through the students' educational path as well as during their 8th grade year. See Appendix A for Survey #1 and Survey #2.

Student Behavior Observations

The second type of instrument used was student observations. The researcher chose 18 students from the 8th grade for observation. Three students from each of the six periods were chosen, and these three students represented an above average, average, and below average-achievement student. These students were observed for the whole class period and their behavior was recorded at two minute intervals. Half of the observations

(n = 18) were recorded when students were involved in a highly interactive, hands-on class, and half of the observations (n = 18) were recorded during lecture/ note-taking classes. The goal was to determine the amount of time students spent on-task versus off-task during different types of lessons. These results allowed the researcher to assess whether hands-on lessons were more interesting for students by determining the amount of time students are engaged or on-task. The results may also suggest implications for student achievement. It is predicted that the more time a student is spent on-task, the greater their achievement will be for that particular assignment. The observation form in Appendix B was used to record on-task and off-task behaviors.

Student Interviews

The third type of instrument used was student interviews. Interview questions were focused on student interest in science, as well as how they view science and the importance of it in their lives. Questions were written to be thought-provoking and require explanation when answering. The researcher's intent was that these questions would provide insight into what middle school students think about science in general, and how they see this subject fitting into their lives in the future.

Students were selected for interviews in a similar to the process of selection for observations. Three students from each of the six periods of science class were asked permission to be interviewed. These students were chosen based on their academic level—above average, average, below average. See Appendix C for a list of interview questions.

The surveys, observations, and interviews provided the researcher with various forms of information describing student interest in science as well as lesson preferences. The questions developed were specifically focused on information taken from the Literature Review. These questions referred to possible causes in the decline of student interest and comprehension, as well as possible remedies.

Procedures

The instruments were chosen to provide the researcher with information regarding 8th grade students' prior thoughts, interests, achievement, and behavior towards science. It was important that the guidelines explained below were followed to provide the most

accurate and useful information. All surveys, observations, and interviews helped the researcher determine the impact hands-on activities have on student interest, achievement level, and comprehension of middle school science learners.

Prior Feelings

In order to understand the role hands-on activities may play in the science classroom, one must establish an understanding of the students. The pre-survey was administered to students during the first week of the fourth grading period, during a typical science unit. A typical science unit in a traditional science classroom is one that involves a combination of lecture/ hands-on lessons/ note-taking/ textbook reading/ and completing worksheets. The pre-survey was administered at the beginning of class, asking all students to participate. The researcher read the directions, and read the questions out loud so all students understood what was being asked (there are several students with low reading ability). The researcher then collected the surveys. The pre-survey took about ten minutes for the students to complete.

The pre-survey provided the researcher with information on students learning preferences, struggles with the textbook, and thoughts towards usefulness of science. Student responses to the pre-survey were analyzed, and the researcher developed future lessons considering student input from the pre-survey. This effort was intended to make science more relevant to the students by using student responses to guide future lesson formats. The post-survey was distributed during the last week of school and analyzed in order to determine if changes in lesson formats impacted the students' interest and impressions about science.

Student observations began during the end of the third grading period and the beginning of the fourth grading period. The researcher observed three students in each of the six periods. Recall that these students represented three different academic levels: above average, average, and below average. These students were observed during class lessons that involved the students in more traditional lessons. Student behavior was recorded at two-minute intervals for a total of thirty minutes. Student behavior was classified as either on task or off task. If the student portrayed behavior not on the

checklist, then the researcher used the context of the behavior in the lesson to determine if it best fits under off task or on task.

The students were interviewed during the end of the school year. Interviews were conducted by the researcher during homeroom or lunch, with permission from the interviewee. The researcher explained to the interviewees that their responses will help the teacher future develop lessons that are more appealing and interesting for the students. An introduction script was included along with the interview questions. Interviewees had an opportunity to explain prior feelings about science, and if those feelings had changed during their 8th grade year.

A table describing the research design and timeline is included below:

Research Instrument	Timeline
Student Observations (Appendix B)	End of third grading period/ Beginning of fourth grading period
Student Pre-Survey (Appendix A)	First week of fourth grading period
Student Interviews (Appendix C)	End of fourth grading period
Student Post- Survey (Appendix A)	Final week of school year

Interactive Lessons

The researcher incorporated hands-on and interactive activities into each lesson beginning during the fourth grading period and lasted eight weeks until the end of the school year. While developing lessons, the researcher paid careful attention to the causes of disinterest and the remedies cited in the Literature Review. Lessons were inquiry-based, and involved much in-depth student thought. Reading strategies were incorporated into lessons, enabling students' comprehension of the text to grow. Results from the pre-survey were analyzed, and student response results were used to plan future lessons. For example, if a majority of the students surveyed answer "disagree" to the question "I see science as being useful in everyday life" then the researcher made a conscious effort to incorporate valuable uses of science into lessons. At the end of the school year the students completed the post-survey. The distribution method was the same as the pre-survey. The time span between the pre-survey and post survey was eight weeks.

Student observations were completed during the beginning of the fourth grading period, with the same students being observed during interactive, hands-on lessons. The same behavior observation sheet was used to record observations. Student interviews were completed during the final weeks of the school year. Input from both the surveys and the observations were considered while the researcher developed future science lessons.

Student feedback from surveys, observations, and interviews helped the researcher in planning appropriate lessons that were appealing to the students, and later helped to interpret the impact of those lessons. The goal was to provide students a learning environment that was interesting, exciting, enjoyable, and educational.

Data Analysis

All data instruments were collected and analyzed separately. The data were used to support a response about how hands-on experiences impact interest and attitudes of middle school science learners. All instruments are included in the appendices.

The pre-survey was collected and analyzed prior to the researcher's student teaching in the fourth grading period. At the end of the school year the post-survey was collected. Questions 1-11 are modeled after the Likert scale. Options were coded as such: Strongly Disagree = 1, Disagree = 2, Slightly Disagree = 3, Slightly Agree = 4, Agree = 5, Strongly Agree = 6. All responses were summed according to this code, and the means were calculated and compared.

Questions 12-15 on both the pre-survey and post-survey were open-ended questions. Responses to these questions were compared for differences. Since these questions were open-ended, responses were grouped according to similarities, and total percentages were calculated and compared.

Student observations were calculated by totaling the "on-task" student behaviors and the "off-task" student behaviors during highly interactive lessons compared to less-interactive lessons. The researcher compared the totals to determine the relationship between the lesson and student behavior and interest.

Interviews occurred during the end of the fourth grading period. The researcher asked all interviewees the same questions. Similar responses were grouped together to allow the researcher to determine the importance of that response.

Summary

Surveys and observations were conducted at the beginning of the researcher's student teaching, and results from these instruments helped the researcher plan more appealing and interactive lessons for the spring. The goal was to provide students science lessons that increase interest which may increase student achievement in science. Results from the pre- and post-survey, observations, and interviews were believed to support this idea. Results from pre-surveys and observations compared with results from post-surveys, observations, and interviews helped to determine the impact hands-on experiences had on the interest and attitudes of middle school science learners. If students had positive attitudes of science then their confidence and achievement in this content area might grow.

IV. Results of Study

After completing the ten week study, all of the data were collected and the results were analyzed in order to determine the effectiveness of hands-on activities and the attitudes and interest level of middle school science students.

Results of Pre-Survey

The pre-survey (see Appendix A) was administered to the students prior to the researcher's student teaching. Students had been exposed to traditional classroom lessons consisting of lecture/ notes, experiments, graphic organizers and worksheets. All students were asked to participate in the survey. There were 142 students in the 8th grade, yet the data in Table 1 represents responses from 129 students: 57 males and 72 females. The 13 surveys that are unaccounted for were from students absent during the day of the survey or from students who did not fully complete the survey. In questions 1-12 students were asked to circle the appropriate response describing their feelings based on the Likert scale: Strongly Disagree = 1, Disagree = 2, Slightly Disagree = 3, Slightly Agree = 4, Agree = 5, Strongly Agree = 6. Questions 13-16 were open-ended questions and student responses were categorized into appropriate groups in order for total responses to be analyzed. Student responses were input into Microsoft Excel and means were calculated. See Table 1 for the means of the data. Data analysis for questions 13-16 follows the written analysis of Questions 1-12.

Table 1. Student Responses on Pre-Survey

Question	Mean (n = 129)
1) <i>I like science class.</i>	3.806
2) <i>I think the things we do in science are interesting.</i>	3.798
3) <i>I have trouble understanding my science textbook.</i>	2.759
4) <i>I learn best when listening to my teachers talk about topics we're learning.</i>	3.617
5) <i>I learn best when doing experiments and hands-on activities.</i>	5.023
6) <i>I feel like my science teachers encourage me to do well.</i>	4.349
7) <i>Science is useful to me.</i>	3.748
8) <i>I look forward to going to science class.</i>	3.543
9) <i>I feel that I will use what I have learned in science class as an adult.</i>	3.550
10) <i>I like to try and solve problems, or figure out challenges.</i>	3.736
11) <i>When my teachers are excited about what we're learning, it makes me more interested in it.</i>	3.773
12) <i>When I like a topic, it makes me want to learn more about it.</i>	5.209

According to pre-survey results, the highest ranking response was to Question 12: “When I like a topic, it makes me want to learn more about it.” Another question with a high response was Question 5: “I learn best when doing experiments and hands-on activities.” The third highest response was from Question 6: “I feel like my science teachers encourage me to do well.” These responses indicated to the researcher that students will want to learn a topic when they like it and that their preferred way of learning included doing experiments and hands-on activities. The mean of the student responses indicated that students slightly agreed that their science teacher was encouraging them to be successful in science class.

The question receiving the lowest response was Question 3: “I have trouble understanding my science book.” The score of 2.759 fell between Disagree/ Slightly Disagree on the scoring scale. Based on the pre-survey results the researcher felt that students assessed themselves as not having trouble with their textbook; however, despite

this response, the researcher included reading strategies and addressed scientific literacy in lesson plans in order to continually improve students' comfort level with reading and understanding science.

The rest of the questions included student responses that fell within the 3-4 numerical range, or between Slightly Disagree and Slightly Agree. This range indicates that the mean of students' responses fell within the "neutral" range.

Questions 13-16 were open-ended questions, and student responses were categorized for analysis. Question 13 asked "What are the best parts of science class?" Student responses were grouped into the following categories: Group work; Hands-on/ Activities/ Experiments, which were grouped together due to the similarities; Being with Friends; and the Subject Matter, which refer to student responses mentioning a particular topic covered in science. Total responses for Question 13 included 125 students. See Table 2 for results.

Table 2. Student Responses to Question 13 on Pre-Survey.

<i>13) What are the best parts of science class?</i>		
Student Response: (n = 125)	Number of Students Responding:	Percentage of Students Responding:
Group Work	18	14.4%
Hands-on/ Activities/ Experiments	69	55.2%
Friends	5	4.0%
Subject Matter	33	26.4%

A majority of student responses (55.2%) indicated that the best part of science was doing hands-on activities or experiments. The second highest response indicated that students felt the best part of science was the subject matter, or a specific topic covered in science class. The responses to this question indicate that students do enjoy some aspects of science content, and feel that hands-on learning is a highlight of science class.

Question 14 asked students "Do you ever get frustrated in science? Why or why not?" The analysis for this question included 128 student responses. Student responses were grouped into the following categories: No; Yes, because I don't understand; and Yes, because I don't like something about the class. See Table 3 for student responses.

Table 3. Student Responses to Question 14 on Pre-Survey.

<i>14) Do you ever get frustrated in science? Why or why not?</i>		
Student Response: (n = 128)	Number of Students Responding:	Percentage of Students Responding:
No	33	25.7%
Yes, I don't understand	82	64.1%
Yes, I don't like an aspect of the class	13	10.2%

A quarter of the students replied that they do not get frustrated in science. However, 64.1% of student responses indicated that they do get frustrated in science and it is because they don't understand something. The remaining students who indicated that they do get frustrated in science explained that they did not like some aspect of the class (i.e. the content, taking notes, group work).

Question 15 asked "What does science mean to you?" This question contained such diversity in responses that they could not be quantitatively categorized. Responses ranged from: "nothing" and "just another class" to "getting prepared for what we may do in life" and "I believe that science is a big part of a person's life, I just do not like to do worksheets." Due to the large range of responses this question was not quantified, but did provide insight into what students feel about science.

The last question (Question 16) asked students to "Name 3 careers or jobs that you might consider when you are out of school." Careers were categorized by the number of careers listed that involved the sciences, such as 1, 2, or 3. For example, careers categorized as a science career include: a profession in the medical field, astronomer, archeologist, park ranger, veterinarian, and crime scene investigator. All 129 complete student surveys contained responses to this question. The results for Question 16 can be found in Table 4.

Table 4: Student Responses to Question 16 in the Pre-Survey.

<i>16) Name 3 careers that you might consider when you are out of school.</i>		
Student Response: (n = 128)	Number of Students Responding:	Percentage of Students Responding:
One science focused career	45	35.2%
Two science focused careers	33	25.8%
Three science focused careers	19	14.8%
No science focused careers	31	24.2%

The highest percentage of students (34.9%) chose one science focused career as a career they may consider then they are out of school. About a quarter of students (25.6%) chose two science focused careers. Twenty-four percent of students did not report any science careers, and 14.7% of students chose three science focused careers as something they may pursue when they are out of school.

The analysis of the pre-survey responses guided the researcher when planning lessons for the remainder of the school year. Based on student responses, the researcher planned hands-on and interactive lessons to teach science content. The goal was to provide students with lessons students enjoyed, with the hope that when students enjoyed learning a topic they would want to learn more about it. Incorporated into lessons were explanations as to why the science topic could be useful in the students' futures, as well as various career opportunities associated with the knowledge of specific content (i.e. during the unit on sound and light waves the class discussed ultrasound and x-rays and the importance of waves in the medical field).

Results of Student Observations

The observations took place during the end of the third grading period and the beginning of the fourth grading period. The students chosen were of three different academic levels: below the class average, at the class average, and above the class average. Ten of the students were females and eight were males, for a total of eighteen students being observed. The observations took place over a 30 minute period, and each student's behavior was recorded at two minute intervals.

Students' behavior was recorded as being "on-task" or "off-task." On-task behavior included making eye contact with the teacher, raising one's hand, taking notes, or participating in the class conversation. Off-task behavior included having one's head down, looking around at other classmates while the teacher is talking, and talking to other classmates while the teacher is talking. A complete list of these behaviors can be found on the observation sheet in Appendix B.

Two different days reflecting two different teaching strategies were chosen. One day was a lecture/ note-taking day, and the second day was a more interactive, hands-on day. The researcher sat in the back of the room watching the eighteen students and checked the appropriate box that best described their behavior at each two minute time interval.

During the lecture/ note-taking day, students were learning about a planet life's cycle as part of their astronomy unit. The instructor used a Power Point and the students had a vocabulary sheet to complete during the class period. During the hands-on activity day, students created different types and properties of waves by using Slinkys and rope as part of their waves unit.

During the hands-on observation, several categories were added to the observation sheet that still fit the requirements of on-task or off-task behavior, but were better suited for the activity the students were completing. Under "On-Task" the researcher added: participating with group, demonstrating the type of wave, reading and/or discussing assignment with group members. Under "Off-Task" the researcher added not participating with group in activity, talking with group members about an unrelated topic, and playing with the Slinkys/ rope in a way that was not related to the assignment.

For the lecture/ note-taking day, between the eighteen students there were a combined total of 120 observations of students on-task, and 150 observations of students off-task. During the hands-on activity lesson there were a combined total of 168 on-task observations and 102 off-task observations.

Table 5 displays the number of observations in relation to the students' academic level for the lecture/ note-taking lesson.

Table 5. Observations of Student Behavior for the Lecture/ Note-taking Lesson.

Student Academic Level	Number of Observations On-Task	Number of Observations Off-Task
Above average	54	36
Average	30	60
Below average	36	54
Total	120	150

The students who displayed the most on-task behavior during this lesson were the above average students. The average and below average students were very similar to each other on-task and off- task behavior observations.

Table 6 displays the number of observations in relation to the students' academic level for the hands-on lesson.

Table 6. Observations of Student Behavior for the Hands-On Lesson.

Student academic level	# observations on-task	# observations off-task
Above average	60	30
Average	48	42
Below average	60	30
Total	168	102

During this lesson, all students displayed more on-task behavior during the hands-on lesson. However, the most dramatic differences were recorded with the above average and below average student with each group recording 60 observations of them on-task, and 30 off- task.

Between the lecture/ note-taking day and the hands-on activity day, the average and below average student showed significantly more on-task behavior. The above average students were more on-task during the hands-on lesson compared to the lecture/ note-taking lesson, but only by six recorded observations.

Student Interviews

During the final weeks of the fourth grading period, eighteen students were asked to participate in an interview about their attitudes toward science. These students were different from the students observed during lessons. These students were also chosen based on academic levels: below the class average, at the class average, and above the class average. Of the eighteen students, eleven were male and seven were female. Each interview consisted of 10 questions and did not last longer than 10 minutes. Interviews were conducted during homeroom, lunch, and planning period as to not interfere with class time.

When asked “What do you think scientists do?” nine out of the eighteen students felt that scientists do experiments. Five students referred to scientists studying an aspect of Earth (such as rocks, astronomy, plate tectonics). Four students answered that scientists use chemicals. Student responses can be found in Table 7.

Table 7. Student Interview Response to “What do you think scientists do?”

Response	Number of Students Responding	Percentage
Experiments	9	50%
Study the Earth	5	27.8%
Use chemicals	4	22.2%

Half of the students interviewed thought that scientists perform experiments. One student responded that scientists “Ask questions and then try to figure stuff out. They get do experiments and to try to solve problems and come up with answers.” Five students answered that scientists study aspects of the Earth. This idea may be fresh in students’ minds due to a large plate tectonics unit that recently concluded. Four student responses referred to scientists using chemicals and laboratory work.

Students were then asked if they thought that science was important in life and to explain why or why not. Sixteen students (88.9%) said that science is important in life and their answers referred to knowing about the Earth, answering questions, and needing to know this information when they grow older. Two students (11.1%) said they did not

think that science was important in life because they wouldn't use this knowledge in the future.

The next question asked the students to describe what types of things we did in science class that helped them to learn. Seventeen students (94.4%) described doing experiments, projects, or labs as an activity that helps them learn. A female student stated that "Being able to watch something happen helps me understand what we are talking about. I like being able to try things and see what happens." One student (6.6%) mentioned that doing the study guides helps her learn science content.

Students were asked to choose which is more interesting to them: doing a scientific experiment or learning about one. Fifteen students (83.3%) replied that doing a scientific experiment is more interesting to them, whereas three students (16.7%) stated that learning about an experiment was of more interest.

Students were then asked a question that required deeper thought: "What would need to happen for you to be really interested in science?" Many students had to think about their answer for a minute, and student responses contained much variety. Table 8 displays student responses.

Table 8. Student Interview Response to "What would need to happen for you to be really interested in science?"

Response	Number of Students Responding	Percentage
Get better grades	7	38.9%
More group projects	4	22.2%
More experiments	4	22.2%
No homework	3	16.7%

Student responses were categorized into four areas: get better grades, more group projects, more experiments, and no homework. Seven students (38.9%) mentioned that getting better grades would help them be really interested in science. Having more group projects and more experiments each were 22.2% of the responses. Three students (16.7%) suggested not having homework would help them become interested in science.

Interviewees were then asked to describe the best and worst parts of science class. Student responses ranged from the lessons themselves to social issues in class. Table 9 contains categorized student responses for interviewees' responses to the best parts of science class.

Table 9. Student Interview Response to "What are the best parts of science class?"

Response	Number of Students Responding	Percentage
Experiments	6	33.3%
Being with friends	5	27.8%
Projects (either group or individual)	4	22.2%
The teachers	2	11.1%
Class is fun	1	5.6%

Six students (33.3%) thought that the best part of science class was the experiments. Five students (27.8%) referred to being with friends as the best part of the class. Four students (22.2%) mentioned working on projects (either group or individual), two students (11.1%) thought that their teachers were the best part of class, and one student plainly stated "I don't know, science class is just fun." The responses to the worst parts of science class can be found in Table 10.

Table 10. Student Interview Response to "What are the worst parts of science class?"

Response	Number of Students Responding	Percentage
Homework	7	38.9%
Taking tests	7	38.9%
Taking notes	3	16.6%
My friends aren't in my class	1	5.6%

As for the worst parts of science class, the most common responses were "homework" and "taking tests" with 38.9% of interviewees responding for each category. Three students (16.6%) described taking notes as the worst part of science class, and one student did not like that her friends were not in the class.

When students were asked “In order for you to feel successful in science class, what would need to happen?” fifteen students (83.3%) remarked that they would want better grades. This indicated that students felt that success was measured by the grade they received in the class. Three students (16.7%) replied “I don’t know” to this question.

Students were then asked “If you are interested in something, does that make you want to learn more about it?” Sixteen students (88.9%) replied “yes” and two students (11.1%) replied “no” or “not really.”

Students were also asked about their feelings towards their textbook: “What do you feel when you read out of your science textbook?” A majority of students interviewed (88.9) indicated that they did not have any negative issues with their textbook by stating comments such as “It’s fine” or “I like the pictures.” Two students (11.1%) had negative feelings towards their textbook responding “I think it’s confusing” and “The diagrams hurt my head.”

Finally, students were asked if they were the 8th grade science teacher, and they realized that their students were not interested in science, what would they do to help their students become interested in science again. Overwhelmingly, the first response out of students’ mouths was they would do more experiments, labs, or projects. Several students suggested “Making science more fun” and when prompted to explain their responses fell in line with their peers.

Based on student interview responses, experiments and hands-on lessons help students become more interested in science, help students learn, and are considered the best part of science class. In order for students to feel successful in science students felt that they need to earn better grades.

Post-Survey Analysis and Comparison

Eight weeks had passed since students took the pre-survey, and students were asked to complete a post-survey during the final week of the school year. Post survey responses were analyzed and compared to pre-survey responses in order to determine if student interests or attitudes toward science had changed based on the addition of hands-on activity focused lessons. In questions 1-12 students were asked to circle the

appropriate response describing their feelings based on the Likert scale: Strongly Disagree = 1, Disagree = 2, Slightly Disagree = 3, Slightly Agree = 4, Agree = 5, Strongly Agree = 6. Questions 13-16 were open-ended questions and student responses were categorized into appropriate groups in order for total responses to be analyzed. Pre- and post-survey means were calculated as well as the difference in means between the two surveys. Table 11 displays the comparison of data between the pre- and post-surveys questions 1-12.

Table 11. Pre- and Post-Survey Student Responses and Comparison.

Question	Pre-Survey Mean	Post-Survey Mean	Difference between Pre- and Post-Survey Responses
<i>1) I like science class.</i>	3.806	4.093	+0.287
<i>2) I think the things we do in science are interesting.</i>	3.798	4.155	+0.357
<i>3) I have trouble understanding my science textbook.</i>	2.759	2.837	+0.078
<i>4) I learn best when listening to my teachers talk about topics we're learning.</i>	3.617	3.535	-0.082
<i>5) I learn best when doing experiments and hands-on activities.</i>	5.023	5.046	+0.023
<i>6) I feel like my science teachers encourage me to do well.</i>	4.349	4.766	+0.417
<i>7) Science is useful to me.</i>	3.748	3.946	+0.198
<i>8) I look forward to going to science class.</i>	3.543	3.566	+0.023
<i>9) I feel that I will use what I have learned in science class as an adult.</i>	3.550	3.736	+0.186
<i>10) I like to try and solve problems, or figure out challenges.</i>	3.736	3.852	+0.116
<i>11) When my teachers are excited about what we're learning, it makes me more interested in it.</i>	3.773	3.828	+0.055
<i>12) When I like a topic, it makes me want to learn more about it.</i>	5.209	5.289	+0.080

The questions with the largest difference in responses between pre- and post-surveys were questions 1, 2, and 6. Students scored Question 1: "I like science class" higher on the post-survey than the pre-survey by a difference of +0.287 points. The mean of student responses for the post-survey was 4.093, which falls under "Slightly Agree." There was a difference in the mean of responses for Question 2 ("I think the things we do

in science are interesting”) of +0.357 points. The post-survey mean was 4.155 which also falls under “Slightly Agree.” The greatest difference between pre- and post-survey responses was found in Question 6: “I feel like my science teachers encourage me to do well.” Post-survey response mean was 4.766, an increase of 0.417 points from the pre-survey.

Several questions did not show much improvement in scores between the pre- and post-surveys. Question 4 (“I learn best when listening to my teachers talk about the topics we’re learning”) actually showed negative results, with a difference of -0.82 between the pre- and post-survey means. Questions that showed slight improvement in responses were Question 8 (“I look forward to going to science class”), Question 11 (“When my teachers are excited about what we’re learning, it makes me more interested in it”), and Question 12 (“When I like a topic, it makes me want to learn more about it”). Questions 5 (“I learn best when doing experiments and hands-on activities”) was the highest scored question in both the pre- and post-surveys, but only showed +0.023 points improvement in the post-survey. In both surveys student response averages indicated that they “Agreed” that they learn best from hands-on activities.

Questions 13-16 were open-ended questions, and as with the pre-survey, student responses were categorized to represent qualitative data. Tables 12-14 display student responses to these questions and compare pre- and post-surveys.

Table 12. Comparison of Student Pre- and Post- Survey Responses for Question 13.

<i>13) What are the best parts of science class?</i>				
Student Response: (n = 125)	Number of Students Responding in Pre-Survey:	Number of Students Responding in Post- Survey:	Percentage of Students Responding in Pre-Survey:	Percentage of Students Responding in Post- Survey
Group Work	18	16	14.4%	12.8%
Hands-on/ Activities/ Experiments	69	78	55.2%	62.4%
Friends	5	6	4.0%	4.8%
Subject Matter	33	20	26.4%	16%

The largest increase in responses were Hands-on/ Activities/ Experiments being the best part of science class seeing a 7.2% increase. The change in responses may be a reflection of eight weeks of hands-on instruction prior to the post-survey. Post-survey responses referring to the subject matter as being the best part of science class received a 4% decrease.

Table 13. Comparison of Student Pre- and Post-Survey Responses for Question 14.

<i>14) Do you ever get frustrated in science? Why or why not?</i>				
Student Response: (n = 128)	Number of Students Responding in Pre-Survey:	Number of Students Responding in Post- Survey:	Percentage of Students Responding in Pre-Survey:	Percentage of Students Responding in Post- Survey
No	33	26	25.7%	20.3%
Yes, I don't understand	82	93	64.1%	72.7%
Yes, I don't like an aspect of the class	13	9	10.2%	7.0%

The post-survey yielded a higher percentage of students (72.7%) who get frustrated in science because they don't understand, compared to the pre-survey (64.1%). This may be due to a different lesson format than the students were previously used to. The percentage of students who get frustrated in science because they don't like an aspect of the class dropped, from 10.2% to 7.0%.

As in the pre-survey, Question 15 (“What does science mean to you?”) was not quantitatively categorized due to diversity in responses. There were negative responses such as “very little” and “just another period on the day” as well as positive responses including “learning more about the world around me” and “a fun class where we get to do experiments.” In the pre-survey, 40 responses out of 127 were categorized as a “negative” response. In the post survey, many more students referred to science meaning “experiments” compared to the pre-survey. There were 28 negative responses out of a total of 127 responses; 12 less negative responses compared to the pre-survey.

Table 14. Comparison of Student Pre- and Post-Survey Responses for Question 16.

<i>16) Name 3 careers that you might consider when you are out of school.</i>				
Student Response: (n = 128)	Number of Students Responding in Pre-Survey:	Number of Students Responding in Post- Survey:	Percentage of Students Responding in Pre-Survey:	Percentage of Students Responding in Post- Survey:
One science focused career	45	34	35.2%	26.5%
Two science focused careers	33	42	25.8%	32.8%
Three science focused careers	19	23	14.8%	18.0%
No science focused careers	31	29	24.2%	22.7%

In the post-survey, the percentage of students who did not choose any science focused career dropped, from 24.2% in the pre-survey to 22.7% in the post-survey. Students who only chose one science focused career also dropped, from 35.2% in the pre-survey to 26.5% in the post-survey. Students who chose two and three science focused careers increased. Students who chose two science focused careers increased by the greatest percentage: from 25.8% to 32.8%, a 7% increase. Students who chose three science focused careers increased from 14.8% to 18.0%.

Summary of Results

Three methods of data collection were chosen because they each revealed information about student interest and attitudes towards science. The pre-surveys were used to establish background information on students' thoughts towards science class and current instructional methods. Based on student responses the researcher developed future lessons with the goal that the lessons would appeal to the students. Observations of students allowed the researcher to "see" how students reacted to different instructional methods. Results identified that interactive lessons kept students more on-task. Student interviews allowed the researcher to discuss instructional methods and impressions of science with the interviewees. This method was chosen to provide further insight into student interests, and also allowed the researcher to include follow-up questions and

encourage students to explain their thought processes. Although time consuming, this method allowed students to identify specific aspects of science class that they enjoyed and did not enjoy. Students identified participating in activities, experiments and projects as the most helpful ways they learn new content. According to the students, these were also the most interesting aspects of science class. Interviewees also suggested that the more they are interested in a subject, the more they want to learn about it.

Perhaps the most informative method used in the data collection was the pre- and post-survey analysis and comparison. During this comparison the researcher identified three major areas of growth. After eight weeks of interactive and hands-on lessons students liked science class more, they thought that the things they did in science were interesting, and they felt that their science teachers encouraged them to do well.

A discussion explaining the results in relation to the research question: “What impacts do hands-on science activities have on the interest and attitudes of middle school science learners?” occurs in the following chapter.

V. Discussion and Conclusion

Discussion of Results

Data were collected during a ten week period in order to provide information to answer the research question “What impact does hands-on science activities have on the interest and attitudes of middle school science learners?” Hands-on lessons that involve inquiry, observation and data collection are foundational components of science and should play a role in influencing student attitudes (Ornstein, 2006). Ornstein (2006) found that while many factors influence students’ attitudes towards school, “personal observations have shown that hands-on laboratory activities have a critical influence (p.286).

Pre-survey results indicated that most students had neutral feelings towards science. The response averages of most questions fell between 3 (Slightly Disagree) and 4 (Slightly Agree). Three question responses did not fall within the 3-4 range. Overall, students slightly disagreed (response mean 2.759) that they had trouble understanding their science textbook. Olson and Mokhari (2010) found that science texts are often challenging to students, especially those transitioning from elementary to middle grades. Students have difficulty understanding how science information is displayed and “grapple with technical or specialized vocabulary to convey scientific ideas and concepts” (p. 56). Observations during class time indicated that students struggle with how to read diagrams and understanding explanations in the textbook, despite students’ self-assessment in the pre-survey.

In the pre-survey, students agreed (response mean 5.023) they learn best when doing experiments and hands-on activities. This result is supported by Skamp (2007) stating that hands-on science helps students reconstruct their ideas about how the world works, conduct investigations, see and experience a phenomenon for themselves, and test predictions. Skamp (2007) also warned that students at the middle school age enjoy project-based work, not because it assists in their learning but because they like to be active and work with others. Teachers need to take care in developing hands-on science lessons and be clear about the lesson’s purpose.

Students also agreed (response mean 5.209) that when they like a topic they want to learn more about it. Beeman-Cadwallader et al. (2010) suggested that in order to make

a subject appealing to students, teachers need to find out what interests the students by learning more about their life experiences through questionnaires.

Results from the pre-survey were used by the researcher to develop appealing lessons for the students. For the eight weeks following the pre-survey, the researcher included hands-on activities into lessons, and strived to have students “do science” and experience the scientific process. The hands-on activity in the lesson supported the overall theme, and was not always the main focus of the lesson. Students were held accountable for their work by being required to record observations, make predictions, and provide explanations. At the end of the class period, students had established the necessary background information to understand a few science concepts. The class reviewed what was observed or predicted, and through class discussions came up with explanations.

The post-survey was given during the final week of the school year and yielded different results from the pre-survey. Student response averages improved in ten out of twelve statements. Student responses were considerably higher for the following statements:

- I like science class
- I think the things we do in science are interesting
- I feel like my science teachers encourage me to do well
- I feel that I will use what I have learned in science class as an adult.

A possible reason for the increase in students liking science class may be due to more hands-on lessons, which was the instructional strategy students preferred. In the pre-survey, 55.2% of students responding stated that the best part of science class were hands-on activities, labs, or experiments. In the post-survey, this percentage increased to 62.5%. Students' increased interest in science class may be related to increased use of hands-on activities, as well as striving to make lessons more relevant to students' lives. According to Beeman-Cadwallader et al. (2008), a strategy that makes science learning more effective values student questions and life experiences. One way for students to become more involved in class is to directly involve their prior life experiences: what have they seen, heard, or wondered? By connecting current science content with previous experiences, students may feel more connected with what they are learning.

“Making science relevant to students’ personal lives makes science worth studying for reluctant learners and those students not interested in science” (Pickens & Eich, 2009, p.350). Incorporating previous knowledge and experiences into hands-on activities makes the lesson much more valuable for the student. By enabling students to see the use of science in everyday life students may feel that science is important and will be used in the future.

Osborne et al. (2003) stated that although student interest and attitudes towards science is affected by many different variables, the impact of the teacher is considered by most researchers to be the most important factor. “The impact that science teachers can have on student interest cannot be overlooked” (Skamp & Logan, 2005, p.14). As instructors, we are showing our students that we want them to be successful when we prepare lessons that are student focused and that encourage students in their preferred learning style. “Student motivation to learn has been shown to be positively correlated with the teacher’s presenting lessons in an energetic, dynamic, and enthusiastic manner” (Pickens & Eick, 2009, p.357). The results of the post-survey suggest that by instructing students with interactive lessons and incorporating students’ life experiences in instruction, it can help students enjoy science class more, which may increase interest and attitudes towards science.

During the pre-survey, 25.7% of students reported that they did not get frustrated in science, and 64.1% reported that they did get frustrated because they do not understand something (the remaining 10.2% of the students said that they got frustrated because they don’t like an aspect of the class). In the post-survey, the number of students who did not get frustrated dropped to 20.3%, and the number of students who did get frustrated because of not understanding increased to 72.7% (the remaining 7.0% of students were frustrated because they did not like an aspect of the class). A possible explanation for an increase in students who were frustrated may be due to the change in lesson format. Hands-on learning can oftentimes be a challenge for a student. If students are used to their instructor telling them answers, and then the student is faced with the task of trying to find a solution for himself/ herself, it can lead to frustration. Not all students prefer hands-on learning. During an interview one student said that he doesn’t really like doing experiments, “I just want someone to tell me the answer. Plus, I’m scared I’m going to

mess it up.” It is important for the instructor to adequately prepare students for hands-on learning by laying out expectations and addressing student concerns. “We all need to remember that a hands-on activity is useless if the students’ hands are on, but their heads are out” (Skamp, 2007, p.19). Perhaps the abrupt change from one instructional style to another led to an increase in student frustration. With more instructional time, the researcher could have better prepared students for adapting to a different lesson method.

During lesson observations students were more on-task with a hands-on and interactive lesson (168 observations on-task as compared to 102 off-task) as opposed to a lecture/ note-taking lesson (120 observations on-task compared to 150 off-task), for all academic levels. “Hands-on science activities motivated not just hard-to-reach students but all students” (Robertson, 2006, p.53). The trick is to structure hands-on activities where the teacher focuses student investigations; therefore, the student can develop a meaningful understanding of scientific concepts, indicating that when students are involved in a structured activity they will more likely stay on-task (Robertson, 2006). When students are on-task, they are most likely interested in what they are learning.

Based on survey results, interviews, and observations, hands-on learning has shown to be an effective method in increasing student interest and improving attitudes towards science. Post-survey data showed an increase in the average responses, indicating that students responded well to the hands-on teaching method. During interviews, students stated that hands-on learning is their preferred way of learning, and the best part of science class. Observations showed that students are more on-task when they are involved in a focused, hands-on lesson. If students like hands-on activities, and say they learn best from this instructional strategy, then why don’t all teachers use this method?

Developing a structured hands-on lesson is difficult. It involves a lot of time to prepare a lab and to gather and distribute materials. Creating a “materials station” where students are responsible for gathering and returning their own supplies gives students responsibility, and also allows the instructor to use his/ her time addressing student questions as opposed to handing out equipment. Having more than one materials station prevents students from crowding each other. Perhaps use a white board for a check-out/ check-in system for materials. Experiments and using manipulative can make a mess in

the classroom. Using class time to prepare a lab one day, and then to actually do the lab the following day allows time for clean-up and a class debrief. Expense is another issue. Many teachers complain about the cost of materials that are needed to do a hands-on activity- especially in middle school classrooms where one teacher may see over 150 students per day. Setting up stations can often solve that problem (Hill, 2004). Although hands-on lessons are often much more time-intensive during the planning and preparation phase, they are worth it. By increasing middle school students' interest and attitudes towards science, instructors are preparing them for a future in the sciences and introducing them to a world full of personal discoveries.

Limitations and Future Research

This study was conducted during a relatively short period of time (ten weeks). It would be interesting to see if pre/ post results would have more dramatic differences if the study was conducted over the entire school year.

Future research could include designing two lessons per day: one that includes a hands-on activity, and one that is more traditional. Several class periods could be taught using the traditional approach, and several with the hands-on approach and their pre/post surveys and interviews could be compared for differences. This method was considered for this study, but was decided against due to the desire for consistency in teaching for the ten-week period.

Although the surveys provided a considerable amount of data, the students self-assessed, so their responses may not accurately represent their behaviors. For future studies, it would be helpful for there to be an observer in the classroom (other than the instructor) that would record student behavior multiple days in a row. Based on student behavior during specific instructional methods the researchers could determine if students are on-task or off-task and judge the interest level in learning the content.

Interest and attitudinal studies are known to be challenging...there is just no way to know for sure the impact something may have on a student. However, based on data collected, one can establish a general idea.

One final suggestion for future research would be to conduct a long-term study. In addition to surveys, interviews, and observations in middle school, students could be

followed throughout their high school career and tracked: researchers could record how many additional science classes taken in high school, even what a student's major would be in college. The middle school time period is when students decide if they are going to love science, or leave it. By the age of 14, students have made up their minds about science (Archer et al., 2010). Would a different instructional method that engages students in real science help guide the students for the rest of their lives?

VI. Implications for Practice

Students were very curious about this project. The researcher discussed with the students that their teachers wanted to know student thoughts about science, and students appeared to “feel important” and responses were quite reflective. The researcher recommends distributing some type of survey to students during the school year, possibly several throughout the year, in order to see what they think about the class, or how class could be improved. During the interviews student responses were in-depth, almost as if they had thought about different instructional methods. Additionally, students seemed to appreciate the fact that their opinion was valued. The surveys provided valuable information to the instructor, and helped guide in planning future lessons.

Previous research supports hands-on learning, yet there is a difference between hands-on and heads-on (Skamp, 2007). When using hands-on activities in lessons the instructor needs to have structure and a guideline for students to follow in order to focus minds on the construction of essential concepts and prevent off-task behavior. Properly preparing students on expectations with hands-on learning can limit apprehensions some students may have. It is important that hands-on learning supports an overall theme to the lesson, and that the activity is providing students with observations and predictions that can be contributed to learning content (Robertson, 2006).

Although hands-on learning involves a lot of planning and preparation, there are resources available to aid teachers in the process. The National Science Teachers Association journal articles contain lesson plans for hands-on and inquiry-based learning. Local universities, the Department of Wildlife, and Department of Natural Resources often have lab equipment for teachers to borrow. There are ways for teachers to overcome the hurdles.

Hands-on learning allows students to experience actual science and to “become” scientists instead of learning “about” science. By using hands-on learning, teachers are introducing students to what real science is. Allowing students to “do” science in the classroom through interactive learning can increase student curiosity and interest, yield positive attitudes and elevate achievement, which may follow them throughout their education.

VII. References

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Appendix A

Pre-Survey

Class Period: _____

Circle one: I am a **male**.I am a **female**.

Directions: Please circle the answer the best describes how you feel. Please answer every question. Put your first thoughts down. These surveys are to remain anonymous, so please feel free to share your thoughts and opinions. These results will help your teachers learn more about what 8th graders feel and think about science.

Example: I think cookies are good.

*Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / **Strongly Agree***

1) I like science class.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

2) I think the things we do in science are interesting.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

3) I have trouble understanding my science textbook.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

4) I learn best when listening to my teachers talk about topics we're learning.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

5) I learn best when doing experiments and hands-on activities.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

6) I feel like my science teachers encourage me to do well.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

7) Science is useful to me.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

8) I look forward to going to science class.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

9) I feel that I will use what I have learned in science class as an adult.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

10) I like to try and solve problems, or figure out challenges.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

11) When my teachers are excited about what we're learning, it makes me more interested in it.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

12) When I like a topic, it makes me want to learn more about it.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

Directions: The next 3 questions require a short response. Please be honest.

13) What are the best parts of science class?

14) Do you ever get frustrated in science? Why or why not?

15) What does science mean to you?

16) Name 3 careers or jobs that you might consider when you are out of school.

1.

2.

3.

Thank you!!!

Post-Survey

Class Period: _____

Circle one: I am a **male**.I am a **female**.

Directions: Please circle the answer the best describes how you feel. Please answer every question. Put your first thoughts down. These surveys are to remain anonymous, so please feel free to share your thoughts and opinions. These results will help your teachers learn more about what 8th graders feel and think about science.

Example: I think cookies are good.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

1) I like science class.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

2) I think the things we do in science are interesting.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

3) I have trouble understanding my science textbook.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

4) I learn best when listening to my teachers talk about topics we're learning.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

5) I learn best when doing experiments and hands-on activities.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

6) I feel like my science teachers encourage me to do well.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

7) Science is useful to me.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

8) I look forward to going to science class.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

9) I feel that I will use what I have learned in science class as an adult.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

10) I like to try and solve problems, or figure out challenges.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

11) When my teachers are excited about what we're learning, it makes me more interested in it.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

12) When I like a topic, it makes me want to learn more about it.

Strongly Disagree / Disagree / Slightly Disagree / Slightly Agree / Agree / Strongly Agree

Directions: The next 3 questions require a short response. Please be honest.

13) What are the best parts of science class?

14) Do you ever get frustrated in science? Why or why not?

15) What does science mean to you?

16) Name 3 careers or jobs that you might consider when you are out of school.

1.

2.

3.

Thank you!!!

Appendix B

**Observing Student Behaviors
At Timed Intervals**

At two minute intervals check every behavior that you observe. For each two minute intervals, decide whether the student was on task or off task and then mark the appropriate column.

Student Behaviors	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
ON TASK															
1. head up, body leaning towards speaker															
2. making eye contact (with teacher)															
3. making eye contact (with peers)															
4. raising hand															
5. volunteering															
6. taking notes															
7. Other															
8. Other															
OFF TASK															
9 Lack of eye contact,															
10. head down															
11. Slumped shoulders,															
12. looking around at classmates while teacher is talking															
13. calling out comments without being recognized															
14. talking while speaker is talking															
15. moving around room without academic purpose															
16. Other															
17. Other															

Appendix C

Interview Questions

Name:

Age:

Date/ Time:

Intro script: Thanks for agreeing to participate in an interview. I am going to ask you some questions on your opinions about science and science class. This interview is to help your teachers better understand what 8th graders think about science. Your responses will in no way affect your grade, so please be honest. At any time, if you feel like you don't want to answer a question you can just say so.

- 1) **What do you think scientists do?**

- 2) **Do you think that science is important in life? Why or why not?**

- 3) **What types of things do we do in science class that really helps you learn?**

- 4) **Which is more interesting to you...doing a scientific experiment or learning about one?**

- 5) **What would need to happen for you to really be interested science?**

- 6) **What are the best parts of science class? The worst?**

- 7) **In order for you to feel successful in science class, what would need to happen?**

- 8) **If you are interested in something, does that make you want to learn more about it?**

9) What do you feel when you read out of your science textbook?

10) Let's say you're the 8th grade science teacher, and you realize that your students are not interested in science anymore. What would you do to help them become interested again?

