COMPARING PROJECT-BASED LEARNING TO DIRECT INSTRUCTION ON STUDENTS' ATTITUDE TO LEARN SCIENCE

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

Students' attitude towards learning science transform during their middle school years. Research provides data showing the affect of different teaching methods on students' attitude. Two teaching methods compared were project-based learning and direct instruction. Project-based learning uses inquiry to promote student attitude by engaging them and increasing their curiosity in the natural world. Direct instruction uses lecture, worksheets, tests, and labs. The Test of Science Related Attitudes (TOSRA) survey was used to measure student's attitude. The TOSRA has seven subscales labeled as Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adaptation to Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. A student's age and gender were variables also used to determine the affect on transformation of attitude using two different teaching methods. The TOSRA survey showed both positive and negative transformation of students' attitude towards science.

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LIST OF ABBREVIATIONS

Abbreviation	Definition
TOSRA	Test of Science Related Attitudes
STEM	Science, Technology, Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
NRC	National Research Council
ISTE	International Society for Technology in Education
NSES	National Science Educational Standards
NIFDI	National Institute for Direct Instruction

CHAPTER 1. INTRODUCTION

Science educators have always been concerned about students' attitude towards science, scientists, and learning science (Akcay, Yager, Iskander, & Turgut, 2010). Students' attitude toward science or science-related careers may be impacted by the teaching method used in the classroom. Myers and Fouts (1992) explained that students with positive attitudes towards science are found in classrooms containing high levels of student engagement, teacher-support, and innovative teaching strategies. Educators strive to develop students' attitude and ability to become life-long learners who self-regulate their acquisition and construction of knowledge. To meet this goal educators use project-based learning.

Project-based learning is different than problem-based learning. Problem-based learning has been used widely in the medical field, where project-based learning is being used in elementary, middle and high schools. The two are easily confused and both originate from constructivism. Project-based learning has students producing a final project. The projects can range from PowerPoint presentations, models, charts, or bulletins. Problem-based learning is based on having students developing possible solutions for the problem.

Boise State University (2005) defined project-based learning as a systematic teaching method engaging students through learning essential knowledge and life enhancing skills. Engaging students in meaningful projects and activities promote exploration, experimentation, construction, collaboration and a reflection of what students are studying. Skills and knowledge are used through the inquiry process structured around authentic and complex questions and products and tasks that have been carefully designed. Scientific inquiry in the classroom aims to improve students' attitudes by motivating them with authentic problems. Garran (2008) states that project-based learning is a practical application allowing learning and teaching to be exciting, challenging and most important fun. Project-based science helps students develop meaningful understandings of scientific ideas and allows a student to take ownership of their own learning (Ladewski, Krajicik & Harvey, 1994). Students reflect upon their own ideas, voice their opinions, make the decisions affecting projects outcome and the learning process. Students work in groups through project-based learning to complete the common goal.

In contrast to project-based learning, instructors use direct instruction. Direct instruction is dominated by direct and unilateral instruction, which follows a fixed body of knowledge a student must learn (Khalid & Azeem, 2012). Lord (1999) explains direct instruction as a teacher-centered method of teaching providing students the same amount of information, and assuming that all students have the same level of background knowledge. Teachers using direct instruction method transfer information to passive students leaving little room for questions initiated by students or interaction among students, or between students and the instructor.

Significance of Study

Attitudes of students for learning science are very important during their middle school years. Research has shown that science attitude is correlated with age and gender. Sorge (2007) showed through research that attitude of students decrease slightly as age (9-14 years) increases. George (2007) found through a number of international studies that children in primary levels have a positive feeling towards science; their attitude decreases with an increase in age.

Further, males showed a weak superiority in attitude and achievement was indicated by gender differences. Sjoberg & Schreiner's (2005) research indicates that girls are not as interested in science as boys. He does state that girls are more focused on the biological sciences than physical and earth sciences.

The study presented in this paper with use the comparison of project-based learning to direct instruction. Students' attitudes will be measured by the TOSRA survey. Age of the students will be a variable for possible changes in attitude. The gender of the student will also be a variable to see which has the greatest effect on students' attitudes to learn science.

Statement of the Problem

Common questions asked of middle-school teachers include, "Why do we need to learn this?" and "How will I use this in my daily life?". These questions have an influence on a student's attitude for learning science. I am interested in experimenting with different types of pedagogy to allow the students to answer the questions on their own. Project-based learning is more that just hands-on experimentation; it also involves students to use inquiry. As a teacher, I want to expand my teaching strategies to increase student's attitude. Project-based learning an instructional approach developed on authentic learning activities to engage students' interest and motivation to increase a positive attitude towards learning science. The activities are designed to solve problems, answer questions, and demonstrate how people work everyday using science in the world outside the classroom. Science instruction using project-based learning is a form of inquiry-discovery teaching (Blumenfeld, Krajcik, Marx, & Soloway, 1994), which is more student-centered and less step-by-step teacher controlled (Wise & Okey, 1983).

Research Questions

Research done by Yager and McCormack (1989) states that students develop negative attitudes toward science classes, studying for science classes, science teachers, and the longer students study science through direct (traditional) instruction. Some other factors that may influence students' attitudes may be gender and age of the student.

The primary research question used to complete this research project on assessing students' attitude to learn science.

- What is the impact of project-based learning on students' attitude to learn science compared to the direct instruction method of teaching?

Subsidiary research questions included in the research are listed below.

- What is the impact of student's gender on their attitude for learning science through the comparison of the two methods?
- What is the impact of student's age on their attitude for learning science through the comparison of the two methods?

CHAPTER 2. NEED OF THE RESEARCH

Research on comparing project-based learning to direct instruction is important, because educators are always searching to find new ways to improve students' attitude toward learning science. The US Bureau of Labor Statistics (2005) predict that between 2004 and 2014 there will be a 22% growth in jobs related to science, technology, engineering and mathematics (STEM). This growth in jobs will create a need for additional students of both genders that have positive attitude towards learning science and mathematics.

A major goal of project-based learning is to construct students' thinking and problem solving skills by requiring them to solve authentic projects (Chin and Chia, 2004). Students need to apply knowledge to solve problems. To accomplish this goal, educators need to increase students' ability to think critically and use inquiry skills.

A student's age and gender do play an important role in determining the attitude of learning scientific knowledge. Project-based learning allows students to try new learning techniques and improve on mistakes that may occur. Direct instruction is a very common and widely used teaching practice that they are accustomed too.

A challenge facing the field of science education is the recruitment, educating, and retaining students to accept the field of sciences, technology, engineering, and mathematics (Welch, 2010). Oliver & Venville (2011) suggest that little research has completed on students' passion for science education and how passion might impact their choices about science subjects and careers in science. Students' passion for science is related to their attitude towards learning science.

The purpose of the study is to examine the change in students' attitude by changing from direct instruction to project-based learning. Age of the students will be used to determine the affect on attitude toward science. Student's gender will be factor in on determining the results of attitude change in the study. Attitude changes will be measured by Test of Science Related Attitude (TOSRA) survey results. Middle school years are important time to increase the students' attitude toward science.

CHAPTER 3. LITERATURE REVIEW

Project-Based Learning

Project-based learning is defined as a systemic pedagogy engaging students to learn knowledge and skills through an inquiry process including complies, authentic questions, and designing projects (Buck Institute for Education, 2008). Project-based learning focuses on engaging students to complete scientific investigations by pursuing solutions for problems by asking and refining questions, debating ideas, making predictions, designing plans and/or experiments, collecting and analyzing data, drawing conclusions, communicating ideas and findings to other students, asking new questions, and producing artifacts (Blumenfeld et al., 1991). For example, a teacher supplies students with a driving question and they craft ideas and suggestions to complete the project. The driving question correlates with a real-world project that the students may encounter during their lifetime. Students become engaged with science by investigating real-world scientific projects for their community. Through his cognitive research, Bybee (2009) explains that learning is an active process occurring within the learner and influenced by the learner.

Student-driven learning enhances the students' curiosity and knowledge to solve authentic real-world problem during the lesson. Students direct the learning and the teacher facilitates the learning. In project-based learning, the role of teacher changes from lecturer to facilitator of information. However, teachers should, at anytime, implement outside knowledge, interest and experiences into their classroom lessons and students enjoy the engagement utilized in the classroom (Garran, 2008).

Project-based learning science lessons focus on a driving question or problem around scientific concepts, principles or real-life experiences (Krajcik et al, 1994). The driving question provided to the students organizes and leads their activities, their investigation to answer questions, formation of models or evidence gathered represents the student's ideas and understanding, use of collaboration to share information, and use technology to research information for a student's future learning tasks (Alozie et al, 2010). Krajick et al. (1994) identified five essential features of project-based learning projects:

- Students are to be engaged investigating an authentic question or problem through activities and organizing concepts and principles.
- Students develop series of artifacts or products that explain the question or problem
- Students develop the investigations
- Teachers, members of community, and other students will be parts of collaborative consulting group
- Teachers encourage students to use cognitive tools.

Instruction using project-based learning embraces these key features by providing students chances to improve their understanding of scientific and mathematical practices by using various situations, students' prior knowledge, discovering new principles, metamorphosing preexisting understanding and application of their understanding to solve the research question or problem (Edelson, Gordin & Pea, 1999).

A number of benefits for using the project-based learning have been found in research over the last decade. Benefits include the development of higher-level thinking skills such as problem solving, planning experiments, self-monitoring of the project (Brown & Campione, 1996). Project-based learning encourages students to form beneficial understandings of scientific ideas and allows students to take ownership of their scientific learning (Ladewski et al., 1994). They also found that students were able to transfer conceptual ideas across a variety of learning situations after using the project method. A reason why this teaching approach is effective is that students are challenged with problems or questions that improve their problem solving, decision-making and research skills.

Difference between Project-Based and Problem-Based Learning

Project-based learning is sometimes confused with problem-based learning. Common aspects of both include the use of realistic problems and situations, based on authentic educational goals, and include formative and summative assessments. Both support cooperative group work with peers, intrinsically engaging and motivating learner-centered and teacher-facilitated, and are used frequently for multidisciplinary units. Problem-based learning has been used widely in the medical field, where project-based learning is being used in elementary, middle and high schools. International Society for Technology in Education (ISTE, 2011) explained that the two styles differ mainly in their application.

Students design and develop the product, presentation or performance to be viewed or used by peers. Problem-based learning concentrates on a problem and process, where as project-based learning concentrates on the production of the final product. ISTE (2011) describes characteristics of project-based learning and problem-based learning. Characteristics of project-based learning include students shaping their project to fit their own interests and abilities, and drawing information from a broad range of knowledge and skills. The students are responsible for collecting and analyzing information, making discoveries, and reporting their results. Projects may cut across many different disciplines and require a significant period of time.

ISTE (2011) characteristics of problem-based learning are determining the problem, developing a specific statement describing the problem, and the developing a possible solution. Students need to identify information and resources that are needed to find a solution. Students will then analyze and refine the final solution. The final solution is presented orally and/or in writing.

Constructivism

Constructivist learning emphasizes that learners interpret and construct meaning based on their own experiences and interactions. Educators believe students' engagement in learning about the natural world around them increases their attitude to learn and understand (Patrick & Yoon, 2004). The engagement of the students provides a project plan to guide the process, support collaborative teamwork, focus on communication, and evaluate the economic objectives of the project.

Project-based learning is grounded in the constructivist theory, which allows for many possibilities to transform classrooms into active learning environments (Krajcik et al., 1994). A core requirement of the constructivist theory is that learners are actively constructing knowledge through activities and goal of learning is designed by teachers to promote a deep understanding rather than rote memorization. Constructivist thinking provides a building block for project-based learning pedagogy to engage students in active, collaborative, reflective, and comparative learning experiences (Johnassen and Grabowski, 2003). Knoll (1997) supports constructivist concepts, inquiry-based, problem solving and design in American fields of education; the "project" is one of the best and most appropriate ways of teaching. Howe and Stubbs (1997) view of the constructivist model emphasizes students understanding of world and application of previous knowledge to new situations.

Attitude and Gender

Students' attitude improves their motivation and ability to learn and understand provoking a life-long interest in science (National Research Council (NRC, 2000). Trends in

International Mathematics and Science Study (TIMSS, 2011) report show that eighth grade students' average science scores have increased 12 points from 1995 to 2011. However, the results show a decline in the overall scores from fourth grade students to eighth grade students in the United States during the same time period. Simpson and Oliver (1990) conducted a ten-year study of students in North Carolina. Their research provided information that the average American youth enters junior high with a less than positive attitude and their attitude does not increase throughout high school. Students' attitudes become less positive between the 6^{th} to 10^{th} grades. Meyers and Fouts (1992) found that students have a positive attitudes were found in classrooms that have a high level of involvement, collaborative group work, the teachers use of teaching strategies.

Sorge (2007) provided research on how gender affects students' attitude to learning science through middle school years. Males showed a weak superiority in attitude and achievement in learning science. Catsambis (1995) found that female student achievement equals male students, but their attitude toward science was less positive. Female students towards science or related field was affected by their achievement scores

Inquiry

National Science Education Standards (NSES, 1996) explains scientific inquiry as diverse ways of science students study the natural world and provide explanations based on evidence provided through their work. Science is based on inquiry, which includes the process of posing a project about the world we live in and investigating and experimenting to find possible answers to the question (Patrick & Yoon, 2004). Unfortunately, students view the subject of science to be difficult, boring and irrelevant to their everyday life (Lunetta, 1998). Inquiry is the quest for information and knowledge. Project-based learning environment allows an opportunity for students to learn through inquiry by incorporating projects and inquiry into daily organization and encourage scientific thinking of students (Polman, 2000). The field of science, technology, engineering and mathematics education (STEM) has pushed for an increase in inquiry-based activities in science classrooms (Miller, McNeal, & Herbert, 2010). Bell (2010) explains Dewey's idea that scientific knowledge develops in students as a product of inquiry. Inquiry-based solutions for authentic problems should be promoted to motivate students' attitude for learning science. Project-based learning allows students to go through a process of inquiry, apply collaborative learning engaging students to complete a project or solve a common problem.

Computer access provides students with a research and communication instrument for project-based inquiry, which allows learners to collaborate results with extended and distant audiences by gathering feedback and motivation from other members or groups (Spires, 2012). Inquiry learning incorporates the element of collaboration, which increases student engagement with group members in solving a common problem by through communicating through email.

Science classrooms require inquiry for the understanding and application of scientific concepts instead of memorization of scientific facts and information. Students develop scientific knowledge by generating and testing ideas. NRC, 1996 describes inquiry-oriented learning as an active process. Brand and Moore (2011) state that having students engage in inquiry-based instruction increases a student's ability to think and behave like a scientist.

By thinking like a scientist students explore their own interests and make connections to the world beyond the school classroom. Real world problems can increase the student's attitude to learn science because of they realize the importance of science to solve real world problems. Weatherby (2007) surveyed teachers and found that projects work well to develop students' skills in a number of areas; including cooperation with group members during group work, retrieving information, analyzing, creating presentations, providing information to support their argument, written and oral communication, and some using foreign languages. Teachers experimenting with instructional changes involving introducing ideas with questions and scheduling more time for quality student discussion through inquiry learning improves students' attitudes to learn science (Brand& Moore, 2011).

Students develop scientific problem solving skills through collecting and analyzing data, developing evidence, and supporting and defending their conclusions based on evidence obtained explained by Bransford et al (1999). The activities the students use in order to develop knowledge and understanding of scientific ideas and their understanding of how scientists study the natural world involve science inquiry (National Research Council, 1996, p.23). Students make observations, pose questions, examine books and conduct other research to check for existing information. They plan investigation based on researched material, use tools to gather, analyze and interpret collected data; propose answers, explanations, and predications; and communicate their results to classroom. Students need to be able to distinguish between reliable and no reliable sources on Internet. Students engaged in inquiry-based activities are required to generate questions, design investigations, gather and analyze data, design explanations and arguments using empirical evidence, orally describe their findings and create connections among ideas (NRC, 2000).

Test of Science Related Attitudes

Test of Science Related Attitudes (TOSRA) will be used to measure student's attitudes toward science and science related issues while participating in the research. The test was composed by Fraser (1981) to assess seven distinct science-related attitudes. Fraser used

Klopfer's (1971) scheme shown in Table 1 (Fraser, 1981) as a guide to set-up his classification subscales. Klopfer's scheme involved six classification categories for measuring attitude. The six categories were: favorable attitudes towards science and scientists, acceptance of scientific inquiry, adopting scientific attitudes, enjoyment of science learning experiences, developing interest in science and science related activities, and interest in pursuing a career in science.

Table 1

Fraser's comparison to Klopfer's

Scale name		Klopfer (1971) classification
Social Implications of Science (S) Normality of Scientists (N)	H.1:	Manifestation of favourable attitudes towards science and scientists
Attitude to Scientific Inquiry (I)	H.2:	Acceptance of scientific inquiry as a way of thought
Adoption of Scientific Attitudes (A)	H.3:	Adoption of 'scientific attitudes'
Enjoyment of Science Lessons (E)	H.4:	Enjoyment of science learning experiences
Leisure Interest in Science (L)	H.5:	Development of interest in science and science-related activities
Career Interest in Science (C)	H.6:	Development of interest in pursuing a career in science

The seven attitude subscales measure social implications of science, normality of scientists, attitudes of scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science and career interests in science.

Social implications of science scale (S or Social) assess the "magnification of favorable attitudes toward science" (Fraser, 1981 p.2). Responses measure favorable attitudes towards science social benefits and problems related to scientific advancements and research.

Normality of scientists scale (N or Normality) assesses attitudes toward scientists being normal people instead of eccentric. This assessment explains what a student's view of a normal scientist's lifestyle would be like.

Attitudes of scientific inquiry scale (I or Inquiry) assess attitudes toward scientific inquiry and experimentation for solving and obtaining data from the natural world. Inquiry is an important variable in learning science.

Adaptation of scientific attitudes scale (A or Adaptation) assesses open-mindedness, willingness to revise opinions, and their adaptability to accept change. The scale demonstrates the student's perception of how they see the world based on scientific evidence.

Enjoyment of science lesson scale (E or Enjoy) assesses the enjoyment received through the completion of the science learning experience. This explains the student's participation during labs and class attendance.

Leisure interest in science scale (L or Leisure) assesses development of interest in science and science related activities. This is designed for students to see the relationship between science and leisure activities students partake after school hours. Activities could include extra curricular, hunting, work, or other hobbies students enjoy.

Career interest in science scale (C or Career) assesses development of interest in obtaining a career in science. They may find a field that sparks an interest and desire to follow.

The TOSRA survey is effective for measuring the attitudes of middle school students by looking at the Cronbach alpha. The alpha coefficients ranged from 0.66 – 0.93 for the scale reliability for samples of students grades 7 to 10 (Fraser, 1981). These results support the hypothesis that students with a greater interest and positive attitude towards learning science score higher on the tests (Bui & Alfaro, 2011).

Direct Instruction

Thomas Good (1979) explained direct instruction as an active teaching style where the teacher sets and explains all learning goals. Teachers need to assess the student's progress, providing frequent classroom presentations or demonstrations on how to do assigned work. Direct instruction programs control all variables. National Institute for Direct Instruction (NIFDI, 2012) explains the characteristics as material covered in small segments and large amounts of practice of applying concepts. Students receive feedback and the teacher provides sequences of skills that are taught. Teachers also need to provide adequate explanations quickly and efficiently. Only 10% of material in a lesson involves a new concept. The rest of the classroom time is used to review material or application of concepts discussed in previous lessons.

Rosenshine (1986) describes characteristics of direct instruction as teacher setting clear goals for students and making sure that they understand these goals. Students are given a sequence of well-organized assignments. Teachers give students clear and concise explanations or illustrations of the subject matter. Frequent questions are asked to see if students understand the material that was covered. Teachers also give students frequent opportunities to practice what they have learned.

Bui and Alfaro (2011) research showed that students participating in the direct instruction method have more of a negative attitude to science than the nontraditional groups. Their study also showed no difference in the gender and age of the students that participated. In our research, we compare project-based and direct instruction methods produces similar results dealing with gender and age. We hypothesized that project-based learning would improve student’s attitude for learning science. Another hypothesis explains that student attitude toward teaching method will be affected by student’s age and gender. Further, in our research using the TOSRA surveys we aimed to better understand how student’s attitudes compare in project-based and direct instruction methods of teaching.

Direct instruction is based on a teacher-centered classroom, while project-based learning focused on student-centered learning. Research demonstrates how project-based learning engages students' interest by involving them with authentic projects that may need solving during their lifetime. Learning by doing is supported by examining discussions involving project and problem-based learning (Barron et al., 1998). Project-based learning is emerging more as a teaching style because the world's workplace concentrates on completion of projects, and requires workers to complete projects in a timely fashion.

CHAPTER 4. SCOPE OF STUDY AND LIMITATIONS

The research that was conducted compared project-based learning and direct instruction on students' attitude towards science. Age was a variable used to track change in attitude. Gender of students was another variable recorded in order to test student attitude for learning science. Limiting factors for research include the short time span for intervention, small sample size, and low cultural diversity. The time span of nine weeks was used to collect data to determine the effects of project-based learning on student's attitudes toward science. Stake and Mares (2001) state through their research that attitude reflecting personal value toward science tends to be resistant to change in a short period of time. Direct instruction was used for twenty-two weeks prior to the research. The small number of participants was a limiting factor, but a small class of 8th grade students was present this year. The results will be consistent with other rural schools in North Dakota. The cultural diversity is small because of the rural location, but there are a few cultures present in the class.

The research study was limited on the short time period to conduct the 9-week time period of using project-based learning because of how the project worked into the school calendar. The small sample size passing through the school this year and conclusions are based on the population that was studied in this research plan. Rural North Dakota schools do not consist of variety of social diversity and races of students. Project-based learning has proved beneficial for minority students by increasing their desire to design, complete science investigations, and plans to major in a science field in college (Kanter and Konstantopoulos, 2010).

The researcher was conducting project-based learning units with a particular group of students for the first time. The training of researcher in project-based learning was a limiting factor in the research, because most training involved direct instruction. The researcher completed project-based learning while completing an undergraduate school degree. Projects require a significant amount of time to complete, and the classroom time with the students was set by the school was 43 minutes.

CHAPTER 5. METHODOLOGY

Purpose of Study

This quasi-experimental study compares two different teaching methods: project-based learning and direct instruction for a change in students' attitude towards learning science. The independent variables for this study included students' attitude, gender and age. Dependent variable for the research was the teaching method implemented during the duration of the research. The study comparing the two teaching methods started in February 2013 and concluded in May 2013. The researcher used project-based learning for nine weeks and provided the students' attitudes measured on the posttest of the TOSRA survey.   Direct instruction had been used in the classroom beginning with first day of August 2012 until February 2013. At the completion of the direct instruction period, student attitude was measured and provided results for the pre test of the TOSRA results.

Research Questions

The purpose of this research was to address a positive or negative change in a student's attitude towards learning science when different teaching strategies are implemented. The hypothesis was: project-based learning will improve students' attitude towards learning science. Age and gender will also affect the attitude. To obtain the objective the following research questions were applied.

1) What is the impact of project-based learning on students' attitude for learning science compared to direct instruction method of teaching?
2) What is the impact of student's gender on their attitude for learning science through the comparison of project-based learning and direct instruction methods?

3) What is the impact of student's age on their attitude for learning science through comparison project-based learning and direct instruction methods?

Participants

Participants of this study were 8th grade students enrolled in a small upper Midwest rural middle school. A total of forty-seven students were invited to participate in the 9-week research study. Forty-five of the forty-seven eighth grade students participated in the research during their required Earth Science course. Participants were 23 males and 22 females ranging from the ages 13-15 years old found on Table 2. The two students who did not sign the consent forms did not complete the TOSRA survey; they were allowed to have a study hall during testing class period. But they did participate in the direct instruction and project-based learning units.

Table 2

Student Gender and Age

Age	Male	Female	Total
13	2	5	7
14	19	17	36
15	2	0	2
Total	23	22	45

Design

The primary focus of the study was to compare students' attitudes for learning science by using two teaching methods. All 45 students were taught using direct instruction and project-based learning. It was a quasi-experimental project comparing two teaching methods to measure a change in students' attitude for learning science. Students were assigned to classrooms by the middle school principal, and were then separated into groups of 3 to 5 randomly for the completion for project-based units. Qualitative and quantitative methods were used to measure student attitudes for learning science. Descriptive statistics including the mean, N, and standard deviation were calculated for all measures. Paired sample *t* tests were conducted on the scores of the pre- and post- TOSRA surveys. Cohen's d was calculated to find the effect size for the paired t-tests that showed significant results.

Instruments

TOSRA is composed of 70 items, with 10 items based on each of the scales. A 5-pt Likert scale is used with responses ranging from strongly agree (1) to strongly disagree (5). Of the 10 items for each scale, 5 of the items show a positive attitude toward science. The remaining 5 items portray a negative attitude. The TOSRA was scored on a Likert scale ranging from positive agreement with a statement as 5 Strongly Agree (SA), 4 Agree (A), 3 Not Sure (NS), 2 Disagree (D), and 1 Strongly Disagree (SD). The negative agreements were scored 1 SA, 2 A, 3 NS, 4 D, and 5 SD. Seven subscales (social, normality, inquiry, adaptation, enjoy, leisure, and career) were used to measure students' attitude toward science. Ten questions were asked for each subscale, with five being positive and five being negative. The TOSRA survey was given as a pre and post-test. The TOSRA survey measures a student's attitudes by using the seven subscales explained in the literature review. The seven subscales are: social, normality, inquiry, adaptation, enjoys, leisure, and career. The pretest was given after the time period using the direct instruction and the posttest was used after the research period using project-based learning. The survey was used to measure positive or negative change in attitude toward learning science. The researcher ran paired sample *t*-tests for the measurement of the change in attitude of students for learning science. Statistical tests were run comparing the whole class; gender, age, and both age and gender to determine the variable effect on attitude of learning science.

Students were given a typed copy of the TOSRA survey found in the Appendix B for the first time, after consent forms were returned. The survey was given to the students to complete during a 43-minute class period. TOSRA is scored using a five-point Likert scale (1) Strongly Disagree and (5) Strongly Agree.

Procedure

The researcher submitted the survey, consent forms and lesson plans for approval to the North Dakota State University Institutional Review Board (IRB) found in Appendix A. Once the study was granted IRB approval, students received consent forms to be taken home for parents or guardians, and the students to sign. Parents were contacted through email explaining the purpose of the consent form.

Students received direct instruction for 22 weeks of the school year. The students and researcher were the same through the time of the research. Direct instruction was implemented in the classroom until the research period started. A schedule for the school year can be found in Appendix F.

The research period used two project-based learning lessons during a nine-week period. Students took the TOSRA survey for a pretest at the beginning of the research period (after direct instruction). The same TOSRA was given as a post-test at the completion of the time period with the intervention of project-based lessons. The survey assessed the students' attitudes toward learning science in a project-based learning classroom.

The direct instruction method was used to teach the following chapters or units: Mapping the Earth's Surface, Plate Tectonics, Weather and Climate, and Rocks and Minerals. A sample test, quiz, worksheet, and copy of notes are found in Appendix G. Chapters or units would take six to twenty days. The material for each chapter or unit was covered through lecture, worksheets, laboratory sessions, quizzes, and tests. Notes were given for 20 to 30 minutes depending on amount of information or amount of time needed for discussion. Notes were given by a PowerPoint presentation with students filling partially completed notes or by full dictation into their notebooks. Following the lecture and discussion a worksheet consisting of 20 to 30 questions, consisting of essay and selected response questions: multiple choices, matching, true or false, completion, or short answer. A quiz was given after covering one or two sections of the notes and a comprehensive test followed the quizzes and worksheets. Students did the work individually, expect for during the laboratory time they worked in groups. Laboratory time was used to give students a chance to experience the material through hands on experiments or textbook provided labs. The labs would last one or two days. Students were allowed to study from their corrected worksheets, quizzes and labs for the test.

Comprehensive test was given at the end of the chapter covering similar questions from worksheets, quizzes, and labs. The test included the same selected response questions as listed above. Students were graded on all assignments with the test score roughly equaling the points from the worksheets, quizzes and labs.

Project-based learning units for 8th grade class concentrated on a city's polluted water supply and alternative energy. The final project for the city's polluted water supply was to build a filtering device to remove the pollutants that are common in our rural farming community. The project for the alternative energy unit was the formation of a solar cooker from a pizza box. The researcher formed the lessons from Internet sources. A sample project sheet is found in Appendix H. Students worked in groups to complete the project-based learning units.

The assigned group members filled out the Group Members Contract found in Appendix D. The contract explained their role for each of the projects before receiving any printed information about the projects. The projects were building blocks for the completion of the final project. The roles consisted of lead scientist, timekeeper, reporter, and equipment manager. A rubric scale was used to grade student performance within their role. Requirements of each of role were graded on a scale from 1 (information missing) to 5 (excellent work) and explained in Group Participant Rubric found in Appendix E. The researcher created the projects being done in classroom similar to a job in the real world. Students were given the opportunity to fire a student, who was not fulfilling their role. The group members warned the student by filling out the back of the Group Members Contract found in Appendix D. The researcher was informed of the date and reason for complaint, and initialed the sheet. Students were allowed three warnings before they were fired from their group.

The polluted water unit involved students researching water supply in area, types of pollution that could contaminate their water supply and providing the class with a collage of the information. Students conducted research to see how much water their family uses in a weeks time and present their groups findings to the class. Weathering and erosion labs were used to determine how water changes the earth's surface and changes the hydrologic cycle for their community. Each group prepared a watershed 3-D model to represent the state and how water moves from headwaters to the mouth of a system. An imaginary town of Fruitvale was used to solve water contamination problems. Soil horizons and soil pH were used to help students design and construct their aquifers. Water filtration involved natural and synthetic materials to clean the polluted water.

The alternative energy unit included producing a PowerPoint of types of alternative energy. Students researched their homes for energy efficient appliances and presented their recordings to the class. An energy lab was conducted to explain the differences between renewable and nonrenewable resources. Students researched the benefits and hazards of each type of resource. Students investigated how to form a solar cooker and designed the project. Each group of students received a list of materials that they could use in the formation of the solar cooker.

The projects were presented by a video, model or PowerPoint and graded by rubric for knowledge of content. Students were responsible for researching to find the material that was covered through lecture in direct instruction. They were provided with computers in the room for research and preparing final projects. Each student had different roles in each project and is explained in Group Participation Rubric found in Appendix F. Student's roles were used to distribute work evenly between members. Students were allowed extra access to the room for work on projects before, during the day if they had study hall, and after school.

CHAPTER 6. DATA COLLECTION AND ANALYSIS

The purpose of the research was to compare two teaching methods to identify a potential change in students' attitudes toward learning science. The teaching methods used were direct instruction for twenty-two weeks and project-based learning for nine weeks. The Test of Science Related Attitude (TOSRA) survey was used to measure a change in students' attitudes. The TOSRA survey was given to the students as a pre-test, which followed the twenty-two weeks of direct instruction. The post-test followed the nine weeks of project-based learning. Pre- and post-tests were identical in questions and the complete class period was given for a student to complete. Each of the subscales were measured to compare the mean scores and for statistical significance. Data for the descriptive statistics were analyzed using Statistical Package for Social Sciences software (SPSS).

The primary research question for this study was: What is the impact of project-based learning on students' attitude to learn science compared to the direct instruction method of teaching? Age was the factor used to measure attitude change in the first subsidiary question comparing project-based learning to direct instruction. Gender of the student was a factor used for the second subsidiary research question to compare attitude change with the comparison of project-based learning and direct instruction. The following tables show the results of TOSRA pretests (after direct instruction) and posttests (after project-based learning). The TOSRA survey for the pre-test and post-test had identical questions and scoring.

The TOSRA survey results in Table 3 show the change in students' attitudes for the whole class. This survey provided results for the primary research question of comparing students' attitudes toward learning science through project-based learning and direct instruction.

A paired sample t-test with an $p < .05$ was conducted to determine whether there was a statistically significant difference in attitude between the pre- and post-TOSRA surveys.

Table 3

TOSRA Paired t-test Results Pretest and Posttest

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Social (p) – Social (P)	1.682	4.992	.753	.164	3.200	2.235	43	.031
Pair 2 Normality (p) – Normality (P)	.733	3.881	.579	-.433	1.899	1.267	44	.212
Pair 3 Inquiry (p) – Inquiry (P)	1.022	4.698	.700	-.389	2.434	1.460	44	.151
Pair 4 Adaptation (p) – Adaptation (P)	1.159	3.550	.535	.080	2.238	2.166	43	.036
Pair 5 Enjoy (p) – Enjoy (P)	-.889	4.488	.669	-2.237	.460	-1.328	44	.191
Pair 6 Leisure (p) – Leisure (P)	-1.023	5.522	.832	-2.701	.656	-1.229	43	.226
Pair 7 Career (p) – Career (P)	-.295	5.789	.873	-2.056	1.465	-.339	43	.737

Note: Pretest (p) and Posttest (P), $p < .05$

Social and adaptation subscales showed significance. Social subscale $t(43)=2.24$, $p=.031$; $d=.34$ shows a medium effect size. Adaptation subscale $t(43)=2.166$, $p=.036$; $d=.33$ also shows a medium effect size. Project-based learning measured a decrease in attitude for students in these two subscales. Comparing the mean scores illustrated the difference between pretest score minus posttest score for each subscale. A positive number shows a decrease in attitude toward science. The subscales social, normality, inquiry, and adaptation showed the decrease in attitude. Enjoy, leisure, and career subscales show a positive increase in attitude.

The results shown in Tables 4, 5, and 6 compare affect of students age comparing project-based learning to direct instruction. The TOSRA survey results in Table 4 show the change in student's attitude for 13-year olds. A paired sample t-test with an $p < .05$ was conducted to determine whether there was a statistical signifigance between the pre-and post-TOSRA surveys. None of the subscales showed significance in change in attitude for 13-year olds. Comparing the mean of the pre- and post-test scores shows a positive increase in attitude for the subscales of inquiry, enjoy, leisure, and career. The subscales of social, normality, and adaptation show a negative attitude for the 13-year olds.

Table 4

TOSRA Paired t-test Results for 13-year olds

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Social (p) – Social (P)	.429	9.144	3.456	-8.029	8.886	.124	6	.905
Pair 2	Normality (p) Normality (P)	1.286	5.090	1.924	-3.421	5.993	.668	6	.529
Pair 3	Inquiry (p) – Inquiry (P)	-1.000	5.538	2.093	-6.122	4.122	-.478	6	.650
Pair 4	Adaptation (p) – Adaptation (P)	.857	3.532	1.335	-2.410	4.124	.642	6	.545
Pair 5	Enjoy (p) – Enjoy (P)	-1.143	3.132	1.184	-4.039	1.754	-.965	6	.372
Pair 6	Leisure (p) – Leisure (P)	-3.143	5.786	2.187	-8.494	2.208	-1.437	6	.201
Pair 7	Career (p) – Career (P)	-.429	5.159	1.950	-5.200	4.343	-.220	6	.833

Note: Pretest (p) and Posttest (P), $p < .05$

The TOSRA survey results in Table 5 show the change in student's attitude for the 14-year olds. A paired sample t-test with an $p < .05$ was conducted to determine whether there was a statistically significant difference in attitude between the pre- and post-TOSRA surveys. Social subscale t(34)=3.20, p=.003 showed significance. Adaptation subscale t(34)=2.079, p=.045 also showed significance for the 14-year olds. Comparison of the pre- and post-test mean scores provide evidence of positive attitude change for subscales enjoy, leisure, and career. A decrease of attitude was found in the subscales social, normality, inquiry, and adaptation for 14-year olds.

Table 5

TOSRA Paired t-test Results for 14-year olds

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Social (p) – Social (P)	2.114	3.909	.661	.771	3.457	3.200	34	.003
Pair 2	Normality (p) – Normality (P)	.694	3.786	.631	-.586	1.975	1.101	35	.279
Pair 3	Inquiry (p) – Inquiry (P)	1.472	4.620	.770	-.091	3.035	1.912	35	.064
Pair 4	Adaptation (p) – Adaptation (P)	1.286	3.659	.618	.029	2.543	2.079	34	.045
Pair 5	Enjoy (p) – Enjoy (P)	-.806	4.857	.809	-2.449	.838	-.995	35	.326
Pair 6	Leisure (p) – Leisure (P)	-.543	5.601	.947	-2.467	1.381	-.573	34	.570
Pair 7	Career (p) – Career (P)	-.343	6.111	1.033	-2.442	1.756	-.332	34	.742

Note: Pretest (p) and Posttest (P), $p < .05$

The TOSRA survey results in Table 6 show the change in student's attitude for 15-year olds. A paired sample t-test with an $p < .05$ was conducted to determine whether there was a statistically significant difference in attitude between the pre- and post-TOSRA surveys. None of the subscales showed significance in change in attitude. The sample size is small (n=2) in the 15-year olds but an increase of attitude was found in the subscales social, normality, enjoy, and leisure. A decrease in attitude was found in career interests. Inquiry and adaptation did not a change in attitude.

Table 6

TOSRA Paired t-test Results for 15-year olds

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Social (p) – Social (P)	-1.500	3.536	2.500	-33.266	30.266	-.600	1	.656
Pair 2	Normality (p) – Normality (P)	-.500	.707	.500	-6.853	5.853	-1.000	1	.500
Pair 3	Inquiry (p) – Inquiry (P)	.000	1.414	1.000	-12.706	12.706	.000	1	1.000
Pair 4	Adaptation (p) – Adaptation (P)	.000	2.828	2.000	-25.412	25.412	.000	1	1.000
Pair 5	Enjoy (p) – Enjoy (P)	-1.500	.707	.500	-7.853	4.853	-3.000	1	.205
Pair 6	Leisure (p) – Leisure (P)	-2.000	1.414	1.000	-14.706	10.706	-2.000	1	.295
Pair 7	Career (p) – Career (P)	1.000	2.828	2.000	-24.412	26.412	.500	1	.705

Note: Pretest (p) and Posttest (P), $p < .05$

The Tables 7 and 8 how gender affects students' attitude toward learning science. The TOSRA survey results in Table 7 show the change in student's attitude for the males. A paired sample t-test with an $p < .05$ was conducted to determine whether there was a statistically significant change in attitude between the pre- and post-TOSRA surveys. Adaptation subscale $t(21)=2.511$, $p=.020$ demonstrated significance in the male gender of the class. Comparison of the pre- and post-test mean scores show an increase in attitudes for males in the subscales enjoy, leisure, and career. A decrease in attitude was found in social, normality, inquiry, and adaptation for males.

Table 7

TOSRA Paired t-test Results for Males

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Social (p) – Social (P)	1.545	3.751	.800	-.118	3.209	1.933	21	.067
Pair 2	Normality (p) – Normality (P)	1.087	3.528	.736	-.439	2.613	1.478	22	.154
Pair 3	Inquiry (p) – Inquiry (P)	1.696	5.497	1.146	-.682	4.073	1.479	22	.153
Pair 4	Adaptation (p) – Adaptation (P)	1.864	3.482	.742	.320	3.407	2.511	21	.020
Pair 5	Enjoy (p) – Enjoy (P)	-.478	3.132	.653	-1.832	.876	-.732	22	.472
Pair 6	Leisure (p) – Leisure (P)	-1.364	4.552	.970	-3.382	.655	-1.405	21	.175
Pair 7	Career (p) – Career (P)	-.783	4.379	.913	-2.676	1.111	-.857	22	.401

Note: Pretest (p) and Posttest (P), $p < .05$

The TOSRA survey results in Table 8 show the change in student's attitude for females. A paired sample t-test with an $p < .05$ was conducted to determine whether there was a statistically significant difference in attitude between the pre- and post-TOSRA surveys. None of the subscales showed significance in change in attitude.

Positive increase in attitude shown by the means scores was in the subscales enjoy and leisure. A decrease in attitude was shown in the subscales of social, normality, inquiry, adaptation, and career for females.

Table 8

TOSRA Paired t-test Results for Females

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Social (p) – Social (P)	1.818	6.076	1.295	-.876	4.512	1.404	21	.175
Pair 2	Normality (p) – Normality (P)	.364	4.271	.911	-1.530	2.257	.399	21	.694
Pair 3	Inquiry (p) – Inquiry (P)	.318	3.682	.785	-1.315	1.951	.405	21	.689
Pair 4	Adaptation (p) – Adaptation (P)	.455	3.555	.758	-1.122	2.031	.600	21	.555
Pair 5	Enjoy (p) – Enjoy (P)	-1.318	5.618	1.198	-3.809	1.173	-1.101	21	.284
Pair 6	Leisure (p) – Leisure (P)	-.682	6.439	1.373	-3.537	2.173	-.497	21	.625
Pair 7	Career (p) – Career (P)	.238	7.099	1.549	-2.993	3.469	.154	20	.879

Note: Pretest (p) and Posttest (P), $p < .05$

CHAPTER 7. DISCUSSION AND CONCLUSIONS

The goal of this study was to compare students' attitudes towards learning science through the implementation of two teaching methods. Middle school students were the focal point of the research, because it is a critical time for students' attitudes towards learning science. This research study focused on comparison of project-based learning to direct instruction on students' attitude for learning science.

Primary Research question

1) What is the impact of project-based learning on students' attitude for learning science compared to direct instruction method of teaching?

Subsidiary Questions

1) What is the impact of student's gender on their attitude for learning science through the comparison of the project-based learning and direct instruction?
2) What is the impact of student's age on their attitude for learning science through comparison of the project-based learning and direct instruction?

Primary research question results were shown by the paired sample *t*-test on the pre- and post- TOSRA survey. Significant results were shown in the TOSRA subscales of social and adaptation with $p < .05$ for the research alpha. Both subscales showed a decrease in the mean scores, which suggested that students' attitudes were negatively impacted. Social subscale (M_{pre}= 34.18, SD = 6.41; M_{post}= 32.50, SD = 6.45) and adaptation subscale (M_{pre}= 32.80, SD = 4.86; M_{post}= 31.64, SD = 5.78) demonstrated a negative effect. A small Cohen's d for both subscales provided a small effect; social is shown as $t(43) = 2.24$, $p = .031$; $d = 0.34$, and adaptation is shown as $t(43) = 2.17$, $p = .036$; $d = 0.33$. The sample for social and adaptation was 43 because one student failed to answer a question on the TOSRA. Subsidiary question 1 to compare attitudes for gender results were gathered from paired sample *t*-test of the TOSRA pre and post surveys used to measure the change in attitude for learning science. Males showed a decrease in attitude by comparing the mean scores for the subscales of social, normality, inquiry, and adaptation. The mean score comparison showed an increase attitude for the subscales of career, leisure, and enjoy. Adaptation showed significance on with a medium effect subscale (M_{pre}= 32.45, SD = 4.90; M_{post}= 30.59, SD = 5.01) with $t(21)$ =2.51, p = .020; d = 0.54. Females showed a negative change in social, normality, inquiry, adaptation and career by comparing the pre- and post-test means. Comparing the mean scores of the pre- and post-test positive swings in enjoy and leisure was shown for the females. No subscale shows significance for a change in attitude between the two teaching methods.

Subsidiary question 2 compared if there was an attitude change for students with the age range of 13 to 15-year olds. The results were compiled from a paired sample *t*-test of pre- and post- TOSRA results. The 13 and 14-year olds showed a negative change in the mean number for the subscales of social, normality, inquiry and adaptation. Enjoy, leisure, and career subscales showed a positive change. There were no significant results for the 13-year olds. The 14-year olds showed significant change social subscale (M_{pre}= 34.80, SD = 5.622; M_{post}= 32.69, SD = 5.56) and adaptation (M_{pre}= 32.80, SD = 4.80; M_{post}= 31.51, SD = 4.85). Social showed a medium effect t(34) = 3.20, p = .003; d = 0.54 and adaptation show a small effect t(34) = 2.08, p = .045; d = 0.35.

The TOSRA survey results provided information showing positive and negative changes in students' attitudes towards learning science by comparing the mean scores. Subscales of enjoy, leisure, and career showed positive changes for the whole class group shown in Table 2. Enjoyment subscale showed that project-based learning provided students with satisfaction for completing the projects. Students reported enjoying the hands-on activities in their post-intervention questionnaire. The answer on the questionnaire could be a factor for the increase in attitude in the enjoyment subscale. Student's positive view on leisure subscale indicates that the students think that scientists can partake in other things than scientific research. Career scale showed a positive increase in mean score. The increase in the mean score showed an increase of attitude in the class that wanted to pursue a science career. The completion of project-based learning showed a small increase, but showed a positive change in the student's idea in pursuing a career in science. A negative mean score was shown in Table 2 for the subscales of society, normality, inquiry, and adaptation. Social implies that students have negative feelings about how scientific research is spending their money and not benefiting them. Students believe scientists do not have a normal life. This could be caused by all the extra time the students needed to come in and finish labs, because the class period of 43 minutes was not long enough. Inquiry and adaptation had small negative changes, because the students did not like change. Project-based learning required them to apply their knowledge and research skills. The students expressed that they like being told the definition or answer for questions instead of finding them on their own.

The first subsidiary question deals with the age of students. The 15-year age group varied the most from the whole group results. This group had a sample size of two, so the data was not very reliable. The 13 and 14-year old groups only changed in the subscale of inquiry. Inquiry showed as a positive change in the 13-year olds.

The second subsidiary question dealt with the student's gender. Male gender provided scores that were consistent with the whole group score, which means that no major change in attitudes took place. Females showed a decrease in attitudes for the career scale. Research done by Catsambis (1995) reports that female may have equal achievement in science scores as males, but have a negative attitude towards science. These could come from preconceived thoughts that science is not their strong subject and will be very challenging for them. This could cause them to feel that a career in science is not for them.

Gender and age statistics showed that 13-year old males and females had the most change in attitude by comparing mean scores to the whole group scores. Thirteen-year-old females showed a positive change in society and inquiry subscales. Providing information that project-based learning increases the students' understanding of the importance of scientific research and how inquiry is an important part of science. Results for male 13-years olds suggest that they believe a scientist can have a normal life. They did not enjoy doing the labs, and were the students that liked having the answers given to them in direct instruction also stated in the post-intervention survey. The 14-year-old males provided the same results as the whole group. Females did improve attitude in the normality of life for a scientist. The 15-year-old group only had two male students and they show results that were very different from the group. They show that a career in science is not in their near future. They showed positive change for social, normal, enjoy, and leisure.

In conclusion, project-based learning and direct instruction changed in students' attitudes. Not all changes were positive, but provided valuable information about the students' attitudes towards the two teaching methods. The projects may not been the most interesting for all students, and a longer time period will be needed to see any full effect. A student's positive change to pursuing a career in a science field motivates the researcher to improve and continue the project-based learning units. TOSRA test did prove to be a good measure of student's attitude changes, and will be used in future research.

CHAPTER 8. SCOPE FOR FURTHER RESEARCH

Further research is needed to find any full effect of attitude change of students for comparing the project-based learning and direct instruction. The research period should contain equal amount of time for each teaching method. Studies have shown that attitudes reflecting personal values toward science are resistant to change in short periods of time (Stake and Mares, 2005). It would be helpful to involve students starting in 6th grade through the 8^{th}, to compare how attitude changes through time that they are in middle school. This would allow for more data collection to examine potential changes in the student's attitudes across several years. The teaching to more grade levels will also involve more teachers to receive training in project-based learning. The involvement of other teachers would be useful in the research to see if the gender of teacher influences student's attitude. Teachers working together as a team, and a group, can improve the project-based learning lessons, and give students more of an opportunity to build a positive attitude toward science. The researcher is planning to continue using project-based learning, but implementing direct instruction to clarify the terminology for the unit.

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APPENDIX A. IRB FORMS

Institutional Review Board …for the protection of human participants in research

Date Received

IRB Protocol #:

North Dakota State University
Sponsored Programs Administration
1735 NDSU Research Park Drive
NDSU Dept #4000
PO Box 6050
Fargo, ND 58108-6050 231-8995(ph) 231-8098(fax)

IRB PROTOCOL FORM

Application to Conduct Research Involving Human Participants

1.Title of Project: **Comparing Student's Attitude for Learning Science Using Project-Based Learning**

2. Principal Investigator: **Dr. Anita Welch** Dept. name: **School of Education**
(PI must be an NDSU faculty or staff member; graduate students must list their advisor as PI)

Campus address/phone: **701-231-5498** Email address: **anita.welch@ndsu.edu**

Specify role in this research: **direct/supervise research**

Highest earned degree and field of study: **Ph.D Curriculum and Instruction**

3. Co-Investigator(s): **Marlen I. Haugen** Dept. name: **School of Education**

Campus address/phone: **701-347-5352** Email address: **marlen.i.haugen@my.ndsu.edu**

Specify role in this research: **Research for Masters Degree**

Highest earned degree and field of study: **BA degree in Biology**

4. Research team: *List all NDSU students, faculty or staff who will assist in the project (project design/oversight, recruiting participants, obtaining informed consent, intervening or interacting with participants to obtain information/data, and/or handling identifiable information for research purposes). May provide as a separate attachment.*

Name, dept. or affiliation:	Specify role in research:	Training date (IRB office only)

Please Note: *Investigators and all members of the research team are required to complete a course in the protection of human research participants prior to protocol review. This training must be current (within the last 3 years). Refer to the 'Training' page of the IRB website for information and links to online training sessions.*

5. Project dates: indicate the anticipated start and end dates for research procedures involving human subjects: *(Note that start date should allow sufficient time for IRB review and approval; no research procedures involving human participants may begin prior to obtaining notification of IRB approval.)*

Anticipated start date: February 11, 2013	**Anticipated end date: April 12, 2013**

6. Requested review category: *(final determination will be made by the IRB)*
☒ Expedited review *(*Include the Expedited Review Categories attachment)*
☐ Full board review

Project Description

Use plain language, avoiding technical terms or jargon, unless explained. The description should be understandable to any person unfamiliar with the area of research. Include a brief summary of the pertinent literature with citations, if applicable.

1. Purpose and goals of the research:

Purpose of the research is to compare pedagogical methods that will enhance the attitudes of middle school earth science students learning science. Attitude may become positive by increasing the student's knowledge base and expanding their thinking to solve future real-life problems. The two methods that will be applied in the research are Project-Based Learning and direct instruction classroom style of teaching. The research goal is to compare which method increases the student's attitudes of learning earth science material by comparing posttest results on a Test for Science Related Attitudes (TOSRA). Research goal will be to see if student's gender affects their attitude toward learning science.

2. Method and procedures: *Explain in detail what subjects will be asked to do or what information will be collected about them. Specify when or how often research procedures will be conducted. Provide a timeline or schedule of events, if applicable. May be provided as a separate attachment, with numbered pages.*

The research will analyze the change in student's attitude (positive or negative) to the use of Project-Based Learning compared to direct instruction. Students will take a Test of Science Related Attitudes (TOSRA) survey to measure attitudes after instruction of direct instruction and project-based learning. The TOSRA survey consists of 70 questions and has been validated for this age group on measuring attitude toward science. The results of TOSRA surveys will be recorded as post-tests for the individual teaching pedagogy. I will use project-based learning for a nine-week period during the second semester, as the instructor. All students will be invited to participate in the research. They will have completed twenty weeks of direct instruction by the same instructor. Project-based learning lessons that the students will be completing will involve water pollution and alternative energy. After the completion of the nine will intervention of project-based learning and completion of the TOSRA survey the second time, the students will be asked to complete a

questionnaire to express their opinions on the two teaching pedagogies.

3. Project/performance site(s): *Specify where the research will be conducted.*

The research will take place at Central Cass Middle School in Casselton, North Dakota.

4. Research design and analysis plan: *If applicable, describe the sampling plan, the size of the sample or study group(s), and the power of the planned statistical tests.* ☐ N/A

Forty-seven 8th grade students participating in Earth Science at Central Cass Middle School, Casselton, ND. A quasi-experimental design will be used because the classes are broken up and arranged by the school district. Students were placed in these classes during summer registration at the school. The TOSRA test will be used to measure any difference in attitude of a student while learning through direct instruction and project-based learning. Students will also complete a questionnaire on their thoughts of both teaching methods.

5. Additional materials: Will the research involve use of data, documents, records or specimens that have already been collected (pre-existing) from individuals, or will be collected solely for non-research purposes?

☒ No

☐ Yes: a. Complete the *'Additional Materials' attachment.*

b. If the research will be *limited* to use of these pre-existing materials, or materials collected solely for non-research purposes *(research will not involve interaction, intervention or observation of human research participants)*, then skip to the 'Risks and Benefits' section. Also complete the *'Informed Consent Waiver or Alteration Request'* if the requirement for informed consent is requested to be waived.

Recruitment

Selection of research participants must consider the following: research setting, equitable recruitment potential for coercion or undue influence, and vulnerable groups.

1. Research participants and recruitment methods: Describe participants, including approximate #, age-range, or any other relevant characteristics. Also describe in detail how they will be selected, identified contacted or approached to participate in the research:

The participants range from thirteen to fifteen years of age. They have been sorted into heterozygous groups by the school. Number of participants will be between forty to forty-seven students. All students will be invited to participate in the Project-based learning and they have already completed the direct instruction for the first semester of school. I will send out a permission form for the students to sign and return if they would like to participate in the research study. The parents/guardian will receive a permission sheet allowing their student to participant in the research. Both the parent/guardian and the student will need to return signed sheets in order for me to use their results in the study. Only those students who have given assent, and have permission from their parent/guardian to partipate will fill out the research survey and questionnaire. The students will be approached during classroom discussion. Parent(s)/ guardian(s) will be contacted through the letter send home with the student. The parent(s)/guardians will also receive an emailed copy of the letter from me.

Attach a copy of any oral script, advertisement, announcement or preliminary invitation that will be used.

2. Describe any inclusion/exclusion criteria that will be used for subject selection, if applicable: ☒ N/A

3. Vulnerable populations: Indicate if individuals from any of the following groups will be specifically targeted:

☒ minors (under age 18) - *also complete the 'Children in Research Attachment' form.*
☐ prisoners - *also complete the 'Prisoners in Research Attachment' form.*
☐ pregnant women, fetuses or neonates
☐ cognitively impaired individuals – may require consent of a legally authorized representative
☐ economically disadvantaged persons
☐ educationally disadvantaged persons
☐ N/A - None of these groups will be specifically recruited

If any vulnerable populations will be recruited, indicate what additional safeguards will be included to protect participants' rights and welfare:

Student's names will be used on the survey sheets that will be locked in the filing cabinet in my classroom. The names will be used to match the two surveys for comparison at the end of the research. The survey data will be recoded and names removed after data is collected.

4. Compensation: Will participants or others be offered incentives for the research (ie, gifts, payment, reimbursement, services, extra course credit, or other forms of compensation)? *Compensating participants for their time and effort is appropriate, although the amount of compensation must not cause undue influence to participate in a study. Any compensation should also be pro-rated, rather than awarded only on completion of the study. If research will involve compensating students with extra credit, specify the amount of extra credit, and what non-research alternatives (equal in time and effort) are available to the students for earning extra credit.*

☒ No
☐ Yes - provide details of the compensation scheme:

5. Alternatives to research participation: Describe any alternative procedures available to those who choose not to participate, if applicable. ☐ N/A

The students providing signed consent forms will complete a post intervention questionnaire and a survey on science related attitudes. Students who do not provide a signed consent form will not take the questionnaire or survey. All students will participate during the lessons taught using project-based learning and direct instruction. The research study data will consist of the results of the post intervention questionnaire and survey on science related attitudes of only the students who provided signed consent forms.

6. Dual relationships*: Does the investigator, co-investigator, any member of the research team, or anyone else assisting with the research has an authority relationship (e.g., instructor/student, employer or supervisor/employee, physician/patient, or other) with potential participants?

☐ No

☒ Yes - describe the relationship, and indicate how the research will be conducted to avoid undue influence on participants:

The investigator will be Marlen Haugen, as the classroom instructor. A team teacher will help me send and collect the consent forms from the students. The team teacher teaches English to all of the students that will be participating in my study. The data will be recoded and any identifying information will be removed after post-tests are completed.

7. Will any aspect of the research be conducted in a classroom setting during class time?

☐ No

☒ Yes - describe what those who choose not to participate will be doing, and provide justification for use of class time for research (Attach course syllabus):

The students that do not sign the consent form will participate in the project-based learning lessons. Their results will not be recorded for data for the research project. They will not be asked to participate in the questionnaire or survey at the end of the nine-week period. They will work on other homework or read AR.

Informed Consent

Potential subjects must be provided with complete and easily understandable information about the study, fully informed of the voluntary nature of their choice, and given sufficient opportunity to consider participation in an environment that is free of coercion or undue influence. Participants cannot be made to waive any of their rights, or release the investigators, sponsor or institution from responsibility for any research-related harms.

1. Informed consent*: Explain procedures for obtaining informed consent from participants, their parent/guardian, or legally authorized representative. Be specific regarding who will obtain informed consent, and in what setting/time frame:

The student consent forms will be handed out the students in class. The parent/guardian consent forms will be handed out to the students to take home for their signatures. The parent/guardian will also receive a email or note on the powerschool site about the consent form.

Attach as applicable: informed consent form, parent/guardian permission form, child/youth assent forms to be used. Templates may be found on the IRB website 'Forms' page. *(Alternatively, a short form written consent document may be used, along with an oral presentation of the elements of informed consent. See IRB Standard Operation Procedures 9.2 Documentation of Informed consent.)*

2. Will all adult participants have the capacity to consent? *Individuals who lack the capacity to consent (as a result of either a permanent or transient condition) may participate in research only if a legally authorized representative (LAR) gives consent on their behalf. For more information, please see the National Institutes of Health guidance at: http://grants.nih.gov/grants/policy/questionablecapacity.htm Also, please see Standard Operating Procedure 10.3 Other Vulnerable Groups.*

☒ Yes

☐ No - explain how legally authorized consent will be sought:

3. Will all participants (and their parents/guardians or legal representatives, as applicable) be fluent in English?

☒ Yes
☐ No - explain how informed consent will be obtained, and provide a copy of the translation to be used:

4. Will the research be conducted at an international site(s)?
☒ No
☐ Yes - indicate site(s) and investigators' familiarity with the culture/cultural norms, whether or not the different cultural context presents any problems or risks that need to be addressed, and how those issues will be handled:

5. Withholding information from participants, or use of deception: Will the research involve purposely withholding some or all information about the research from participants prior to their involvement, or involve any use of deception?
☒ No
☐ Yes - Attach the '*Informed Consent Waiver or Alteration Request*.'

6. Is a waiver of the signature requirement requested? *Participants will be provided with full information about the research, but their signature will not be required. Agreement will be obtained in another manner*.
☒ No
☐ Yes - Attach the '*Informed Consent Waiver or Alteration Request'*.

Risks and Benefits

Risks to subjects must be minimized by using sound research design, procedures that do not unnecessarily expose subjects to risk, or procedures that are already being performed on subjects for diagnostic or treatment purposes. Risks must be reasonable in relation to any anticipated benefits.

1. Risks: Indicate all potential risks of harm/discomfort to subjects or others in this research:
☒ Privacy
☐ Psychological
☐ Social
☐ Legal
☐ Economic
☐ Physical
☐ Dignitary
☐ Other -

2. Protection against risks: Describe each possible risk of harm/discomfort, including the probability and magnitude, as well as the steps that will be taken to minimize these risks for subjects or others:

The students should not have any harmful risks or discomforts.

3. Describe what steps will be taken if participants experience serious injury, distress, discomfort or decompensation during research participation: ☒ N/A

4. Risk category: Categorize the level of risk you consider appropriate for the research: *Federal regulations define 'minimal risk' as the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.*

☒ No more than minimal risk
☐ A minor increase over minimal risk*
☐ More than a minor increase over minimal risk*

4a. Indicate what provisions will be taken to monitor the data collected to ensure the safety of subjects, and report unanticipated problems involving risks to subjects or others.

5. Benefits and risk-benefit analysis: *Describe any potential benefits to participants and/or society in general. Explain why the risks should be considered reasonable in relation to any anticipated benefits and/or in relation to the importance of the knowledge that is expected to result.*

Potential benefits of the research will be a student with an improved attitude to learn science. The real world inquiry learning may encourage students to become interesting a scientific career after he or she finishes their education.

6 Clinical trial: *NIH defines a clinical trial as a prospective biomedical or behavioral research study of human subjects that is designed to answer specific questions about biomedical or behavioral interventions (drugs, treatments, devices, or new ways of using known drugs, treatments, or devices). Behavioral studies involving an intervention to modify behavior (diet, physical activity, cognitive therapy, etc.) also fit the definition of a clinical trial.*

☒ No
☐ Yes - indicate what provisions will be taken to monitor the data collected to ensure the safety of subjects, and report unanticipated events involving risks to subjects or others: (*may provide as an attachment)*:

Data and safety monitoring information: http://grants2.nih.gov/grants/policy/hs/data_safety.htm *)*
Clinical trial registration requirement: Federal law requires pre-registration of clinical trials involving FDA-regulated drugs, biologics and devices. See FAQs at: http://prsinfo.clinicaltrials.gov. Also note that some journals and sponsors may require registration for all clinical trials, including those involving only social or behavioral interventions.

7. Use of human blood, tissues, or specimens:

☒ No
☐ Yes – Project also requires review/approval from the Institutional Biosafety Committee.

If an NDSU employee will handle human blood/tissues/specimens, participation in NDSU's Bloodborne Pathogen Program is also required; contact the University Police and Safety Office for more information.

8. Investigational use of a drug, biological product, medical device, or other product regulated by the FDA:

☒ No
☐ Yes - Attach additional information regarding risks and FDA approval status.

Instrument(s)
Provide the list of survey, interview or focus group questions, or oral history objective (may be provided as a separate attachment)

The Test of Science Related Attitude (TOSRA) survey produced by Fraser (1978) will be used to compare any change in the student's attitude between the two teaching methods. The TOSRA survey includes seventy questions will ten based on seven distinct science-related attitudes. Seven science-related attitudes covered in the survey include social implication of science, normality of scientists, attitudes of scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science, and career interests in science. Five of the questions show a positive attitude and the other five demonstrate a negative attitude. Survey question that will be given to the students is attached. A list of supplementary questions will also be added to the survey. A copy of the questions is attached also.

The students will also be asked to complete a questionnaire after the completion of the intervention period. Questionnaire will provide information about student's thought of both teaching methods. Students will explain, which method improved their attitude towards science and why.

Privacy and Confidentiality
When appropriate, there must be adequate provisions to protect the privacy of subjects and maintain the confidentiality of data.

1. Confidentiality: Describe whether or not participants will be promised confidentiality of their responses or information. Include who will have access to individual data, and how results will be reported:

Participants will be promised confidentiality. Students will place first and last name on the survey for science related attitudes. The student's name will used to match and compare results of posttest for direct instruction and posttest for project-based learning. The survey data will be recoded, to eliminate any identifying information, after the completion of final survey. The post intervention questionnaire will not contain any identifying information other than gender of student for data collection. All electronic data will be maintained on a laptop secured by Central Cass Schools. The computer is password protected and has antivirus protection through the school. Results of the project will be reported in Mr. Haugen's thesis paper and to the school's administration, parents, and students that participated in the study, and other school officials as requested and deemed appropriate by the school.

2. Identifiable information: Will any information be collected, even temporarily, that could potentially identify an individual? *(This would include not only names, personal ID #s, address, video or audio recordings, or other direct identifiers, but also may include certain demographic or unique information that would enable an individual's identity to be deduced.)*
☐ No
☒ Yes:

2a. Describe use of any identifying information, including codes, or linkages to identifiers; and indicate why these are necessary for the research:

Student first and last names will be place on the surveys so that they can be matched for the comparision of the posttest results.

2b. Indicate whether these identifiers, codes or linkages will be retained after data collection, and if they will be removed at some point:

All identifiers will be removed as soon as the last survey is completed at the end of the study and the results of varios items are collect and matched up.

2c. Would identification of subjects or their responses place them at risk of: ☐ criminal liability, ☐ civil liability, or be damaging to their: ☐ financial standing, ☐ employability, ☐ insurability, ☐ reputation, or be ☐ stigmatizing?
☒ N/A

<u>3. Video/audio tape recording*:</u> Will participants be recorded (e.g., audio, video)?
☒ No
☐ Yes - describe the type of recordings and specify how they will be used, stored/secured, and their final disposition *(also provide this information to participants on the consent document)*:

**Note that recordings are considered individually identifiable.*

<u>4. Data safeguarding procedures (hard-copy records):</u> Specify the physical security procedures that will be used to prevent a breach of confidentiality of participants' information during data collection, transfer, analysis and storage: ☐ N/A

All hard copies of permission forms and records of the student's surveys and questionnaires will be locked in the filing cabinet in classroom. Only Mr. Haugen and administration would have access to the file cabinet.

<u>5. Data safeguarding procedures (electronic records):</u> Specify the electronic security procedures that will be used to prevent a breach of confidentiality of participants' information during data collection, transfer, analysis and storage (*ie, password authentication, use of unique log-ins, data encryption, secure server, firewall, latest anti-virus protection, etc. Research data should be stored on computers maintained by NDSU ITS, or that conform to NDSU ITS standards)*: ☐ N/A

The results will be saved on my laptop computer and backed-up saved in the faculty folder issued by Central Cass Schools. The grade book and opening the computer required a password at login. The technology cordinator and myself are the only ones with access to my password. The firewall is a state issued controlled by the state.

<u>6. Mandated reporting responsibility:</u> Is there is a possibility that certain information will be obtained in the course of the research that you will be legally obligated to disclose to the proper authorities (e.g., child abuse, or other abuse, or threats of harm)?
☒ No
☐ *Yes –describe:

* This must also be disclosed to participants in the consent document.

***Note**: For some studies involving sensitive data collection, a Certificate of Confidentiality may be obtained from the National Institutes of Health to protect an individual participant's information from involuntary disclosure. Visit the NIH website for more information.*

Other Information

1. External Interests. Does any investigator responsible for the design, conduct or reporting of the project (including their immediate family members) have a financial, personal or political interest that may conflict with their responsibility for protecting human participants in NDSU research?

Financial, personal or political interests related to the research (the sponsor, product or service being tested, or a competing product or service) may include:

- compensation (e.g., salary, payment for services, consulting fees)
- intellectual property rights or equity interests
- board memberships or executive positions
- enrollment or recruitment bonus payments

Refer to *NDSU Policy 151.1, External Activities and Conflicts of Interest, and NDSU Policy 823, Financial Disclosure – Sponsored Projects* for specific disclosure requirements.

☒ No – As PI, I attest that I have conferred with my co-investigators and key personnel and confirmed that no financial, personal or political interests currently exist related to this research.
☐ Yes – Describe the related financial, personal or political interests, and **attach documentation of COI disclosure and review** *(as applicable).*

For more information, see SOP 6.2, Conflict of Interest in Human Research, Investigator and Research Team.

2. Funding: Has an external agency or sponsor agreed to provide funding for the project?
☒ No
☐ Yes- PTF #: FAR00 Agency or Sponsor*:
*Attach **complete** copy of final grant application, agreement or contract.*

2a. Were external funds made available for the project prior to IRB approval (via the IRB pre-screening process?) ☐ No ☐ Yes:

2b. Does the grant, agreement or contract related to this project include multiple human subjects research activities that are ***not*** described in this IRB protocol?
☒ No; all human subject activities are covered in this IRB protocol
☐ Yes; these activities will be covered in a future IRB protocol(s)*
☐ Yes; these activities have been covered by a previous IRB protocol(s) #:
☐ Yes; these activities have been or will be reviewed by another IRB:
☐ Other; explain:

*** The PI is responsible for obtaining IRB approval prior to initiation of any future human subjects research activities.**

***Note**:

- *To certify IRB approval of an award, the final funding proposal and the IRB protocol are compared to verify consistency with respect to human subjects activities.*
- *If external funds will be used for the project, Sponsored Programs Administration requires internal approval of the proposal by submission of a Proposal Transmittal Form (PTF). Consult the SPA website (http://www.ndsu.edu/research/spa/index.php) for more information.*

3. Other institution(s): Are any outside entities engaged in this research (e.g., receiving a direct award, grant or contract to perform research, directing or supervising the research, intervening and/or interacting with participants for research purposes, obtaining informed consent, obtaining private identifiable information or specimens from any source for research purposes, or utilizing private information or human specimens for FDA regulated research)? For additional information, please see the 'NDSU Collaborative, Multi-Site or Off-site Research Worksheet' available on the 'Forms' page of the IRB website.

☒ No – *skip all remaining questions*
☐ Yes – name entity or institution, contact person(s), and describe their role in the research:

Name of outside entity or institution:
Contact person:
Their role in the research:

3a. Other IRB review: Has/will this project be submitted to another IRB for review?

☐ Yes* - name of IRB and status of the application:

*Attach a complete copy of the protocol reviewed and the IRB's determination. *(if not immediately available, may be forwarded upon receipt)*

☐ No: provide either:

- a letter of permission/cooperation stating:
  - a brief description of the entity's role in the research that appropriate training will be completed prior to involvement of human subjects
  - the project will be conducted according to the approved protocol and NDSU policies for protecting research subjects.

***NOTE**: If letter(s) or approval(s) from sites or collaborator(s) are not immediately available, the IRB may approve the protocol provided that:*

1) *all other requirements are met, and*
2) *the documentation from the site(s) will be forwarded to the IRB prior to initiating research at each site.*

Investigator's Assurance

The signature(s) below certify that:

- information provided in this application is complete and accurate*
- the principal investigator has the ultimate responsibility for the protection of the rights, safety and welfare of human subjects and the ethical conduct of this research
- each individual listed as principal, co-investigator, or research team member has received the required human research protections education
- each individual listed as an investigator or member of the research team possesses the necessary experience for conducting research activities in their assigned role, and is aware of and will abide by NDSU policies and procedures for the protection of research participants

- no research procedures with human subjects will be initiated until documented approval has been obtained from the IRB Office
- the research will be conducted according to the protocol approved by the IRB, in accordance with NDSU policies and procedures

____

Principal Investigator signature, date

____

Co-investigator (s) signature, date

The signature below certifies that:

- the research is scientifically valid;
- the investigator(s) and their team are qualified to conduct the project;
- facilities, equipment, and personnel are adequate; and
- continued guidance will be provided as appropriate.

____

Chair, Dean or Director* signature, and date:
** If the PI or co-investigator is the Dept. Chair, College Dean must sign.*

* Carefully review the application to ensure it is complete, contains sufficiently detailed responses to all questions, and all attachments. <u>Incomplete applications will be returned without IRB review or approval</u>, potentially delaying the research. Contact the IRB Office for questions or assistance at: 231-8995 or 231-8908.

Recruitment script (oral format)

Given by the teacher (myself):

I am conducting research study for the completion of my masters' degree from North Dakota State University comparing teaching methods. The teaching methods will be direct instruction and project-based learning to measure your attitude toward learning science.

A Test for Science Related Attitudes (TOSRA) survey will be given at the beginning and end of the research period. The results of the first survey will be your attitude toward learning science after direct instruction. You will then participate in project-based learning for the next nine weeks. You will then take the TOSRA survey again to see if there is any change in your attitude of learning science. You will also be asked to complete a post intervention questionnaire at the end of the nine-week period to provide feedback on the two teaching methods.

You are required to take earth science during your 8th grade year at Central Cass School. The class has been taught using direct instruction and I am looking at using project-based learning in the future. You have the option of not participating in the data collection for my research project, but not from participating in the classroom using project-based learning.

Do you have any questions?

Your assistance in my research study will be greatly appreciated.

Parent/Guardian PERMISSION to Participate in ResearchComparing STudent's ATtitudes for learning science through Project-based and direct instruction

1. <u>Research Study</u>

Your child/legal ward is invited to participate in a research study comparing students' attitudes about learning science through project-based learning in comparison to direct instruction. This study is being conducted by Marlen Haugen (master's student at NDSU) and Dr. Anita Welch (advisor and instructor at NDSU).

2. <u>Purpose of Study</u>

The purpose of this research is to determine whether different teaching methods affect students' attitudes regarding learning science. We will also look at whether the students' gender affects the relation between method of instruction and their attitude towards learning science. To accomplish these goals, students' attitude toward learning science will be measured after students have engaged in project-based learning and through direct instruction.

3. Explanation of Procedures

A Test of Science Related Attitudes (TOSRA) survey will be used to measure students' positive or negative attitudes towards learning science. Students will be taught first through direct instruction and then for nine weeks using project-based learning. Direct instruction uses lecture, structured laboratory sessions, worksheets, quizzes, and tests. Project-based learning requires that students become more involved in planning the lessons to complete a final real world project. Students will complete parts of the project individually and in small groups. A post intervention questionnaire will be given to the students to receive personal reflection on the two types of teaching methods.

4. Potential Risks and Discomforts

There will be no foreseeable risks or discomforts involved in the study.

5. Potential Benefits

There may not be any direct benefits for your child, but this study will inform my teaching for the future and advance the study of project-based learning.

6. **Alternatives to Participation**

All students in the eighth grade class will participate in the lessons of direct instruction and project-based learning teaching methods. However, if you do not provide permission for your child to participate, or your child declines to participate in the research, he/she may work on other homework while the questionnaire is being given.

7. Assurance of Confidentiality

Your students' results will be kept confidential. The students will use their names on the surveys. The students' names will allow me to match their surveys. This will allow me to measure if a positive or negative change in attitude occurred between the two surveys. The post intervention questionnaire will not have the students name on the sheet, but will contain their gender for research purposes. The papers will be locked in the filing cabinet in my classroom. Results from the surveys and questionnaire will be used in the final report of the research, but children's' names will not be included in the final paper.

8. Voluntary Participation and Withdrawal From the Study

Your child/legal ward's participation is voluntary and he/she can quit at any time. Your decision whether or not to allow your child/legal ward to participate will not affect you or your child/legal ward's classroom grade or any other benefits to which they are otherwise entitled. If you decide to allow your child/legal ward to participate, you are free to withdraw your permission and to discontinue their participation at any time.

9. **Offer to Answer Questions**

You and your child/legal ward should feel free to ask questions now or at any time during the study. If you or your child/legal ward has questions about this study, you can contact Marlen Haugen at 701-347-5352 or at marlen.i.haugen@my.ndsu.edu. If you have any questions about the rights of human research participants, or wish to report a research-related problem, contact the NDSU IRB Office at (701) 231-8908 or ndsu.irb@ndsu.edu.

10. **Consent Statement**

By signing this form, you are stating that you have read and understand this form and the research project, and are freely agreeing to allow your child/legal ward to be a part of this study. If there are things you do not understand about the study, please ask the researchers before you sign the form. You will be given a copy of this form to keep.

____

Parent/Guardian Signature Printed Name Date

____

Parent/Guardian Signature Printed Name Date

____

Relation to Participant Name of Child/Legal Ward

____

Researcher obtaining permission:
Signature Printed Name Date

Youth Assent Form

Research Thesis Evaluating Attitudes of Middle School Students Towards Learning Science

Invitation

You are invited to take part in a research study on students' attitudes towards learning science. The survey is being done by Marlen Haugen, a teacher at Central Cass Schools as part of his graduate program at North Dakota State University where he is a student completing his masters degree.

What will the research involve?

If you agree to take part, you will be asked to complete a survey measuring your science related attitude. You will take this survey first after the direct instruction teaching method. Then you will take the survey again as a post-test after nine weeks of project-based learning units dealing with water pollution and alternative energy.

What are any risks or benefits for me?

This research will not involve any risks to you. While there may not be direct benefit to you, the study will contribute to the advancement of knowledge in this area

Potential Benefits

It will be good for you to take part in this research because you will be providing the researcher information on which instruction method improves students' attitudes to learn science.

Do I have to take part in the research?

Your parent(s) or legal guardian(s) have given their permission for you to be in the research, but it is still your choice whether or not to take part. Even if you say yes, you can change your mind later, and stop participating. Your decision will have no effect (bad or good) on *your class grade or relationship with your teacher or the investigator*.

Who will see my answers and information?

I will make every effort to keep your information private; only I will see your answers on the surveys. Your name will be placed on the surveys in order for me to match them after they are completed. The surveys will be locked in the filing cabinet in my classroom. The questionnaire will only record your gender. Your information will be combined with information from other people in the study. When I write about the study, I will write only about this combined information, and no one will be able to know what your information is.

What if I have questions?

You should ask any questions you have right now, before deciding whether or not to be part of the research. If you or your parent(s) have questions later, they can contact Marlen Haugen, 701.347.5352, marlen.i.haugen@my.ndsu.edu or Dr. Anita Welch at 701.231.5498, anita.welch@ndsu.edu. Your parent(s) or legal guardian(s) will receive a copy of this form to keep.

What are my rights?

- You have rights as a research participant.
- For questions about our rights, or to tell someone else about a problem with this research, you can contact the NDSU Human Research Protection Program (HRPP) at (701) 231-8908 or ndsu.irb@ndsu.edu
- The HRPP is responsible to make sure that your rights and safety are protected in this research. More information is available at: www.ndsu.edu/research/irb.

Sign this form only if you:

- have understood what the research is about and why it's being done,
- have had all your questions answered,
- have talked to your parent(s)/legal guardian(s) about this project, and
- agree to take part in this research

Your Signature	Printed Name	Date

APPENDIX B. TEST OF SCIENCE RELATED ATTITUDES (TOSRA)

(Fraser, 1981)

Name: ______________________

Directions:

1. This test contains a number of statements about science. You will be asked what you think about these statements. There are no “right” or “wrong” answers. Your opinion is what is wanted.
2. For each statement, draw a circle around the specific numeric value corresponding to how you feel about each statement. **Please circle only ONE value per statement.**

5 = Strongly Agree (SA)
4 = Agree (A)
3 = Uncertain (U)
2 = Disagree (D)
1 = Strongly Disagree (SD)

Statement	**SA**	**A**	**U**	**D**	**SD**
1. Money spent on science is well worth spending.	5	4	3	2	1
2. Scientists usually like to go to their laboratories when they have a day off.	5	4	3	2	1
3. I would prefer to find out why something happens by doing an experiment than be being told.	5	4	3	2	1
4. I enjoy reading about things that disagree with my previous ideas.	5	4	3	2	1
5. Science lessons are fun.	5	4	3	2	1
6. I would like to belong to a science club.	5	4	3	2	1
7. I would dislike being a scientist after I leave school.	5	4	3	2	1
8. Science is man’s worst enemy.	5	4	3	2	1
9. Scientists are about as fit and healthy as other people.	5	4	3	2	1
10. Doing experiments is not as good as finding out information from teachers.	5	4	3	2	1
11. I dislike repeating experiments to check that I get the same results.	5	4	3	2	1
12. I dislike science lessons.	5	4	3	2	1

Statement	SA	A	U	D	SD
13. I get bored when watching science programs on TV at home.	5	4	3	2	1
14. When I leave school. I would like to work with people make discoveries in science.	5	4	3	2	1
15. Public money spent on science is the last few years has been used widely.	5	4	3	2	1
16. Scientists do not have enough time to spend with their families.	5	4	3	2	1
17. I would prefer to do experiments rather than to read about them.	5	4	3	2	1
18. I am curious about the world in which we live.	5	4	3	2	1
19. School should have more science lessons each week.	5	4	3	2	1
20. I would like to be given a science book or a piece of science equipment as a present.	5	4	3	2	1
21. I would dislike a job in a science laboratory after I leave school.	5	4	3	2	1
22. Scientific discoveries are doing more harm than good.	5	4	3	2	1
23. Scientists like sports as much as other people do.	5	4	3	2	1
24. I would rather agree with other people than do an experiment to find out for myself.	5	4	3	2	1
25. Finding out about new things is unimportant.	5	4	3	2	1
26. Science lessons bore me.	5	4	3	2	1
27. I dislike reading books about science during my holidays.	5	4	3	2	1
28. Working in a science laboratory would be an interesting way to earn a living.	5	4	3	2	1
29. The government should spend more money on scientific research.	5	4	3	2	1
30. Scientists are less friendly than other people.	5	4	3	2	1
31. I would prefer to do my own experiments than to find out information from a teacher.	5	4	3	2	1
32. I like to listen to people whose opinions are different from mine.	5	4	3	2	1
33. Science is one of the most interesting school subjects.	5	4	3	2	1

Statement	SA	A	U	D	SD
34. I would like to do science experiments at home.	5	4	3	2	1
35. A career in science would be dull and boring.	5	4	3	2	1
36. Too many laboratories are being built at the expense of the rest of education.	5	4	3	2	1
37. Scientists can have a normal family life.	5	4	3	2	1
38. I would rather find out things by asking an expert than by doing an experiment.	5	4	3	2	1
39. I find it boring to hear about new ideas.	5	4	3	2	1
40. Science lessons are a waste of time.	5	4	3	2	1
41. Talking to my friends about science after school would be boring.	5	4	3	2	1
42. I would like to teach science when I leave school.	5	4	3	2	1
43. Science helps to make life better.	5	4	3	2	1
44. Scientists do not care about their working conditions.	5	4	3	2	1
45. I would rather solve a problem by doing an experiment than be told the answer.	5	4	3	2	1
46. In science experiments, I like to use new methods which I have not used before.	5	4	3	2	1
47. I really enjoy going to science lessons.	5	4	3	2	1
48. I would enjoy having a job in a science laboratory during my school holidays.	5	4	3	2	1
49. A job as a scientist would be boring.	5	4	3	2	1
50. This country is spending too much money on science.	5	4	3	2	1
51. Scientists are just as interested in art and music as other people are.	5	4	3	2	1
52. It is better to ask a teacher the answer than to find it out by doing experiments.	5	4	3	2	1
53. I am unwilling to change my ideas when evidence shows that the ideas are poor.	5	4	3	2	1
54. The material covered in science lessons is uninteresting.	5	4	3	2	1
55. Listening to talk about science on the radio would be boring.	5	4	3	2	1
56. A job as a scientist would be interesting.	5	4	3	2	1

Statement	SA	A	U	D	SD
57. Science can help to make the world a better place in the future.	5	4	3	2	1
58. Few scientists are happily married.	5	4	3	2	1
59. I would prefer to do an experiment on a topic than read about it in science magazines.	5	4	3	2	1
60. In science experiments, I report unexpected results as well as expected ones.	5	4	3	2	1
61. I look forward to science lessons.	5	4	3	2	1
62. I would enjoy visiting a science museum on the weekend.	5	4	3	2	1
63. I would dislike becoming a scientist because it needs too much education.	5	4	3	2	1
64. Money used on scientific projects is wasted.	5	4	3	2	1
65. If you met a scientist, he/she would probably look like anyone else you might meet.	5	4	3	2	1
66. It is better to be told scientific facts than to find them out from experiments.	5	4	3	2	1
67. I dislike other people’s opinions.	5	4	3	2	1
68. I would enjoy school more if there were no science lessons.	5	4	3	2	1
69. I dislike reading newspaper articles about science.	5	4	3	2	1
70. I would like to be a scientist when I leave school.	5	4	3	2	1

APPENDIX C. POST INTERVENTION QUESTIONNAIRE

Answer the following questions; make sure to give supporting details.

1. Which teaching method did you like best? Why?

2. How do you learn science the best?

3. Are you interested in pursuing a career in science? Why or why not?

4. What do teachers do to make you want to come to class, participate, and learn science?

APPENDIX D. GROUP MEMBER CONTRACT

Printed name	Signature
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

Roles and Duties Assigned

Project	**Lead Scientist**	**Equipment**	**Reporter**	**Timekeeper**
Watersheds in ND				
Weathering & Erosion				
Soil Profiles				
Aquifers				
Water Usage				
Water, Clean Water & Polluted Water				
Soil Horizons and pH				
Evaporation and Condensation				
Fruitvale				
Water Filtration				

Group must follow these procedures for warning and firing group members:

1. 1st time a student fails to complete a duty assigned for that project, student **MUST** be warned. Warning must be logged on the back of this sheet to be counted.
2. 2nd time a student fails to complete a duty assigned for project, they receive a second warning and group meets with the teacher on the following day. Warning must be logged on the back to be counted.
3. 3rd time a student fails to complete a duty assigned, team **MUST** fire the student.

4. If a group member is sick or absent, the other group members will need to complete their task. This will not count as a warning. (Two unexcused absences can be counted as a warning.)

Student Being Warned	Reason Why?	Warned Student's Signature	Teachers Initials

APPENDIX E. GROUP PATICIPANT RUBRIC

Lead Scientist Rubric (______________)

Name: ________________________ Project: ______________________________ Date: _____________ Class: ______________

Learning target	Score					#
I will **provide and read** the directions for the group.	5	4	3	2	1	
I will **communicate** our group's results with teacher and other groups (when needed) about our project.	5	4	3	2	1	
I will **monitor** our group's performance during experiments and **encourage** everyone to stay on task.	5	4	3	2	1	
I am **responsible** to report daily with teacher on our group member's performance.	5	4	3	2	1	
Reporter (______________)						
I am responsible for **developing** and **synthesizing** answers on the lab reports for our group.	5	4	3	2	1	
I will **evaluate and critique** the facts provided by group members.	5	4	3	2	1	
I will **assess, collect and interpret** group members' observations to use in synthesizing our answers	5	4	3	2	1	
I will **edit** papers for the correct use of spelling and grammar	5	4	3	2	1	

A score of 5 means work is excellent. I worked hard to meet or exceed expectations.
A score of 4 means work is proficient. I met required expectations.
A score of 3 means work is inadequate. I struggled to meet required expectations.
A score of 2 means work is limited. I did not meet required expectations.
A score of 1 means work is incorrect or missing.

Total Score: ________________

Comments

Time/Date Keeper (______________)

Name: ________________________ Project: ______________________________ Date: _____________ Class: ______________

Learning target	Score					#
I will **control** the stopwatch and **manage** our time to complete the project on time.	5	4	3	2	1	
I will **plan** with the lead scientist to set up a schedule for events that will complete the lab.	5	4	3	2	1	
I will be **responsible** hand in the data sheets on time from our reporter.	5	4	3	2	1	
I will **provide** assistance in the cleanup of our lab station.	5	4	3	2	1	
Equipment Manager (______________)						
I will **locate and collect** all materials from the lab supply station during the class period.	5	4	3	2	1	
I will **perform** the duty of returning all materials to lab supply station when finished for the day.	5	4	3	2	1	
I will **provide** group members a list of materials that they need to bring from home for the project.	5	4	3	2	1	
I will **complete** the cleanup of our lab station, and with help from the Time/Date Keeper and others.	5	4	3	2	1	

A score of 5 means work is excellent. I worked hard to meet or exceed expectations.
A score of 4 means work is proficient. I met required expectations.
A score of 3 means work is inadequate. I struggled to meet required expectations.
A score of 2 means work is limited. I did not meet required expectations.
A score of 1 means work is incorrect or missing

Total Score: ________________

Comments

APPENDIX F. SCHEDULE FOR PROJECT-BASED LEARNING AND DIRECT INSTRUCTION LESSONS

Color Key for Direct Instruction Lessons

Black – Notes
Green – Laboratory session
Brown – Worksheets
Red – Tests
Blue -- Quizzes
Gold -- Videos
Purple – No School

August

Monday	Tuesday	Wednesday	Thursday	Friday
		1	2	3
6	7	8	9	10
13	14	15	16	17
20	21	22 Syllabus of Earth Science Class	23 Gyro Lab	24 Notecard Mission Lab
27 SI Measurement	28 Notes WS 1.1-2	29 Core Samples	30 Notes WS 1.3-4	31 Core Samples

September 2012

Monday	Tuesday	Wednesday	Thursday	Friday
3 No School	4 Chapter 1	5 Notes 2.1-2	6 Globe Activity	7 WS 2.1
10 Notes 2.2	11 Latitdue & Longitude Lab	12 Latitude & Longitude WS 2.2	13 Notes 2.3	14 Topgraphic Map Model
17 Topographic Map Profile	18 Compass Notes	19 Quiz 2.2 WS Compass	20 Orientering Lab	21 WS 2.3
24 Wood River	25 Quiz 2.3	26 Time Zones	27 Review	28 Chapter 2

October 2012

Monday	Tuesday	Wednesday	Thursday	Friday
1 Chapter 2 Lab Test	2 Atmosphere Notes WS 15.1	3 Atmosphere Heating Notes WS 15.2	4 Electro-magnetic spectrum	5 Video Weather Forcasting
8 Q 15.1-2	9 Global and Local Winds Notes WS 15.3	10 Video Air Polluiont	11 Air Pollution Notes WS 15.4	12 Air Movement
15 Q 15.3-4	16 Review	17 Chapter 15	18 No School	19 No School
22 Water Cycle Notecards	23 Water Cycle WS 16.1	24 Clouds Triangle WS 16.2	25 Convection Lab	26 Quiz 16.1-2
29 Air Masses and Fronts Foldable WS 16.3	30 Lab 16.1-2	31 Lab 16.3-4		

November 2012

Monday	Tuesday	Wednesday	Thursday	Friday
			1 Lab 16.5-6	2 Quiz 16.3-4 WS 16.4
5 Chp 16.7-8	6 Chp 16.9-10	7 Air Masses and Fronts	8 Review	9 Chapter 16
12 Storm Lab 1-2	13 Storm Lab 3-4	14 Storm Lab 5&8	15 Storm Lab WS	16 Video Climate and Seasons
19 Biome Research	20 Biome Research	21 Biome Research	22 Biome Research	23 Seasons Lab
26 Present Biome Brochure	27 Present Biome Brochure	28 Biome	29 No School	30 No School

December 2012

Monday	Tuesday	Wednesday	Thursday	Friday
3 Notes WS 7.1-2	4 Notes WS 7.3-4	5 Fault Lab	6 Fault Lab	7 Quiz Chp 7
10 Notes WS 8.1-2	11 Notes WS 8.3	12 Triangulation	13 Quiz Chp 8	14 Notes WS 9.1-2
17 Notes WS 9.3	18 Quiz Chp 9	19 Video	20 Chp 7-9 Test	21 Video

January 2013

Monday	Tuesday	Wednesday	Thursday	Friday
	1	2	3 Chap 3 Vocabulary Words	4 Mineral & Rock Research WS 3.1
7 Mineral & Rock Research WS 3.2	8 Mineral & Rock Research WS 3.3	9 Minerals	10 Minerals	11 Minerals
14 Minerals	15 Video	16 Mineral Lab Test	17 Review	18 Mineral Test
21 Mineral &Rock Research WS 4.1-2	22 Mineral and Rock Research WS 4.3-4	23 Rock Lab	24 Rock Lab	25 Rock Lab
28 Present Mineral & Rock PowerPoint	29 Present Mineral & Rock PowerPoint	30 Rock Lab Questions	31 Rock Test	

February 2013 DI

Monday	Tuesday	Wednesday	Thursday	Friday
				1 Notes WS 6.1-2
4 Notes WS 6.3-4	5 Current Science	6 Notes WS 6.5	7 Fossils	8 Video
11 Fossils	12 Layers of Earth	13 C-14 Lab	14 Chp 6 Test	15 No School

Color Key For Project-Based Lessons

Paper work – Plum
Water Filtration – Blue
Soil Horizons and pH – Bronze
Weathering and Erosion – Red
Field trip – Neon Green

Water Collage – Blue
Watershed – Purple
Fruitvale – Orange
Aquifer – Blue

Water Usage –Olive Green
Solar oven -- Yellow
Alternative energy -- Orange
Energy guides -- Green

February 2013 Project-based

Monday	Tuesday	Wednesday	Thursday	Friday
				1
4	5	6	7	8
11	12 Handed out Consent Forms	13	14	15
18 Collected Consent Forms TOSRA Survey (Pre)	19 Student Contracts and Review Rubrics	20 Power Point Preview Group Selection	21 Water, Clean Water, Polluted Water Everywhere Collage	22 Reserach and Work on Collage
25 Reserach and Work on Collage	26 Started Water Usage Recordings Reserach and Work on Collage	27 NAEP Testing	28 Weathering and Erosion Lab	

March 2013

Monday	Tuesday	Wednesday	Thursday	Friday
				1 Weathering and Erosion Lab›
4 Watershed	5 Watershed	6 Watershed	7 Watershed Presentation	8 No School
11 Presented Water Usage Recordings	12 Water, Clean Water, Polluted Water Everywhere Collage Presentation	13 Water, Clean Water, Polluted Water Everywhere Collage Presentation	14 Soil Horizons & Soil pH	15 Soil Horizons & Soil pH
18 Soil Horizons & Soil pH	19 Fruitvale Lab	20 Fruitvale Lab	21 Fruitvale Lab	22 No School
25 Fruitvale Lab	26 Fruitvale Lab	27 Fruitvale Lab	28 Aquifers	29 No School

April 2013

Monday	Tuesday	Wednesday	Thursday	Friday
1 Aquifer Research	2 Aquifer Research	3 Aquifer Build	4 Aquifer Test	5 Water Filtration Research
8 Water Filtration Research	9 Water Filtration Testing	10 Water Filtration Testing	11 Water Filtration Building	12 Water Filtration Final Test
15 Wolf Ridge	16 Wolf Ridge	17 Wolf Ridge	18 Wolf Ridge	19 Wolf Ridge
22 Student Contracts and Review Rubrics Energy Guides	23 Alternative Energy Research	24 Alternative Energy Research	25 Energy Guides	26 No School
29 Alternative Energy	30 Alternative Energy			

May

Monday	Tuesday	Wednesday	Thursday	Friday
		1 Alternative Energy Lab	2 Alternative Energy Lab	3 Solar Oven Reeaerch
6 Solar Oven Research	7 Solar Oven Building	8 Solar Oven Testing	9 TOSRA Survey (Post) Final Questionaire	10

APPENDIX G. SAMPLE TEST, QUIZ, WORKSHEET, AND NOTES FOR DIRECT INSTRUCTION

CHAPTER 1 TEST -- THE WORLD OF EARTH SCIENCE

Name: ____________________________ Class: ___________________ Date: _____________________

Multiple Choice -- *Write the letter of the correct answer in the space provided.*

____ 1. The science that uses geology to study how humans affect the natural environment is_____.
A. paleontology. B. environmental science. C. cartography. D. volcanology.

____ 2. A pencil measures 14 cm long. How many millimeters long is it?
A. 1.4 mm B. 140 mm C. 1,400 mm D. 1,400,000 mm

____ 3. Which of the following is NOT an SI unit?
A. meter B. foot C. liter D. degrees Celsius

____ 4. Which of the following is a limitation of models?
A. They are large enough to be seen.
B. They do not act exactly like the thing they model.
C. They are smaller than the thing they model.
D. They use familiar things to model unfamiliar things.

____ 5. Gillette's hypothesis was ____.
A. supported by his results.
B. not supported by his results
C. based only on observations.
D. based only on what he already knew.

____ 6. A scientist finds a vase that she believes is 2,000 years old. She compares its features to those of similar vases in a museum. She is _____.
A. asking a question.
B. forming a hypothesis.
C. testing a hypothesis.
D. drawing conclusions.

____ 7. If you wanted to learn about plants and animals that live in the ocean, you would speak to a _____ oceanographer.
A. physical B. biological C. geological D. chemical

____ 8. What kind of model is a miniature space shuttle?
A. a physical model
B. a conceptual model
C. an astronomical model
D. a mathematical model

____ 9. How is a climate model an example of a complex mathematical model?
A. Its data can be processed by using equations with few variables.
B. Its variables are based on a system of ideas.
C. It has many variables that must be processed by computers.
D. It allows you to calculate simple measurements.

____ 10. Why is it important for members of the scientific community to learn the results of an investigation?
A. They can make scientific laws based on new discoveries.
B. They can include the information in science textbooks.
C. They can honor scientists for their achievements.
D. They can review evidence to investigate further .

____ 11. If you wanted to learn about the origin, history, and structure of the Earth, you would study
A. meteorology. B. geology. C. astronomy. D. oceanography.

_____ 12. Which unit would be most appropriate for measuring the mass of a cow?
A. a kilogram B. a meter C. a cubic meter D. a gram

_____ 13. What step is the beginning of the process that scientists use to learn more about the natural world?
A. drawing conclusions
B. analyzing data
C. communicating results
D. asking questions

_____ 14. An explanation that ties together many hypothesis and explanations is called a(n)
A. model. B. concept. C. theory. D. investigation.

_____ 15. A safety symbol that shows a picture of a bottle reminds you to
A. wear goggles during a science investigation.
B. use chemicals safely.
C. be careful when handling scissors.
D. use a lot of water during a science investigation.

_____ 16. To find the area of a surface, you
A. use a thermometer.
B. multiply length times width times height.
C. divide mass by volume.
D. multiply length times width.

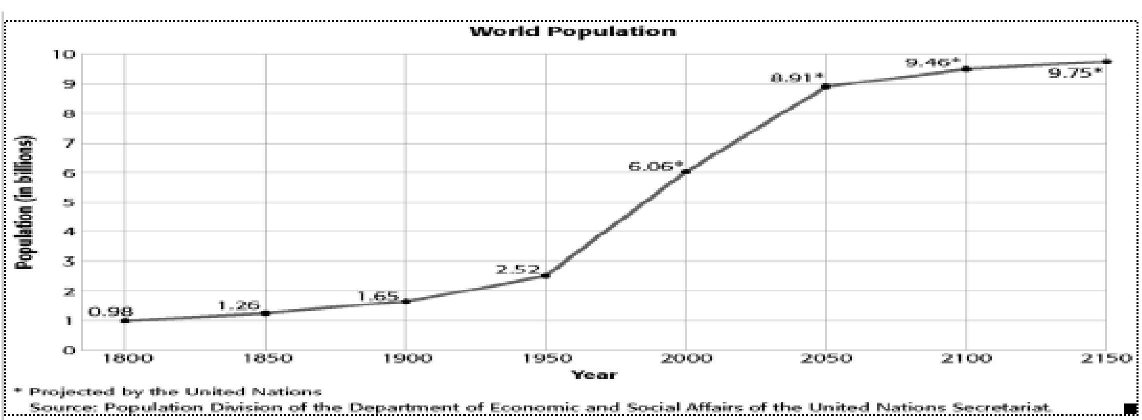
_____ 17. A scientific theory
A. is often used to explain scientific models.
B. is a single hypothesis.
C. ties together many hypotheses and observations.
D. is not useful in predicting the future.

_____ 18. After the results of an investigation are shared, scientists
A. review how the scientific methods were used.
B. evaluate the evidence used.
C. question the reasoning behind the explanations.
D. All of the above

_____ 19. The International System of Units allows scientists to
A. share data around the world.
B. translate data into English.
C. note data in multiples of five.
D. base data on many variables.

_____ 20. Visual aids in your textbook that alert you to use caution during science investigations are called
A. chemical symbols. B. safety symbols. C. hazard signs. D. red flags

Multiple Choice -- *Use the graph below to answer questions 21 through 23. Write the letter of the correct answer in the space provided.*



_____ 21. The graph above is an example of a model called a _____ model.
A. physical b. conceptual c. mathematical D. climate

____ 22. A scientist can use the graph to

A. make predictions about population growth.
B. see the variables that affect population growth.
C. test hypotheses about life span in the future.
D. brainstorm solutions to overpopulation on Earth.

____ 23. According to the graph, what period of time shows the greatest increase in population growth?

A. 1800 - 1900 B. 1900 - 1950 C. 1950 - 2000 D. 2000 - 2050

MATCHING -- *Use the terms from the following word bank to complete the sentences below. Each term may be used only once. Some terms may not be used.*

_____24. ____ is a pattern, representation, or description designed to show the structure or workings of an object, system, or concept.

_____ 25. The measure of the size of a body or region in three-dimensional space is known as the ___.

_____ 26. The study of the Earth's atmosphere, especially in relation to weather and climate is called ____.

_____ 27. The ____ is a series of steps scientists use to solve problems and answer questions.

_____ 28. The study of objects in space is known as ____.

_____ 29. A ____ is a possible explanation or answer to a question that can be tested.

_____ 30. ____ is the ratio of mass to volume of a substance.

_____ 31. ____ can be described by the unit degrees Fahrenheit, degrees Celsius, or kelvin.

_____32. A scientist who maps the surface features of the Earth is known as a ____.

_____33. A scientist tests a hypothesis by observations or doing an ____.

_____34. A scientist who studies and runs tests on surface and subsurface features of the Earth is known as a _____.

_____35. You can use ____ to measure the distance between two buildings.

Word Bank

A. area	E. density	I. mathematical model	M. physical geographer
B. astronomy	F. hypothesis	J. meteorology	N. scientific method
C. experiment	G. liters	K. meters	O. temperature
D. geologist	H. model	L. volume	

CRITICAL THINKING -- Answer the following in complete sentences.

36. Suppose that you find an object that looks like it could be either wood or stone. You hypothesize that it is wood. How would you use the scientific method to determine if your hypothesis is correct? 5 pts

37. Your friend in France sends you an e-mail saying he is not feeling well and that he has a temperature of 37.5 degrees. Should you be worried? Explain. 5 pts

38. A rock that contains fossil seashells might be studied by scientists in at least two branches of Earth science. Name those branches. Why did you choose those two branches? 6 pts

Section 3 & 4 Quiz Scientific Models & Measurement and Safety

Name ________________________________ Class___________________Date__________________

Match the correct description with the correct term. Write the letter in the space provided.

_____ 1. a pattern, plan, representation, or description designed to help us understand the natural world

_____ 2. a model made up of a system of ideas

_____ 3. a model that can be touched and looks and acts like the real thing

_____ 4. a model made up of mathematical equations and data

_____ 5. An explanation that ties together many hypotheses and observations

Word Bank

a. Physical model
b. theory
c. Mathematical model
d. model
e. Conceptual model

Write the letter of the correct answer in the space provided.

_____ 6. Which of the following is NOT a way that models can be used in science?
a. to replace real things in the natural world
b. to explain or analyze something in detail
c. to help explain theories
d. to help us understand the natural world

_____ 7. What model is used to show objects that are too small or too large to see completely?
a. a physical model
b. a mathematical model
c. a conceptual model
d. a climate model

_____ 8. A climate model is an example of a _____.
a. physical model.
b. mathematical model.
c. conceptual model.
d. global model.

_____ 9. The data in a climate model has
a. a large margin of error.
b. a small margin of error.
c. few variables.
d. many variables.

_____ 10. To learn from a model, a scientist must
a. measure the model.
b. choose the right model.
c. visualize the model.
d. take apart the model.

_____11. Why is it important to have the International System of Units?
a. It preserves the system used in England long ago.
b. It uses the smallest possible numbers.
c. Its units are based on objects that vary in size.
d. It can be used by scientists everywhere.

_____12. The volume of a liquid is often given in
a. meters. b. centimeters. c. liters. d. square units.

_____ 13. The basic unit for mass is the
a. kilogram. b. metric ton. c. cubic meter. d. meter.

_____1 4. What should you do during any science investigation?
a. Make predictions.
b. Change your questions.
c. Follow safety rules.
d. Memorize the lab procedures.

Match the correct definition with the correct term. Write the letter in the space provided.

_____ 15. the measure of the size of a surface	a. meter
_____ 16. the measure of how hot or cold something is	b. volume
_____ 17. the basic SI unit of length	c. mass
_____ 18. the ratio of the mass of a substance to the volume of the substance	d. temperature
_____ 19. the measure of the amount of matter in an object	e. area
_____ 20. the measure of the size of a body or region in three-dimensional space	f. density

Essay -- Answer the following in complete sentences.

21 Name three of the five rules stated in the notes for lab procedures. 4 pts

Chapter 1.2 Scientific Methods in Earth Science Worksheet

Name: __________________________ Class: ________________ Date: _________________

Multiple Choice -- *Place the letter the of the answer on the line in the left margin.*

______ 1. An experiment that tests only one factor, or variable, at a time is a(n) _____.

A. biological experiment C. uncontrolled experiment
B. controlled experiment D. all of these

______ 2. What did David Gillette already know when he started examining some bones discovered by hikers?

A. They were dinosaur bones. C. The bones were 10 million years old.
B. They were leg bones. D. The bones were from *Seismosaurus*.

______ 3. Why do scientists draw conclusions about their results?

A. to make sure their hypotheses are true C. to avoid asking new questions
B. to see if their results support their hypotheses D. to make sure they made no errors

______ 4. What can scientists do if their tests do not support their hypothesis?

A. They may repeat investigations to check for errors. C. They organize their data.
B. They keep careful records. D. They try to control all variables.

Essay -- *Answer in complete sentences!*

5. How do scientists test hypotheses? 3pts

6. When scientists want to learn about the natural world, how do they begin the process? 3 pts

7. What is the purpose of changing only one variable in an experiment? 3 pts

8. What do scientists often do to organize and summarize their data? 3 pts

9. Why might an investigation continue after its results are accepted? 3pts

Match the task that David Gillette performed with the correct step in the scientific method from the Word Bank below. Write the letter in the space provided.

______ 10. found that the bones did not match any bones of a known dinosaur

______ 11. concluded that the bones were from a yet unknown dinosaur

______ 12. measured the bones and compared them with known dinosaurs' bones

______ 13. wondered what kind of dinosaur the bones came from

______ 14. shared his results at a press conference and in a scientific journal

______ 15. thought that the bones came from a dinosaur not yet known to scientists

Word Bank

A. Ask a question.	C. Test the hypothesis.	E. Draw conclusions.
B. Form a hypothesis.	D. Analyze the results.	F. Communicate results

Chapter 1: The World of Earth Science Notes

Branches of Earth Science

· Geology (Geologist)

-D-

· Most geologists specialize in a particular aspect of the Earth

- Volcanologists - Seismologists - Paleontologist

· ·

.

· Oceanography (Oceanographer)

-D-

· Specialized oceanographers

- Physical

· Studies physical features of the ocean

-

- Biological

·

- Geological

·

- Chemical

·

- Exploring the Ocean Floor

· Alvin (minisub)

-

· Robert Fronk

· Meteorology (Meteorologist)

-D-

· Specialized meteorologists

- Weather forecasting

· Study the weather patterns for certain areas

- -

-

- Use animal behaviors

· Astronomy (Astronomer)

-D-

· Stars, planets, asteroids, and everything else in space

- Optical telescopes

·

- Radio telescopes

·

Special Branches of Earth Science

· Environmental Science

-

· Ecology (Ecologist)

-

· Geochemistry (Geochemist)

- Chemistry of rocks, minerals and soil

·

·

· Geography (Physical) and Cartography (Cartographers)

- Physical study

- Cartographers make maps by

Scientific Methods in Earth Science
· Ask a Question
- Observation
·
- Leads to questioning and formation of a problem
- David D. Gillette
· Gather information
-
· Hypothesis
- D-
· Controlled experiment
-
· Variable (group)
-
· Control (group)
-
· Making observations
-
· Keeping Accurate results
-
· Analyze the results
-
· Make tables, graphs or models
· Draw conclusions
-
· Hypothesis is
· Communicate results
-
-

Scientific Models
· Model
-D-
· Physical Model
-
· Ex.
· Mathematical Model
-
· Ex.
· Conceptual Model
-
· Ex.
· Climate Model
-

Building Scientific Knowledge
· Theory
-
· Models are used
- Ex.
· Scientific Laws
-

International System of Units

·

- Used by most scientists

· All SI units are based on the number

· Length

-D-

·

· Mass

-D-

·

· Volume

-D-

· ·

· Time

-

·

· Temperature

-D-

· ·

·

· Area

-D-

· Area = length X width

-

· Density

-D-

· Density (D) = $\frac{\text{Mass}}{\text{Volume}}$

·

Safety Rules

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•Safety symbols on page 25

APPENDIX H. SAMPLE OF PROJECT-BASED LESSON

Final Filtration Device

Duration: 2 class periods of 43 minutes

Grade Level: 8th

Objectives:
- Design, build, and test a water filter device.
- Understand the role of engineers in water filtration.
- Explore the types of pollutants that are removed by filtration.

North Dakota State Standards and Benchmarks
- 8.2.2 – Use evidence to generate descriptions, explanations, predictions and models
- 8.2.4 – Design and conduct a scientific investigation
- 8.7.1 – Explain the interaction of science and technology with social issues

Materials:
- 2 liter bottle cut in half (you will need both halves)
- Filtering materials your group choose from the supply station
- Polluted water supply prepared in previous lab.
- Stopwatch
- Marker

Safety Issues:
- Clean up spills immediately and report to teacher.

Background:

Millions of residents of the United States rely solely on groundwater for drinking, cleaning, and cooking. Soil acts as a filter for water, but not all types of pollutants are removed as it travels through the layers. Remember that you are working for an engineering company to provide the city of Casselton with a filtering device to clean up their polluted water.

Procedure:

Day 1

1. Your group will design the best filter system to clean up the polluted water the fastest for the Casselton.
2. You will need to include the cost of the materials also. You will need to justify the reasoning for choosing the filtering material your group chose. Record your budget on the data sheet.
3. Draw filter device on the data sheet and hand in your design to the teacher.
4. Your group will present your design. The other groups should take notes on every presentation. On the data sheet, record which of the filter systems that will produce the purest water and is the quickest to produce 150 mL of water.

Day 2

1. Collect your pieces of the 2-liter bottle and filter materials.
2. Dump 150mL of tap water into the bottom of the cut bottle and mark the 150mL mark with a marker.
3. Dump out the tap water and dry out the bottle.
4. Assembly your filtering device like the example on the front table at your station. (Clean up any spills or excess materials and return to supply station.
5. Collect 250mL of polluted water.
6. Empty the 250mL of polluted water slowly into the device and start timing.
7. Teacher will tell you the four pollutants that were in the water and record on data sheet.
8. Record your observations about what is happening during the filtration process.
9. Stop the stopwatch when your sample reaches the 150mL mark and record on your data sheet.
10. After every group has completed their filtration, we will test for amounts of pollutions left in the water.
11. We will compare the water samples from each group to determine the purest water.
12. If the water samples are tied, the amount of time used will be the tiebreaker.
13. Check to see if your predictions were correct.
14. We will clean up the filtration device by discarding the filtering materials in their properly assigned containers and rinsing out the 2-litter bottles to be used again.

Websites:

www.esi.utexas.edu/outreach/groundwater/
www.teachengineering.org

Data Sheet for Filtration Device

Name: ___________________________ Date: _________________ Class: ___________________

1. Budget for the formation of your Filtration Device.

2. Draw your design in detail and give an explanation for each piece.

3. State your prediction for the group that constructed the best plan for filtration device and why?

4. Which filtration material(s) were effective at filtering each and why, for the following:
    A. Pollutant 1
    B. Pollutant 2 ----
    C. Pollutant 3 ----
    D. Pollutant 4 ----

5. Record your observations of things that happened during the filtration process.

6. What was the time it took for your recovered water to reach the 150mL mark?

7. What pollutants were left in your recovered water if any? Explain why?

8. Was your prediction correct?

9. If you were able to retest the same polluted water, what changes would you make in your filtration device?

10. Did the order in which you placed the filtering materials make any difference? Explain why or why not.