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Problem based learning in a middle school science class : effect on student retention of concepts in plate tectonics and rocks

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PROBLEM BASED LEARNING IN A MIDDLE SCHOOL SCIENCE CLASS: EFFECT ON
STUDENT RETENTION OF CONCEPTS IN PLATE TECTONICS AND ROCKS

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Natural Science

in

The Interdepartmental Program in Natural Sciences

by
Brittany S. Hinyard
B.S., Louisiana State University, 2008
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ABSTRACT

This study investigated the effectiveness and student perceptions of Problem Based Learning (PBL) compared to Traditional Based Learning (TBL) in an eighth grade rural, public middle school using two earth science concepts. Over a four week period, students were taught concepts related to both Plate Tectonics and Rocks. The control group (TBL) for Plate Tectonics (n = 46) was the experimental group (PBL) for Rocks (n = 47). Similarly, the experimental group (PBL) for Plate Tectonics (n = 49) was the control group (TBL) for Rocks (n = 51).

The pretest scores and learning gains for the students were compared to suggest PBL is equally effective as TBL for the concepts. In addition, the pretest questions were categorized into lower order and higher order questions and the positive learning gain for the higher order questions suggests PBL is effective as TBL. Student retention for the concepts was assessed six months after the original study. The data implies students in both the experimental and control groups are not statistically different in terms of content retention. Finally, student perceptions suggest the experimental groups enjoyed learning about their concept more when PBL techniques were used.

INTRODUCTION

The educational system in the United States of America has drawn both national and international attention. In 2002, the former President of the United States of America, George W. Bush, signed into law the No Child Left Behind Act of 2001 (NCLB). This rigorous decree was implemented with the goal of increasing student achievement for all students by the 2014 school year. As the title, No Child Left Behind, suggests, this law was implemented to ensure no child is left behind in the learning process as educators push for all students to be on grade level in both reading and math by 2014 (No Child Left Behind [NCLB], 2002). This change in public education requires schools to be held accountable for student learning. Educators are encouraged to seek alternative ways to improve student achievement while decreasing student achievement gaps in both social economic status and ethnicity, as noted by proficient ratings on state assessments (Braverman, 2002; Jorgensen, 2003). In November 2011, various state educational systems applied for waivers under President Obama's Administration. These waivers restructured the NCLB by requiring states to implement their own specific reforms in exchange for district and state flexibility in the demands set forth by the original NCLB (Ayers et al., 2012).

The political aspect of education reform stems in part from America's international comparison in areas such as problem solving, scientific literacy, reading and mathematics. With the advancement of technology and the need for individuals with analytical and technical skills, students who are leaving high school must be able to read, write and problem solve effectively to fulfill the demands of future careers within the United States (Haynes, 2012).

The Program for International Student Assessment (PISA) is an international assessment composed of reading, mathematics and scientific literacy. The PISA is conducted by the Organisation for Economic Co-operation and Development (OECD). It involves fifteen year old students and is administered every three years since its beginning in 2000 (Literacy Skills, 2003). Data from this assessment shows American students' reading and scientific literacy average scores have hovered around the international average since PISA's implementation. Whereas in mathematical literacy, the data shows America's scores have continually fallen significantly lower than the international average. In addition, achievement gaps between American's racial and ethnic groups exist for each component of the assessment (International Data Explorer, n.d.).

The PISA defines literacy in a boarder context than having the ability to only read and write. In reading literacy, students must be able to interpret and evaluate various forms of reading. With mathematical literacy, students must be able to apply and make judgments using real-life mathematical problems. For, scientific literacy

students must be able to “draw evidence-based conclusions” to understand the natural world we live in. Scientific literacy is a skill that lends itself to increasing college and career readiness due to its applicable nature. In other words, scientific literacy makes transparent the use of higher order thinking skills such as evaluation to draw conclusions about real-life situations (Literacy Skills, 2003).

In 2006, the United States of America’s scientific literacy score on the PISA was 489 which ranked America as twenty-first among thirty countries belonging to the organization. This score classified America statistically below the average of 500, with Finland topping the chart as number one and Mexico trailing the chart. Current 2009 international performance scores released by OECD shows the United States’ scientific literacy ranking has improved to 502, which is above the international ranking average. A slight improvement occurred between the 2006 and 2009 studies but questions remain pertaining to noted achievement gaps and an overall need to improve well above the international average (Literacy Skills, 2003; OECD, 2010). To change the current viewpoint of the American education both nationally and internationally, educators must join together and provide strategies that meet the needs of the 21st century student.

In April 2013 at The Third Annual White House Science Fair, President Obama stated that making Science, Technology, Engineering and Math (STEM) a hands on approach to learning should be a top priority for new teachers and the community. STEM is a focal point to this advancing technological era where students are required to contribute to societal demands of being college and/or career ready by the time they exit high school. The goal of President Obama’s Educate to Innovate Program is to accelerate American students to higher rankings on this international assessment specifically in Math and Science (Educate to Innovate, 2013).

One possible solution to our national and international concern as well as the City of Baker’s school district is to implement active learning techniques, such as Problem Based Learning. Research suggests PBL is equally effective as Traditional or Lecture Based Learning approaches (Biligin et al., 2009; Maxwell et al., 1995; Wong and Day, 2009). In Louisiana, my school is ranked in the 10th percentile in regards to the School Performance Score (SPS). Currently, the SPS is based using a formula which factors in attendance, student dropout rates and state standardized assessment scores, according to NCLB. Not only is it time to change the perception of American education on a macro scale but at Baker Middle on a micro scale as well.

Active learning is a learning theory that has captured the attention of educators in STEM fields and has shown to improve student achievement (Sirinterlikci, 2009). It is an approach to teaching that allows student

participation throughout the learning process. But, passive learning is the teacher-accepted approach that dominates our secondary and higher educational classrooms. During this process, the teacher is the main contributor of knowledge and the students passively receive knowledge from the teacher. In active learning, the teacher is a facilitator of knowledge and many sources of information are used to impart knowledge to the learner (Bonwell and Eison, 1991).

Active learning is an approach to teaching and not necessarily a teaching strategy. The scope of research on active learning includes educational fields such as pharmacy, medical, dental, primary and secondary educational settings. Brenda Gleason et al (2011) discussed the common trends which exist between pharmaceutical education and secondary education. This paper states learning does not specifically occur when an instructor is leading the lesson because “learning without meaning is often soon forgotten.” This method of teaching leads to a learner’s rote memorization of a topic and not the ability to apply the skill being taught (Gleason et. al, 2011). Nevertheless, passive learning has dominated the secondary and higher institutions of learning as the method of educating for breadth instead of depth decades (Bacay, 2005). Gleason et al. also noted active learning techniques incorporated within any field of education, promotes the use of higher order thinking by allowing students and not teachers an opportunity to explain, apply, analyze, design and critique according to Bloom’s Taxonomy (Bloom et al., 1956; Gleason et al., 2011; Mergendoller et al., 2006). Bloom’s Taxonomy lists a progressive state of learning from simple or lower order thinking to more complex or higher order thinking. The higher levels on Bloom’s Taxonomy require the learner to first have a foundational knowledge of the concept and then develop a deeper understanding by thinking critically (Bloom et al., 1956; Bonwell and Eison, 1991) (Appendix A).

Since the nation’s educational goal, as presented by NCLB, is to improve student achievement, it is important for educators to rely upon techniques and methods which foster higher order thinking, problem solving skills, student concept retention and intellectual freedom for all learners. Active learning encourages student-developmental approaches by incorporating meaningful learning instead of rote memory (Gleason et al., 2011). Meaningful learning is an opportunity for students to make connections between new learning and unknown concepts. Students are able to use higher order thinking skills and problem solve as they make these new connections (Limbach and Waugh, 2010; Stepien et al., 1993). Harry Wong, the author of the First Days of School, states “the person who does the work is the only one learning.” In other words, when the teacher dispenses knowledge by explaining the key concepts and students are required to use rote memory to complete the activities,

then the teacher is the one who is learning. Students must be actively involved and engaged in lessons where they are responsible for their learning while the teacher is responsible for facilitating the learning process.

An active learning instructional strategy which restructured medical education in the 1960's was Problem Based Learning (Stepien et al., 1993). Problem Based Learning (PBL) creates new pathways to learning and thinking such as developing students' higher order thinking skills, problem solving abilities, scientific literacy and long-term content retention (Barrows, 1985; Gleason, 2011; Hmelo and Ferrari, 1997). The students are the focal point of the learning process because they construct new knowledge through inquiring and collaborating with their peers on real-world problems presented by the teacher. During the PBL lesson, the teacher is the facilitator of instruction rather than the dispenser of knowledge. The facilitator is responsible for coaching, tutoring and probing students throughout the learning process (Barrows 1985; Stepien et al., 1993). According to Stepien et al., there are four steps which are present in a PBL lesson. These steps include:

1. an ill-structure problem,
2. small collaborative groups,
3. researching and/or creating, and
4. presenting.

Before instruction is received, students are presented with an ill-structured, realistic problem. According to Barrows (1985) an ill-structured problem is characterized by its loose nature where more information is needed than available to suggest options and draw conclusions. The problem provides students with the freedom to determine their plan of action to conduct the investigation. In addition, ill-structured problems must be realistic in nature. Authenticity motivates students by providing them with a challenge where they are stakeholders (Stepien and Gallagher, 1993). The ill-structured problem in PBL is the main mechanism used to uncover multiple concepts and develop new knowledge as students' progress through their investigation.

Step two of PBL is centered on collaborative learning and active student participation. Students work together in small groups to build on one another's strengths and knowledge. Each student is responsible for a task while solving the problem. White and Frederiksen (1998) suggest that the use of collaborative learning effectively supports minority students' knowledge retention. Peer collaboration leads to students analyzing the problem using scientific skills such as: dissecting the problem, asking questions, making observations, explaining key concepts, brainstorming on the information known and the information unknown (Gleason et al., 2008; Wong and Day, 2008).

During this step, the teacher guides students but provides no content knowledge as students attempt to resolve the problem.

Step three of Stepin et al. provides time for students to research their problem. Students use multiple resources to collect answers to the questions they asked; evaluate the information they researched; discuss the answers to questions; build models and create products as necessary.

For the final step, students communicate their findings to others by presenting. The teacher and the other students provide feedback and recommendations for the presenting group. Effective, timely feedback is a great tool to encourage and motivate students (Brookhart, 2008). Collectively, these steps for PBL are geared towards improving student knowledge retention, higher order thinking and problem solving skills while incorporating collaborative grouping and inquiry techniques (Stepien et al., 1993).

In a study by Wong and Day, PBL was compared to Lecture Based Learning (LBL) in a Hong Kong secondary science class [middle school] that involved students ages twelve and thirteen years old. This study examined a concept deemed highly motivating to students, Human Reproduction, and Density, which was noted as a less motivating topic for students. For this study, 37 students were in the experimental group receiving PBL and 38 students were in the control group receiving LBL. The LBL group received habitual lecturing with formative questioning but the PBL group received an ill-structured problem, where the students examined the content related to the concept independently from the teacher's shadowing. Students in the PBL group were not pre-exposed to the PBL procedures; however, the teacher explained possible student collaborative roles and responsibilities and various researching techniques. In the study, Wong and Day found that PBL is as effective as LBL in increasing student's short term knowledge from pretest to posttest for Human Reproduction (LBL +25% and PBL +29%) where students had similar pretest knowledge and Density (LBL +9% and PBL +60%). For Density, students in the LBL had significantly higher pretest results than the PBL group but the PBL learning group had greater short term improvements. The data also suggests PBL is more effective than LBL in increasing student's long term retention of knowledge, comprehension and application questions from pretest to delayed posttest (Wong and Day, 2009).

Maxwell et al (2005) completed a similar study in the fall of 1998. They compared PBL to traditional methods of learning for macroeconomics concepts. Two hundred fifty-two high school students in California were involved in their study. Maxwell et al. noted students entered college level courses in Economics with weak background knowledge of economical concepts, even though understanding economics is central to the lives of

adults. The researchers explained, engagement in PBL methods helped the learner become more self-directed and encouraged the learner to apply [higher order thinking skills] the new information he learned. Their data suggests PBL is as effective as traditional methods in increasing high school students learning of macroeconomics concepts (Maxwell et al., 1995).

For this research study, I decided to compare Baker Middle's TBL structure and PBL learning techniques. The TBL structure is a modified form of the Five E instructional model where student collaboration throughout the learning process is minimized. However, PBL is a collaborative process that supports many physical, emotional and psychological benefits for a middle school student. PBL will allow students to actively walk around and engaged in the learning process; collaborate with their peers; and challenge their thinking about science concepts as they explore an ill-structured problem. In this study, I assessed the following:

1. Is Problem Based Learning with an emphasis in collaborative inquiry skills equally effective as Traditional Based Learning for two earth science concepts, Plate Tectonics and Rocks?
2. Are Problem Based Learning students' as effective as Traditional Based Learning students' in answering higher order thinking questions?
3. Is Problem Based Learning as effective as Traditional Based Learning in students' long-term retention, using a delayed posttest?
4. Do student's perception of scientific learning including instruction delivery, activities and content enjoyment improve?

METHODS AND MATERIALS

Demographics

The participants in this study included 118 eight-graders who attended Baker Middle School, a rural Louisiana public school located in the northern portion of East Baton Rouge Parish. All the students were taught by the same Earth Science teacher in six different sections. The study took place over a four-week period during the first semester in the Fall of 2012.

The participants shared similar demographics to the school's total student demographics. At Baker Middle School, 92.84% are African American; 5.97% are Caucasian; 0.95% are Hispanic; and 0.24% are Hawaiian/Pacific Islander (Table 1). For this study, 94.91% are African American; 3.39% are Caucasian; 0.85% are Hispanic; and 0.85% are Hawaiian/Pacific Islander (Table 1). The gender demographics were also similar for the school and the study group population (Table 1). Ninety-nine percent of students are classified as eligible for free or reduced lunch, which is an indicator of low social economic status in the area serviced by the school district (Table 1). The school receives Title 1 federal funds, due to the social economic status of the school's demographics, to provide programs and resources for the student population (NCLB, 2002).

Table 1: The whole school demographics of Baker Middle School compared to the study group's demographics.

Category	Whole School Population of Baker Middle	Study Group Population by Class Period							
		1	2	3	5	6	8	Total	Percent
Ethnicity									
African American	92.84%	19	19	16	25	18	15	112	94.91%
Caucasian	5.97%	0	0	2	0	2	0	4	3.39%
Hispanic	0.95%	0	0	0	0	0	1	1	0.85%
Hawaiian/Pacific Islander	0.24%	1	0	0	0	0	0	1	0.85%
Gender									
Female	46.30%	11	7	7	13	11	8	57	48.30%
Male	53.70%	9	12	11	12	9	8	61	51.70%
Free or Reduced Lunch Status	99%								99%
Total by Class Period		20	19	18	25	20	16	118	
Plate Tectonics Study Group		E*	C	E	E	C	C		
Rocks Study Group		C*	E	C	C	E	E		

*Note: C: Control Group (Traditional Based Learning)

E: Experimental Group (Problem Based Learning)

Plate Tectonics and Rocks were the two concepts examined during this study. The participants in the control group received TBL and the experimental group received PBL. Students who were in the experimental group for Plate Tectonics were placed in the control group for Rocks. Similarly, the control group for Plate Tectonics was the experimental group for Rocks (Table 1).

For the purposes of this investigation, students who did not meet the criteria to ensure similarity in the students' content exposure and to decrease group bias were eliminated from this study. Nine students in the Plate Tectonics TBL group and twelve students in the Rocks TBL were eliminated from this study. Therefore, 46 students were involved in this study for Plate Tectonics TBL and 51 students for Rocks TBL. The criteria set forth for the control group is as follows:

1. Students had to be present four or more days;
2. Students had to be present on days one, seven and eight;
3. Students had to take both the pretest and the posttest.

Fourteen students in the Plate Tectonics PBL group and eight students in the Rocks PBL group were eliminated because they did not meet the criteria. Therefore, 49 students were involved in this study for Plate Tectonics PBL and 47 students for Rocks PBL. The criteria for the experimental group are as follows:

1. Students had to be present four or more days;
2. Students had to be present on days three, four and eight;
3. Students had to take both the pretest and the posttest.

On the three days where students were required to be present for the study, similar material was being presented or researched for both the control and experimental groups.

Instruments

The participants were assessed using a nine multiple choice question pretest prior to studying each concept. The pretests were used to gauge prior knowledge of students and for comparison between the control and experimental groups. Additionally, the pretest contained five attitudinal survey questions, which were used to measure student's attitudes toward learning science concepts, participation in science class, scientific skills and instructional methods. After instruction occurred for each concept, the participants were administered the posttest with the same nine multiple choice questions and five attitudinal survey questions. In contrast to the pretest, the

posttest had one additional attitudinal survey question. In an attempt to eliminate additional variables into the study, students were given twenty minutes to complete the pretest and posttest on the assessment days (Appendix B).

During the second semester in May, six months after the original study, students were administered a delayed posttest that included the nine multiple choice questions from the pretest. The delayed posttest was used to determine students' long-term retention of the concepts according to Bloom's Taxonomy higher order and lower order levels (Appendix A). The TBL group for Plate Tectonics delayed posttest had 28 students and the PBL group had 36 students. Likewise, the TBL group for Rocks delayed posttest had 39 students and the PBL group had 30 students. Students who were present for the pretest, posttest and delayed posttest data were analyzed to determine their long-term content retention. The numerical difference between the pretest number of students and the delayed posttest number of students demonstrates the efflux turnover at Baker Middle School.

The multiple choice questions for the assessments were assembled using the Geoscience Concept Inventory (GCI) and the Enhanced of Grade Level Expectations (EAGLE). According to Michigan State University website, "the GCI is a valid and reliable assessment instrument designed for diagnosis of alternative conceptions and assessment of learning in entry-level Earth Science courses (The Geoscience Concept Inventory [GCI], 2010; Libarkin, 2006). EAGLE is a district mandated formative assessment program that uses Grade Level Expectations and Common Core Standards to aid in student mastery of core subject concepts (EAGLE, 2007).

The assessment for Plate Tectonics contained four questions from the Geoscience Concept Inventory and five questions from Eagle. In contrast, the Rocks assessment contained three questions from the Geoscience Concept Inventory and six questions from Eagle.

Each assessment contained four questions considered higher order thinking questions according to Bloom's Taxonomy (Appendix A). To determine the Bloom Taxonomy level of questioning, five secondary Science teachers were given the pretests for Plate Tectonics and Rocks, the article *Biology in Bloom: Implementing Bloom's Taxonomy to Enhance Student Learning in Biology* and a copy of Bloom's Taxonomy level classification (Crowe, Dirks and Wenderoth, 2008; "What are Higher Order Thinking Skills?," n.d.). The educators assigned each question on the pretests to one level on Bloom's Taxonomy. The two cognitive skills lower on Bloom's hierarchy, which are knowledge and comprehension were labeled lower order thinking questions; whereas, application and analysis were classified as higher order thinking questions. The teacher responses were compiled and each question was classified as lower order or higher order (Appendix C).

The survey questions on the assessment required students to agree or disagree with the statements as well as give a brief explanation of why they agreed or disagreed with each statement. The questions were generated by two middle school science teachers who previously taught the students and their current science teacher. The survey questions were not mandatory but students were asked to complete them after completing their assessment within the twenty minute timeframe. To ensure continuity within this study, students who were eliminated from the control or experimental groups because they did not meet the criteria were also eliminated from the survey data (Appendix D).

The ill-structured problems for the experimental groups were adapted from The Interactive Pearson Science Textbook Resource Chapter Activities and Projects. The assignment had to be restructured to ensure there were multiple pathways students could arrive at a possible solution to the problem (Barrows, 1985; Appendix G; Appendix H).

Control versus Experimental Groups

The Traditional Based Learning (TBL) group resembled the Lecture Based Learning (LBL) group from Wong's study. Both TBL and LBL study groups were taught in the traditional method of passive learning. The TBL group for this study covered Plate Tectonics and Rocks using the Interactive Pearson Science textbook. Each chapter is composed of four sections and each section took two days to study. In total, the TBL group received eight days of instruction to correspond to the experimental group's instructional days. The Interactive Pearson Science textbook uses the Five E model of instruction (Buckley, Miller, Padilla, Thornton and Wyssession, 2011). During this study, a modified Five E Model was used by eliminating student collaboration and maximizing teacher-student interaction or whole class interactions.

For the control group, Day One of each chapter section consisted of the first three steps in the Five E model, which are Engage, Explore and Explain. Day One begins with an Engager activity called My Planet Diary. Students had five minutes to read the required snippet of real-world information, and then answer the question(s) that followed the paragraph. Next, during the Explore phase of the lesson, students watched a five to ten minute teacher demonstration that related to the concept discussed. While the teacher conducted the Explore demonstrations, two students volunteered as aides. After the demonstration, the class discussed key concepts revealed through the teacher model. Day One concluded with the Explain phase of the Five E model. For the explanation phase, students were required to read the text from their textbooks (Table 2).

The following day is Day Two of instruction for the control group. Day Two starts with a review of Day One's instruction, the Elaborate Phase and the Evaluate Phase of the Five E model. When students entered the classroom on Day Two, they viewed a five minute video from the Interactive Science Textbook resource kit (Buckley et al., 2011; Pearson, 2005). Next, the students had five minutes to use their textbooks and knowledge gained from the video to review and recap the previous day's instruction. A teacher composed question was given to ensure the key concepts of the lesson were investigated. Students had an opportunity to share their responses with the whole class, after the five minute review and recap period.

Day Two continued with the Elaboration Phase of the Five E model. Students completed three figures and one Assess Your Understanding question from the textbook. The information in the figures and the Assess Your Understanding referred back to the text students read on Day One. The final stage to the modified Five E model, the Evaluation phase, included a review worksheet that summarized the lesson (Buckley et. al, 2011). This two day process was repeated for all four sections within the chapter. After the four lessons, the topic is completed and students were administered their posttest on day nine (Table 2).

Table 2: The Traditional Based Learning Group's modified Five E model Daily Agenda.

Five E model	Engage	Explore	Explain	Recap	Elaborate	Evaluate
Day One	My Planet Diary	Teacher demonstration	Reading the lesson			
Day Two				Video and Recap	(IN) Figures and AYU	(IN) Worksheet
Day Three	My Planet Diary	Teacher demonstration	Reading the lesson			
Day Four				Video and Recap	(IN) Figures and AYU	(IN) Worksheet
Day Five	My Planet Diary	Teacher demonstration	Reading the lesson			
Day Six				Video and Recap	(IN) Figures and AYU	(IN) Worksheet
Day Seven	My Planet Diary	Teacher demonstration	Reading the lesson			
Day Eight **				Video and Recap	(IN) Figures and AYU	(IN) Worksheet

**Note: Day Nine consists of the posttest for both the experimental and control groups.

IN: Independent work

AYU: Assess Your Understanding

The experimental group in this study followed Stepien et al's (1993) four features of Problem Based Learning (Table 3). Day one of instruction included a vague teacher facilitated introduction of the concept. A map which shows locations of earthquake and volcanic activity was presented to introduce Plate Tectonics. In groups,

students discussed the pattern they noticed on the maps which lead to the ill-structured problem PowerPoint presentation by the teacher. For Rocks, students were introduced to minerals and rocks using pictures of the Grand Canyon on a PowerPoint presentation. Next, the groups discussed the pattern they noticed with the pictures and identified the difference between a rock and mineral. After the discussion, students were presented with Rocks ill-structured problem via a PowerPoint presentation. This is the first step in the sequence of PBL (Stepien et. al 1993).

Table 3: The Problem Based Learning Group’s Daily Agenda according to Stepien et al. features of Problem Based Learning.

Stepien et. al’s Four features of PBL	Introduction of the problem	Analyzing the problem in small collaborative groups	Researching the topic and producing the product	Presentation of findings
Day One	Presentation using maps and pictures; and introduction of problem via PowerPoint	Identify and dissect the problem		
Day Two		Identify and dissect the problem; and turn in plan of action		
Day Three			Research problem and put plan of action into play; Teacher guidance included	
Day Four			Research problem and put plan of action into play. Teacher guidance included	
Day Five			Research, models and write discussion	
Day Six			Models and write discussion	
Day Seven			Models and write discussion	
Day Eight **				Presentations and Feedback

**Note: Day Nine consists of the posttest for both the experimental and control groups.

Step two of PBL consists of the student groups identifying and dissecting the ill-structured problem. On day two, the groups continued to dissect the problem and were required to turn in their plan of action, which was viewed by the teacher. The plan of action was used as a checkpoint to assess students’ progress on the ill-structure problem. On days three and four, groups researched their problem using their plan of action as a guide. The teacher facilitated, encouraged and guided students as they completed their research. This is step three of PBL.

Next, on day five students continued their research, begin creating their models and writing their discussion concerning their ill-structured problem. Days six and seven were dedicated to completing models and student written discussions. On day eight, students presented their models and discussions to their audience and feedback was provided. On day nine, students completed their posttest (Table 3). Students were not given official outside class time to work on their problems. To control for the time allotted for the experimental group the materials used in Problem Based Learning were collected daily. Likewise, for the control group, student textbooks were collected daily.

Data Analysis

The effects of PBL for Plate Tectonics and Rocks on student knowledge of each topic, student's ability to apply and analyze and student long-term retention were examined using the Mann-Whitney Test in GraphPad InStat. Using SPSS 12.0 1 for Windows, a Nonparametric Binomial Test was used to analyze the pretest and posttest survey responses for the control and experimental groups. Frequencies above 0.50 means more students agreed with the response than disagreed. Likewise, frequencies below 0.50 means more students disagreed with the response than agreed.

Institutional Review Board

The students participating in this study were fully aware of their voluntary services and agreed to participate by providing a signed parental consent letter (Appendix F). This research project and the consent form were approved by the City of Baker Schools and the Louisiana State University Institutional Review Board.

RESULTS

To determine the effectiveness of PBL compared to TBL, students' pretest scores and learning gains were analyzed. Table 4 shows Plate Tectonic pretest scores for the TBL group was 3.11, while it was 2.98 for the PBL group. The p value 0.6864 indicates that there is not a significant difference in terms of student content knowledge before instruction was delivered. After the teaching strategies were implemented, positive learning gains for both groups were noted. However, there were no significant differences (p value= 0.2862) between the control ($\bar{x} = 2.07 \pm 0.28$) and experimental groups ($\bar{x} = 1.76 \pm 0.21$) learning gains. Similar results occurred for the concept of Rocks. There were no significant differences (p = 0.3541) between the pretest scores for the TBL group ($\bar{x} = 3.29 \pm 0.21$) and the PBL group ($\bar{x} = 3.70 \pm 0.25$). Students in both groups performed at the same level prior to receiving instruction about Rocks. The learning gain for students that used TBL ($\bar{x} = 1.71 \pm 0.26$) was not different from the learning gain of students that used PBL ($\bar{x} = 1.26 \pm 0.26$). Each teaching strategy positively impacted students' learning.

Table 4: TBL and PBL groups pretest and learning gain results for Plate Tectonics and Rocks.

Concept of Study	Test Type	Mean \pm Standard Error	Standard Deviation	p value
Plate Tectonics	Control Pretest (n = 46)	3.11 \pm 0.22	1.51	0.6864
	Experimental Pretest (n = 49)	2.98 \pm 0.17	1.16	
	Learning Gain Control	2.07 \pm 0.28	1.91	0.2862
	Learning Gain Experimental	1.76 \pm 0.21	1.48	
Rocks	Control Pretest (n = 51)	3.29 \pm 0.21	1.51	0.3541
	Experimental Pretest (n = 47)	3.70 \pm 0.25	1.73	
	Learning Gain Control	1.71 \pm 0.26	1.86	0.1683
	Learning Gain Experimental	1.26 \pm 0.26	1.76	

The second goal of this study was to determine if PBL is equally effective at improving student's ability to answer higher order thinking questions compared to students who were exposed to TBL. For Plate Tectonics higher order thinking questions, the pretest for the TBL ($\bar{x} = 1.35 \pm 0.15$) and PBL ($\bar{x} = 1.25 \pm 0.14$) groups and learning gains for the TBL ($\bar{x} = 0.72 \pm 0.16$) and PBL ($\bar{x} = 0.73 \pm 0.20$) showed there were no significant differences (p value = 0.6275; p value = 0.9471, respectively). The higher order thinking questions showed there were no statistical

differences (p value = 0.3217) for the Rocks pretest control (\bar{x} = 1.18 \pm 0.10) and experimental groups (mean = 1.38 \pm 0.14). The learning gains were analyzed for the TBL group (\bar{x} = 0.84 \pm 0.14) and PBL (\bar{x} = 0.70 \pm 0.17) and there was not difference between the two groups (p value = 0.5285). For both Plate Tectonics and Rocks the groups had the same higher order thinking knowledge before instruction and after instruction. Students demonstrated positive learning gains from pretest to posttest. The lower order thinking questions data were also analyzed for this study (Table 5).

Table 5: Plate Tectonics and Rocks pretest and learning gain categorized based on Bloom's Taxonomy.

Concept of Study	Bloom's Level	Test type	Mean \pm Standard Error	Standard Deviation	p value
Plate Tectonics	Lower order	Pretest Control (n = 46)	1.78 \pm 0.16	1.05	0.8704
		Pretest Experimental (n = 49)	1.76 \pm 0.16	1.15	
		Learning Gain Control	1.33 \pm 0.22	1.48	0.3096
		Learning Gain Experimental	1.04 \pm 0.18	1.24	
	Higher order	Pretest Control	1.35 \pm 0.15	0.99	0.6275
		Pretest Experimental	1.25 \pm 0.14	0.99	
		Learning Gain Control	0.72 \pm 0.16	1.11	0.9477
		Learning Gain Experimental	0.73 \pm 0.20	1.43	
Rocks	Lower order	Pretest Control (n = 51)	2.11 \pm 0.16	1.13	0.5659
		Pretest Experimental (n = 47)	2.32 \pm 0.18	1.24	
		Learning Gain Control	0.86 \pm 0.21	1.47	0.2862
		Learning Gain Experimental	0.55 \pm 0.20	1.38	
	Higher order	Pretest Control	1.18 \pm 0.10	0.74	0.3217
		Pretest Experimental	1.38 \pm 0.14	0.99	
		Learning Gain Control	0.84 \pm 0.14	1.00	0.5285
		Learning Gain Experimental	0.70 \pm 0.17	1.20	

The next goal of this study was to determine students' long-term content retention of Plate Tectonics and Rocks after six months using a delayed posttest. For Plate Tectonics lower order thinking questions, the TBL (\bar{x} = 1.68 \pm 0.24) and PBL (\bar{x} = 1.89 \pm 0.17) groups and posttest for the TBL (\bar{x} = 3.32 \pm 0.19) and PBL (\bar{x} = 2.94 \pm 0.15) groups were analyzed. The data showed there were no statistical differences in the pretest (p value = 0.3577) or posttest (p value = 0.2006) results for the two groups. Prior to instruction the students for the delayed data had the same level of knowledge before instruction and after instruction. However, the delayed posttest for the lower order

thinking questions with the TBL ($\bar{x} = 2.70 \pm 0.20$) and PBL ($\bar{x} = 2.19 \pm 0.19$) groups showed a significant difference between the two groups (p value = 0.0268). The students in the TBL group retained a greater lower order content knowledge than the students in the experimental group (Table 6).

The higher order thinking questions for the pretest TBL group ($\bar{x} = 1.57 \pm 0.18$), pretest PBL group ($\bar{x} = 1.47 \pm 0.15$), posttest TBL group ($\bar{x} = 2.32 \pm 0.22$), posttest PBL group ($\bar{x} = 2.06 \pm 0.18$), delayed posttest TBL group ($\bar{x} = 2.36 \pm 0.18$) and delayed posttest PBL group ($\bar{x} = 2.28 \pm 0.16$) showed there were no statistical differences (p value = 0.6595; p value = 0.4707; p value = 0.8810, respectively) for Plate Tectonics. Therefore, students in both groups started at the same level of knowledge and their learning positively progressed at the same level (Table 6).

Table 6: Plate Tectonics and Rocks pretest, posttest and delayed posttest results (mean, standard error, standard deviation and p value) categorized based on Bloom's Taxonomy.

Concept of Study	Bloom's Level	Test type	Mean \pm Standard Error	Standard Deviation	p value
Plate Tectonics	Lower order	Pretest control (n = 28)	1.68 \pm 0.24	1.25	0.3577
		Pretest experimental (n = 36)	1.89 \pm 0.17	1.04	
		Posttest Control	3.32 \pm 0.19	1.02	0.2006
		Posttest Experimental	2.94 \pm 0.15	0.92	
		Delayed Posttest Control	2.70 \pm 0.20	1.08	0.0268**
		Delayed Posttest Experimental	2.19 \pm 0.19	1.12	
	Higher order	Pretest control	1.57 \pm 0.18	0.96	0.6595
		Pretest experimental	1.47 \pm 0.15	0.91	
		Posttest Control	2.32 \pm 0.22	1.19	0.4707
		Posttest Experimental	2.06 \pm 0.18	1.07	
		Delayed Posttest Control	2.36 \pm 0.18	0.95	0.8810
		Delayed Posttest Experimental	2.28 \pm 0.16	0.94	

** The p value notes a statistical significance between compared groups with an alpha level of 0.05.

In Table 7, students' long-term retention for Plate Tectonics was calculated by subtracting the posttest mean from the delayed posttest mean. The PBL students (+0.22) long-term retention for the higher order questions was greater than the TBL students (+0.04). There were no significant differences in long-term retention between the

two groups. Students in the experimental group retain the same level of knowledge as those in the control group (Table 7).

Table 7: Long-term retention for Plate Tectonics TBL and PBL groups according to Bloom's lower order and higher order levels.

Plate Tectonics				
Bloom's Level	Grouping	Posttest	Delayed posttest	Long-term retention
Lower order	TBL	3.32	2.70	-0.62
	PBL	2.94	2.19	-0.75
Higher order	TBL	2.32	2.36	+0.04
	PBL	2.06	2.28	+0.22

The lower order and higher order thinking questions were analyzed for the concept of Rocks. The data showed there were no statistical differences between the various groupings (Table 8). In addition, students' long-term retention for Rocks higher order questions was greater for the PBL (+0.13) than for the TBL group (0.0). There were no significant differences in long-term retention between the two groups for Rocks. Students in the experimental group retain the same level of knowledge as those in the control group (Table 9).

Table 8: Plate Tectonics and Rocks pretest, posttest and delayed posttest results (mean, standard error, standard deviation and p value) categorized based on Bloom's Taxonomy.

Concept of Study	Bloom's Level	Test type	Mean ± Standard Error	Standard Deviation	p value
Rocks	Lower order	Pretest Control (n = 39)	2.10 ± 0.18	1.14	0.2895
		Pretest Experimental (n = 30)	2.47 ± 0.23	1.25	
		Posttest Control	2.95 ± 0.20	1.26	0.3644
		Posttest Experimental	3.20 ± 0.18	0.96	
		Delayed Posttest Control	2.64 ± 0.21	1.29	0.3953
		Delayed Posttest Experimental	2.37 ± 0.24	1.30	
	Higher order	Pretest control	1.26 ± 0.11	0.72	0.6141
		Pretest Experimental	1.40 ± 0.18	1.00	
		Posttest Control	2.15 ± 0.16	0.99	0.7623
		Posttest Experimental	2.27 ± 0.17	0.94	
		Delayed Posttest Control	2.15 ± 0.17	1.07	0.3283
		Delayed Posttest Experimental	2.40 ± 0.23	1.28	

Table 9: Long-term retention for Rocks TBL and PBL groups according to Bloom’s lower order and higher order levels.

Rocks				
Bloom’s Level	Grouping	Posttest	Delayed posttest	Long-term retention
Lower order	TBL	2.95	2.64	-0.31
	PBL	3.20	2.37	-0.83
Higher order	TBL	2.15	2.15	0.0
	PBL	2.27	2.40	+0.13

For the final research question in this study, an attitudinal survey was administered to students. There were no statistical differences between most of the survey questions from the pretest survey to the posttest survey for either concept. But, on the Plate Tectonics survey students were asked do they use inquiry skills often during scientific lessons and there was a statistically difference between students’ pretest and posttest survey responses. The experimental group (+0.25) agreed more than the control group (+0.19) and a statistically difference was noted between the posttest frequencies of the groups (Figure 1, Appendix I). In addition, students in the TBL (+0.51) and the PBL (+0.55) groups agreed they enjoyed learning about Plate Tectonics. A greater rate of agreement was seen in the PBL group but there were no significant differences between the posttest survey frequencies (Figure 1, Appendix I).

Pretest Survey and Posttest Survey Mean Differences Plate Tectonics

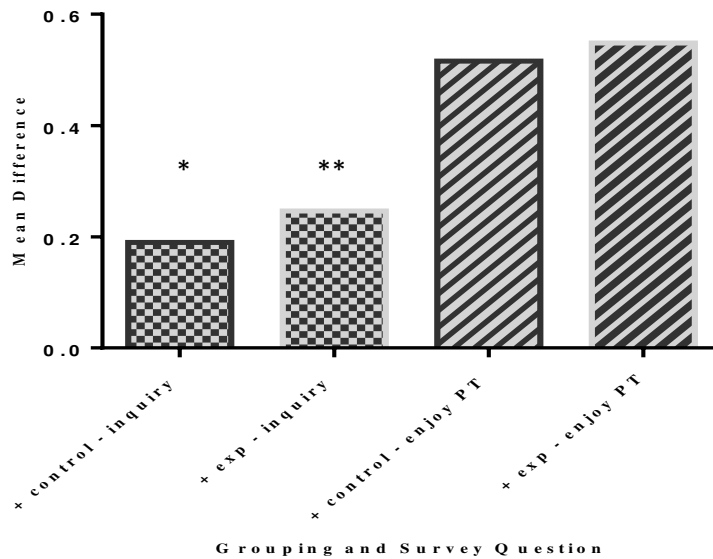


Figure 1: Mean difference between student pretest survey and posttest survey responses for Plate Tectonics.

- * Statistical difference between control and experimental pretest survey frequencies
- ** Statistical difference between control and experimental posttest survey frequencies
- + control: Statistical difference between control pretest and posttest survey frequencies
- + exp Statistical difference between experimental pretest and posttest survey frequencies

On the Rocks survey, there were also notable differences between the pretest and posttest survey responses. In Figure 2, after instruction the control (+0.18) and experimental groups (0.0) agreed that they prefer to create while learning new science concepts. There was a difference between the control and experimental groups (p value = 0.019) posttest survey responses with the control group agreeing more than the experimental group (Figure 2, Appendix I). The next question on the survey, asked students do they prefer the teacher teaching while they listen. Prior to instruction a statistical significant number of students agreed more in the control group (0.87) agreed than in the experimental group (0.65). However, after instruction there were no statistical differences between the control (0.78) and experimental (0.76) groups with students in the control group agreeing less after instruction (Figure 2, Appendix I).

In addition, students were asked did they enjoy learning about Rocks. There were significant differences between the pretest and posttest survey responses for the control (+0.25) and experimental (+0.16) groups. The control group agreed more after TBL instruction for Rocks occurred than the PBL group; however, both groups had a positive gain for enjoyment (Figure 2, Appendix I).

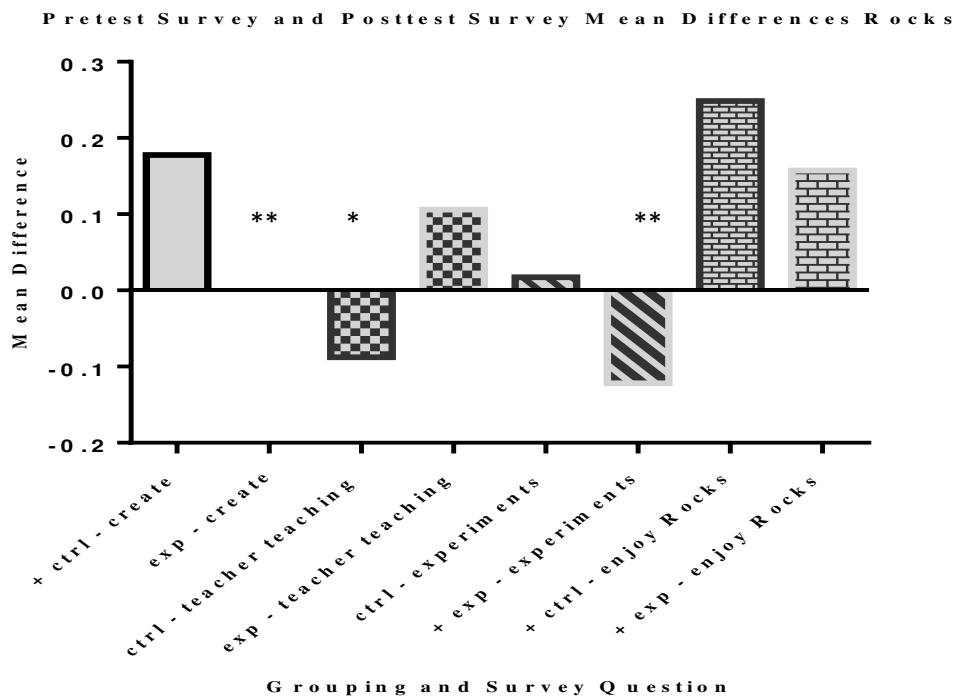


Figure 2: Mean difference between student pretest survey and posttest survey responses for Rocks.

* Statistical difference between control and experimental pretest survey frequencies

** Statistical difference between control and experimental posttest survey frequencies

+ ctrl: Statistical difference between control pretest and posttest survey frequencies

+ exp: Statistical difference between experimental pretest and posttest survey frequencies

The final survey questions on Plate Tectonics and Rocks posttest showed significant differences. For Plate Tectonics, the question asked students do they enjoy participating in all of their science activities. More students in the PBL agreed with a frequency of 0.97 than in the TBL (0.87). For Rocks, the question asked students did they enjoy how Rocks was taught over Plate Tectonics. The experimental group for Rocks agreed more (0.83) than the students in the control group (0.58). These questions were used to determine students enjoyment of the teaching strategies used for each concept.

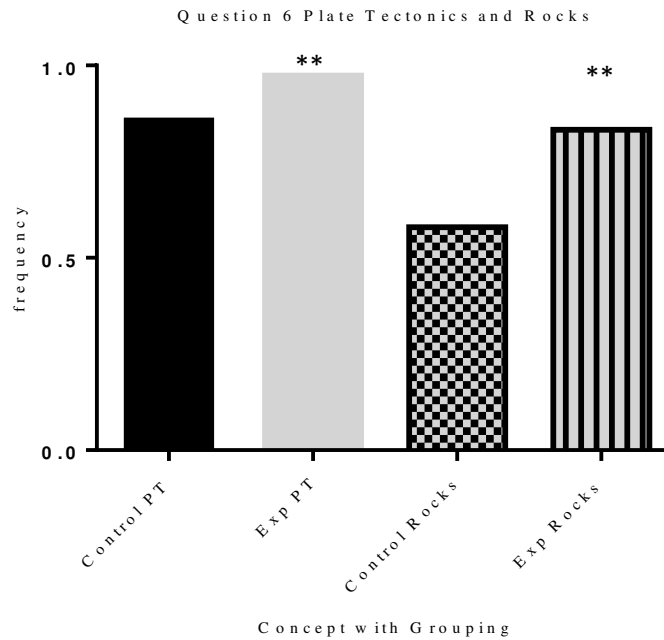


Figure 3: Question six control and experimental groups' posttest survey frequencies for Plate Tectonics and Rocks.
 ** Statistical difference between control and experimental pretest survey frequencies

DISCUSSION

Problem Based Learning and other active learning techniques are expanding into secondary classrooms all across the nation, as educators implement strategies to improve student achievement. Few research studies are available on the impact of PBL for middle school students in the United States. The overall purpose of this study was to compare the effectiveness of PBL in a rural, low social economic status middle school classroom to Traditional Based Learning. Plate Tectonics and Rocks were two concepts chosen in this study from the Eight Grade Louisiana Curriculum.

In this investigation, students in Traditional Based Learning and Problem Based Learning groups had positive learning gains which showed no significant differences between the groups. This suggests PBL is effective as TBL in teaching students about the two earth science concepts. Student's ability to answer higher order thinking questions was studied during this investigation. This study proposes PBL is effective as TBL in teaching students higher order thinking skills. Next, students' long-term retention was analyzed. Students in the control group for Plate Tectonics answered the lower order questions on the delayed posttest with a greater mean than the students in the experimental group. This could be explained because students in the control group were exposed to the factual concepts associated with Plate Tectonics during and after the investigation more often than those who were in the PBL group. Both groups delayed testing higher order questions and Rocks lower order questions did not show significant differences in long-term retention. However, greater positive long-term gains for the higher order questions were noted for each experimental group. This research suggests PBL students are as effective at answering higher order questions after a delayed posttest as students who are taught by traditional methods such as the modified 5 E model.

This study focused on student's perception of scientific learning including teaching strategies, science content and activities. On the Plate Tectonics posttest survey [question six], the PBL group enjoyed participating more than those students who belonged to the TBL group. One student stated "it's better than doing work out of a book." In general, students' responses suggest they participate because science activities can be fun.

The Rocks posttest survey [question six] asked students to determine if they enjoyed how Rocks was taught more than Plate Tectonics. There was a significantly greater agreeable response from students in the PBL group for Rocks than the TBL group. One student responded "I know more information about rocks than plate tectonics." On the other hand, some students in the control group responses referred back to their enjoyment of using PBL to study

Plate Tectonics. PBL groups for both concepts suggest students enjoy the instructional delivery more because they were able to complete a project (Figure 3, Appendix E). Similarly, research studies suggest students perform as effective as students receiving TBL techniques but they prefer to participate in PBL activities (Gleason et al., 2011; Mergendoller et al., 2006).

For Plate Tectonics, significant differences were found when students were asked about using inquiry skills. The experimental group agreed more than the control group on the pretest and posttest about their use of inquiry skills (Figure 1). From the survey responses, students lacked an understanding of inquiry prior to instruction but both groups acquired a better understanding after instruction (Appendix E).

For the Rocks survey, students in the control group for Rocks determined they like to create more than the experimental group during the learning process because it helps them learn better (Figure 2, Appendix E). This could be explained because the students in the control group experienced PBL before TBL and they preferred the strategies used in PBL due its hands-on engagement (Appendix E).

Students in the experimental and control groups enjoyed learning about Plate Tectonics and Rocks after instruction occurred. Survey responses implied students did not have an expansive background knowledge of either concept but became knowledge once instruction occurred (Appendix E).

Research suggests active learning strategies such as PBL are effective as traditional teaching techniques (Gleason et al., 2011; Stepien et al., 1993). Maxwell et al. (2005) results were similar to the results obtained in this study. The researchers noted that students in the PBL group were able to acquire the same level of knowledge as students taught by traditional methods. In Wong and Day's (2008) study, PBL was deemed as effective as traditional techniques involving lecturing, teacher questioning and book assignments. Contrary to this study, Wong and Day noted a difference between students' long-term ability to comprehend, apply and analyze when in the PBL group. Prior to PBL delivery the researchers provided students with the background on how to research and the roles and responsibilities of group members necessary to approach a problem based task. But the students in this study did not have prior knowledge concerning problem based strategies. Another reason could be Wong and Day's students were more motivated to complete this task because they were just entering the secondary education setting with a lack of knowledge pertaining to teacher teaching strategies in the secondary setting. In this study students were exposed to forms of the 5 E model [TBL] for over two months before the research investigation.

The instructional method of choice for most educators involves passive learning techniques such as lecturing and direct instruction (Bacay, 2005) as seen by the traditional methods used in the above studies. In contrast to TBL, a focus of PBL is the teacher's role as a metacognitive coach or guide and not the teacher as the expert (Bonwell and Eison, 1991; Sirinterlikci and Sirinterlikci, 2009; Stepien et al., 1993; White and Frederiksen, 1998). For this study, survey responses imply that the students were comfortable when the teacher was teaching the class [expert] but they also prefer to work with hands-on activities (Appendix E). One possible reason could be the recent implications of active learning strategies within the secondary classroom, specifically at Baker Middle. Students are not accustomed to student-centered instruction which may cause them to be bias towards teacher-centered instruction. Research suggests that active learning strategies prompt student motivation to learn (Stepien et al., 1993). As educators, if the classroom were active learning centered students would become comfortable with strategies that encourage them to think.

The results from this study support previous research about the effectiveness of active learning strategies motivating students during the learning process (Figure 3, Appendix E). In this study, PBL students seem more engaged in solving their ill-structured problem even though differences were not seen in the learning gains between the two groups. Bonwell and Eison (1991) suggest active learning is when the participant is involved in learning process and reflecting on their learning. When students are given an opportunity to take ownership of their own learning it leads to the development of higher order thinking skills (Bloom et al., 1956; Gleason et al., 2011; Mergendoller et al., 2006). All students had the opportunity to engage independently on their assignments, which may account for positive learning gains for the control and experimental groups with answering higher order thinking questions (Table 5).

Bloom et al (1956) provided a hierarchy for thinking that has been used by educators all across the nation and the world since its introduction. At the top of the hierarchy are skills which require students to go beyond the surface of knowledge and into the depths of critical thinking. For the PBL group, students distinguished between relevant and irrelevant information; composed models; reflected on their own models; made recommendations; and evaluated the models of their peers. These skills are at the top of Bloom's Taxonomy [analysis, synthesis and evaluation]. In contrast, the TBL students read, recalled, identified, reviewed, explained and summarized information during instruction of the modified Five E model. These abilities are at the bottom of Bloom's Taxonomy [knowledge and comprehension] (Bloom et al., 1956). Further research using subjective testing could

determine if there exists a difference between PBL students and traditional method students' abilities to think critically and problem solve.

Furthermore, PBL, inquiry, higher order thinking and scientific literacy encourages the pupil to participate in the learning process while developing the skills needed to be life-long learners (Hmelo and Ferrari, 1997; National Research Council [NRC], 1996). Stepien et al. (1993) states students in PBL groups work with ill-structured problems which permits them "to gather information, assess what they know, form hypotheses, support their conclusions and evaluate the work of others." Students have an opportunity with the problem based model to inquire about the world around them and support their conclusions by using research based evidence [literacy]. As noted above, evaluation is a higher order thinking skill.

There is a need within our educational system which requires students to function on grade level and to be competitive nationally and internationally. Active learning strategies can support decreasing student achievement gaps in regards to ethnicity and social economic status. In this study, students were from a low social economic status background but when compared to other studies with different student demographics both groups performed equally as well (Maxwell et al., 2005; Wong and Day, 2009). With current research suggesting the long-term effectiveness of PBL, this strategy could be vital to positively influencing student achievement for all learners (Beng, 2005; Stepien, 1993; Wong and Day, 2009).

Student responses suggests when given the opportunity to learn new material, they prefer using hands-on techniques to create models (Table 9). President Obama stated STEM should be a hands-on approach to learning (Educate to Innovate, 2013). The pioneers of PBL in medical schools and on the secondary level stress the importance of providing students with ill-structured realistic problems that will provide them with an opportunity to research and create throughout the learning process (Barrows, 1985; Stepien et al., 1993). The societal demands placed on the next generation encourage students to have problem solving and critical thinking skills to fulfill the careers of the future. PBL is an instructional strategy driven by authentic ill-structured problems. Students have the opportunity to involve themselves in real-world problems.

In addition, there were limitations in this study. This research took four weeks to implement two concepts from the Louisiana Grade Eight Comprehensive Curriculum. The curriculum provides four days to study each topic (EAGLE, 2007). Time constraints imposed by state testing and curriculum completion modified the time students needed to completely explore the PBL topic. PBL requires flexibility in implementation with respect to curriculum

demands. Stepien et al. (1993) supports the use of post-holes which are problem scaled down due to timing. Another limitation of this research involved student's ability to demonstrate their problem solving skills. Students were given a multiple choice pretest and posttest but were not provided with the opportunity to demonstrate their problem solving and critical thinking skills.

Problem Based Learning has potential to influence student achievement across different backgrounds and in different classroom settings. Therefore, future studies should be completed to determine the effectiveness of higher order thinking for students involved in a longitudinal study at the secondary education level.

SUMMARY AND CONCLUSION

This study tested the effectiveness of Problem Based Learning on student knowledge of the concepts of Plate Tectonics and Rocks, long-term student retention of the concepts and student conceptual knowledge using higher order thinking questions. The results suggest PBL is equally effective as TBL on student learning gains and on the delayed posttest (Tables 4, Table 6, Table 8). The questions on the pretest were categorized as lower order and higher order questions. There were no statistical differences in student's ability to answer higher order thinking questions which suggest PBL is as effective as TBL (Table 5). Although, there were no statistical differences the experimental group had greater levels of long-term retention than the control group for the higher order thinking questions (Table 7, Table 9). In addition, students' were surveyed and the results of this study indicate there are differences between the control and experimental groups in terms of students use of inquiry during lessons; student enjoyment of science activities; and the method used to aid in concept delivery (Figure 1, Figure 2, Figure 3).

In conclusion, Problem Based Learning is equally effective as Traditional Based Learning in terms of student concept retention of the concepts Plate Tectonics and Rocks and the students in the PBL enjoyed participating in the activities more than the TBL.

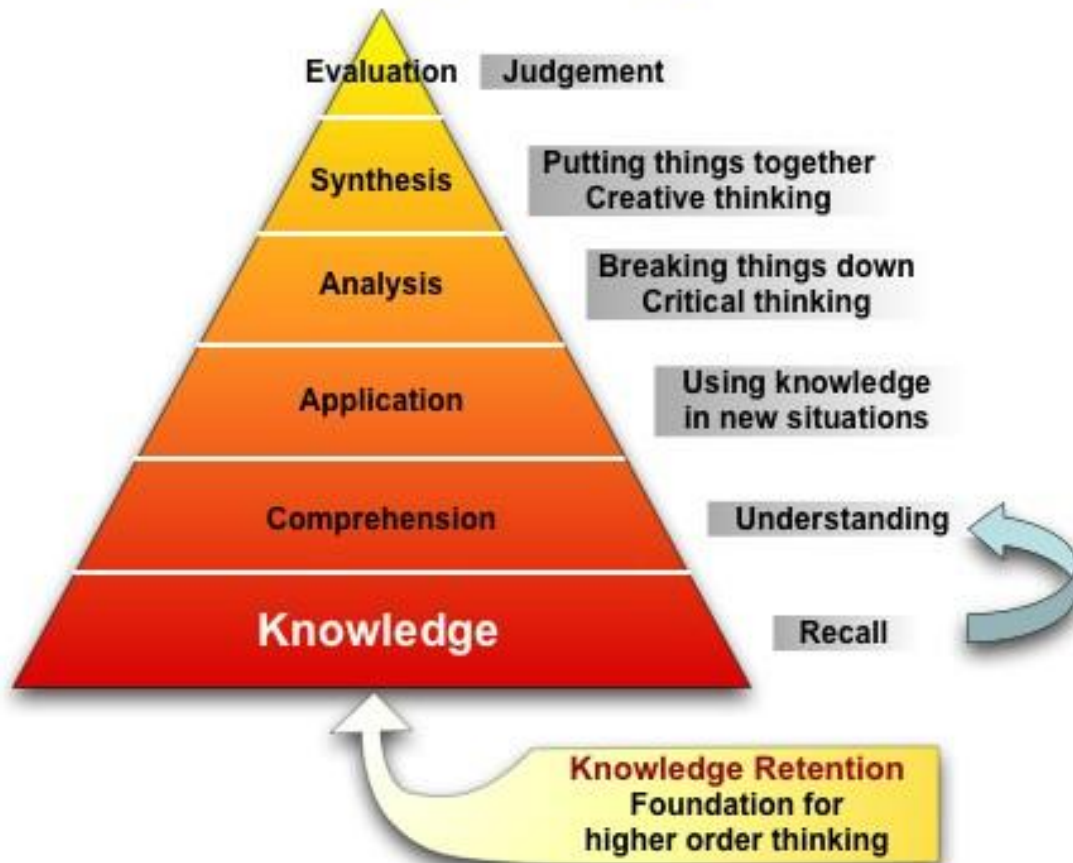
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APPENDIX A
BLOOM'S TAXONOMY

Bloom's Taxonomy for Thinking



("What are Higher Order Thinking Skills?," n.d.)

APPENDIX B PLATE TECTONICS AND ROCK ASSESSMENTS

Plate Tectonics Assessment

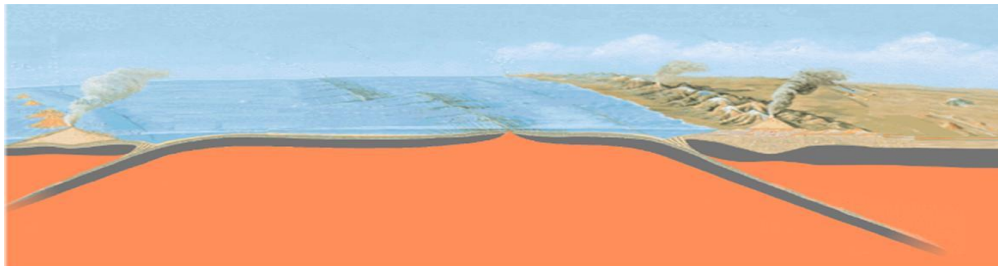
1. Below the outermost rocky shell of the Earth, it becomes:
 - a. hotter, melted, and gravity increases
 - b. hotter, gaseous, and magnetism increases
 - c. colder, solid, and pressure increases
 - d. hotter, denser, and pressure increases

2. Some people believe there was once a single continent on Earth. Which of the following statements best describes what happened to this continent?
 - a. Meteors hit the Earth, causing the continent to break into smaller pieces
 - b. The Earth lost heat over time, causing the continent to break into smaller pieces
 - c. Material beneath the continent moved, causing the continent to break into smaller pieces
 - d. The continents have always been in roughly the same place as they are today

3. How far do you think continents move in a single year?
 - a. A few inches
 - b. A few hundred feet
 - c. A few miles
 - d. Continents do not move

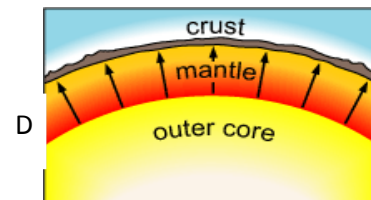
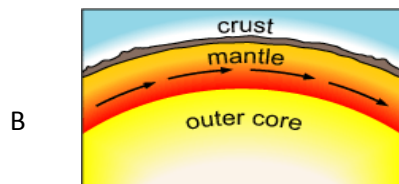
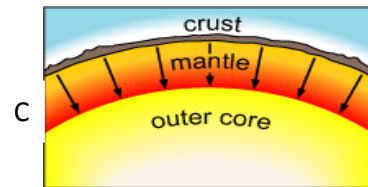
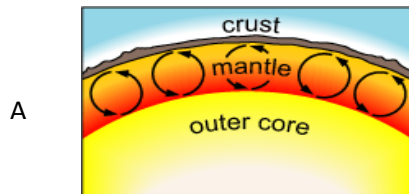
4. What is the best explanation of the movement of tectonic plates?
 - a. Lava moves the tectonic plates
 - b. Currents in the ocean move the tectonic plates
 - c. Earthquakes move the tectonic plates
 - d. Gravity moves the tectonic plates

5. How many tectonic plates are illustrated in the image?



- a. 1
- b. 2
- c. 3
- d. 4

6. Which diagram best shows how convection currents cause movements within Earth's mantle



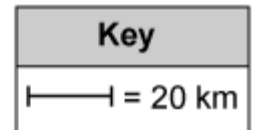
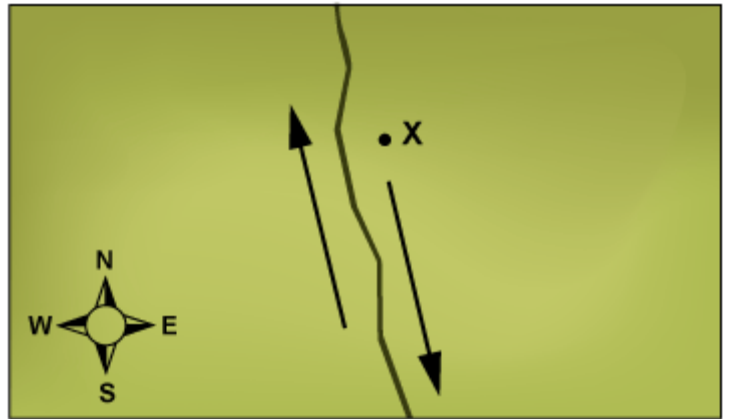
7. Use the map to answer the question.

The thick line on the map shows a transform boundary between two tectonic plates.

Which geologic phenomenon is **most likely** to occur near location X as a result of movements at the plate boundary?

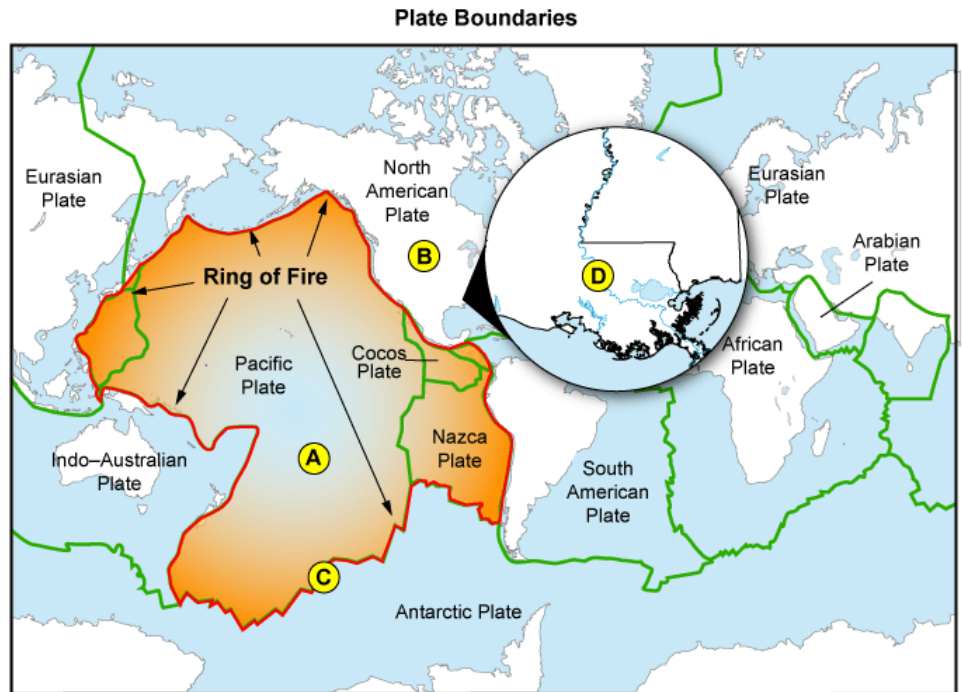
- a. Active volcanoes
- b. Canyon formation
- c. Block uplift and tilt
- d. Frequent earthquakes

Transform Boundary between Tectonic Plates



8. The map “Plate Boundaries” shows tectonic plate boundaries in a region. Volcanoes are most likely to occur at which location in this region?

- a. location A
- b. location B
- c. location C
- d. location D



9. What geologic activity is most likely to occur when two lithospheric plates converge?

- a. Volcanic islands form over a hot spot in the ocean.
- b. An underwater ridge forms in the middle of an ocean.
- c. A series of valleys form between low mountains.
- d. Mountains form along the edge of a continent.

Rocks Assessment

- Why do rocks become hard?
 - The Sun baked the material in the rock, causing the material to harden
 - Water exerted pressure on the material in the rock, causing the material to harden
 - The material in the rock was buried, causing the material to harden
 - Water mixed with the material in the rock, causing the material to harden
- Are rocks and minerals alive?
 - Yes, rocks and minerals grow
 - Yes, rocks are made up of minerals
 - Yes, rocks and minerals are always changing
 - No, rocks and minerals do not reproduce
 - No, rocks and minerals are not made up of atoms
- What is the relationship between rock formation and Earth's surface?
 - Most rocks form underground and reach the Earth's surface as melted rock moves
 - Most rocks form underground and reach the Earth's surface as other rocks are destroyed
 - Most rocks form underground and never reach the Earth's surface
 - Most rocks form at the Earth's surface and stay there for a long time
- A geologist took a piece of basalt rock from Chaitén Volcano and analyzed it in her lab. Her analysis showed that the rock was made of several types of minerals. However, when she looked at the rock with a hand lens, it appeared to be all one consistent type of material.

Why did the rock most likely appear to be so uniform when viewed through the hand lens?

- Because all minerals have approximately the same appearance
 - Because the crystals of the minerals are very small due to rapid cooling
 - Because the whole rock takes the appearance of only one of the minerals present within it
 - Because the different minerals had formed a single crystals structure within the rock
- The earliest compasses used the mineral lodestone. Which property of lodestone allowed these compasses to show direction?
 - Magnetism
 - Cleavage
 - acid reaction
 - luster

- Use the pictures to the right to answer the following question.

Ava examines the two samples shown. Which statement best describes how sample A is different from sample B?

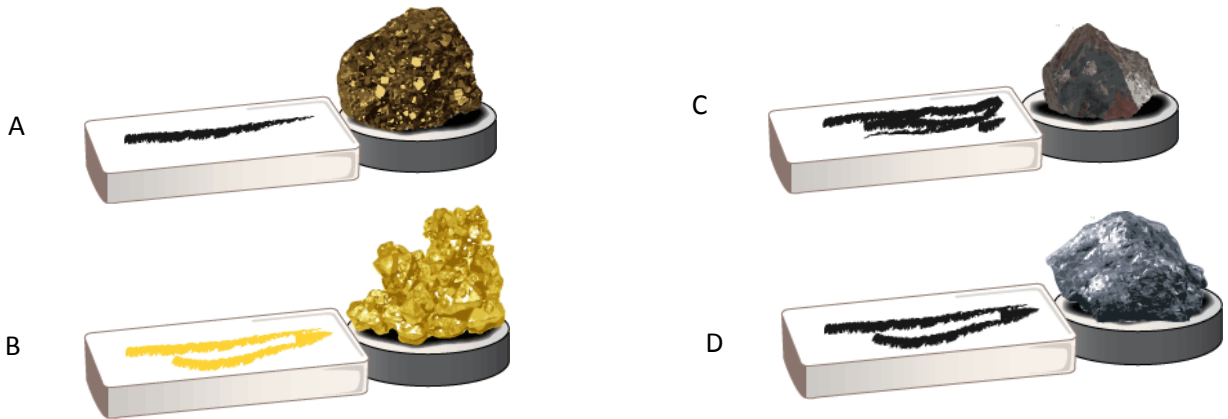
- Sample A is formed by the fast cooling of lava and sample B is formed by the slow cooling of magma.
- Sample A is a pure substance and sample B is composed of many different substances.
- Sample A is naturally occurring and sample B is made by humans.
- Sample A is a rock and sample B is a mineral.



7. Use the following chart to answer question 7.

Carl examines a mineral and records his observations in the chart. Which picture shows the mineral that Carl is observing?

Color	Luster	Streak	Hardness
gold/yellow	metallic	black/gray	6



8. Tricia is performing tests to identify a mineral. She records these observations in her science journal:

1. jagged edges when broken
2. reddish orange in natural light
3. glassy appearance
4. somewhat easy to see through

Which observation **best** describes the object's luster?

- a. Observation 1
- b. Observation 3
- c. observation 2
- d. observation 4

9. Which statement is the best description of what happens in the rock cycle?

- a. Rocks on old mountains are gradually weathered away, while mountain building and volcanism form new mountains.
- b. Once formed, rocks stay in place until rocks above them are weathered away and they reach the surface.
- c. As sedimentary rocks are buried deep below other rocks, they are changed by heat and pressure, eventually return to the surface, and are weathered again.
- d. Younger sedimentary rocks are always deposited on top of older metamorphic or igneous rocks.

APPENDIX C
TEACHER BLOOMED RESPONSES

Plate Tectonics Assessment – Bloomed Ratings							
Question	Teacher 1: Middle School	Teacher 2: Middle School	Teacher 3: High School	Teacher 4: High School	Teacher 5: High School	Tally of Lower and Higher Order	Classification According to Bloom’s
1	Knowledge	Comprehension	Comprehension	Comprehension	Knowledge	Lower: 5 Higher: 0	Lower Order
2	Knowledge	Comprehension	Knowledge	Comprehension	Knowledge	Lower: 5 Higher: 0	Lower Order
3	Comprehension	Comprehension	Comprehension	Comprehension	Comprehension	Lower: 5 Higher: 0	Lower Order
4	Comprehension	Analysis	Application	Comprehension	Comprehension	Lower: 3 Higher: 2	Lower Order
5	Analysis	Application	Analysis	Analysis	Analysis	Lower: 0 Higher: 5	Higher Order
6	Analysis	Application	Comprehension	Analysis	Comprehension	Lower: 2 Higher: 3	Higher Order
7	Analysis	Application	Comprehension	Application	Application	Lower: 1 Higher: 4	Higher Order
8	Analysis	Application	Analysis	Analysis	Analysis	Lower: 0 Higher: 5	Higher Order
9	Knowledge	Comprehension	Knowledge	Knowledge	Comprehension	Lower: 5 Higher: 0	Lower Order

Rocks Assessment – Bloomed Ratings							
Question	Teacher 1: Middle School	Teacher 2: Middle School	Teacher 3: High School	Teacher 4: High School	Teacher 5: High School	Tally of Lower and Higher Order	Classification According to Bloom’s
1	Knowledge	Comprehension	Knowledge	Application	Comprehension	Lower: 3 Higher: 2	Lower Order
2	Comprehension	Comprehension	Comprehension	Comprehension	Comprehension	Lower: 5 Higher: 0	Lower Order
3	Comprehension	Application	Comprehension	Analysis	Comprehension	Lower: 3 Higher: 2	Lower Order
4	Application	Analysis	Analysis	Comprehension	Analysis	Lower: 1 Higher: 4	Higher Order
5	Knowledge	Comprehension	Comprehension	Knowledge	Comprehension	Lower: 5 Higher: 0	Lower Order
6	Comprehension	Analysis	Application	Analysis	Comprehension	Lower: 2 Higher: 3	Higher Order
7	Comprehension	Application	Analysis	Comprehension	Application	Lower: 2 Higher: 3	Higher Order
8	Comprehension	Comprehension	Application	Comprehension	Comprehension	Lower: 4 Higher: 1	Lower Order
9	Application	Comprehension	Analysis	Comprehension	Analysis	Lower: 2 Higher: 3	Higher Order

APPENDIX D

PLATE TECTONICS AND ROCK SURVEY QUESTIONS

Attitudinal Survey Plate Tectonics

Directions: For the following questions, you are to agree or disagree and give a brief explanation of why you agree or disagree with the statement. Please be honest. This will not hurt your grade.

1. I use inquiry skills often during scientific lessons?
2. I enjoy teacher directed instruction over student directed instruction?
3. I enjoy learning new science concepts and information?
4. I enjoy learning about plate tectonics?
5. I participate in all of my science activities?
- *6. I enjoy participating in all of my science activities?

*Note: Question 6 was only on the posttest.

Attitudinal Survey Rocks

Directions: For the following questions, you are to agree or disagree and give a brief explanation of why you agree or disagree with the statement. Please be honest. This will not hurt your grade

1. When learning about new concepts, I like to create things during the process?
2. I prefer the teacher standing in front of the class and teaching while I listen?
3. Doing experiments and projects helps me understand and learn science better?
4. I enjoy learning about Rocks?
5. I prefer not to work on worksheets in science class?
- *6. I enjoy the way Mrs. Hinyard taught Rocks more than how she taught Plate Tectonics?

*Note: Question 6 was only on the posttest.

APPENDIX E

STUDENT PRETEST AND POSTTEST SURVEY RESPONSES

Topic: Plate Tectonics
Group: Control Group
Test: Pretest

Question 1: I use inquiry skills often during science lessons?

1. Agree because I understand it better
2. agree because inquiry skills can help you clarify things
3. agree cause I have to give my opinion
4. agree I use inquiry to help with problems
5. Agree use what I know to help solve problems or answer questions
6. agree, every skill a teacher can teach me I try to use
7. Agree, so that I can come up with a good answer
8. Agree. I agree, my teacher Mrs. Hinyard does this with us
9. Disagree because I always follow the steps the teacher gives me
10. Disagree because I don't think I need to use inquiry skills
11. disagree because I don't use inquiry skills
12. Disagree cause when I do math I don't use scientific inquiry
13. disagree not most of the time
14. Disagree, I disagree with this because not everyone uses inquiry skills during scientific lessons
15. Disagree, I don't know what this is
16. I agree because at times I am curious so I use the scientific method when in science
17. I agree because sometimes I don't think about it, it is very important and useful
18. I disagree because I forgot what that means
19. I disagree because in some lessons a student can already know about it and don't need to inquire
20. I don't know what inquiry skills are
21. No because I don't know what this is
22. No not really
23. Yes, I do because it helps me get in the habits of using inquiry in other classes
24. Yes, I do so I can be informed and ready for the test

Question 2: I prefer Teacher Directed Instruction over Student Directed Instruction?

1. Agree because a teacher is smarter and knows better
2. Agree because a teacher know more than a student and it confuse me when students do all the work
3. Agree because teachers know more than students
4. Agree because the teacher can break it down simply to me
5. Agree so I can understand it more
6. Agree sometimes the students lie
7. Agree you can learn a lot more
8. Agree you give better information and more important information than my classmates
9. Agree, because its more scientific than the student input
10. Agree, I rather have the teacher give me instruction about the lessons not a student they don't know anything
11. Agree, so I can know a little more
12. Agree, teachers know what they are talking about but students do not
13. Agree, the teacher explains the whole process
14. Agree. The teacher is the one who is supposed to give directions and instructions and teach
15. Agreed because you learn more from a teacher than a student
16. Disagree to me your teaching is too quick
17. Disagree, I like hands on work
18. Disagree, some teachers move too fast
19. Disagree, students explain in a way I understand it more
20. I agree an the teacher instruction because she nows more

21. I agree because a teacher has more knowledge than a student
22. I agree because even though some kids can know some things teachers grade us on what they expect
23. I agree because the teacher is knowledgeable in the subject and can give better information
24. I agree because they have the right to do that
25. I agree, because a teacher can break it down to where you can understand it
26. I disagree I prefer more student interactions
27. No, I prefer student directed instruction because I could related to the student and see what we both do or did wrong
28. Yes because without the teacher direction you wouldn't get it
29. Yes, because the teacher makes it sound simpler
30. Yes, cause the teachers have more knowledge

Question 3: I enjoy learning new science concepts and information?

1. Agree I love to learn science concepts and information to get a good look at it
2. Agree because I like science on most days
3. Agree because science is complex but understandable
4. Agree I do like learning more because I will run into stuff I don't know
5. Agree I love science so it's not a big problem to me
6. Agree it not really something I want to do but I know I have to
7. Agree it would improve my knowledge
8. Agree it's fun learning about new things
9. Agree learning new things is a good thing
10. Agree, because I always find out things I didn't know
11. Agree, because I would know more about science then I did before
12. Agree, because it interest me and I like to learn new things
13. Agree, I like science
14. Agree, I've always liked science
15. Agree, it shoes me there is more things I need to know
16. I agree because every time I learn something I look at the world differently
17. I agree because it will help me later in life
18. I agree because science is the explanation of the natural world
19. I agree I do enjoy learning new science concepts
20. I agree science is my favorite subject
21. I agree, because it gives a whole new way of thinking and have wondering how did the world come about?
22. I do enjoy it, it teaches things I would like to know
23. Yes, because in order for me to become a pulmonologist I must know a lot of science
24. Yes, because science is very interesting
25. Yes, cause I want to know more

Question 4: I enjoy learning about Plate Tectonics?

1. Agree, because plates tectonics sound interesting (learning different areas).
2. Agree, cause I'm very curious
3. Agree, I want to learn more
4. Disagree because I don't know what it is to enjoy it
5. Disagree because I really did not know it
6. Disagree because I really don't know what that is yet
7. Disagree because it's hard to understand
8. Disagree because its boring
9. Disagree I really don't believe I learned about that yet
10. Disagree I'm not sure what tectonics are
11. Disagree it really not exciting
12. Disagree, because I've never heard of plate tectonics
13. Disagree, because with certain things it is hard to understand
14. Disagree, I don't know what plate tectonics is
15. Disagree, I never heard of this "plate tectonics."
16. Disagree, I not a big fan of plate tectonics when it comes to science

17. Disagree, it feels as if I learned this already
18. Disagree, it is really confusing
19. Disagree, its just something that's not interesting to me
20. I agree because plate tectonics has a lot to do with the world like there being seven continents and earthquakes
21. I agree I like to see how land formation were formed
22. I disagree it is difficult
23. I don't really know what it is, I not into those kinds of things
24. I don't what plate tectonics is
25. I never really had a whole lesson about plate tectonics
26. No, cause IDK what it is
27. No, I do not because I never really learned about it before
28. Not that much because it starts to get a little confusing how landforms form

Question 5: I participate in all my science activities?

1. Agree – I do participate in all my activities because I want a good grade
2. Agree is better than doing book work
3. Agree so that way I'm learning and I understand as well.
4. Agree, because I do my work
5. Agree, I do participate in everything
6. Agree, I do participate in many science activities
7. Agree, I do participate in many science activities
8. Agree, I have some fun
9. Agree, I like to get my grade
10. Agree, I love doing science experiments
11. Agree, there wasn't a time I didn't if I like it or didn't like it
12. Disagree because most of the time in getting fused at
13. Disagree, because some activities I really don't understand
14. Disagree, I get tired sometimes
15. Disagree, it depends on the assignment
16. I agree because I would like to get a good grade
17. I agree because they are fun
18. I agree because when I participate it helps me learn better
19. I agree I'm trying to get a better grade
20. I agree sometimes I do
21. I agree, because I enjoy doing it so I always do it
22. I agree, I do participate in all of my science activities because they are fun and incredible
23. No, not all of them like my project couldn't get to a computer for a powerpoint, I'm scared of my grade in this class
24. Yes, because I am a hands on person
25. Yes, because I find science activities extra interesting
26. Yes, cause it can be fun

Topic: Plate Tectonics

Group: Experimental Group

Test: Pretest

Question 1: I use inquiry skills often during science lessons?

1. Agree because it help me better understand what my teacher is teaching
2. Agree because it help me understand things better
3. Agree because it make science a lot easier
4. Agree I infer often
5. Agree! During a scientific lesson, I usually use inquiry skills so I can understand and get the concept of the lesson
6. Agree, because I use it always in science and in life
7. Agree, because it helps me understand the problem better

8. Agree, because it's just common sense
9. Agree, I do it to make sure my thoughts are right
10. Disagree I do not use this skill
11. Disagree, because I rarely every use this
12. Disagree, I don't know how to use inquiry skills
13. Disagree, I don't know what this is
14. Disagree, I honestly don't know what this is
15. Disagree, what is inquiry skills?
16. I agree because it's important to do so
17. I agree because when doing scientific lessons there is always something to analyze or break down to make it seem easier
18. No, I do not know
19. No, I forgot what this means
20. Yes, it sometimes helps me understand what I'm looking for

Question 2: I prefer Teacher Directed Instruction over Student Directed Instruction?

1. Agree because I understand better when a teacher gives instruction
2. Agree because most of the time the students don't act right, it depends on the topic
3. Agree because sometimes students directions and instructions are not always right
4. Agree because the students directions maybe wrong
5. Agree because we need to learn
6. Agree! When teachers give instructions, they usually break it down for you so you will know what to do
7. Agree, because my teacher explains what she wants me to do clearly
8. Agree, easier to know what to do
9. Agree, I just need the teachers instructions for the lesson
10. Agree, its easier
11. Agree, most students cannot teach
12. Agree, teachers are more help than students
13. Agree. The students might leave something important out in student directed instruction
14. Disagree because when I hear it from my peers they may be able to explain it so I can understand it better
15. Disagree I don't follow directions well
16. I agree because a teacher can explain it better than a student could
17. I agree because it just lets me know that I am doing it right
18. I agree because sometimes the students work might be wrong its best to have the teacher help
19. I agree because teacher's instructions are more reliable than students
20. I agree because the teacher likes to teach student's that listening she don't want to teach students that don't listen

Question 3: I enjoy learning new science concepts and information?

1. Agree because I like to know what's going on around me
2. agree because I love to do experiments in science
3. Agree because you have to know this science stuff for high school
4. Agree information helps me understand better
5. Agree! I do enjoy learning new things
6. Agree, because I might need to remember something I learned in science
7. agree, because I need to learn everything that I possibly can
8. Agree, because that improves your skill of knowledge and understanding
9. agree, even though it can get frustrating I still like to learn
10. Agree, I like to learn new things in science.
11. Agree, it can be fun
12. Agree, it good to learn new things
13. agree, only if it's easy
14. Agree. The more I learn the smarter I become.
15. Disagree – I really do not
16. Disagree, it's boring and wasn't taught well
17. I agree because it is very interesting

18. I agree because learning new things in the world of science is usually interesting
19. I agree because when I learn new things it makes me want to learn about that particular thing in more detail
20. Yes because I love science
21. yes, because it fun to learn new things about science
22. Yes, I do like learning about new things in my science class

Question 4: I enjoy learning about Plate Tectonics?

1. Agree, because I will know if a volcano ever erupted and why it erupted when it did
2. Agree, because it tells me about what happens under earth
3. Agree, this tells me how earthquakes come and volcanoes
4. Disagree because I always forget about plate tectonics
5. Disagree because I don't know anything about it
6. Disagree because it's not interesting its boring
7. Disagree I don't know a lot about plate tectonics
8. Disagree I don't know about it
9. Disagree I don't really know much about it
10. Disagree I don't understand it
11. Disagree I know nothing about them
12. Disagree I never learned about plate tectonics but I bet you will teach it to us
13. Disagree its boring
14. Disagree, because I don't know nothing about plate tectonics
15. Disagree, because that's something I don't understand
16. I disagree because it sounds stupid
17. I disagree because plate tectonics is not all that interesting
18. No, I really do not know what it is
19. Yes I think plate tectonics is an interesting concept to learn

Question 5: I participate in all my science activities?

1. Agree because it help me learn better in a fun way
2. Agree because sometimes it can be fun
3. Agree I do because I need my grades to be good
4. Agree I want my grade to be good all times
5. Agree, because I love all science activities
6. Agree, because it might answer things you've always wanted to know
7. Agree, I participate to get good grades
8. Agree, it is what I'm supposed to do and my way of showing that I understand
9. Agree, learning, education, teamwork, and good grades is a must!!
10. Agree, most likely I'm participating
11. Agree. It's a way of making science even more exciting
12. Disagree because the teacher talks too much sometimes
13. Disagree, science can be boring
14. I agree because everything we do will be a part of my grade it's fun.
15. I agree, because I do my work and participate in all my labs
16. I disagree because sometimes we don't do fun stuff and I go to sleep
17. Yes because I love science
18. Yes I participate in all my science activities
19. Yes, because I like working in groups
20. Yes, I do because I think you learn more when you do participate
21. Yes, I participate in all my science activities so I can learn more science

Student Survey Responses
Plate Tectonics Posttest

Topic: Plate Tectonics
Group: Control Group
Test: Posttest

Question 1: I use inquiry skills often during science lessons?

1. Agree because I am able to remember information easier with skills
2. Agree because it helps me remember how I got my answer
3. Agree I only use it when we need to
4. Agree, because it helps me solve stuff
5. Agree, because using inquiry is basic a common sense skill to me
6. Agree, but you don't always need them
7. Agree, I am curious
8. Agree, I kinda of use it sometimes when we work in groups
9. Agree, I use inquiry skills in class to help me solve problems better
10. Agree, most work that I do in science I use examples and resources to help me
11. Agree, so I could no what I'm doing on the assignment
12. Disagree because I don't always use inquiry skills
13. Disagree because I don't want to
14. Disagree because you don't have to use them all the time just sometimes
15. Disagree, I do not use inquiry skills often because we don't do much
16. Disagree, I don't use these type of skills
17. I agree because I might not know it, but I use inquiry to work problems
18. I agree, that I use inquiry skills often during scientific lessons
19. I disagree because I don't know what inquiry skills are
20. I disagree because sometimes I don't know where to find answers or what's going on
21. I do use inquiry skills during scientific lessons because I research and listen a lot
22. No because I don't understand it
23. No, because there's not much now for me to use it for everything in Baker is a little simple to me
24. True, I use it sometimes but not all times when we are doing activities
25. Yes because I hypothesize before I answer questions or write things down
26. Yes often when we are doing experiments
27. Yes, because it help's me work better
28. Yes, I agree, because I use my brain to think about the problems and the computer to research the problems
29. Yes, it helps me get answers easier because I am able to think about science more
30. Yes, Mrs. Hinyard uses inquiry skills
31. Yes, so I can get the correct answers by thinking more
32. Yes, so that I can come up with a better answer

Question 2: I prefer Teacher Directed Instruction over Student Directed Instruction?

1. Agree because I think a teacher gives better information than a student
2. Agree because I understand a teacher better than a student
3. Agree because it helps me more
4. Agree because most likely the teacher knows what he/she is doing than the student
5. Agree because teachers been to school for this already
6. Agree because the teacher always explain things simpler
7. Agree because the teacher is the one who knows everything on our lesson
8. Agree so I would know what to do and I won't be lost
9. Agree, because teacher direction instruction is more valuable
10. Agree, because the teacher know more than the students
11. Agree, the teacher has went to school and go a degree the child is in school trying to get a degree
12. Agree, the teacher knows what she's talking about
13. Disagree because I like to work with other students and let them help me

14. Disagree because teachers go a little too fast for me
15. disagree I feel as if they are lecturing us when they do that
16. Disagree, I am more of a hands on guy
17. Disagree, I don't understand what teacher directed instruction is
18. Disagree, I like student instruction but I would still need help from the teacher
19. False, I like doing it myself so I learn the teacher already knows it all
20. I agree because a teacher is less likely to mess up than a student
21. I agree because I believe that the teacher can explain it better and also help me understand more
22. I agree because it is how I know what and what need to be done
23. I agree, that I enjoy teacher directed instruction over a student instructions because the teacher can break it down
24. I enjoy teacher directed instruction because I can get more help from the teacher
25. No, I prefer hands on things
26. Teacher because they learn things already
27. Yes because I don't want to guess when doing something
28. Yes because the teacher knows the direction and the teacher is a grown up and it will help me get to college
29. Yes, because it helps being able to understand it easier
30. Yes, because the teacher directed instruction is more specific than student directed instruction
31. Yes, because you are good at it
32. Yes, you would get more information

Question 3: I enjoy learning new science concepts and information?

1. Agree because I just want to no new things because I might have to use it later on in life
2. Agree because it help me figure out answers better on a test
3. Agree because it helps me learn
4. Agree because it will help with a good job career like becoming a doctor
5. Agree its good to learn new things
6. Agree, a lot of things in science interest me
7. Agree, because learning new things helps me not give bias opinions a lot
8. Agree, I do so I can be something in my life and be somebody
9. Agree, I enjoy learning new concepts because it will help me know more in life
10. Agree, it can help me past a test or learn more things
11. Agree, it's fun and makes me smarter
12. Agree, its good to learn new things everyday
13. Agree, science is my favorite subject that's why I like to learn new concepts and information
14. Agree, science, the world are forever evolving
15. I agree because I always want to learn new thing and experience more
16. I agree because I like learning new things
17. I agree because science is fun and exciting to learn
18. I agree, I do like learning new science concepts and information because it makes me think about the world more.
19. No, because it often leads to more school work and projects
20. True most of the stuff I learn will help me in life
21. Yes I do enjoy learning science
22. Yes science is fun
23. Yes, because science is more fun then any other subject
24. Yes, I agree, because I like to learn new things
25. Yes, I would gain more knowledge
26. Yes, it brings more excitement to Baker
27. Yes, it helps me no more in life that I can use in the future
28. Yes, its nice to understand the natural world
29. Yes, to know more about the earth

Question 4: I enjoy learning about Plate Tectonics?

1. Agree because I will now what happened when a earthquake comes
2. Agree because it explain to me how mountain and valleys form also how volcanoes erupt

3. Agree because this was interesting information
4. Agree cause tectonics can effect our environmental
5. Agree I do love to learn about tectonic plates it help me learn more things
6. Agree learning about plate tectonics is very interesting to me
7. Agree so I could no what is going on in the world today and how the earth is how it is now
8. Agree, I enjoy learning about plate tectonics but they are kind of confusing
9. Agree, I like knowing how the earth moves
10. Agree, I like to know about how earthquakes and volcanoes happen
11. Agree, it teaches you about earthquakes and volcanic eruptions
12. Disagree because I don't really understand it
13. Disagree it causes natural disasters
14. Disagree, this just didn't catch my eye, it didn't interest me
15. I agree, because plate tectonic and how they change earth
16. I disagree because I get confused
17. I disagree because it was confusing
18. I enjoy learning about tectonic plate because it is cool to know how the continents move
19. I enjoyed learning about plate tectonics
20. I kinda liked learning about plate tectonics it wasn't that fun.
21. True it is cool how they move in all directions
22. Yes I did and learned why/how earthquakes happen
23. Yes, because I learned about how the continents can move over time
24. Yes, because now I no more about earth.
25. Yes, I agree, because it was interesting
26. Yes, I found out how the world had split
27. Yes, I love to know about volcanoes and tsunamis and earthquakes

Question 5: I participate in all my science activities?

1. Agree because I am a hands on learner
2. Agree because I do my work
3. Agree because once again participating helps me learn better especially if its hands on
4. Agree I do participate in all science activities because I can get graded on it
5. Agree so I could have some fun with science
6. Agree, because I will like to pass science
7. Agree, I only missed one
8. Agree, I participate in all my activities so that I can get a good grade
9. Agree, I participate in everything I could because I do care about my education
10. Agree, I try to participate in all my activities
11. Agree, most of them are very fun
12. Agree, participating grades are easy, just apply yourself
13. Agree, to make my best effort in science to do good on the leap testing
14. Disagree I fall asleep to much
15. Disagree of them I don't participate in
16. I agree, because I love science
17. I participate in all science activities if I know what's going on
18. I try to participate in all science activities
19. No, I be tired a lot
20. No, some I don't participate in
21. No, sometime I'm very sleepy
22. True and also when I do I try my very best
23. Yes because it's for a grade
24. Yes I agree, I do participate in all of my science activities. Really like being the leader of things.
25. Yes I do participate in all my science activities

Question 6: I enjoy participating in science activities?

1. Agree because I help me learn about earth and different planets and how they support the earths system
2. Agree because its better than working in books everyday.

3. Agree because science activities are always creative to me
4. Agree it can be fun
5. Agree it's a fun way to learn new things
6. Agree so my grades would be good
7. Agree to get my full points and learn new and more different things
8. Agree, activities are a fun way to learn
9. Agree, because even though I dislike science some of the activities are enjoyable
10. Agree, I enjoy participating in all my activities because they can be fun
11. Agree, it is always fun to participate in lots of science activities
12. Disagree because most of them are boring
13. Disagree, I dislike some of them
14. Disagree, some science activities are boring
15. I agree because I like to get good grades and participating is how you get it
16. I agree, because I love science and the work
17. I enjoy participating in science activities cause there always fun
18. I really enjoy all of my science activities
19. No only when I'm in the mood
20. No, I don't enjoy participating in all my science activities because I don't understand all of it
21. No, some are not that interesting
22. True, I am doing what I am learning which helps me understand better
23. Yes I agree, I do like participating in all of my science activities they can be really fun.
24. Yes, I do because I don't want to be left out
25. Yes, I want participating points

Topic: Plate Tectonics

Group: Experimental Group

Test: Posttest

Question 1: I use inquiry skills often during science lessons?

1. Agree because it helps
2. Agree because it helps me learn better
3. Agree because it is a way to help you learn
4. Agree because sometimes I do use it
5. Agree because you have to try everything you learned
6. Agree, because you should use some type of skill when in science
7. Agree, I have heard of these skills at the beginning of school
8. Agree, I like to use inquiry when we do our lessons
9. Agree, when we did the scientific process we used it
10. Agree, why because I use inquiry skills when I don't know the answer
11. Disagree I disagree because I don't know what it is but I know I need it
12. Disagree I don't know what this is
13. Disagree we don't use it on easy information
14. I agree, I use inquiry skills often during science lessons when we at the lab stations
15. No because I never do
16. We use inquiry often but I don't know how often we use it though
17. Yes because it helps me out a lot
18. Yes I use inquiry skills because it help me understand what I am doing
19. Yes we used it when we had to research in groups
20. Yes when I use it to find a hypothesis
21. Yes, if it helps me understand better

Question 2: I prefer Teacher Directed Instruction over Student Directed Instruction?

1. Agree because teachers explain things better than students
2. Agree cause the teacher know more than the student do
3. Agree I agree because if you listen to the teacher you could know all you need to know
4. Agree I feel the teacher knows what he is talking about

5. Agree the teacher can help me more
6. Agree they should be more accurate than students
7. Agree, because the teacher knows best
8. Agree, I prefer teacher instruction because the teacher knows how to teach the information to us
9. Agree, so the teacher teaches well since I like how she teaches
10. Agree. Because the teacher can explain it a little better
11. Agree: the teacher could always give easy ways to hard situations
12. Disagree because I want to make my own instructions
13. Disagree I think some teachers should listen to children because they can be right sometimes too
14. Disagree why because I need to sit and listen to see what I need to take notes on
15. I agree, the teacher knows what she talking about so I rather listen to her than students
16. No I do not catch on easily with the teacher
17. No, I want to work with my peers to get the instructions
18. Yes because the teacher gives better answers
19. Yes I enjoy teacher instructions better because the student can give me the wrong information
20. Yes, because a teacher knows her stuff
21. Yes. Because its much easier to catch on too.

Question 3: I enjoy learning new science concepts and information?

1. Agree – the more I learn the better I get in science.
2. Agree because it is very fun to learn about
3. Agree because science come easy to me most times
4. Agree because that would get me to new heights
5. Agree I agree because you learn more things about the stuff you didn't know
6. Agree I like new things
7. Agree I like to learn new things and I like to participate when I learn new things
8. Agree it is fun to learn more about our world
9. Agree, because it's nice to learn more about scientific questions
10. Agree, because you can always learn something new in science
11. Agree, I enjoy learning new science concepts because it makes me smarter
12. Agree, I like to learn new things in a subject I don't even like
13. Agree, science have interesting stuff to learn
14. Agree, science information is a lot but it is fun at the same time
15. Disagree because science can be hard at some points
16. Yes because everyday I learn something, can do some better
17. Yes I do enjoy learning new concepts because it can help me in my future
18. Yes science is my favorite subject
19. Yes, because it help me learn something
20. Yes. Because in the long run I don't know if I might come across a situation and don't know how to solve it

Question 4: I enjoy learning about Plate Tectonics?

1. Agree – I noticed how easy plate tectonics is and to understand
2. Agree – I think it's a fun way to know mountains are formed
3. Agree because I got to learn about plate boundaries and earth structure
4. Agree because it was kinda of fun
5. Agree because we got to work with the hands-on stuff
6. Agree, because you learn more about different locations around the earth
7. Agree, its not hard to know about them the more you model the concept with activities
8. Agree, this is my favorite and it is kind of simple
9. Disagree because I don't really understand it
10. Disagree it is a very hard lesson
11. Disagree it was tooo much information to remember and my group didn't like me
12. Disagree, we had to do a whole project by ourselves
13. I agree that plate tectonics is enjoyable to learn about because you get to see how the earth got like it is today and that it was not always like it is today
14. I enjoy learning about tectonics plates because it's easy and I understand it

15. No it is boring
16. Plate Tectonics was fun to learn about.
17. Yep, It tell how volcanoes and earthquakes form
18. Yes, because I love to learn new things
19. Yes, I have learned a lot this week!!
20. Yes, plate boundaries convergent and divergent was fun to create

Question 5: I participate in all my science activities?

1. Agree – I'm trying to get a good grade in science and be able to do it
2. Agree because I want to pass to the next grade
3. Agree because participating in activities is a fun way to learn
4. Agree because science is a big subject
5. Agree cause I enjoy it when we do activities
6. Agree I do so I can pull my grade up
7. Agree I get good grades
8. Agree I like to participate
9. Agree, because I'm not going to be in 8th grade next year
10. Agree, if you do not participate you want get a grade
11. Agree, must if you want a grade
12. Disagree, because I am absent sometimes
13. Disagree, I try to but sometimes I do not do a good job
14. I do participate in all my science activities because I don't want to fail
15. I participate in all my science activities because I have to make good grades
16. Yes I must participate in all my science activities
17. Yes, because that's the right thing to do and I love to learn
18. Yes, the only time I don't is when I'm not here but I still find ways to complete them
19. Yes, They are fun to do in class

Question 6: I enjoy participating in science activities?

1. Agree – it fun to do and I enjoy it
2. Agree because it always something you learn everyday
3. Agree because it's better than doing work out of a book
4. Agree because it's really fun and hard at the same time
5. Agree because its nice to learn something new
6. Agree because science is fun much better than math
7. Agree because we usually make things and present them. I don't like to present.
8. Agree cause participating can be fun
9. Agree I like doing things in science and make new things
10. Agree if I know what I am doing
11. Agree, I like the things we do in science class
12. Agree, I participate all the times and I enjoy it
13. Disagree because sometimes I don't like the people that I'm working with
14. I agree I enjoy participate in science activities because the teacher helps out most of the time
15. I agree I enjoy participating because science activities are a good way to learn more science
16. Yes because I like to do hands-on things
17. Yes because it's fun and it also helps my grade
18. Yes, I have to enjoy it to get a good grade the teacher will give you a bad grade if you don't

Student Survey Responses
Rocks Pretest

Topic: Rocks
Group: Control Group
Test: Pretest

Question 1: When learning about new science concepts, I like to create things during the process?

1. Agree – I'm a hands on person
2. Agree because creating things give you a better understanding on things
3. Agree because I like to explore new things
4. Agree because im a kinesthetic learner
5. Agree because it helps me learn better
6. Agree because its easier and a model of something helps break it down
7. Agree I like to try different things
8. Agree it helps me learn better
9. Agree it is easier to follow when its taught to me
10. Agree! I'm creative person to me and when I make an example of what I'm being taught its usually easy
11. Agree, because it help me understand more
12. Agree, depending on what I am thinking about and creating
13. Agree, it helps get a better understanding about the concept
14. Agree, it's a hands-on way to learn
15. Disagree because creating takes to much time an effort, you shouldn't create new things if you already know the concepts
16. Disagree because I may confuse myself
17. Disagree I'm not the type of person that would create things
18. Disagree, because I like to know more about it
19. Disagree, because I'm afraid I'll mess up
20. Disagree, I don't like science at all. It's a hard subject
21. Disagree, it don't help me learn anything by create things.
22. I agree because I think you learn more by doing that
23. No, because im not a creative person

Question 2: I prefer the teacher standing in front of the class and teaching, while I listen?

1. Agree – very helpful and useful
2. Agree because I learn better that way
3. Agree because I understand things a lot better
4. Agree because some teachers don't do that
5. Agree because teachers explain things better to me
6. Agree help me learn better while a teacher is up front
7. Agree I learn better when listening not writing
8. Agree I learn good that way
9. Agree it lets me know that the teacher know what him/her is doing (unlike the math teacher)
10. Agree so I can ask questions and take notes
11. Agree! I can sit and listen its just that it's the fact if the information is interesting
12. Agree, because it's easier to learn that way
13. Agree, it's the way I'm used to learning
14. Disagree because I like to be up and active
15. Disagree because I rather do something instead of sit in my desk
16. Disagree because it's hard for me to remember some of the stuff
17. disagree I gets very sleepy when the teacher talks in front of the class
18. Disagree I hate that it is boring
19. Disagree I like to participate in things
20. Disagree, depends on what they are talking about some things I do not like
21. I agree that when the teacher is standing in front of the class teaching its better to learn that way
22. Yes, because its much easier to understand the concept

Question 3: Doing experiments and projects help me understand and learn science better?

1. Agree – I'm a hands on person
2. Agree because I get a image on how it looks
3. Agree because I like hands on better
4. Agree because it give me more practice
5. Agree because it help you understand and really see what you are doing
6. Agree because just a talking about it is not all that but when working hands on it helps
7. Agree because you are making it an that helps you because in order to make it you have to know what it is
8. Agree because you learn more about science when doing projects
9. Agree cause I get to research stuff I didn't previously know
10. Agree I could learn better during the process
11. Agree I enjoy learning hands on
12. Agree I love doing experiments
13. Agree it allows me to do hands on learning
14. Agree it gives me a change to be a smart scientists
15. Agree it's easier and more fun to learn
16. Agree! When I make scientific models, it helps me get an understanding of the situation
17. Agree, because it give you the change to teach yourself.
18. Agree, its hands on.
19. disagree, I learn the same if I'm doing a project or busy work
20. I agree because it help you get a better understanding
21. Yes because it makes me understand the where, how and when it was formed
22. Yes, if I can make a model of it then I will know that I understand what's essential to that lesson

Question 4: I enjoy learning about Rocks?

1. Agree – they are somewhat enjoy to learn about
2. Agree because it is easy
3. Agree because its easy and there's a big different between them
4. Agree because rocks have different types of information that you can learn
5. Agree I have listen to past 8th graders talk about it and I like what they have said
6. Agree you find what different types of substances make up rocks
7. Agree! I love to learn about the natural world.
8. Agree, because we might do an experiment with them
9. Agree, I like learning about rocks because my dad has a rock collection
10. Agree, rocks are interesting
11. Disagree because it sounds boring
12. Disagree because rocks are boring they don't do nothing
13. Disagree I do not like learning about rocks because I don't know much about it but that I see them outside everyday which is boring
14. Disagree it's a boring subject
15. Disagree never learned the parts of a rock
16. Disagree, because I don't everything about them yet, even though I know something about them.
17. Disagree, I didn't learn anything about rocks yet
18. Disagree, rocks are confusing
19. I disagree because I was never taught about rocks I just see them every day
20. Yes, because I want to know where they come from

Question 5: I prefer not to work on worksheets in science class?

1. Agree because I rather projects which are fun with people you know
2. Agree because projects are better
3. Agree I don't like science at all
4. Agree I really like projects not so much worksheets
5. Agree I want to do fun stuff
6. Disagree – I participate in anything I must get a good grade
7. Disagree because I love doing worksheets

8. Disagree because I love science
9. Disagree I always participate regardless of what the assignment is
10. Disagree I do so I can get my grade
11. Disagree I have to get good grades
12. Disagree I like to participate in all things to get my points
13. Disagree I need the grades
14. Disagree I participate in all lessons I don't care if it is a worksheet
15. Disagree! I love to participate any means necessary.
16. Disagree, because that gives you an opportunity to show what you have learned
17. Disagree, because they help you understand too
18. Disagree, I enjoy participating
19. I disagree that I prefer not to work on worksheets in science class because it helps me learn the information on science

Topic: Rocks

Group: Experimental Group

Test: Pretest

Question 1: When learning about new science concepts, I like to create things during the process?

1. Agree because I can understand it more
2. Agree because it can make learning science more creatable
3. Agree because it is easier for me to memorize
4. Agree because it makes the activity more hands on.
5. Agree its gives me an better picture of what I am working on
6. Agree when we did the volcanoes you made a clay display
7. Agree, always good to learn something new
8. Agree, because when you learn new things and create your understand more
9. Agree, creating a thing could give you somewhat of an visual of whatever that thing is.
10. Agree, helps you get a better understanding
11. Agree, I am very creative
12. Agree, I like to create things so that I can study the things I did or wrote later
13. Agree, I like to learn from example and experience
14. Agree, I wonder about how new things work all the time
15. Agree, so I will have notes on the progress
16. Disagree because I might not like the concept that we are learning
17. Disagree, creating things doesn't always help me
18. Disagree, I disagree because I like to learn about the concept first
19. Disagree, I don't like to create when I'm trying to work
20. Disagree, I just like to learn about the new concepts
21. I agree because I like to create my idea a head of time
22. I agree because this helps me understand the assignment better
23. I agree with I like to create things during the process of learning because it makes learning fun.
24. I disagree because I never did a project on rocks
25. Yes, I agree because it makes me learn better
26. Yes, it helps me understand
27. Yes, so I can understand it a little more

Question 2: I prefer the teacher standing in front of the class and teaching, while I listen?

1. Agree because I am learn more about something I don't know
2. Agree because when the teacher teaches it's better so the learner will understand
3. Agree because when the teacher teaches us I understand it better
4. Agree better than writing
5. Agree that's how I learn
6. Agree, because I am able to have a good understanding when she explains it
7. Agree, because so that I know how to do things correctly
8. Agree, because when the teacher seats it mean she down care about your education

9. Agree, I like to hear everything I have to do so I can know beforehand.
10. Agree, I understand it better
11. Agree, it easier to learn
12. Agree, so that see can see that I don't make a sound
13. Agree, that just how it goes
14. Agree, To get the correct information I need
15. Agree, when they stand up and teach I get a better concept of the lesson
16. Disagree it gives me a headache
17. Disagree, because after a while it get boring and I start to fall asleep
18. Disagree, I am an active person
19. Disagree, I disagree because when the teacher does that I get sleepy
20. Disagree, I just don't want to sit in one spot the hole period
21. Disagree, I like hands on and doing other group work
22. Disagree, I need to take notes so I can study
23. Disagree, I would really get bored and start to sleep
24. Disagree, we need instruction not a lecture
25. I agree because I listen when she speaks
26. I agree because it is easier to listen to the teacher and I can ask questions when needed.
27. I agree because it's better to learn while a teacher is standing up
28. I agree because when the teacher explains it, it makes it a lot easier for me to learn
29. I agree with I like when the teacher stand up and teaches because if everyone is up out of their seat then things get confusing
30. I disagree because I feel like if I did it on my own, I would understand better
31. No, I like to do labs
32. Yes, because you can learn more from a person that already knows

Question 3: Doing experiments and projects help me understand and learn science better?

1. Agree because I enjoy hands on
2. Agree because if you draw it out or make something, you can relate to it better
3. Agree because it helps me with the stuff she give me because I can study it
4. Agree because It is telling, showing and I am explaining it myself
5. Agree because it shows me how to do it and how it should go
6. Agree because somethings might have to be hands on for me to understand it
7. Agree cause you or looking up research about what you are doing
8. Agree I am doing what I am learning
9. Agree I understand what the experiment and project is trying to teach me
10. Agree its fun and better
11. Agree, because its hands on
12. Agree, doing projects when you research you find new information
13. Agree, helps me get to know the information better
14. Agree, I am more of a hands on guy
15. Agree, I get a clearer understanding about when I am learning
16. Agree, I understand what goes on better
17. Agree, it becomes fun to do
18. Agree, it breaks the work down for me so that I can understand it better
19. Agree, it do help me learn science better because without science I would not know how to do anything
20. Agree, it helps me learn my work in a fun way
21. Agree, it just more hands on
22. Agree, they do because I love to do things physically
23. Agree, they go farther into detail
24. Agree, when I do experiments it helps me understand more
25. I agree because I feel like I can learn it better and quicker that way
26. I agree because it helps me get it in my brain
27. I agree because it helps me learn by seeing it happen.
28. I agree because when doing an experiment you get hands on training
29. I agree because while doing experiments you have to find important information

30. I agree with doing experiments and projects to help me learn science better because it shows how things really form.
31. Yes, it is more interesting

Question 4: I enjoy learning about Rocks?

1. Agree I can see how they form
2. Agree I like to know the different names of them
3. Agree, because I can know what type of rock I am looking at
4. Agree, cause that can affect me in some way as well
5. Agree, I do enjoy learning about rocks because it will help me understand science
6. Agree, I'm big on rocks
7. Agree, the information might be fascinating
8. Disagree it is long and not interesting
9. Disagree not really because that is not interesting to me
10. Disagree rocks are boring to learn about
11. Disagree, I could never tell the difference
12. Disagree, I don't like them
13. Disagree, it is a little hard to understand
14. Disagree, its hard
15. Disagree, its just a lesson I think want interest me and catch my eye
16. Disagree, rocks aren't that interesting to me
17. Disagree, they don't peak my interest
18. Disagree, to much information
19. I disagree because I don't know much about rocks
20. I disagree because it really doesn't matter to me
21. I disagree with learning about rocks because sometimes it cannot be fun.
22. Yes, because I like to learn about the Earth
23. Yes, so I can know how they are formed

Question 5: I prefer not to work on worksheets in science class?

1. agree because I would like to experiment
2. Agree because it is busy work
3. agree it's boring
4. agree, because I get a grade for it
5. Disagree because I enjoy reading and writing
6. Disagree because I have to practices and get better
7. Disagree I do not like to participate on them
8. Disagree I like doing projects
9. Disagree, because I like talking
10. Disagree, because it is good to get grades that I need for the nine weeks
11. Disagree, cause I love to learn and do good on my work
12. Disagree, I always love to participate in lessons
13. Disagree, I do because I really need a good grade
14. Disagree, I do like to so I can get a good grade
15. Disagree, I just don't like worksheets
16. disagree, I like to do worksheets and projects because it helps me to learn more
17. disagree, I love doing projects in class
18. Disagree, I want my grades
19. Disagree, I'm able to understand the work
20. disagree, science lessons and worksheets and projects are good to help understand
21. I disagree because they are fun and different
22. I disagree I love working on worksheets
23. I disagree with I don't like to participate in science lessons including worksheets and projects because it can be fun.
24. No, I like projects
25. No, that's my favorite part

Student Survey Responses
Rocks Posttest

Topic: Rocks
Group: Control Group
Test: Posttest

Question 1: When learning about new science concepts, I like to create things during the process?

1. Agree – im a creative person
2. Agree – it helps me learn even more.
3. Agree because I get to learn new things
4. Agree because if I create things when learning new concepts I understand better.
5. Agree because it helps me learn better
6. Agree because it makes things more interesting
7. Agree creating things is easier to learn quicker
8. Agree- hands on activities help me learn better
9. Agree- I like hands on activities
10. Agree I like to create things that would help me
11. Agree it allows me to stay on track
12. Agree it helps me learn better
13. Agree it helps me out with learning about it more
14. Agree It makes it easier to learn
15. Agree models help me more
16. Agree, because I enjoy hands-on activities
17. Agree, because I learn more by doing hands-on activities
18. Agree, because I want to know how to make it
19. Agree, because it helps me learn.
20. Agree, because it makes it easier along the way
21. Agree, because it's fun and a quicker way to learn in the process
22. Disagree because I have to stay focus on one thing at a time
23. Disagree because I might mess something up
24. Disagree it waste time when I already know it
25. Disagree that don't help me at all
26. Disagree, I don't like science
27. Disagree. The reason is because I don't really create things especially while learning
28. I agree because sometimes they can be very helpful
29. Yes because I love to image the answer
30. Yes I agree, because I could learn more things by doing it that way
31. Yes, because it give me more things to do
32. Yes, because its hands-on
33. Yes, I do agree about when learning about new concepts I like to create things during the process

Question 2: I prefer the teacher standing in front of the class and teaching, while I listen?

1. agree – organization of the class and you can learn properly
2. Agree because hands on activities are great, but everything in life is not going to be demonstrated for you
3. agree because I can be observing for what she teaches
4. Agree because I can take notes while she's talking
5. Agree because I learn about new things all that
6. Agree because I understand better if I'm hearing it from the teacher's mouth
7. agree because she has her degree and I want mines
8. Agree cause I can sit down listen and write down what I need to know
9. Agree I can hear it and understand it better when the teacher says it
10. Agree I learn better
11. Agree it is helpful
12. Agree the teacher could give us a better understanding than a book
13. Agree, because the teacher explains things better

14. agree, I learn more
15. Agree, yes because I will rather hear the teacher talk than trying to find out on my own.
16. Agree, yes I do because when all the kids are moving it makes me nervous
17. Disagree because it can get boring.
18. Disagree because it gets boring
19. Disagree because she can talk on and on
20. disagree but I am a hands on learner
21. disagree I get board very easy
22. Disagree I like to learn standing up
23. Disagree when she teach I get bored
24. Disagree, because I get bored fast
25. Disagree, I don't like to sit in one place for long or listen
26. Disagree, its boring
27. I agree because if you need help just raise your hand and ask for help
28. I agree because that's how I learn
29. I agree because you teach the materials
30. No I'm a kinesthetic learner
31. Yes, I learn better
32. yes, that is the way I am used to learning

Question 3: Doing experiments and projects help me understand and learn science better?

1. Agree – it helps me better understand
2. Agree – yes because it takes you away from listening and let you do it yourself
3. Agree because I can show how much I know
4. Agree because I learn faster doing hands on things.
5. Agree because it is new things
6. Agree because it makes it more fun and easy
7. Agree because its easier to grasp if you do it
8. Agree because its fun and you get it faster
9. Agree because your making it fun and easy to understand
10. Agree experiments and models help me
11. Agree finding out more about the assignment
12. Agree I am a hand on learner
13. Agree I like to create things with my hands
14. Agree I like to do class experiments
15. Agree it helps me understand the steps or processes
16. Agree it makes learning the lesson even better
17. Agree it's fun to do it your own way
18. Agree, but not if you are rushing
19. Agree, I like doing projects better than sitting for an hour listening to the teacher
20. Agree, it helps you learn more about what you already know
21. Because it is fun while I am learning
22. Disagree, because its very hard to understand the project if a whole group is doing it
23. I agree because you have to do the research and understand what you are presenting. But I am not a fan of projects.
24. I agree it gives me a better understanding
25. Yes, because I learn something new
26. Yes, because its hands-on

Question 4: I enjoy learning about Rocks?

1. Agree – like rocks and what they are made up of
2. Agree because I learned a lot about rocks
3. Agree because I like learning about rocks
4. Agree because it was cool to see all the different types of rocks
5. Agree because its easy and nothing was hard about it
6. Agree because there was so much to a rock I didn't know

7. Agree because when I get older I might want to collect them
8. Agree I learned some good stuff that I didn't know before
9. Agree it was very interesting I like all the different types of rocks
10. Agree tell how rocks are created and how they came to be
11. Agree there very interesting
12. Agree, because some of it is easy
13. Agree, I loved learning about how rocks are classified by geologists and also streak, luster and hardness
14. Agree, it lets me know about how do rocks form
15. Agree, it was fun looking at different rocks
16. Disagree – I really do not
17. Disagree – it's boring and wasn't taught well
18. Disagree – its pretty easy but not one of my favorite subjects in science
19. Disagree - they are boring
20. Disagree all we talk about is rock and how they form
21. Disagree because it's not important
22. Disagree because they are easy to understand
23. Disagree because they're like the same thing but have different structures
24. Disagree cause it's too much to remember
25. Disagree it was okay but not great
26. I agree because there were many way to classify rocks I didn't know about
27. I agree yes I did enjoy learning about rocks because I got to see different kinds
28. Yes, cause I like rock
29. Yes, it was easy to learn

Question 5: I prefer not to work on worksheets in science class?

1. Agree because I don't like everyone in this class
2. Agree because I really don't like doing projects
3. Agree because it's so hard
4. Agree because they're easy to use with the book to help us out
5. Agree because worksheets are very hard to do
6. Agree I don't like doing worksheets
7. Agree, when we do worksheets it helps
8. Disagree – I love doing projects
9. Disagree – it allows me to learn more therefore I participate
10. Disagree because those things help me learn more
11. Disagree because we can learn things
12. Disagree I participate in everything
13. Disagree I think that it is very helpful
14. Disagree it helps me
15. Disagree it helps me learn
16. Disagree, I get extra points
17. Disagree, I love too
18. Disagree, I want my grade and something they are fun
19. Disagree, my parents would kill me if I sat and did nothing everyday
20. I disagree because I like participating in everything
21. No but it can help
22. No, its fun

Question 6: I enjoyed the way Mrs. Hinyard taught Rocks more than how she taught Plate Tectonics?

1. Agree – I never understood plate tectonics
2. Agree because I understand everything she was saying
3. Agree because it let me see what rocks contain
4. Agree because learning about rocks are fun
5. Agree because she's one of my favorite teachers
6. Agree I taught it really good and I understand
7. Agree I think it is because she showed us all types of different rocks

8. Agree she made it so easy
9. Agree, plate tectonics I didn't understand that much really
10. Disagree because I learned about plate tectonics faster
11. Disagree because it was easier to understand
12. Disagree because they had all kinds of rocks
13. Disagree because we had more practice with plate tectonics
14. Disagree even though Mrs. Hinyard is the best teacher at Baker Middle plate tectonics was a better thing to learn
15. Disagree I feel she taught plate tectonics better because I understood it better
16. Disagree I like it because I got to make a plate boundary
17. Disagree it was not taught well enough. I don't understand anything about it
18. Disagree no cause rocks are different from plate tectonics
19. Disagree plate tectonic was broken down perfectly in a way that was understandable
20. Disagree plate tectonics was very thorough with all the research we did
21. Disagree she made it good to learn that way with plate tectonics
22. Disagree, because she made it fun doing experiments
23. Disagree, I guess because of the model we made last time
24. Disagree, I like them equally the same
25. Disagree, we did the project thing with plate tectonics and it was much easier to do hands on
26. No, plate tectonics is easy to learn
27. Yes because I didn't know how rocks formed
28. Yes I love the way Mrs. Hinyard taught us that lesson because she let us see different kinds of rocks

Topic: Rocks

Group: Experimental Group

Test: Posttest

Question 1: When learning about new science concepts, I like to create things during the process?

1. Agree because fun things help/make me learn better
2. Agree because I think it is better to create when learning
3. Agree because it helps me get a better look at somethings
4. Agree because it helps us learn better
5. Agree cause its fun
6. Agree I agree because I like for the class to be exciting
7. Agree it can help me understand it more
8. Agree it help me get the concept of it
9. Agree it helps me understand
10. Agree it made me understand more
11. Agree it's fun to participate
12. Agree so I can understand it more
13. Agree, because I can be a more creative learner
14. Agree, because it's fun when I'm learning in a hands on way.
15. Agree, because to keep it interesting
16. Agree, it keeps me up and make the work interesting
17. Agree, so that it would help me on the specific subject
18. Agree. Helps get a better understanding of it.
19. Disagree because it don't interest me and I'm not into it
20. Disagree it takes to long
21. Disagree some things are just not for creating
22. Disagree that takes up to much time
23. Disagree, because I don't really like to create
24. Disagree, I'd rather just learn it
25. I agree because I like to create cause its easier for me to learn
26. I agree because if I create it helps me break it down
27. I agree with when learning about new concepts I like to create things during the process because it helps me better understand

28. I disagree because if I do that I will lose focus
29. I disagree because it is easier to learn about it then making something while learning
30. No because I have trouble creating some school related projects
31. No because it take time off learning
32. No, I like to keep on the same paste as everyone else
33. Yes, because I love working hands on
34. Yes, because it show gives a fun way to learn and it shows a better way to your work
35. Yes, it helps me understand better

Question 2: I prefer the teacher standing in front of the class and teaching, while I listen?

1. Agree because as I sit and listen I learn a lot of interesting things
2. Agree because I get to write important details
3. Agree because I like to hear the teacher explain things so we could get the lesson
4. Agree but half of the time you teaching the class get interrupted by students
5. Agree cause I don't have to stand up
6. Agree I like it better you learn more
7. Agree it helps me focus a lot better
8. Agree it helps me out
9. Agree she is the focal point in learning
10. Agree so I can understand the directions
11. Agree you would learn more than reading it out a book
12. Agree, because I leave notes in my head about important info.
13. Agree, because it helps me the learner
14. agree. Its how it goes.
15. Disagree because I like to do hands on
16. Disagree because I would like to do projects on the concepts
17. disagree because sometimes I have to do an experiment to understand
18. Disagree I like to move around and do activities
19. Disagree its boring
20. Disagree when the teacher teach we should be doing a fun activity
21. Disagree, it gets boring and puts me to sleep but it really depends on the lesson
22. I agree because can pay attention easily
23. I agree because it is simple and easy to follow
24. I agree because science will catch on with us later in life
25. I agree long as I understand what and how I'm doing on the classwork
26. I agree with I enjoy when the teacher stand in front of the class and teachers while I sit down and listen it makes it better to learn
27. No I disagree because I like to actually do work
28. No, because if you want to get someone's attention let the person show how they did it
29. No, because when she in form of the class I don't get it sometimes
30. Yes because I can learn more in a short period of time instead of doing work and missing time
31. Yes I agree it help me learn better when she stand up teaching us

Question 3: Doing experiments and projects help me understand and learn science better?

1. Agree because fun activities, experiments and projects help me understand better because its fun and easy
2. Agree because I like doing things like that
3. Agree because it describes it better
4. Agree because it makes it easier for me to understand
5. agree because why I'm learning I can show that I know my work
6. Agree because working on projects in class is like studying with someone, teaching each other
7. Agree I learn better by hands on work
8. Agree it helps me learn
9. Agree it helps me sometimes during the processing
10. Agree it's a fun and easy way to learn more
11. agree its physical
12. Agree they show me how fun science is and how incredible you can learn it

13. agree you are doing exactly what you are learning
14. Agree! Because I can see if I really being paying attention
15. Agree, because when doing projects it helps me understand more
16. Agree, because when we work it out I understand it better
17. Agree, cause it helps me better understand the concepts
18. Agree, I understand better with examples
19. Agree, it goes deeper in explanations
20. agree. Because it helpse me get a better understanding than what I already know
21. Agree. Just listening to the teacher talk isn't going to help.
22. Disagree, because it may be physical but you still don't understand it
23. I agree because it breaks stuff done and shows the process of which it happened
24. I agree because it makes me learn better
25. I agree because when I do a project on something in science it makes me learn science better
26. I agree with doing project help me learn science better because I can learn hands on how something is done or created
27. I disagree because you might not learn everything when doing a project
28. Yes because we learn work in a fun way
29. Yes, because if your doing something that helps you better by showing how you did it
30. Yes, they are hands ons

Question 4: I enjoy learning about Rocks?

1. agree because I didn't know how they were formed
2. Agree because it helps me learn different things I did not know
3. Agree because it might have something to do with my life which makes it important to me
4. Agree I never thought that rock are different
5. Agree it is cool how the different types of rocks form
6. Agree it is good because I didn't know anything about rocks
7. Agree it was a good lesson
8. Agree it was something new to learn
9. Agree it's interesting
10. Agree learning about rocks was fun
11. Agree rocks are fun to research and make my own models about them
12. Agree, because learning about rocks could help my life
13. Agree, because they're interesting in many ways
14. Agree, its interesting to learn about the different kinds of rocks
15. Disagree because it is not interesting to me I just don't like it
16. Disagree because its boring
17. Disagree is boaring
18. Disagree it was boring
19. disagree it was boring to me and they don't interest me
20. Disagree to many types of rocks to remember
21. Disagree, its complicated
22. Disagree, rocks aren't that interesting to me
23. disagree, there were a lot of factors that were hard to understand
24. I agree because I need to understand them for my future in science
25. I agree because I understand them
26. I agree because the many different kinds of rocks are interesting
27. I agree that rocks are fun to learn about
28. I agree with I enjoyed learning about rocks because they were fun to learn about
29. No because I did the writing and research mostly
30. No because its boring
31. Yes because it helped explain how rocks are formed
32. Yes, because learning where they come lets you know alot about the Earth
33. Yes, they are very interesting

Question 5: I prefer not to work on worksheets in science class?

1. Agree, I don't care for science but my work will get done
2. Disagree because I do it makes me better
3. Disagree because I feel that you need to do all of these things to pass
4. Disagree because I like to participate in everything
5. Disagree because I only like doing projects
6. Disagree because participating is a fun way to learn
7. Disagree cause I like them
8. Disagree cause that's teaching you more
9. Disagree I have to do what I do to get to college
10. Disagree I like doing worksheets
11. Disagree I like to do worksheets but I like projects more
12. Disagree I like to get all of the credit I can get
13. Disagree I like to participate
14. Disagree I love to work on worksheets in science
15. Disagree its fun to do
16. Disagree, because it all gets me a good grade
17. Disagree, I enjoy doing projects in class
18. Disagree, I like to participate sometimes
19. Disagree, it is really fun to do
20. I disagree because they are easy and simple to do
21. I disagree with I don't prefer worksheets in science because I am serious about my education
22. No I disagree because I like to see if I actually understand the concept
23. No I do if I get a grade for it
24. No, I can not tolerate worksheets
25. No, I like to participate
26. Yes, because you have to do it to improve your grade

Question 6: I enjoyed the way Mrs. Hinyard taught Rocks more than how she taught Plate Tectonics?

1. Agree because I got a better understanding of it
2. Agree because I know more information about rocks than plate tectonics
3. Agree because I like the way the project broke it down
4. Agree because she actually broke down the format of the project which was easy to complete
5. Agree because she does a good job at teaching rocks
6. Agree because she helped me learn it a little better but I still don't quite get it yet
7. Agree because she makes it feel easy
8. Agree because she taught plate tectonics way to fast and I didn't catch on
9. Agree because you had us do the project
10. Agree but it still was complicated
11. Agree cause I mostly know everything now about rocks
12. Agree I did love when Mrs. Hinyard teaches me
13. Agree I liked it very much agree cause she taught it good with the project
14. Agree it was fun
15. Agree she is the best teacher ever
16. Agree she taught it better than last time
17. Agree, because the information was basically explained in the research
18. Agree, I understood it and it was fun
19. Agree. She knows how to break it down.
20. Disagree, it was just a project
21. Disagree, we basically learned it by ourselves
22. I agree because it's good she can teach
23. I agree that Mrs. Hinyard taught me well with rocks because of the project
24. I agree the project really helped me with what I need
25. I agree with I enjoyed the way Mrs. Hinyard taught Rocks because I was able to lead a group of students as we learned about rocks and I understand it better than I did at first.
26. I didn't understand it until now

27. I disagree because I prefer to learn from the teacher and not research
28. No, we had to learn ourselves
29. Yes because I liked working on the project as a group
30. Yes because she taught it well
31. Yes, because I actually learned alot from it

APPENDIX F PARENTAL PERMISSION FORM

PROJECT TITLE: Does Problem-Based Learning with an emphasis in inquiry collaborative skills have an effect on student retention of plate tectonics and rocks and conceptual knowledge of higher order thinking questions?

PERFORMANCE SITE: Baker Middle School
City of Baker School System
5903 Groom Road
Baker, LA 70714

INVESTIGATORS: The following investigators are available for questions about this study,
Monday – Friday 9:00a.m. – 3:00 p.m.
Dr. E William Wischusen 225-578-8239
Brittany Hinyard 225-775-9750

PURPOSE OF THE STUDY: The purpose of this research project is to determine whether there is an increase in student's content knowledge, ability to answer higher order thinking questions and retention of concepts at Baker Middle School when using the instructional strategy of Problem Based Learning with an emphasis in inquiry versus using Traditional Based Learning.

INCLUSION CRITERIA: Students in 8th grade enrolled in Earth Science taught by Brittany Hinyard.

DESCRIPTION OF STUDY: Over the course of the 2012-2013 school year, the investigator will introduce students to the instructional strategies of Problem Based Learning and Traditional Based Learning. The investigator will provide a pretest to determine students' knowledge of the content of study. The investigator will proceed with either Traditional Based Learning where students are lectured to and asked to work independently mostly of the time for the span of the content or Problem Based Learning where students are presented with a problem they must solve using inquiry skills for the span of the content. Prior to the actual investigation students will be familiar with both techniques of learning. After the content has been presented to students, the teacher will provide students with a posttest to determine how much knowledge they gained throughout the study and a survey to determine students' viewpoint of the information and the strategy used to present the information.

BENEFITS: It is anticipated that the subjects will notice improved academic performance pertaining to students' ability to grasp content knowledge and student's ability to retain content knowledge presented. This study will also enhance behavior patterns within students, social capacity with peers, and an overall confidence of scientific knowledge by participating in this study.

RISKS: There are no known risks with participation within this study.

RIGHT TO REFUSE: While participation in this study is highly suggested and recommended, it is not mandatory that a student subject choose to participate. At any time, either the subject may withdraw from the study or the subject's parent may withdraw the subject from the study. Non-participation in this study will leave no impact on student's final grades or assessments throughout the duration of the school year.

PRIVACY: The records of participants in this study include, but are not limited to test scores and attendance, which may be reviewed by investigators. Also, results of the study may be published, but no names or other identifying information will be disclosed in publication. All subjects' identity will remain confidential unless otherwise advised by law.

FINANCIAL INFORMATION: There is no cost for participation in this study, nor is there any compensation to the student subjects and/or their representatives for participation.

SIGNATURES: This study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the primary and/or co investigators. If I have questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Chairman, Institutional Review Board (225) 578-8692, irb@lsu.edu, www.lsu.edu/irb. I will allow my child to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Parent's Signature: _____ Date: _____

IF APPLICABLE:

The parent/guardian has indicated to me that he/she is non- English speaking/reading, or unable to read. I certify that I have read and/or translated this consent form to the parent/guardian and explained that by completing the signature above, he/she has given permission for the child to participate in the study.

Parent's Signature: _____ Date: _____

Teacher's Signature

Date

Principal Signature

Date

APPENDIX G

PLATE TECTONICS ILL-STRUCTURED PROBLEM

Thanks for joining our global team!!!! With you today are the new employees of the Baker Insurance Company. Members of your group include a geologist, an architect, a planner/Insurance Supervisor and an engineer. You (_____) are the _____. Your job entails a detail analysis of your two locations within the world. You must do your part to ensure that the plan of action is put into place by _____. Every member of your group will be responsible for specific tasks throughout your visits (research) to your locations.

Congrats on your first assignment. We have been contacted by a major architectural firm to insure its structural holding in _____ and _____. Your group should complete thorough research to help your understanding of building foundations in your locations. For example, understanding earth's structure is a great place to begin your research. Next, you are required to design and construct a model of your plate boundary that you researched. Then, your group will write a discussion on your findings which in turn you will present to the underwriters of Baker Insurance Company recommending to build or not to build. We want you to insure the architectural firm and your product, in order to get paid. Remember you are on a tight schedule. Your report is due to the underwriters on _____ or the team suffers and your pay deducted. You will present your model and discussions to the underwriters on _____.

Rubric	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
Research Problem	The research is thorough, excellent recommendations are given for your locations and reliable sources are provided.	The research is adequate, good recommendations are given for your locations and reliable sources are provided.	The research is incomplete, one recommendation is given for one location and sources provided are not reliable.	The research is incomplete, poor recommendations are given for your locations, and no resources are provided.
Plan of action	Correctly defines the goal and accurately identifies the parts of the action plan needed to accomplish the goal.	Correctly defines the goal and identifies most parts of the action plan needed to accomplish the goal.	Correctly defines the goal and identifies half of the action plan.	Incorrectly defines the goal and does not complete the action plan.
Making a Model of a Plate Boundary	Model is well constructed and shows the correct type of movement between plates.	Model is adequately constructed and shows the correct type of movement between plates.	Model is poorly constructed and somewhat shows the type of movement between plates.	Model is poorly constructed and/or incorrectly shows the type of movement between plates.
Presenting Research and Model	Leads in a thorough and interesting presentation of the model and discussion	Participates fully in a thorough presentation of the model and discussion.	Briefly participates in a presentation of the model and discussion.	No part in the presentation of the model and research.

APPENDIX H ROCKS ILL-STRUCTURED PROBLEM

Congrats on joining our national team!!!! With you today are the new employees of the Baker Geological Survey Company. Members of your group include a Geologist, a Mining Engineer, Geotechnical Engineer and a Paleontologist Supervisor. You (_____) are the _____. Your job entails a detail analysis of your location within the United States. You must do your part to ensure that the plan of action is planned by _____ and put into place by _____. Every member of your group will be responsible for specific tasks throughout your visits (research) to your location. Our company has been contacted by the United States Geological Survey (USGS) Division of the United States Government to confirm the history and types of rocks native to _____. To accomplish this task your group must complete thorough research about your community and earth's structure composition in that region. Next, you are required to write a detailed analysis concerning the native rocks which can be used to grow the community's buildings and structural foundations. Also, you should focus on one native rock in your community by explaining its lifecycle (past events and future events of the rock). Then, your group will design and construct a model of the process required to make your rock. Finally, your group will present to the USGS your findings and your model. Remember you are on a tight schedule and your analysis is due to the Surveyors on _____ or the **team** suffers and your pay deducted. You will present your model and discussions on _____.

Rubric	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
Research Problem	The research is thorough, excellent which lead to an informative detailed analysis of how the rock became the rock it is today and its future using reliable sources.	The research is adequate, good which lead to an informative analysis of how the rock became the rock it is today and its future using some reliable sources.	The research is incomplete which lead to an analysis of one of the requirements for the paper using resources which are not reliable.	The research is incomplete, poor analysis of the rocks in the area and no resources are provided.
Plan of action	Correctly defines the goal and accurately identifies the parts of the action plan needed to accomplish the goal including resources, responsibilities and potential obstacles.	Correctly defines the goal and identifies 3 of the 4 parts of the action plan needed to accomplish the goal.	Correctly defines the goal and identifies 2 of the 4 parts of the action plan.	Incorrectly defines the goal and does not complete the action plan.
Model of your Rock Cycle	Model is well constructed and shows the correct process required to make your rock.	Model is adequately constructed and shows the correct process required to make your rock.	Model is poorly constructed and partially shows the correct processes.	Model is poorly constructed and incorrectly shows the processes.
Presenting model and research	Takes lead in a thorough and interesting presentation of the model, research and analysis.	Participates fully in a thorough presentation of the model, research and analysis.	Briefly participates in a presentation of the model, research and analysis.	No part in the presentation of the model, research and analysis.

APPENDIX I
FREQUENCY COMPARISONS FOR SURVEY RESPONSES

The frequency comparisons between the control and experimental groups for the pretest and posttest on the Plate Tectonics survey questions.

Question Number	Compared Groups	Frequency	p value
1	Control Pretest Survey	0.51	0.044**
	Experimental Pretest Survey	0.65	
	Control Posttest Survey	0.70	0.003**
	Experimental Posttest Survey	0.90	
2	Control Pretest Survey	0.79	0.522
	Experimental Pretest Survey	0.80	
	Control Posttest Survey	0.79	0.143
	Experimental Posttest Survey	0.87	
3	Experimental Pretest Survey	0.96	0.173
	Control Pretest Survey	1.00*	
	Control Posttest Survey	0.97	0.662
	Experimental Posttest Survey	0.98	
4	Control Pretest Survey	0.28	0.553
	Experimental Pretest Survey	0.28	
	Control Posttest Survey	0.79	0.377
	Experimental Posttest Survey	0.83	
5	Control Pretest Survey	0.86	0.312
	Experimental Pretest Survey	0.83	
	Control Posttest Survey	0.82	0.130
	Experimental Posttest Survey	0.90	
6	Control Posttest Survey	0.87	0.034**
	Experimental Posttest Survey	0.97	

*The test proportion for the control group was 1.00; therefore, the experimental group's test proportion was used to obtain a p value.

**The p value notes a statistical significance between the two frequencies tested.

The frequency comparisons for the control pretest and posttest and the experimental pretest and posttest for the Plate Tectonics survey responses.

Question Number	Compared Groups	Frequency	p value
1	Control Pretest Survey	0.51	0.014**
	Control Posttest Survey	0.70	
	Experimental Pretest Survey	0.65	0.000**
	Experimental Posttest Survey	0.90	
2	Control Pretest Survey	0.79	0.561
	Control Posttest Survey	0.79	
	Experimental Pretest Survey	0.80	0.180
	Experimental Posttest Survey	0.87	
3	Control Posttest Survey	0.97	0.270
	Control Pretest Survey	1.00*	
	Experimental Pretest Survey	0.96	0.521
	Experimental Posttest Survey	0.98	
4	Control Pretest Survey	0.28	0.000**
	Control Posttest Survey	0.79	
	Experimental Pretest Survey	0.28	0.000**
	Experimental Posttest Survey	0.83	
5	Control Pretest Survey	0.86	0.301
	Control Posttest Survey	0.82	
	Experimental Pretest Survey	0.83	0.167
	Experimental Posttest Survey	0.90	

The frequency comparisons between the control and experimental groups for the pretest and posttest on Rocks survey questions.

Question Number	Compared Groups	Frequency	p value
1	Control Pretest Survey	0.68	0.336
	Experimental Pretest Survey	0.73	
	Control Posttest Survey	0.86	0.019**
	Experimental Posttest Survey	0.73	
2	Control Pretest Survey	0.87	0.000**
	Experimental Pretest Survey	0.65	
	Control Posttest Survey	0.78	0.415
	Experimental Posttest Survey	0.76	
3	Control Pretest Survey	0.96	0.204
	Experimental Pretest Survey	1.00	
	Control Posttest Survey	0.98	0.001**
	Experimental Posttest Survey	0.88	
4	Control Pretest Survey	0.48	0.233
	Experimental Pretest Survey	0.55	
	Control Posttest Survey	0.73	0.430
	Experimental Posttest Survey	0.71	
5	Control Pretest Survey	0.12	0.181
	Experimental Pretest Survey	0.18	
	Control Posttest Survey	0.15	0.393
	Experimental Posttest Survey	0.18	
6	Control Posttest Survey	0.58	0.000**
	Experimental Posttest Survey	0.83	

**The p value notes a statistical significance between the two frequencies tested.

*The test proportion for the control pretest group was 1.00; therefore, the control posttest survey test proportion was used.

**The p value notes a statistical significance between the two frequencies tested.

The frequency comparisons between the control pretest and posttest and the experimental pretest and posttest for Rocks survey questions.

Question Number	Compared Groups	Frequency	p value
1	Control Pretest Survey	0.68	0.004**
	Control Posttest Survey	0.86	
	Experimental Pretest Survey	0.73	0.532
	Experimental Posttest Survey	0.73	
2	Control Pretest Survey	0.87	0.053
	Control Posttest Survey	0.78	
	Experimental Pretest Survey	0.65	0.102
	Experimental Posttest Survey	0.76	
3	Control Pretest Survey	0.96	0.412
	Control Posttest Survey	0.98	
	Experimental Posttest Survey	0.88	0.007**
	Experimental Pretest Survey	1.00*	
4	Control Pretest Survey	0.48	0.000**
	Control Posttest Survey	0.73	
	Experimental Pretest Survey	0.55	0.029**
	Experimental Posttest Survey	0.71	
5	Control Pretest Survey	0.12	0.352
	Control Posttest Survey	0.15	
	Experimental Pretest Survey	0.18	0.566
	Experimental Posttest Survey	0.18	

*The test proportion for the experimental pretest survey group was 1.00; therefore, the experimental posttest survey group's test proportion was used.

**The p value notes a statistical significance between the two frequencies tested.

APPENDIX J IRB APPLICATION

Application for Exemption from Institutional Oversight



Institutional Review Board
 Dr. Robert Mathews, Chair
 131 David Boyd Hall
 Baton Rouge, LA 70803
 P: 225.578.8692
 F: 225.578.6792
 irb@lsu.edu
 lsu.edu/irb

Unless qualified as meeting the specific criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/ projects using living humans as subjects, or samples, or data obtained from humans, directly or indirectly, with or without their consent, must be approved or exempted in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

- Applicant, Please fill out the application in its entirety and include the completed application as well as parts A-E, listed below, when submitting to the IRB. Once the application is completed, please submit two copies of the completed application to the IRB Office or to a member of the Human Subjects Screening Committee. Members of this committee can be found at <http://www.lsu.edu/screeningmembers.shtml>
- A Complete Application Includes All of the Following:
 - (A) Two copies of this completed form and two copies of part B thru E.
 - (B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1&2)
 - (C) Copies of all instruments to be used.
 - *If this proposal is part of a grant proposal, include a copy of the proposal and all recruitment material.
 - (D) The consent form that you will use in the study (see part 3 for more information.)
 - (E) Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB. Training link: (<http://phrp.nihtaining.com/users/login.php>.)
 - (F) IRB Security of Data Agreement: (<http://www.lsu.edu/irb/IRB%20Security%20of%20Data.pdf>)

1) Principal Investigator: Rank:
 Dept: Ph: E-mail:

2) Co Investigator(s): please include department, rank, phone and e-mail for each

Brittany Hinyard Graduate Student bshinyard@gmail.com	Biological Sciences 225-953-0511
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IRB# <u>E5989</u>	LSU Proposal #
<input checked="" type="checkbox"/>	Complete Application
<input checked="" type="checkbox"/>	Human Subjects Training

3) Project Title:

Study Exempted By:
 Dr. Robert C. Mathews, Chairman
 Institutional Review Board
 Louisiana State University
 203 B-1 David Boyd Hall
 225-578-8692 | www.lsu.edu/irb
 Exemption Expires: 5/28/2015

4) Proposal? (yes or no) If Yes, LSU Proposal Number

Also, if YES, either This application completely matches the scope of work in the grant
 OR More IRB Applications will be filed later

5) Subject pool (e.g. Psychology students)

*Circle any "vulnerable populations" to be used: (children <18; the mentally impaired, pregnant women, the aged, other). Projects with incarcerated persons cannot be exempted.

6) PI Signature Date (no per signatures)

** I certify my responses are accurate and complete. If the project scope or design is later changes, I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted. I also understand that it is my responsibility to maintain copies of all consent forms at LSU for three years after completion of the study. If I leave LSU before that time the consent forms should be preserved in the Departmental Office.

Screening Committee Action: Exempted <input checked="" type="checkbox"/> Not Exempted <input type="checkbox"/>	Category/Paragraph <u>1</u>
Reviewer <u>Mathews</u>	Signature <u>Robert Mathews</u> Date <u>5/29/12</u>

VITA

Brittany Sharday Hinyard was born to Broderick and Vanessa Fountain in 1986. She is a native of Baton Rouge, Louisiana where she graduated from Belaire High School in May 2004. In 2008, she received her bachelor's degree from Louisiana State University Agricultural and Mechanical College in Biological Sciences. After completing her undergraduate studies, she taught middle school science in a rural community in East Baton Rouge Parish. She is a 2013 candidate for the Master of Natural Science degree from Louisiana State University. She plans to seek future employment as a Curriculum Specialist at a local school district.