EFFECTS OF CLASSROOM DISCUSSIONS ON STUDENT PERFORMANCE AND CONFIDENCE IN THE SCIENCE CLASSROOM

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Middle school can be a tough time for students to be willing to share their ideas and thoughts aloud in class. This study challenges that unwillingness to speak aloud in class and teaches students how to participate appropriately in formal class discussions. While conducting this study, data was collected to determine if the discussions had an effect on student performance and confidence in the science classroom. Students were observed during five different class discussions. Data was collected by using tools such as rubrics, self-assessments, pre-assessments and post-assessments. After two months of post-treatment, the study concluded with the knowledge that class discussions can be used as another strategy to engage students to be active participants in their learning of science topics while also allowing students to demonstrate oral speaking skills in a respectful learning environment.

INTRODUCTION AND BACKGROUND

E.O. Coffman Middle School in Lawrenceburg, Tennessee is the only middle school in the Lawrence County School System. Coffman School has approximately 356 students enrolled in the 7th and 8th grade. Coffman is divided into four mini-schools. Each mini-school consists of a reading/language arts teacher, a mathematics teacher, a general science teacher, and a social studies teacher and each mini-school contains approximately 90 students. From the students enrolled at E.O. Coffman, 88.8% are Caucasian, 7.4% are African American, 3.2% are Hispanic, and .5% are Asian. Seventy-nine percent of the school population is listed as economically disadvantaged. Therefore, the school is considered a Title I school and receives federal funding (TDOE Report Card, 2011).

Tennessee state curriculum standards for the eighth grade require me to teach various general science topics. The main themes taught in my classroom are biodiversity, physical science, and forces of nature. My study consisted of 21 students with high, average, and low ability levels. With so much diversity in each classroom, my goal of teaching all of the students how to communicate effectively proved to be challenging. I chose to accept this challenge and provided my students with the necessary skills that led them to be excellent oral communicators both inside and outside the classroom.

The purpose of this study was to determine how classroom discussions affected student performance and confidence. Students were introduced to different strategies that provided them with the skills needed to participate in classroom discussions. These discussions were centered on the science topics that were introduced in the classroom. The idea of implementing effective classroom discussions was first introduced to me at a standards-based training conference in the summer of 2010. A high school science teacher presented the topic of *accountable talk*. Accountable talk is just one of several ways to describe classroom communication. After attending the training session, I noticed in my classroom that several of my students were not effective communicators or listeners. The strategies provided me with ways to better teach my students how to communicate in a respectful manner and to be critical thinkers in the science classroom.

My study was conducted to answer the following primary question: What impact does classroom discussion have on student performance and confidence in the science classroom? The sub-questions are as follows:

1. What strategies can be used to implement classroom discussions effectively?
2. How will classroom discussions impact students' ability to communicate appropriately?

CONCEPTUAL FRAMEWORK

Communication in the science classroom can be an essential part of every student's learning when supported by the teacher. According to the National Science Education Standards (1996), "students should begin developing the abilities to communicate, critique, and analyze their work and the work of other students. This communication might be spoken or drawn as well as written," (pg. 122-123).

Communication strategies require the teacher to be a facilitator of student communication in the classroom. Students may debate, argue, or reason with each other about different science topics that arise in the classroom. For example, climate change and evolution are often interesting topics for students. While communication strategies are taught, the teacher must also instruct the students on how to respect each other even if they disagree with each other. This will have a major effect on the results of classroom discussion (Larson, 2000; Mitchell, 2010).

Jean Piaget and Lev Vygotsky viewed student learning as an active process that allows each student to develop his or her learning through social experiences. These experiences help students connect the classroom content to real-life situations (Atwood, Turnball, & Carpendale, 2010). Therefore, it is important to make connections between the science topics being learned in the classroom and students' prior knowledge while allowing learners to communicate their thoughts to their classmates in a way that is respectful and conducive to science learning (Emdin, 2010; Larson, 2000; Shemwell & Furtak, 2010).

Communication in the science classroom allows pupils to simulate discussions as scientists in a laboratory setting. The National Science Education Standards (NSES) requires students to discuss data analysis and conclusions with their peers so that they may provide evidence to support their experimental results (NRC, 1996). Thinking and speaking as scientists is generated by a positive learning environment where communication is encouraged and the teacher allows students to think on their own without always having the right answer (Emdin, 2010; Mitchell, 2010). Once teachers are comfortable with allowing students to discuss their thoughts aloud with each other, learners will begin to build on their own learning while gaining insight from their peers. When participating in classroom discussions, pupils are active in their learning, and they are able to associate the topics being learned with experiences they have had in their lives already (Larson, 2000). This knowledge supports the constructivist theory in which "the learner is constantly filtering incoming information based on his or her existing conceptions and preconceived notions to construct and reconstruct his or her own understanding" (Llewellyn, 2005, p.28).

To be effective, classroom discussions must be practiced at the beginning of each school year so students will have a clear understanding of what is expected of them. To best teach discussion, different methods and methodologies should be incorporated in the classroom. A positive classroom environment must be established at the beginning of the year. The teacher must set the discussion expectations, and the students must understand that they are responsible for their own learning. Teachers must provide ownership to each learner's comment after he or she has spoken. This requires the teacher to put the student's name and his or her statement together so that other pupils in the classroom will know to whom to direct their next comment or question. Not only does this repeat the statement from the student, but it also allows him or her to feel a sense of ownership to his or her statement (Atwood, Turnball, & Carpendale, 2010; Emdin, 2010; Larson, 2000; Marcum-Dietrich, 2010; Mitchell, 2010). This allows for the teacher to "build a classroom environment in which all are equal participants" (Mitchell, p.173). Other methods and methodologies include speaking to students in a language they understand such as their social talk with peers (Emdin, 2010), allowing the opportunity for students to use important science words and concepts in their discussions (Shemwell & Furtak, 2010), expecting students to make eye contact with each other, and turning to the speaker while also not talking while another student is talking (Emdin, 2010).

Students play an important role in classroom discussion. They must feel a high level of comfort before being able to communicate their views about a topic with their peers. The best way to facilitate this level of confidence is to allow students time to work in cooperative learning groups before having to speak in front of an entire room of their classmates. Teachers may supervise and observe these first few meetings before actively engaging as a participant in the discussions with the students. Once students are more comfortable with the discussion format, a whole group discussion can ensue which may give them the confidence to share different points of view. When this occurs, learners will be able to use the evidence they have gathered for the topic being discussed to defend their ideas. Other students may also want to offer new ideas to the discussion topic. The ideas expressed will depend on the students' prior experiences (Atwood, Turnball, & Carpendale, 2010; Larson, 2000; Mitchell, 2010).

The Predict-Observe-Explain (POE) strategy also allows students to express their ideas to their classmates. Instead of students following "cookbook" style laboratory activities, they can discuss and take part in their own design of experiments. In cooperative learning groups, learners can predict what materials and steps should be included in their experiment, they can observe their decisions by testing their ideas, and as a class, they can explain if their ideas were successful or unsuccessful. This allows for participants to have a common goal, but different ideas about how an experiment may work. It also gives students a chance to talk positively to each other about a common topic (Emdin, 2010; Larson, 2000; Mercer, 2010; Mitchell, 2010). Another way to get students talking as scientists is to teach them to ask questions as scientists. Mitchell (2010) refers to these questions as "thinking" questions. "Thinking questions are ones that indicate reflection on the content and on the students' understandings and experiences," (Mitchell, 2010, p.183). Instead of students saying "I'm confused" or "I don't understand," they ask questions that pertain to the topic at hand. This strategy allows the teacher to understand what students still need help on and what they understand.

Teachers provide the strategies needed for students to develop good science communication for the classroom. Mitchell (2010) identified twelve important behaviors for teachers that are needed to induce an effective communication environment. Samples of these behaviors include allowing students to create instructions, encouraging students to listen to other peers for learning purposes, and identifying assessment that evaluates student learning daily. Once teachers reflect on their own teaching and establish what twelve behaviors are appropriate for them, a sense of ownership can be established in the classroom by the teacher. One teacher strategy that can be effective if implemented correctly is *Challenge the Right Answer*. For some teachers, this strategy may be intimidating. Students are allowed to question the teacher's answer or the information in the textbook. This strategy identifies students' thoughts about a topic. Instead of students accepting the teacher or the textbook's word as the truth, students can challenge what has been stated leading to a possible classroom discussion. This allows for "student talk that is exploratory, tentative, and hypothetical," (Mitchell, 2010, p. 175). Once again, learners will explore their prior knowledge and experiences.

Once the teacher and students have established a positive learning environment for classroom discussion, data collection and analysis will need to be implemented to ensure effectiveness of the methods and strategies. Several different tools can be used to collect data and are highlighted in Table 1. Marcum-Dietrich (2010) provides sample rubrics and research sheets used to collect student data, Emdin (2010) uses field notes and videos that identify both verbal and nonverbal gestures, and Mercer (2010) describes teacher observations, voice recording, and video recording to collect data. State standardized tests can also be used to indicate learning as a pre- and post-assessment as seen in the data collected by Murphy, Wilkinson, Soter, Hennessey, and Alexander (2009). Table 1 displays these methodologies along with the strategies used for the data collection.

Table 1
Authors, Methodologies, and Data Collection Techniques/Strategies

Author	Methodology	Author	Data Collection Techniques/ Strategies
Emdin, 2010	Social Talk with Peers	Mitchell, 2010	Predict-Observe-Explain
Emdin, 2010	Use of Important Science Words and Concepts	Mitchell, 2010; Murphy, Wilkinson, Soter, Hennessey, & Alexander, 2009	*Thinking Questions*; *Challenge the Right Answer*; Pre- and post-standardized tests
Shemwell&Furtak, 2010	Classroom Discussion Expectations	Marcum-Dietrich, 2010; Emdin, 2010; Mercer, 2010	Rubric and research sheets

In summary, the constructivist theory, along with Piaget's and Vygotsky's ideas of education, has a major effect on the importance of classroom discussion. Students must be provided with a positive learning environment that allows for "students to have the opportunity to share their views," (Atwood et al., 2010, p.362). When the right environment is established and the teacher presents the students with the adequate guidance for discussion, participants will be able to communicate their views, ideas, and conclusions with their classmates as real scientists do in the laboratory. Research shows that when teachers and students both exhibit cooperation, classroom discussions can be beneficial to student and teacher confidence. Limitations and weaknesses can be overcome with the correct preparation from the teacher. "Studies show that most classroom talk is done by the teacher" (Atwood et al., p.375). When teachers understand how discussion in the science classroom helps students make connections to their lives, they may allow for less teacher talk and more student talk that will benefit both groups in the end.

METHODOLOGY

The treatment of this study implemented effective use of classroom discussion during an eight week period. All 21 students and their parents completed an Informed Consent and Assent Form (Appendix A), and the students were then introduced to teaching strategies that required them to participate in both teacher-led and student-led discussions. The discussions occurred before, during, and after new science topics were introduced in the class. The classroom discussions were evaluated based on student performance and student confidence. A variety of the discussion strategies were outlined in Table 1.

Before implementing the classroom discussion strategies, eight students were chosen randomly to participate in the Pre-Discussion Interview (Appendix B). The students answered eight questions that were related to the structure of classroom discussions. The same eight students also answered the Post-Discussion Interview Questions as well (Appendix C). Before and after the implementation of classroom discussion techniques, all students completed the Pre-and Post-Discussion Questionnaire (Appendix D). The questionnaire determined students' opinions on classroom discussion based on student likeness, comfort level, and previous experience. Students rated the statements with "5" being "Strongly Agree" to "1" being "Strongly Disagree." The survey and the interview questions were used to gather even more of an understanding of students' opinions of discussions in the classroom. Before beginning the classroom discussion strategies, students completed the science portion of the Tennessee Comprehensive Assessment Program (TCAP) Practice Test for Grade 8 Part 1 as a pre-assessment (TCAP, 2009). The pre-assessment strategies were evaluated during a two week non-treatment period before implementing the classroom discussion strategies.

During the eight weeks of implementation of the classroom discussion techniques, the teacher provided students with the techniques and research-based strategies listed in Table 1. These techniques and strategies were evaluated by the teacher during the treatment period. The Confidence Rating Form was used after each discussion to identify changes in student confidence before and after each discussion session (Appendix E).

The scale included the three main topics related to the day's discussion. These observations allowed the teacher to determine what areas in which students needed more help. The pre-assessment strategies were evaluated over a four week time period before implementing any of the classroom discussion strategies. Students also completed the form Continue Thinking after Discussion (Appendix F). This allowed students to compare their thoughts about the three main topics for the day before, during, and after each discussion.

The students completed numerous teacher-made pre-and post-assessments that provided feedback on student performance (Appendix G-N). Also, during this time, students participated in classroom discussions and completed the Discussion Self-Assessment after each session (Appendix O). The teacher used a journal to document observations and important learning from the discussions. A Classroom Discussion Rubric (Appendix P) was used during each of the discussion sessions to evaluate students' oral communication skills. The teacher communicated the expectations from the rubric before evaluating the students. The rubric was used to gather a quantitative evaluation of students' discussion abilities.

The Popsicle stick strategy was implemented during the treatment period also. Students were given five sticks per discussion. Each time that they spoke they had to place a stick in their plastic bag. When they had used all their sticks, they could no longer talk unless called upon by the teacher or another student.

After eight weeks of the treatment period, the teacher had the students complete the Post-Discussion Questionnaire (Appendix D) and the TCAP Practice Test Part 1

(TCAP, 2009). The teacher also conducted the interview again with the same small group of students (Appendix C). The results from all the data collection tools were used as comparisons to determine student performance and to determine if student confidence increased during the treatment period as outlined in Table 2.

Table 2
Classroom Discussion Triangulation Matrix

Research Questions	Data Source 1 and Timeframe	Data Source 2 and Timeframe	Data Source 3 and Timeframe
1. What impact does classroom discussion have on student performance and confidence in the science classroom?	Interview-During two weeks before treatment	Questionnaire-During two weeks before treatment	TCAP Practice Test Part 1-Beginning of the school year
2. What strategies can be used to implement classroom discussions effectively?	Teacher-made tests-Approximately one test every two weeks during treatment	Discussion Self-Assessment-After each discussion	Journal (teacher)-After each discussion session
3. How will classroom discussions impact students' ability to communicate appropriately?	Interview- After last discussion	Questionnaire- After last discussion	Rubric-During each discussion

DATA AND ANALYSIS

The data collected during the pre-treatment period helped build a foundation for the post-treatment period. Students began by completing the Tennessee Comprehensive Assessment Program (TCAP) the first week of school. This served as a practice test for the Tennessee state test. Thirty-eight percent of students scored a B, another 38% scored a C, and the other 24% scored a D (*N*=21). No A's or F's were reported.

The Pre-Treatment Questionnaire showed that 86% of the students believed that science was fun and important. For learning styles, 90% of students agreed that they learn best by being an active participant and 86% enjoyed learning and working in groups. Only 48% agreed that they had participated in formal whole group discussions. Students showed confidence in answering questions with an agreement of 57% of the class. However, only 24% of the class enjoyed answering questions aloud.

After interviewing a random sample of 8 students about classroom discussion, 50% of the students agreed that they would rather answer out loud in class than write their answers and information down on paper. The other 50% did not want to answer out loud because they did not like to talk out loud. To implement more discussions in the science classroom, 25% of the students stated that they would like to write down the material that we want to discuss first before we talk in class. One student discussed the idea of writing the answers on the board and then talking about it. Thirteen percent of the students believed classroom discussions should take place after group work has been completed. Other ideas from the students included talking more, having no writing assignments at all, and making sure all students stay on track.

The discussions in the science classroom were believed to be helpful by all students. Eighty-eight percent of students realized that classroom discussions help them understand the science content. The other 13% believed that discussions help them get a feel of what everyone else thinks. One student replied, "I think you are doing a pretty good job, Mrs. Green." However, students did make suggestions on how to improve our discussion time. Of the students that gave suggestions, 50% of the students believed that all students should talk during discussions. Ten percent of the students stated that we should "add more talking activities." The other 50% of the students thought the discussions needed no improvement.

Concerning who should lead the discussions in class, 100% of the students stated that the teacher should lead. All students stated in a simple fashion that the teacher should lead because she is smarter than us. Fifty percent of the students said that discussions should take place weekly while 38% of the students stated that discussions should take place on a daily basis. Thirteen percent stated that discussions should take place on a daily or weekly basis depending on what topic we are studying in class. As for the idea of when students participate more in class discussions, 88% of the students claimed that the topic being learned in science class determined how well they participate. One student stated, "If you don't like it then you probably don't know it." Ten percent did say that it did not matter what we were learning about he would "always participate" in discussion time.

In the pre-treatment discussion, the results of the Discussion Self-Assessment indicated that 33% of students felt a *high* level of confidence during the discussion whereas the *middle* level of confidence showed 62%. Another 5% of students felt a *low* level of confidence during the first discussion. As for the enjoyment of the whole group discussion, 100% of the students had an enjoyment level of *high* to *middle* level. The level of learning ranged from 24% of the students who believed the discussion was highly helpful while 71% had a *middle* level learning experience from the discussion. Only 5% believed that a *low* level of learning was achieved during the discussion. Participation was low during our first pre-treatment discussion with 44% talking at least three times. The other 56% talked two times or less. Many students commented that the discussions could be improved by more people from the class talking and for the teacher to call on people who do not willingly talk aloud. Students were asked to write down what they learned from the discussion. Eighty-one percent of the students gave an appropriate response that related to the topics discussed. However, the other 19% wrote “none” as their response to this question.

The Confidence Rating Form for Discussion 2 showed that 24% of students wrote a concise answer about what they learned from others while 29% wrote about information they had gained during the discussion. Student confidence levels decreased slightly from the first discussion. Nineteen percent of students felt a *high* level of confidence, 43% left the discussion with a *middle* level of confidence, and 38% had a *low* level of confidence. Forty-eight percent of students enjoyed the day’s discussion with 38% also developing a *high* level of learning from the discussion. Thirty-four percent of the students participated in the discussion four to five times.

Sixty-two percent of the students claimed that they had learned at least one component of chemical reactions with 38% not giving a response for the day’s discussion. Once again, students suggested that we needed to make more people talk and to call on people when no one is talking as ways of improving our discussions. The performance level of learning from the two discussions did show some amount of learning. The comparisons were made using Chemical Reactions Quiz and Chemical Reactions Test (Figure 1).

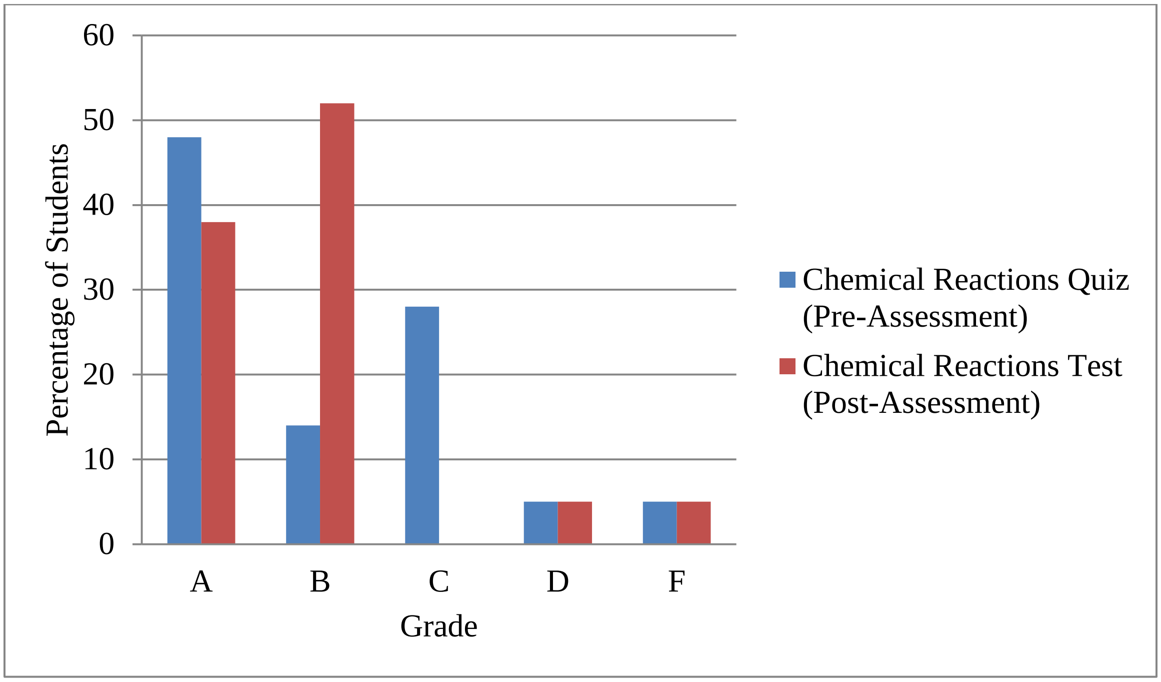

Figure 1. Comparison of scores from the Chemical Reactions Quiz and Chemical Reactions Test, (*N*=21).

Discussion 3 took place two weeks later and consisted of the topic of Acids and Bases. It was noted in my journal that this topic was the most relatable to the students and the most enjoyable and pleasing discussion for me as a teacher. Discussion 3 began with students writing about the differences between acids and bases, how acids and bases were used in everyday life, and what happens when an acid and base is mixed together. Eighty-one percent of students were able to write down at least one new idea that they learned from their classmates with 67% of students able to write about what they had learned that changed the way they thought about the topic of acids and bases. During this discussion the Confidence Rating Form was implemented to allow for a better understanding of the increase of confidence of students' scientific learning. A majority of the students showed an increase in their confidence for each of the three topics for the day (Figure 2).

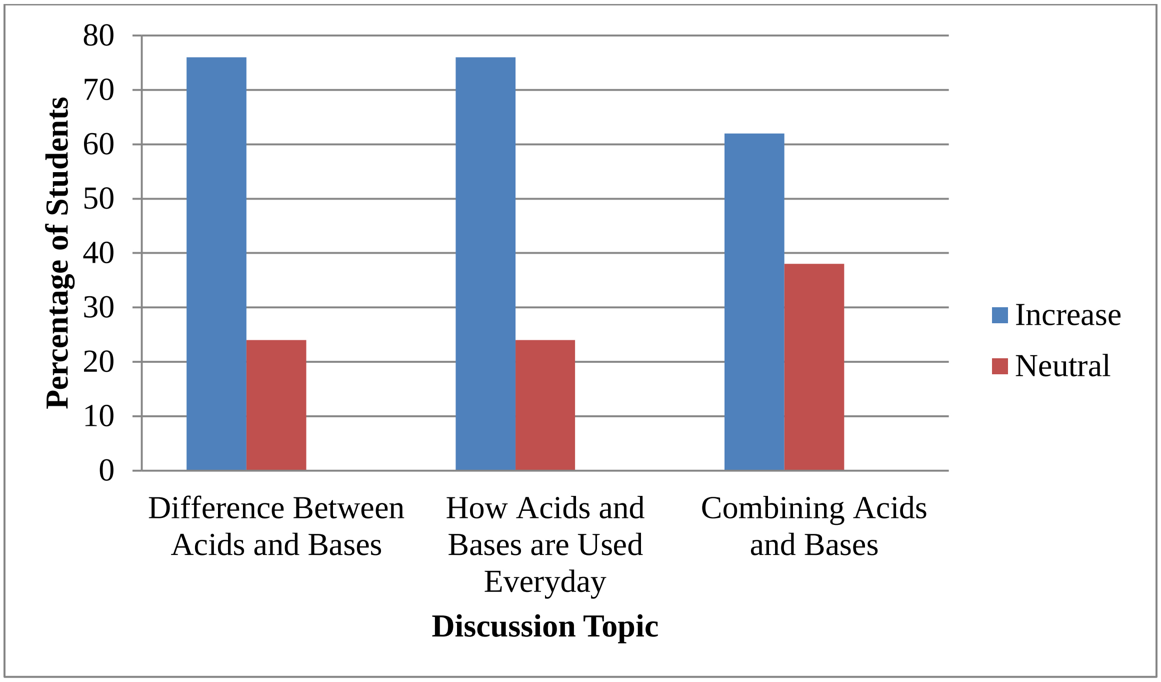

Figure 2. Confidence Rating Form change in confidence before and after Discussion 3, (*N*=21).

Major increases were shown in the areas of confidence, enjoyment, and learning of the topics for Discussion 3. Nineteen percent of students showed a *high* level of confidence, but 66% of students showed a *middle* level of confidence and only 14% showed a somewhat *low* level of confidence. Enjoyment of the discussion showed that 43% highly enjoyed the lesson, 48% mildly enjoyed the lesson, and 9% had a *low* level of enjoyment. Learning remained similar with 24% with a *high* amount of learning, 52% had a middle level of learning, and 24% had a *low* level of learning. Improvement in this category was shown with only 10% of students not speaking during the discussion at all.

Compliments from the students were given due to the use of the sticks. These were a success with the kids, and they suggested that we keep using them. Eighty-six percent of the students were able to describe at least one idea that they had learned for the day's discussion. Fourteen percent of students expressed that the day's lesson was great with regards to the use of the sticks and the ideas and questions that were mentioned about acids and bases.

An increase in performance on the topic of acids and bases also suggested that the students' comprehended much of what was discussed during Discussion 3. Students' performance was compared by using the Acids and Bases Quiz that was given before the discussion and the Acids and Bases Test that was given after the discussion. An increase in the number of A's and a decrease in the number of C's and D's are shown below (Figure 3).

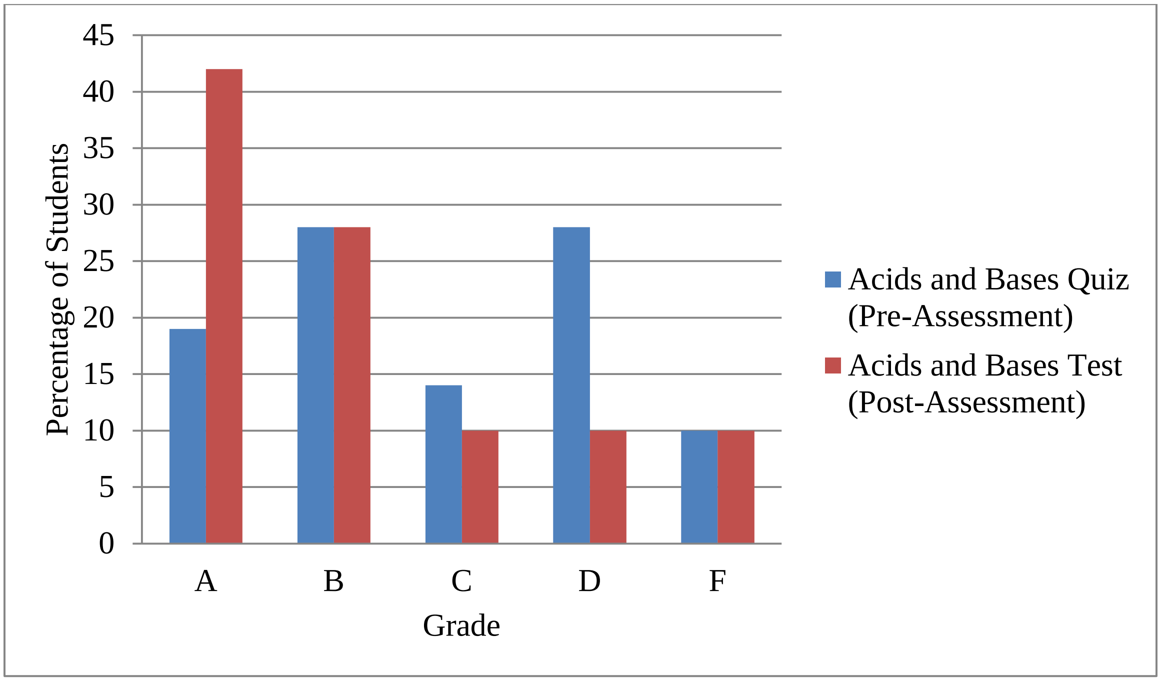

Figure 3. Comparison of scores from the Acids and Bases Quiz and Acids and Bases Test, (*N*=21).

Electromagnetism was the topic of discussion for the fourth installment of our research. As seen for the topics of acids and bases, 81% of students gained knowledge from their peers and 67% were able to gain a better understanding of the topic by the end of the day's discussion. The amount of learning and understanding of the topic of electromagnetism increased according to the Confidence Rating Form that students completed before and after the lesson. Seventy-one percent of students increased their confidence on the topic of what a magnet is, 81% increased their confidence for how a magnet works, and 81% showed an increase for the topic of how the Earth is like a magnet.

The Discussion Self-Assessment proved to be quite useful for providing an overall look at how students view the whole group discussions. An increase was shown when 82% of students exhibited *middle* to *high* confidence in the day's discussion. Eighty-six percent of students showed a *mid* to *high* level of enjoyment for the lesson, and 91% of students felt that they had received much help about the day's discussion topic and magnets and magnetism. Fifty-seven percent of students talked at least three times which was an increase from the topic of acids and bases. Eighty-one percent of students were able to explain at least one new science related idea they had learned from the day's lesson. Again, the students suggested that more people should talk and that the Popsicle sticks were a positive for our discussions. One student claimed that the day's discussion provided her with some "much needed help" on the topic of electromagnetism. Distribution of students' progress was not consistent with the students' ideas from the self-assessment to the Electromagnetism

Quiz to the Electromagnetism Test (Figure 4).

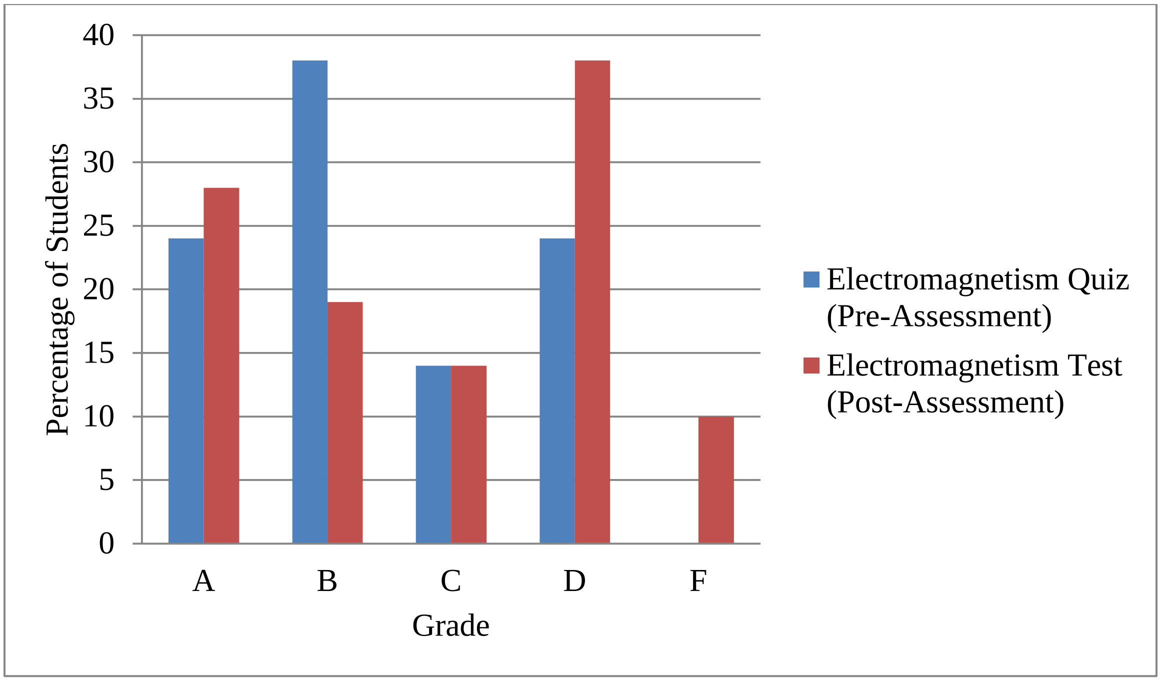

Figure 4. Comparison of scores from the Electromagnetism Quiz and Electromagnetism Test, (*N*=21).

For our last discussion, Discussion 5, the topic of gravity was discussed. The topic gravity proved to be one of the more challenging topics, yet the performance shown for this topic was quite astounding. Students began by explaining their thoughts about what gravity is, how gravity affects objects on Earth, and the difference between mass and weight on the Continue Thinking after Discussion handout. Sixty-two percent wrote about what they learned from others, and 57% combined their thoughts with others to write new thoughts about gravity. The Confidence Rating Form showed that many students' thinking and learning remained neutral after the day's discussion. For the first time, 5% of students showed a decrease in their confidence on the difference between mass and weight (Figure 5).

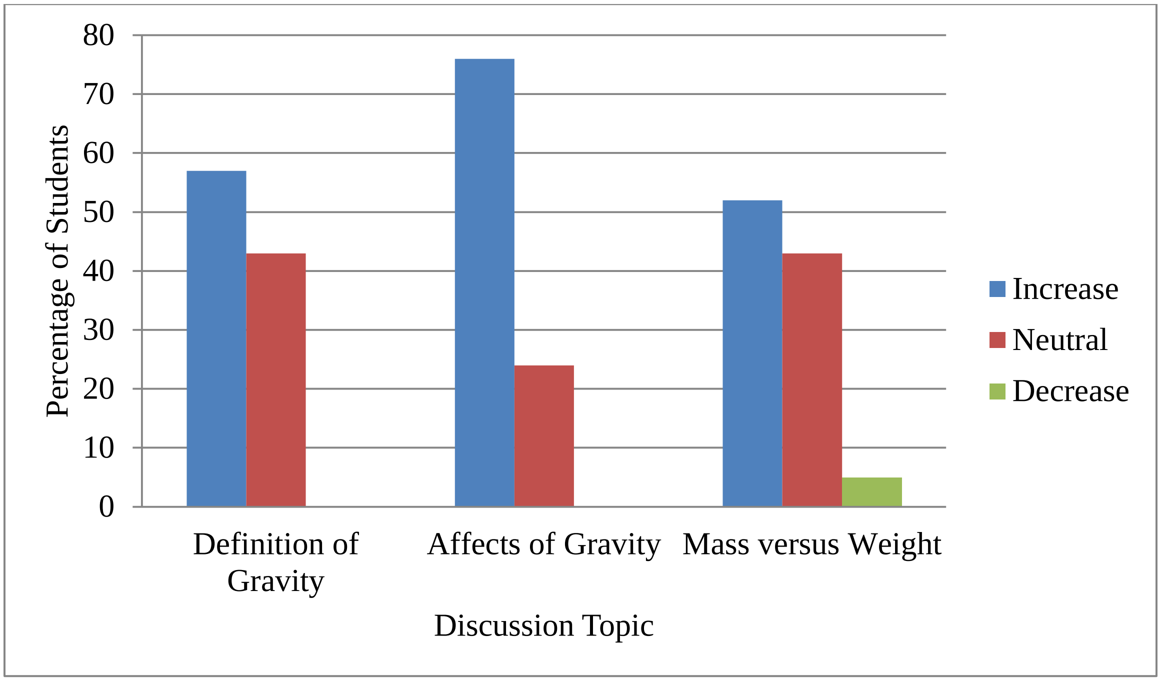

Figure 5. Confidence Rating Form change in confidence before and after Discussion 5, (*N*=21).

As seen on the day's Discussion Self-Assessment, 81% of students showed *middle* to *high* confidence on the topic of gravity. Ninety-one percent of students relayed that they enjoyed the discussion while 90% agreed that the discussion was helpful with their learning of the topic of gravity. Sixty-seven percent of the students still did not participate consistently in the day's discussion. Sixty-seven percent of students did talk at least two times. Eighty-one percent of students were able to convey their learning from the lesson by writing at least one idea on the self-assessment.

During our last session, the students gave me an abundance of compliments and comments regarding our class discussions. Students, first, suggested that more people talk again, some people need to be called upon, and more topics could be added. Other students commented that the discussion on gravity was a "good discussion" and it “helped me understand”. One other student commented, “I wish this wasn’t our last one.” Sixty percent of the students scored an “A” on the post-assessment compared to 38% on the pre-assessment (Figure 6).

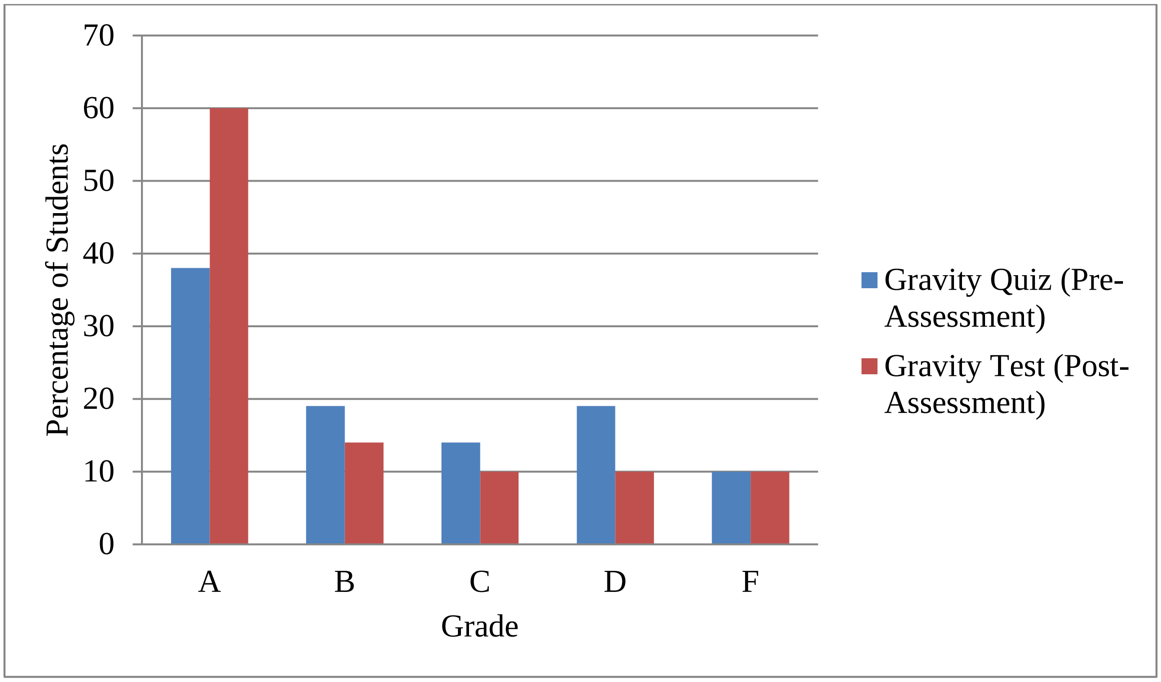

Figure 6. Comparison of scores from the Gravity Quiz and Gravity Test, (*N*=21).

During each discussion, I used the Discussion Rubric to rate the whole class’s performance related to their accountability to the learning community, the use and gain of knowledge, and the ability to use critical thinking skills. The subheadings for each of these categories were averaged together and a comparison of the headings was compiled (Figure 7).

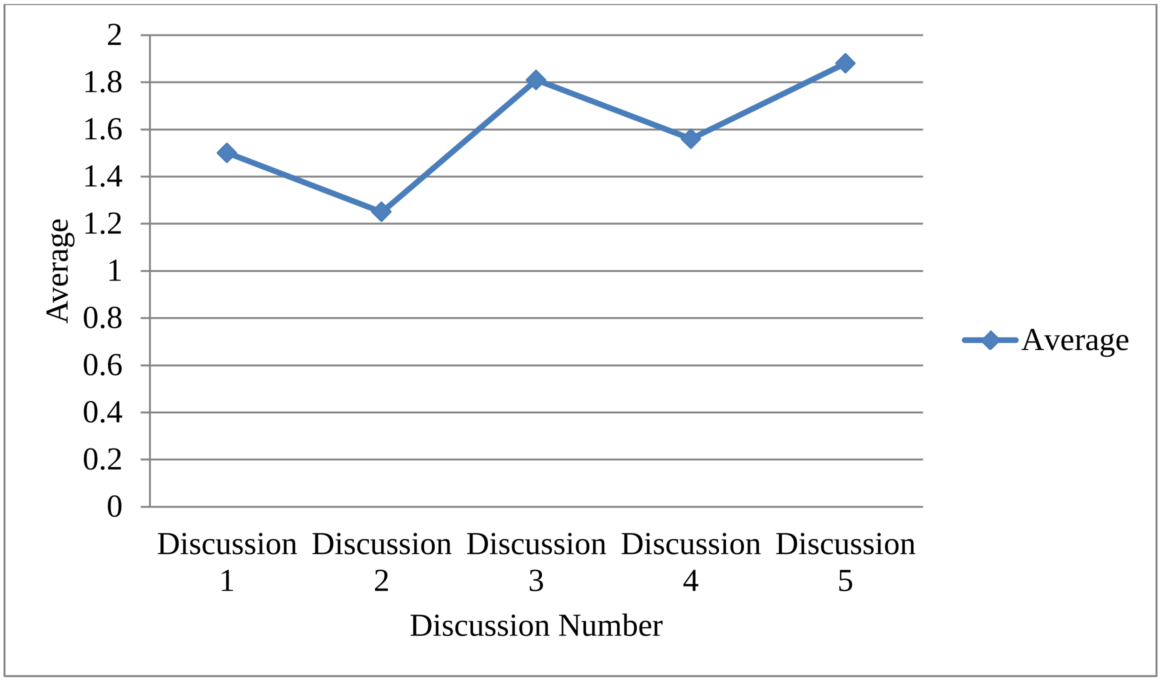

Figure 7. Averages from the Discussion Rubric for Discussion 1-5.

The results of the individual assessments showed improvement in pre- and post-assessments for the discussions on acids and bases with a gain of 19% and gravity with a 13% gain. The chemical reactions assessments stayed the same at 90% with electromagnetism decreasing by 15% (Table 3).

Table 3
Percentage of Students Passing Pre-Assessments and Post-Assessments with a Grade of C or higher, (N=21)

Discussion Number and Topic	Pre-Assessment (% passed)	Post-Assessment (% passed)
1-Chemical Reactions	90	None
2-Chemical Reactions	None	90
3-Acids and Bases	61	80
4-Electromagnetism	76	61
5-Gravity	71	84

After all discussions were concluded, students completed the Tennessee Comprehensive Assessment Program (TCAP) practice test, the questionnaire, and the interview again. The TCAP test showed great results as shown in Figure 8. As shown, 48% of students made an A on the test compared to 0% in August. The number of B's and C' decreased. However, no D's or F's were reported (Figure 8).

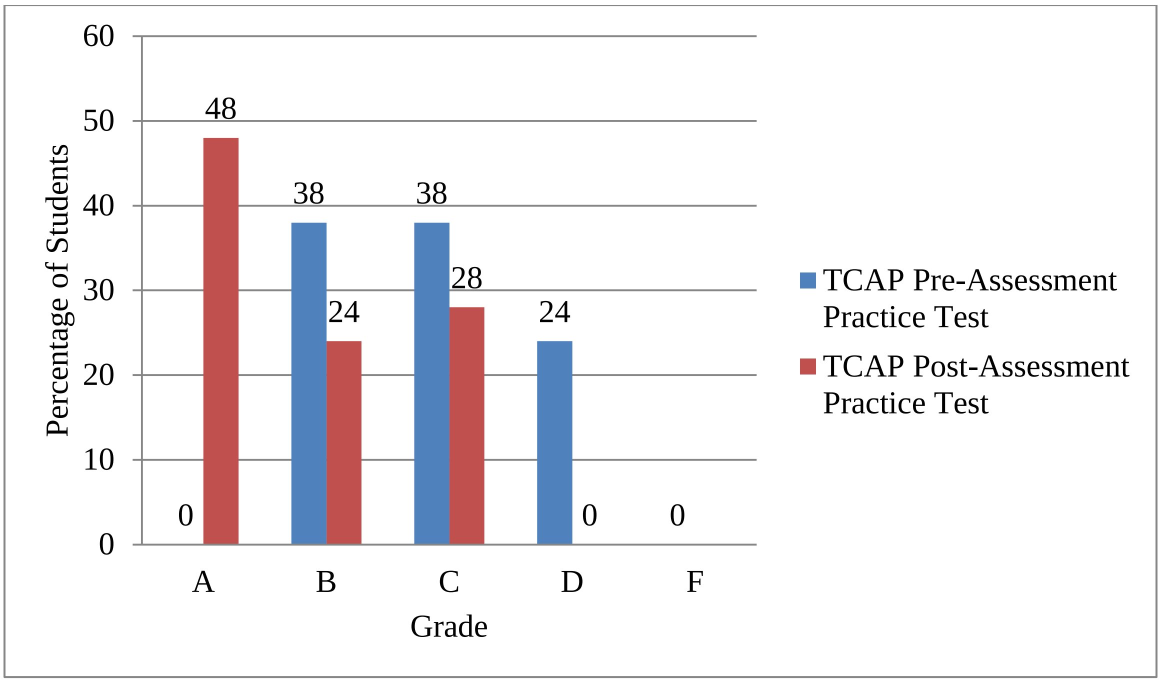

Figure 8. Comparison of TCAP Practice Test score for pre- and post-discussion, (*N*=21).

Student confidence was calculated after each discussion. The pre-treatment discussion results indicated that 33% of students felt a *high* level of confidence. This number decreased for Discussions 2 and 3 with 19%. The level of confidence increased to 24% for Discussions 4 and 5 (Table 4).

Table 4
Percentage of students that exhibited a high level of confidence after each discussion, (N=21)

Discussion 1 (Pre-Treatment)	33%
Discussion 2	19%
Discussion 3	19%
Discussion 4	24%
Discussion 5	24%

The importance of science category increased from 90% in November to 95% in April. Ninety-five percent of students reported that they learn best when being an active participant. In November, this number was 90%. Forty-three percent of students reported that they enjoyed answering questions in class. Students did show a decrease in their enjoyment of science after the discussions with a decrease from 86% to 62%. Eighty-one percent of students reported that they had participated in whole class discussions. The other 19% reported that they did not actively participate in the discussions (Figure 9).

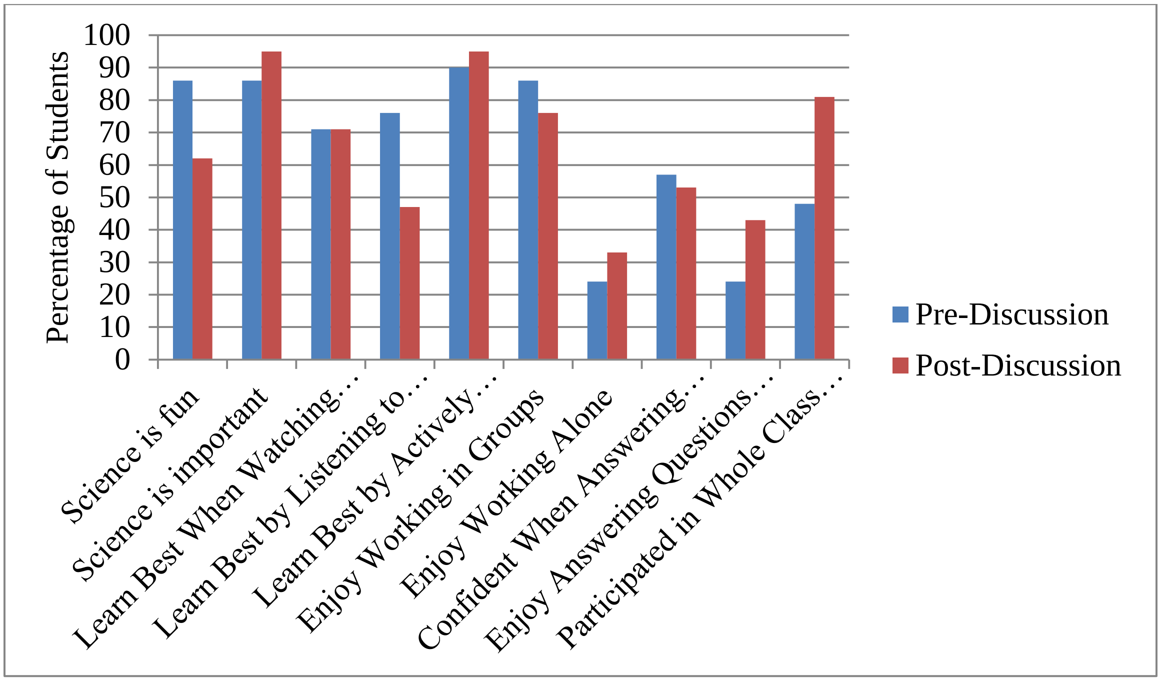

Figure 9. Results of Pre- and Post-Discussion Questionnaire, (*N*=21). Results show a combined percentage of students scoring a 4 (agree) or 5 (strongly agree) for each category. Categories include science is fun, science is important, learn best when watching the teacher, learn best by listening to the teacher, learn best by actively participating in learning, enjoy working in groups, enjoy working alone, confident when answering questions in class, enjoy answering questions in class, and participated in whole class discussions.

The post-interview showed that 63% of the students now prefer to answer questions out loud in class rather than write their answers. One student stated that she felt more comfortable talking aloud because she was not a good writer. However, another student stated that he did not want to answer incorrectly and look dumb in front of the class. One hundred percent of the students did agree that the whole group discussions were helpful to their science learning. When conducting discussions, 88% of students agreed that discussions should take place on a weekly basis with 75% of the students believing that students should lead discussions. The other 25% believed the teacher should start the discussion then allow the students to continue the discussion.

When asked how the discussions strengthen their science knowledge, one student expressed that her test grades were better since we began the discussions. Another student said that the discussions were “great review.” Other comments made included, “I learned from others,” “I understand topics better,” and I do better on my work.”

INTERPRETATION AND CONCLUSION

The results showed that students do benefit from classroom discussions. However, other factors cannot be ruled out as beneficial as well. After looking at the questionnaire responses, each student’s learning style could have an influence on the student’s ability to learn from the discussions. Auditory learners definitely benefited from our discussions. According to the results of the TCAP Practice Test, students benefited from the discussions and learning that took place throughout the school year. Specifically speaking, students showed improvement in the area of chemical reactions which was a very poor area noticed in August. Student performance, as a whole, fluctuated from discussion to discussion. It would have been beneficial to look at individual students’ scores to get a better understanding of student performance. Even though the results of the quizzes and tests did not give a clear insight into how well the discussions helped performance, many students stated that the discussions helped them in their learning and understanding of particular topics.

By looking at the Confidence Rating Forms and the Discussion Self-Assessments, students felt a higher sense of confidence in their public speaking skills and their knowledge of our science topics. By the end of Discussion 5, most students had become more willing to speak up about our day's topics and felt more comfortable sharing their ideas in front of the class. The Discussion Rubric results showed that the students' speaking abilities fluctuated from each discussion. However, looking at individual headings from the rubric, students were respectful to the learning community and accountable for their own thinking. The area of improvement observed was the section on rigorous thinking. This is an area that needs improving in other aspects of our science class before now.

The students' feedback from the Discussion Self-Assessment and the interview questions were extremely helpful in determining what strategies were beneficial to our class discussions. The Popsicle stick strategy for determining the number of times a student talks was praised by my students. It helped limit the number of times my talkative students gave responses which allowed my quieter students to have a chance at talking. Also, having the day's topics ready for the students to think about before the discussions, helped to keep them on track. With limited time, few other strategies were implemented but many more ideas could be used to enhance the benefits of the class discussions. Watching 21 eighth graders sit in a circle and talk respectfully to each other was pleasing to me as a teacher. Students' feedback provided from the self-assessment and the interview provided me with ways to improve our classroom discussions. Their feedback proved to be invaluable to me as a teacher.

VALUE

"True discussion is purposeful interchange of ideas through which meaning has the possibility of being revised and extended," (Spiegel, 2005, p. 9). Through our class discussions, students were able to converse with their classmates about science topics and relate their learning to real-life examples and situations. Students became active participants when speaking about what they had learned. By sharing their ideas, my students allowed me insight in to their ideas about what we had learned which allowed for me to identify misconceptions within their learning. I was also surprised to see that many of my students who did not speak up when answering questions in class were some of the first students to share their ideas during our discussion time. As I mentioned before, the respect with which they talked to each other and the respect they gave for the learning of science would make many teachers envious. Ability level was not an issue during our whole class discussions. Many of my students with disabilities were willing to share their thoughts, and they gave some simple but excellent examples that related to what we were talking about in class. For example, one student compared the colors on the pH scale to warm and cool colors that he had learned in art. He expressed the following during discussion, "The acids are like the warm colors and the bases are like the cool colors." He had to explain what he meant to many students of all ability levels.

To improve this project, I would include a larger sample size as well as calculate my student performance by also looking at individual scores. This project would work better with the research beginning at the start of the school year.

As I concluded my research, I began to think about how this project affected me as a teacher. I found that I connected more with my students with us all sitting in a circle "talking" about science. I also learned that my students have real-life experiences about science to share when the opportunity is given. Many times my students understand better when a peer can put what I say into simpler words. Our discussion time was a great way to incorporate this strategy, and I know my students benefited from the process. This project also changed my way of looking at students' abilities. I realized that many of my students that had trouble writing their thoughts on paper were some of the best speakers in my class. This has led me to examine my ways of testing students in class. I may give more oral quizzes that will allow students to talk about what they have learned. I have also examined how I group my students for cooperative learning. In the future, I will feel more comfortable about assigning students of all ability levels to different roles in our groups. This includes students with disabilities working as leaders. I would like to continue having formal classroom discussions in my future classes, not only to share ideas and learn about science, but to help my students develop a sense of community in our classroom and a sense of ownership and pride in what they learn about science.

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APPENDICES

APPENDIX A

INFORMED CONSENT AND ASSENT FORM

Appendix A

Vanessa Green
E.O. Coffman Middle School
Lawrenceburg, TN
931-762-6395
vanessa.green@lcss.us

Informed Consent and Assent Form for Research Study

The purpose of this research project entitled "Communication in the Science Classroom," examines the effects of classroom discussion on student performance and confidence in talking about science topics. For this project, students will be asked to complete the following:

- Questionnaires
- Interviews
- Journals
- Various pre- and post-assessments for science units

All of these data collection instruments fall within the area of common classroom assessment practices.

Identification of all students involved will be kept strictly confidential. Most of the students involved in the research will remain unidentified in any way, and their levels of environmental interaction will be assessed and noted. Ten students will be selected by random numbers to complete the pre-study and post-study interviews. Nowhere in any report or listing will students' last name or any other identifying information be listed.

There are no foreseeable risks or ill effects from participating in this study. All treatment and data collection falls within what is considered normal classroom instructional practice. Furthermore, participation in the study can in no way affect grades for this or any course, nor can it affect academic or personal standing in any fashion whatsoever.

There are several benefits to be expected from participation in this study. Students participating in the study will begin to develop proper communication skills that are needed for future use in high school and beyond. Also, the verbal information shared will help students develop deeper understandings of the science information learned from the lessons. Furthermore, the research study will help the teacher gain a better understanding of what teaching strategies are helpful in building student confidence and heighten student performance in science.

Participation in this study is voluntary, and students are free to withdraw consent and to discontinue participation in this study at any time without prejudice from the investigator.

Please feel free to ask any questions of Mrs. Vanessa Green via e-mail, phone, or in person before signing the Informed Consent form and beginning the study, and at any time during the study.

Parent Signature: ____________________________ Date: ___________________
Student Signature: ___________________________ Date: ___________________

APPENDIX B

PRE-DISCUSSION INTERVIEW QUESTIONS

Appendix B

Pre-Discussion Interview Questions

1. How do you prefer to communicate in class: out loud or with written word? Why?

2. How could we move from writing on paper to sharing conversations during class?

3. Are the discussions in this classroom helpful to you? Why or why not?

4. How could our discussion time be improved?

5. Who should the lead the class discussions? Why?

6. When should class discussion take place: daily, weekly, monthly basis?

7. Do the science topics in this class determine how well you participate in class discussions?

8. Is there any other information about classroom discussions that you would like to share with me?

APPENDIX C

POST-DISCUSSION INTERVIEW QUESTIONS

Appendix C

Post-Discussion Interview Questions

1. How do you prefer to communicate in class: out loud or with written word? Why?
2. How could we move from writing on paper to sharing conversations during class?
3. Are the discussions in this classroom helpful to you? Why or why not?
4. How could our discussion time be improved?
5. Who should the lead the class discussions? Why?
6. When should class discussion take place: daily, weekly, monthly basis?
7. Do the science topics in this class determine how well you participate in class discussions?
8. Have your views about classroom discussions changed since we began our formal discussions in January? Why or why not?
9. How did the class discussions strengthen your knowledge of science topics in this class?
10. Is there any other information about classroom discussions that you would like to share with me?

APPENDIX D

PRE-DISCUSSION AND POST-DISCUSSION QUESTIONNAIRE

Appendix D
Questionnaire for Classroom Discussions
8^{th} Grade Science
Mrs. Green
Name ___________________________________ Date ________________

Directions: Based on a scale from 1 to 5 with 1 being Strongly Disagree and 5 being Strongly Agree, rank the following statements using your honest opinion.

5 = Strongly Agree (SA)
4 = Agree (A)
3 = Neutral (N)
2 = Disagree (D)
1= Strongly Disagree (SD)

Statement	SA	A	N	D	SD
1. Science is fun.	5	4	3	2	1
2. Science is important.	5	4	3	2	1
3. I learn best when watching the teacher.	5	4	3	2	1
4. I learn best by listening to the teacher.	5	4	3	2	1
5. I learn best by actively participating in learning.	5	4	3	2	1
6. I enjoy working in groups.	5	4	3	2	1
7. I enjoy working alone.	5	4	3	2	1
8. I am confident when answering questions in class.	5	4	3	2	1
9. I enjoy answering questions aloud in class.	5	4	3	2	1
10. I have participated in whole class discussions.	5	4	3	2	1

APPENDIX E

CONFIDENCE RATING FORM

Appendix E

Name: ____________________________________ Date: _________________

CONFIDENCE RATING FORM

Directions: Write the three main topics for today's discussion. Use the rating scale below to rate each topic according to your confidence level of knowledge.

5 = Very Confident
4 = Confident
3 = Somewhat Confident
2 = Little Confidence
1= No Confidence

Information Leading to Our Discussion	Confidence Rating Before Discussion	Confidence Rating After Discussion
1.		
2.		
3.		

Adapted from Spiegel, D.L. (2005). *Classroom discussion*. New York City, NY: Scholastic Inc.

APPENDIX F

CONTINUE THINKING AFTER DISCUSSION

Appendix F

Name: ____________________________________ Date: ____________________

CONTINUE THINKING AFTER DISCUSSION

Directions: Complete each category for today's discussion. Write any new thoughts you gain from other's ideas and how your thoughts have changed at the end of the discussion.

What I Originally Thought	New Information from Others	What I Think Now
1.		
2.		
3.		

Adapted from Spiegel, D.L. (2005). *Classroom discussion*. New York City, NY: Scholastic Inc.

APPENDIX G

CHEMICAL REACTIONS QUIZ

Appendix G

Chemical Reactions Quiz

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

______ 1. Which of the following statements describes a chemical change?
  a. A gas is given off when a liquid boils.
  b. A solid forms when a liquid freezes.
  c. A new substance is formed with different properties.
  d. A solid dissolves in a liquid.

______ 2. Which of the following is NOT a sign of a chemical reaction?
  a. gas formation
  b. solid formation
  c. energy change
  d. state change

______ 3. What occurs when water freezes?
  a. a physical change
  b. a chemical reaction
  c. a chemical bond
  d. a diatomic molecule

______ 4. What is the force that holds atoms together called?
  a. a chemical solution
  b. a chemical mixture
  c. a chemical reaction
  d. a chemical bond

______ 5. What causes chemical bonds in molecules to break?
  a. when molecules bump into each other with enough energy
  b. when different substances are combined in a solution
  c. when the temperature of a solution is lowered
  d. when a solid dissolves in a liquid

______ 6. How do substances form during a chemical reaction?
  a. One or more substances are combined.
  b. Chemical bonds in molecules add atoms to make more molecules.
  c. A solid substance is formed in a solution.
  d. Chemical bonds break, atoms rearrange, and new chemical bonds form.

APPENDIX H

CHEMICAL REACTIONS TEST

Appendix H

CHEMICAL REACTIONS TEST

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. Which of the following statements describes a chemical change?
- a. A gas is given off when a liquid boils.
- b. A solid forms when a liquid freezes.
- c. A new substance is formed with different properties.
- d. A solid dissolves in a liquid.

____ 2. What occurs when water freezes?
- a. a physical change
- b. a chemical reaction
- c. a chemical bond
- d. a diatomic molecule

____ 3. What is the force that holds atoms together called?
- a. a chemical solution
- b. a chemical mixture
- c. a chemical reaction
- d. a chemical bond

____ 4. What causes chemical bonds in molecules to break?
- a. when molecules bump into each other with enough energy
- b. when different substances are combined in a solution
- c. when the temperature of a solution is lowered
- d. when a solid dissolves in a liquid

____ 5. How do substances form during a chemical reaction?
- a. One or more substances are combined.
- b. Chemical bonds in molecules add atoms to make more molecules.
- c. A solid substance is formed in a solution.
- d. Chemical bonds break, atoms rearrange, and new chemical bonds form.

____ 6. Which is the product in this chemical formula? $N + O_2 \rightarrow NO_2$
- a. N
- b. O
- c. O_2
- d. NO_2

____ 7. Which of these uses coefficients correctly to balance this equation?
$N_2 + H_2 \rightarrow NH_3$
a. $N_2 + 3H_2 \rightarrow 2NH_3$
b. $2N_2 + 2H_2 \rightarrow 4NH_3$
c. $N_2 + H_2 \rightarrow NH_3$
d. $3N_2 + 4H_2 \rightarrow 6NH_3$

____ 8. Which of the following states the law of conservation of mass?
a. Atoms are rearranged in a chemical reaction, and some join new molecules.
b. Two compounds combine to form a new compound with different properties.
c. Mass cannot be created or destroyed in a chemical reaction.
d. Energy is neither created nor destroyed in a chemical reaction.

____ 9. How many oxygen atoms are present in the reactant in this chemical equation? $4Fe + 3O_2 \rightarrow 2\ Fe_2O_3$
a. 2
b. 3
c. 4
d. 6

____ 10. Which chemical formula shows an endothermic reaction?
a. $4H + O_2 \rightarrow 2H_2O$
b. $2Na + Cl_2 \rightarrow 2NaCl +$ *energy*
c. $2H_2O +$ *energy* $\rightarrow 2H_2 + O_2$
d. $C + O_2 \rightarrow CO_2 +$ *energy*

____ 11. Which of the following is NOT an example of a chemical reaction?
a. milk turning sour
b. food being digested
c. a match burning
d. ice melting

____ 12. For a chemical bond to break,
a. individual atoms must be present.
b. energy is required.
c. covalent compounds must be mixed.
d. solids must be dissolved.

____ 13. How many atoms are represented in the formula $CaCO_3$?
a. three
b. four
c. five
d. six

____ 14. If a chemical symbol in a chemical formula has no subscript, it means
a. the chemical symbol is written without any numbers.
b. the element has no charge.

c. the chemical is listed last in the formula.
d. only one atom of the element is in the molecule.

____ 15. Which example shows where a coefficient is used correctly to balance the equation?
a. $Na + Cl_2 \rightarrow 2NaCl$
b. $Na + 2Cl_2 \rightarrow 2NaCl$
c. $2Na + Cl_2 \rightarrow 2NaCl_2$
d. $2Na + Cl_2 \rightarrow 2NaCl$

____ 16. In which kind of chemical reaction do two or more substances combine to form one new compound?
a. synthesis reaction
b. decomposition reaction
c. single-displacement reaction
d. double-displacement reaction

____ 17. Most chemical reactions
a. result in substances that have different properties.
b. do not break bonds.
c. do not rearrange atoms.
d. cannot be seen.

Matching

Match each item with the correct statement below.
a. exothermic reaction
b. decomposition reaction
c. endothermic reaction
d. single-displacement reaction

____ 18. $6CO_2 + 6H_2O + \textit{energy} \rightarrow C_6H_{12}O_6 + 6O_2$

____ 19. $H_2CO_3 \rightarrow H_2O + CO_2$

____ 20. $2Na + Cl_2 \rightarrow 2NaCl + \textit{energy}$

____ 21. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

Short Answer

22. Identify the reactants and product(s) in the following equation.

$$C + O_2 \rightarrow CO_2$$

Use the terms from the following list to complete the sentences below.
subscript exothermic reaction

inhibitor
coefficient
synthesis reaction
reactant

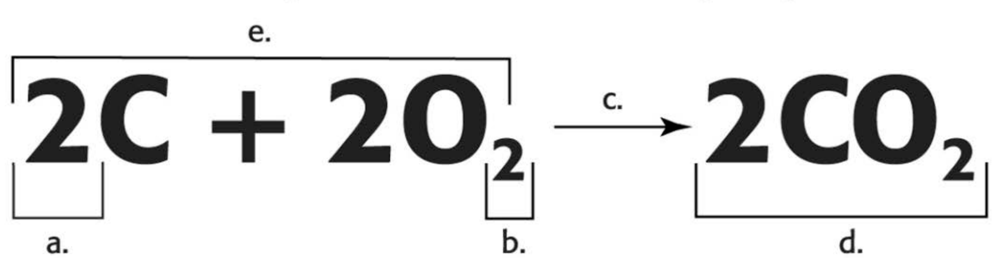
23. Adding a(n) ______________________ will slow down a chemical reaction.

24. A chemical reaction that gives off heat is called a(n) ______________________.

25. A chemical reaction that forms one compound from two or more substances is called a(n) ______________________.

Other

Use the diagram below to answer questions 1 – 5.



26. yields sign

27. subscript

28. product

29. coefficient

30. reactant

APPENDIX I

ACIDS AND BASES QUIZ

Appendix I

Acids and Bases Quiz

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

_______ 1.any compound that increases the number of hydronium ions when dissolved in water

______ 2.a compound that can reversibly change color depending on conditions such as pH

______ 3.any compound that increases the number of hydroxide ions when dissolved in water

a. indicator
b. base
c. acid

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

_______ 4. What substances can acids react with to produce hydrogen gas?
a. water c. metals
b. sugars d. poisons

_______ 5. Acids conduct electric current by forming
a. hydrochloric acids. c. hydronium ions.
b. hydrogen gases. d. hydroxide ions.

_______ 6. Acids have a
a. sour taste. c. slippery feel.
b. bitter taste. d. soapy feel.

_______ 7. Bases have a
a. sour taste. c. slippery feel.
b. sweet taste. d. mild taste.

_______ 8. When a base is added to red litmus paper, the indicator turns
a. blue. c. purple.
b. red. d. orange.

_______ 9. If a cleaning product includes ammonia as an ingredient, it probably is made from a(n)
a. acid. c. indicator.
b. base. d. powder.

APPENDIX J

ACIDS AND BASES TEST

Appendix J

Acids and Bases Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Acids have a
- a. sour taste.
- b. bitter taste.
- c. slippery feel.
- d. soapy feel.

____ 2. Bases have a
- a. sour taste.
- b. sweet taste.
- c. slippery feel.
- d. mild taste.

____ 3. When a base is added to red litmus paper, the indicator turns
- a. blue.
- b. red.
- c. purple.
- d. orange.

____ 4. If a cleaning product includes ammonia as an ingredient, it probably is made from a(n)
- a. acid.
- b. base.
- c. indicator.
- d. powder.

____ 5. When acids and bases come in contact with each other, they
- a. explode.
- b. become bitter.
- c. make hydroxide.
- d. neutralize each other.

____ 6. A neutral solution has a pH of
- a. 7.
- b. 11.
- c. 3.
- d. 1.

____ 7. A base is a substance that
- a. feels slippery.
- b. tastes sour.
- c. reacts with metals to produce hydrogen gas.
- d. turns blue litmus paper red.

APPENDIX K

ELECTROMAGNETISM QUIZ

Appendix K

Electromagnetism Quiz

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

______ 1. Two poles, magnetic forces, and magnetic fields are magnets'
a. auroras.
b. alignments.
c. domains.
d. properties.

______ 2. When is an object magnetic?
a. when it only has a north pole
b. when it only has a south pole
c. when it is free to rotate
d. when it attracts iron

______ 3. Which of the following are two kinds of magnets?
a. magnetic fields, magnetic poles
b. ferromagnets, electromagnets
c. magnesia magnets, magnetite magnets
d. atoms, domains

______ 4. Which of the following are two effects of Earth's magnetic field?
a. compass points to geographic north, auroras seen at the equator
b. compass points to geographic south, auroras seen at the equator
c. compass points to magnetic north, auroras seen at both poles
d. compass points to geographic north, auroras seen at both poles

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

_____ 5.one of two points, such as the ends of magnets, that have opposing magnetic qualities

_____ 6.any material that attracts iron or materials containing iron

_____ 7.attraction or repulsion generated by moving or spinning electric charges

a. magnet
b. magnetic pole
c. magnetic force

APPENDIX L

ELECTROMAGNETISM TEST

Appendix L

Electromagnetism Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Two poles, magnetic forces, and magnetic fields are magnets’
a. auroras.
b. alignments.
c. domains.
d. properties.

____ 2. When is an object magnetic?
a. when it only has a north pole
b. when it only has a south pole
c. when it is free to rotate
d. when it attracts iron

____ 3. Which of the following are two kinds of magnets?
a. magnetic fields, magnetic poles
b. ferromagnets, electromagnets
c. magnesia magnets, magnetite magnets
d. atoms, domains

____ 4. Which of the following are two effects of Earth’s magnetic field?
a. compass points to geographic north, auroras seen at the equator
b. compass points to geographic south, auroras seen at the equator
c. compass points to magnetic north, auroras seen at both poles
d. compass points to geographic north, auroras seen at both poles

____ 5. What uses an electromagnet to measure electric current?
a. armature
b. commutator
c. galvanometer
d. solenoid

____ 6. Whether a material is magnetic or not depends on which of the following?
a. the material’s weight
b. the material’s mass
c. the material’s atoms
d. the material’s density

____ 7. As electrons move, they make
a. electromagnetism.
b. magnetic fields.
c. ferromagnetism.
d. auroras.

____ 8. A compass needle responds to a magnetic field, because the compass needle is a
- a. transformer.
- b. generator.
- c. motor.
- d. magnet.

____ 9. What is created when a magnet moves through a coil of wire?
- a. an electric current
- b. an electromagnet
- c. a solenoid
- d. a ferromagnet

____ 10. What is created when a wire moves between the poles of a magnet?
- a. an electric current
- b. an electromagnet
- c. a solenoid
- d. a ferromagnet

____ 11. What can demagnetize a magnet?
- a. high altitudes
- b. low altitudes
- c. high temperatures
- d. low temperatures

____ 12. A coil of wire with an electric current in it is called a(n)
- a. transformer.
- b. electric generator.
- c. electric motor.
- d. solenoid.

____ 13. A coil of wire that has a soft iron core and that acts as a magnet when an electric current is in the coil is called a(n)
- a. ferromagnet.
- b. electromagnet.
- c. permanent magnet.
- d. temporary magnet.

____ 14. Increasing the number of loops per meter in the coils of a solenoid is one way to
- a. increase the wire's electric current
- b. decrease the wire's electric current.
- c. strengthen the solenoid's magnetic field.
- d. weaken the solenoid's magnetic field.

____ 15. Increasing the electric current in the wire is one way to
- a. strengthen a solenoid's magnetic field.
- b. weaken a solenoid's magnetic field.
- c. make a solenoid become an electromagnet.
- d. make an electromagnet become a solenoid.

____ 16. What can you make visible by sprinkling iron filings around a magnet?

a. the areas called domains
b. the magnetic field lines
c. the magnetic forces
d. the north and south poles

____ 17. How does a galvanometer make use of the relationship between electric current and magnetic fields?

a. Galvanometers generate electric current.
b. Galvanometers change AC to DC.
c. Galvanometers use magnets to measure current.
d. Galvanometers use magnets to convert current into other forms of energy.

____ 18. What do you end up with if you cut a magnet in half?

a. one north-pole piece and one south-pole piece
b. two unmagnetized pieces
c. two pieces each with a north pole and a south pole
d. two north-pole pieces

Matching

Match each item with the correct statement below.

a. electromagnetism
b. solenoid
c. electromagnet
d. electric motor

____ 19. a coil of wire with an electric current in it

____ 20. a device that converts electrical energy to mechanical energy

____ 21. a coil that has an iron core and that acts as a magnet when an electric current is in the coil

____ 22. the interaction between electricity and magnetism

Match each item with the correct statement below.

a. magnet
b. magnetic pole
c. magnetic force
d. electromagnetism
e. electric motor
f. electromagnetic induction
g. electric generator
h. transformer

____ 23. any material that attracts iron or materials containing iron

____ 24. the interaction between electricity and magnetism

____ 25. a device that converts electrical energy into mechanical energy

____ 26. a device that converts mechanical energy into electrical energy

____ 27. one of two points, such as the ends of a magnet, that have opposing magnetic qualities

____ 28. the attraction or repulsion created by spinning electric charges

Other

Use the illustration below to answer the questions that follow.

29. Which magnetic pole is closest to the geographic North Pole?

30. Is the magnetic field of Earth stronger near the middle of Earth (in Mexico) or at the bottom of Earth (in Antarctica)? Explain your answer.

APPENDIX M

GRAVITY QUIZ

Appendix M

Gravity Quiz

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

_______ 1. a measure of the gravitational force exerted on an object

_______ 2. a measure of the amount of matter in an object

_______ 3. a force of attraction between objects that is due to their masses and the distance between the objects

a. gravity
b. weight
c. mass

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

_______ 4. All matter has mass
a. but objects with small masses are unaffected by gravity.
b. and all mass is affected by gravity.
c. but only the Earth's gravity affects matter.
d. but only the Earth's and sun's gravity affects matter.

_______ 5. The force of gravity
a. is not related to the mass of the objects.
b. is only related to the mass of large objects.
c. is related to weight of the objects.
d. is related to the mass of the objects.

_______ 6. As the distance between two objects increases, the force of gravity between them
a. decreases.
b. does not change.
c. increases only slightly.
d. increases greatly.

_______ 7. Which of the following does NOT describe mass?
a. remains constant
b. is a measure of matter
c. is a measure of gravitational force
d. is measured in kilograms

_______ 8. Which of the following does NOT describe weight?
a. changes as gravitational force changes
b. is constant everywhere in the universe
c. is a measure of gravitational force
d. can be measured in newtons

APPENDIX N

GRAVITY TEST

Appendix N

Gravity Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. All matter has mass
a. but objects with small masses are unaffected by gravity.
b. and all mass is affected by gravity.
c. but only the Earth's gravity affects matter.
d. but only the Earth's and sun's gravity affects matter.

____ 2. The force of gravity
a. is not related to the mass of the objects.
b. is only related to the mass of large objects.
c. is related to weight of the objects.
d. is related to the mass of the objects.

____ 3. As the distance between two objects increases, the force of gravity between them
a. decreases.
b. does not change.
c. increases only slightly.
d. increases greatly.

____ 4. Which of the following does NOT describe mass?
a. remains constant
b. is a measure of matter
c. is a measure of gravitational force
d. is measured in kilograms

____ 5. Which of the following does NOT describe weight?
a. changes as gravitational force changes
b. is constant everywhere in the universe
c. is a measure of gravitational force
d. can be measured in newtons

____ 6. The gravitational pull is greater between two objects that
a. have greater masses.
b. have rougher surfaces.
c. are farther apart.
d. are moving at greater speed.

____ 7. Mass is
- a. different on the moon than on Earth.
- b. a measure of gravitational force.
- c. a measure of the amount of matter.
- d. measured in newtons.

____ 8. If a student has a weight of 420 N on Earth, what is the student's weight on the moon? (Moon's gravity = 1/6 of Earth's gravity)
- a. 70 N
- b. 2520 N
- c. 70 kg
- d. 2520 kg

____ 9. The law of universal gravitation says that gravitational force is
- a. related to mass and distance.
- b. related to weight and distance.
- c. related to mass and friction.
- d. related to weight and friction.

Matching

Match the correct definition with the correct term.

- a. gravity
- b. weight
- c. mass

____ 10. a measure of the gravitational force exerted on an object

____ 11. a measure of the amount of matter in an object

____ 12. a force of attraction between objects that is due to their masses and the distance between the objects

Short Answer

13. In your own words, write a definition for the term *gravity*.

14. Use each of the following terms in a separate sentence: *mass* and *weight*.

15. What is the law of universal gravitation?

APPENDIX O

DISCUSSION SELF-ASSESSMENT

Appendix O

Discussion Self-Assessment
8th Grade Science
Mrs. Green

Name __________________________________ Date ________________

Directions: Complete the following questionnaire after each class discussion.

1. On a scale from 1 to 5, how confident did you feel in participating in today's discussion?

1	2	3	4	5
Low Confidence				High Confidence

2. On a scale from 1 to 5, how did you enjoy today's discussion?

1	2	3	4	5
Low Enjoyment				High Enjoyment

3. On a scale from 1 to 5, how well did today's discussion help you in learning about (insert science topic)?

1	2	3	4	5
Little Help				Much Help

4. How many times did you verbally participate in today's discussion?

1 2 3 4 5 or more times

5. What could we do to improve today's classroom discussion?

____
____
____
____

6. What did you learn about science from today's discussion?

____
____
____
____

7. Is there anything else you would like to share about today's discussion?

____
____
____

APPENDIX P

CLASSROOM DISCUSSION RUBRIC

Appendix P

Classroom Discussion Rubric

	Listen	**Summarize**	**Build**	**Mark**
Accountable to the Learning Community	Pays attention to the statements of others, maintains eye contact, uses appropriate tone and volume ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)	Restates the ideas of a previous speaker in new language ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)	Adds to the statement of a previous speaker ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)	Directs attention to the importance of another's statement ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)

	Verify Check your understanding of previous statements and knowledge ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)	**Unpack** Explain how you arrived at your answer ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)	**Support** Give examples and evidence to support your answer ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)	**Link** Point out the relationships among previous statements and knowledge ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)
Accountable to the Knowledge				
Accountable to Rigorous Thinking	**Defend** Defend your reasoning against a different point of view ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)	**Challenge** Ask a previous speaker to explain and provide evidence for a statement ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)	**Combine** Incorporate knowledge from multiple resources to form your ideas ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)	**Predict** Draw conclusions about what might happen next or as a result of ideas ____4 (consistently) ____3 (most of the time) ____2 (some of the time) ____1 (rarely) ____0 (not at all)

Adapted from Classroom Discussion Guidelines
www.education.ky.gov/users/otl/AOB/AOB%20Resource%204E.doc