# THE EFFECTS OF HIGHER-LEVEL QUESTIONING IN A HIGH SCHOOL MATHEMATICS CLASSROOM

A Thesis by

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I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Curriculum and Instruction.

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# DEDICATION

To my loving and supportive husband, Matthew; son, Elijah;
and parents, Steve and Sally Benoit

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## ABSTRACT

The purpose of this study was to address questioning and higher-level thinking in a low-level high school mathematics class. Students in this study included twenty-two high school freshmen (experimental group) and twenty-three high school freshmen (control group) who were enrolled in Algebra 1. This study included a pretest that both groups took to determine their cognitive level or thinking prior to new information and modifications in teaching. The experimental group received modifications that included cooperative learning activities and higher-level questions over a six-week period. The modifications were aimed at helping them reach higher levels of Bloom's Taxonomy. The control group received the same information, but it was presented in a more traditional teaching manner. At the end of the six weeks, students in both groups were given a posttest to determine if they could answer higher-level questions. An analysis of covariance was used to determine the results, which were significant, showing that the experimental group did perform at higher levels of Bloom's Taxonomy than the control group at the end of the six weeks.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

# LIST OF ABBREVIATIONS/NOMENCLATURE

| | |
|---|---|
| Analysis of Covariance | ANCOVA |
| Classroom Performance System | CPS |
| Degrees of Freedom | df |
| Standard Deviation | sd |

# CHAPTER 1

# INTRODUCTION

*Overview*

Questions are the most common instructional tool used by all teachers. Cotton (1988) found that on the average, 60% of the questions asked in a lesson are of a lower level, 20% are of a higher level, and 20% are procedural. Knowing these statistics, it is important to think about the questions most often asked in a mathematics classroom and their effect on student thinking, examples of which follow:

- What is a linear equation?
- How would you define an ordered pair?
- Can you label the axis appropriately?
- How would you define solving an equation?
- How would you describe what happened to the equation?
- Which choice—a, b, c, or d—is the best choice for an answer?

These questions and many more similar to them are common questions for students in a mathematics class. However, they do not require students to think deeply about the answer. These questions are low-level thinking questions; in fact, they are at the knowledge level of Bloom's Taxonomy (Bell & Fogler, 1995). That is, students do not have to apply prior knowledge to answer most of these questions; they are not asked to synthesize information, make predictions based on previous knowledge, or defend their solutions.

Teachers have been aware of Bloom's Taxonomy since 1956 (Huitt, 2004). If teachers are aware of the cognitive levels promoted by higher-level questions, why do they still ask the low-level questions? Do teachers think that it is not important to incorporate high-level questions? Do they think it is not worth the time and energy to incorporate them? Is it just easier to ask low-level questions? Do they think the level of questioning has no direct impact on student achievement? Are students more willing to answer low-level questions?

As a teacher, it is frustrating to ask a question and not get an answer. It appears that the higher the level of question, the fewer students that attempt to answer it. If teachers do not ask higher-level questions, students may not learn to think at higher levels—all the more reason to ask the higher-level questions.

*Purpose*

The purpose of this study was to investigate the effects of asking higher-level questions on students' improvement of their ability in handling mathematical problems requiring higher-level thinking.

*Definitions*

*Bloom's Taxonomy levels.* Students' ability to think critically and problem solve are important. Benjamin Bloom designed a hierarchy to categorize students' cognitive levels of thinking. His six-level hierarchy, beginning from the lowest level to the highest level, includes the following: knowledge, comprehension, application, analysis, synthesis, and evaluation (Barton, 1997). When this hierarchy is applied to questioning strategies, it is noted that questions contain key words which identify the level of question. The *knowledge level* requires students to recall information, but they do not have to understand the information. Some key words for knowledge-level questions include the following: who, what, define, and choose. The *comprehension level* requires students to understand and interpret information. Some key words for comprehension-level questions include the following: compare, explain, demonstrate, interpret, and summarize. The *application level* requires students to apply information to new and varied situations. Some key words for application-level questions include the following: apply, solve, organize, and construct. The *analysis level* requires students to break a situation into small components. Some key words for analysis-level questions include the following: analyze, classify, discover, and distinguish. The *synthesis level* requires students to propose alternate solutions and find new patterns. Some key words for synthesis-level questions include the following: design, create, compile, predict, plan, and adapt. The highest level, the *evaluation level*, requires students to defend their opinions and to make judgments or conclusions about information. Some key words for evaluation-level questions include the following: conclude with supporting evidence, determine, prove, and deduce. (Bell & Fogler, 1995). See Figure 1 for a summary of the above information.

FIGURE 1

SUMMARY OF BLOOM'S TAXONOMY FOR LEVELS

OF COGNITIVE THINKING

| **Level** | **Some Key Words** | **Requirement of Student** |
|---|---|---|
| Knowledge | Who, What, Define, Choose | Recall information |
| Comprehension | Compare, Demonstrate, Interpret, Summarize | Understand and interpret information |
| Application | Apply, Solve, Organize, Construct | Apply information to various situations |
| Analysis | Analyze, Classify, Discover, Distinguish | Break a situation into smaller components |
| Synthesis | Design, Create, Compile, Predict, Plan, Adapt | Propose alternate solutions and find new patterns |
| Evaluation | Conclude, Determine, Prove, Deduce | Defend opinions and make judgments or conclusions |

*Double-block algebra classes.* These classes include only freshman and are divided into three levels. The highest level is Tier One in which students are seen every other day for ninety minutes. The next level is Tier Two in which students need more time and assistance to understand the material; they are seen every day for ninety minutes. These students use the same textbook as Tier One, but they have more time and more supplemental activities to help them learn the material. The lowest level is Tier Three and these students are also seen every day for ninety minutes. However, they use a different textbook that has lower reading levels. They are required to learn the same material but at a slower rate. Students involved in this study were in Tier Two.

*Classroom Performance System (CPS).* CPS is a form of technology that students use to take multiple-choice tests or quizzes, for in-class practice, or to participate in team competitions. The lessons in CPS are multiple-choice, and all students use a remote control to submit their answers. The CPS program tracks what students have answered, what students score individually, and how the class scores as a group on each question and the entire lesson. CPS allows automatic feedback for both the teacher and the student and allows for immediate remediation if necessary.

*Majority of Teaching and Levels*

Teachers frequently teach to the lower three levels of thinking, because they find it too challenging to help students reach the higher levels. Shiu-Ching (1979) showed that during an average mathematics lesson (covering algebra, geometry, and trigonometry), only the three lower levels of thinking—knowledge, comprehension, and application—were reached, and very little, if any, of the higher levels were achieved on a regular basis. The study spanned a time period of seventy lessons and was completed by forty-two teachers who gathered the data. Since the majority of lessons taught are at the basic level, most students will only reach the lower levels of thinking on their own. Many students know and comprehend the information required of them and some can apply it to a basic concept, but few can analyze, synthesize, and evaluate the information without guidance through the use of higher-level thinking activities (Stice, 1987). Biggs (1996) noted that many of the tests and tasks that students will complete reach the higher levels of Bloom's Taxonomy; however, when they practice in class, students frequently do not reach higher than the comprehension level.

*Research Study*

For this research project, two possible confounding variables were identified for consideration when completing the research and data analysis of the results. These variables were attendance and the initial cognitive level of students. Therefore, the monitoring of students' cognitive levels was done frequently, based on observations, quizzes, and projects. Since attendance was a factor when collecting data, every effort was made to emphasize the importance of attending every class and making up missed work.

Students were initially at different cognitive levels. It was assumed that the majority of students in this study were operating at the lower two levels. These students failed state mathematics tests in the past and struggled in mathematics courses; this is why they were enrolled in a double-block algebra course as freshmen. All students in the study were given a pretest to determine achievement levels prior to modifications in instructional questioning strategies. This assisted the researcher in avoiding predetermined assumptions about the students' initial capabilities; this score was measured against an identical posttest.

Another class of students was given the pretest and posttest at similar times as the experimental group. They had a different teacher who taught in a more traditional manner. The control group and experimental group received the same information, but in different ways.

This research study addressed the following question: Will asking higher-level questions and doing higher-level activities in this mathematics classroom help students become better problem solvers and critical thinkers? The researcher used a variety of activities and strategies, including cooperative and individual activities, to help the students build confidence to reach higher levels of thinking on their own.

The remainder of this thesis consists of six parts: literature review, methodology (design of the study), results and analysis of the study, discussion of the overall study and future research, references, and appendices. Within the appendices are artifacts used in the research, assignments, questions, and quizzes, as well as results from the pre and posttests.

# CHAPTER 2

# LITERATURE REVIEW

The following literature review includes studies that support the incorporation of Bloom's Taxonomy in the classroom, studies that identify a possible downfall of incorporating Bloom's Taxonomy, and a short summary of findings from all the studies. Some of the supporting research includes the use of technology in the classroom, projects, and changing standard assignments. The downfall involves the time-implementation factor in the classroom.

*Implementation of Various Strategies*

The strategy of allowing wait-time after questioning has been shown to enhance students' responses. When teachers are asking higher-order questions, they want to receive thoughtful answers and better questions from the students. Eison (2006) found that allowing for more wait-time, three to five seconds as opposed to one second, will enhance students' responses. Students tend to give a more in-depth, thoughtful answer when more wait-time is allotted. Students will then in turn ask more questions of the teachers.

Athanassiou, McNett, and Harvey (2003) showed how using Bloom's Taxonomy and scaffolding in their classes helped students become better critical thinkers and made their classroom less teacher-centered and more student-centered. Scaffolding is a teaching method to help students go from one cognitive level to another. It allows the student to take ownership for his/her own level. Here the student must do a self-evaluation.  Based on the self-evaluations, students will then, try to improve and become aware of their improvement or lack of improvement.

This study included forty-two undergraduate college students—twenty-one in one course and twenty-one in another course. Students in both classes were first exposed to information about Bloom's Taxonomy and the various cognitive levels represented. They were then given assignments and journal entries to complete throughout the semester, and these were graded using Bloom's Taxonomy levels and content knowledge. The difference between the treatment of the two classes was that one class's work was evaluated on a more frequent basis (four times during the semester), and the other was only evaluated twice during the semester. Students showed growth in their scores throughout the semester, indicating that they had become better critical thinkers. Those students evaluated more frequently showed more growth in their scores than students in the other class.

Costa and Lowery (1989) discussed the importance and implementation of active learning. Active learning requires students to come prepared to class and participate. Students often will work in pairs or small groups. This allows them to be involved in more activities that require them to brainstorm about topics, apply information, and problem solve.

Kenimer and Morgan (2003) showed that active learning has helped students reach higher-thinking levels. They state that having students simply memorize the material allows them to reach only the two lowest levels, knowledge and comprehension, but involving them in cooperative learning activities and higher-order thinking activities allows them to become better problem solvers and critical thinkers.

This study was completed with twenty college engineering students through an activity given to them on the first day of class and followed up with discussion in the next class session. After the completion of the activity, students were asked to fill out questionnaires to ascertain how helpful the activity was and the difficulty level of the activity. Many students' responses inferred that they could do the lower cognitive level aspects of the activity with ease, but the higher-level aspects were much more difficult.

The teaching method cooperative learning helps students retain information better and master more difficult information. According to Duren and Cherington (as cited in Futch, 2005), students were more willing to continue working during cooperative learning even when the material was difficult. Thus, students were willing to persevere through the higher-thinking levels since they had help from their peers while trying to work on the material. This study was conducted with twenty engineering college students over a semester course.

Another way teachers have been trying to address Bloom's Taxonomy in their classrooms is through various technology strategies. These strategies include, but are not limited to, presentations, on-line quizzes and tests, simulations, and WebQuests. Bell and Fogler (1995) used technology (presentations and on-line quizzes) to teach a semester of undergraduate engineering students. Their findings showed that students understood the material better, and that their work was more complete and accurate than that of students who did not receive the information through technology.

Hativa and Reingold (1987) showed that using audiovisual and computer-based presentations as a means to relay information to students improved their knowledge and learning abilities. This study involved ninety-two ninth graders who were randomly assigned to two groups. One was the control group, and the other was the treatment group. The treatment group received information through the use of audiovisuals and computer-based presentations. The control group received information in a more traditional manner. They were tested in various ways prior to, during, and after treatment. They were tested on geometry content. In both studies, the information taught was presented at various levels of Bloom's Taxonomy. The treatment group performed better than the control group, thus showing that the use of audiovisual and computer technology did help the students.

The Internet as a source of knowledge is increasing daily. Teachers and students use this technology to gain information on a topic, view how to teach or learn something, and do activities on topics. According to Rhynard (2002), WebQuests are geared toward all levels of Bloom's Taxonomy. WebQuests require the students to have prior knowledge about a topic, use the Internet to further their knowledge, apply that knowledge to real-world examples, and make judgments, predictions, or conclusions on that topic (based on what is in the WebQuest). WebQuests are learner-centered, which is important when incorporating higher-order thinking.

The use of WebQuests in the mathematics classroom is a newer form of instruction. Mathematics classrooms are perfect for WebQuests and, in addition to the World Wide Web, allow teachers to relate the mathematical content to real-world, problem-solving situations through simulations. The Internet has unlimited resources of real-world scenarios in order for students to apply what they learn in the classroom. WebQuests are a way for teachers to scaffold the information (Crawford & Brown, 2002).

*Questioning*

Teachers ask students questions for various reasons, trying to determine if their students understand something, need further information or guidance, can use that information to problem solve later. Teachers ask questions at various levels to obtain this information, but the higher-level questions provide teachers with more information (Lewis, 2006). In order to ask higher-level questions of students on a frequent basis, they must be well thought-out questions. Questions may need to be rehearsed or written down. If questioning is not reflected on by the teacher prior to and following classes, it will be harder to incorporate the higher levels of Bloom's Taxonomy on a frequent basis. Wilen (1986) has provided seven suggestions for effective questioning. These are summarized as follows: plan key questions, phrase questions clearly, adapt questions to students' abilities, ask questions sequentially, ask questions at a variety of levels, follow-up on responses, and allow for think time. Wilen shows that a teacher cannot employ innovative teaching strategies if the questions themselves are not being thoroughly considered. Teachers must think about the questions they are asking in order to raise students to higher cognitive levels.

Beyer (1997) states that the sequence of questions is very important for raising cognitive levels in students. Students cannot answer the highest-level questions without the foundation of low-level questions. For students to be successful, teachers need to incorporate all levels of questions and in the proper sequence.

*Various Abilities*

Heyworth (1979) showed that lower-ability students performed better when the material was personalized to them and when the teacher had expectations of them to achieve at higher levels. This seems very obvious and is what Blooms' Taxonomy does for students. As students are required to reach higher levels of thinking, assignments and projects become more personal. According to the Heyworth study, if a teacher chooses situations that the students can relate to, they will perform better. The levels above application require students to do more than regurgitate information; they relate material to situations. If a teacher presents the material at higher levels of Bloom's Taxonomy and tries to make it more personal for students, then this creates better problem solvers and critical thinkers due to the higher levels of thinking and the personal connections.

McGrail (1997) addressed higher-ability students' performance in school. He found that many of these students become bored and that it is just as difficult, if not more, to make modifications for them in the classroom as it is for lower-ability students. He suggested incorporating all levels of Bloom's Taxonomy into lessons and assignments. By using a range of questions that appeal to all of students it becomes more personal for them. Not only should Bloom's Taxonomy be addressed in alternate assignments as well as standard drill and practice assignments, but they should be included within in-class projects more frequently in order to reach higher levels of cognition on a regular basis.

Studies show that when teachers incorporate Bloom's Taxonomy on a regular basis in their classroom, it is beneficial for students. But why do so many teachers refuse to do this on a regular basis? If studies show that using cooperative learning and technology benefit the students, why do so few teachers consistently incorporate these methods in their classroom?

*Negative Studies*

Many studies have shown that incorporating Bloom's Taxonomy into everyday teaching helped students become better problem solvers and critical thinkers. However, one study identified a downfall of teaching with Bloom's Taxonomy on a regular basis. This downfall was time. Lessons that primarily use teaching strategies incorporating the various levels of Bloom's Taxonomy require much more in-class time than just teaching how to solve a problem (Stice, 2005). However, this study hoped to show that the time spent in class to teach to higher levels of thinking is worthwhile if, in the long run, it helps the students become better thinkers and problem solvers.

*Summary*

When students reach the ability to think and work using higher levels of cognitive processes, the benefit to them continues far beyond their in-class performance. Research shows that as students become better problem solvers and critical thinkers, this will be reflected not only in their performance on class tests and assignments, but also on state tests and life problems.

Studies showed that incorporating Bloom’s Taxonomy in the classroom produced beneficial results for students’ abilities to be critical thinkers. They also showed that a teacher cannot expect these results by simply asking higher-level questions; these questions need to be relevant to the students’ life and personal experiences. Teachers must incorporate these questions using various strategies including the use of technology, cooperative learning, and personal problem-based learning, thus making the classroom more student-centered instead of teacher-centered. Teachers must also consider the questions they ask, the time allowed to answer questions, and in what sequence they ask those questions. Studies from various time periods—from 1979 to 2006—show that Bloom’s Taxonomy is not a whim in education but rather is here to stay.

Teachers need to consider the responses they are trying to solicit through the questions they ask. If they want low-level answers, they should ask low-level questions. If teachers want to know that their students can memorize basic facts and have them regurgitated back to them, then they need to continue the practice of asking low-level questions. However, if teachers want their students to become more involved in their own learning and to become critical thinkers, they need to ask higher-level questions. Using questions that fit into the higher levels of Bloom’s Taxonomy is a strategy that currently is not incorporated on a regular basis in classrooms. Some teachers treat it as a fad by overlooking the importance of incorporating it into their classrooms.

# CHAPTER 3

## METHODOLOGY

Participants in this study were freshmen enrolled in a double-block Algebra 1 course at an urban Midwestern high school. In the control group, the twenty-three participants—fifteen girls and eight boys—include seventeen white/other students, four African-American students, one Hispanic student, and one Asian student. In the experimental group, the twenty-one participants—nine girls and twelve boys—include twelve white/other students, four African-American students, four Hispanic students, and one multi-race student. The high school had 402 freshmen of which 112 were in the double-block Algebra 1 course. The ethnicity breakdown for the entire high school was 1,083 white/other students, 197 African-American students, 128 Hispanic students, 59 Asian students, 42 American Indian students, and 32 multi-race students. The experimental group in the research study represented four of the six ethnic groups in the school. The control group in the research study also represented four of the six ethnic groups in the school. A percentage breakdown of the number and types of students is shown in Table 2.

Participants were considered to be some of the lower-performing students in the school hence the reason they were in a double-block Algebra 1 class. Since these students were already operating at a lower level, they were ideal candidates for this research. They had more difficulty reaching the higher cognitive levels and needed more remediation than some of the other students in the school. Therefore, these students would most likely benefit more from the research than some of the other students.

TABLE 1

SUMMARY OF SCHOOL, CLASS AND COURSE DEMOGRAPHICS

| Group | Entire School | | Just Freshman | | Experimental Group | | Control Group | |
|---|---|---|---|---|---|---|---|---|
| | **Number** | **%** | **Number** | **%** | **Number** | **%** | **Number** | **%** |
| **White/Other** | 1,083 | 70.2 | 281 | 69.9 | 12 | 57.1 | 17 | 73.9 |
| **African-Am** | 197 | 12.8 | 57 | 14.2 | 4 | 19.0 | 4 | 17.4 |
| **Hispanic** | 128 | 8.3 | 33 | 8.2 | 4 | 19.0 | 1 | 4.3 |
| **Asian** | 59 | 3.8 | 7 | 1.7 | 0 | 0 | 1 | 4.3 |
| **Am. Indian** | 42 | 2.7 | 10 | 2.5 | 0 | 0 | 0 | 0 |
| **Multi-Race** | 32 | 2.1 | 14 | 3.5 | 1 | 4.8 | 0 | 0 |

Students' cognitive abilities for solving algebra problems in the Algebra 1 course were measured with a pretest (Appendix A) to determine their skill levels prior to any modifications in instruction. Each pretest and posttest consisted of eighteen questions requiring various cognitive levels of thinking (three questions at each level). The questions covered material that the students would be learning over a six-week period. During the data collection, students' abilities were monitored on a daily basis through observations, their performance on assignments and activities designed to promote critical thinking, and their ability to answer various levels of questions, according to Bloom's Taxonomy. Questions were asked through lecture, student activities, use of the Classroom Performance System (CPS), and quizzes (Appendix B). The assignments that the students completed were not typical textbook assignments. They required students to answer questions at various cognitive levels. Students had to use a variety of problem-solving skills to answer the questions, such as working backwards, creating equations, making predictions, etc. Students were also asked to think about vocabulary in the mathematics content and in the questions. Some of the assignments were recommended assignments that the district found and/or created for the curriculum. Other assignments (Appendix C, D, E, and F) were created.

After interventions were completed, students were given a posttest, which was identical to the pretest.

Throughout this intervention it was assumed that the students would become better problem solvers and critical thinkers. It was also assumed that after completing the prescribed assignments, students would be able to complete similar assignments without as much instruction as it took to complete the previous assignments. In the beginning, students completed the assignments using cooperative learning. As the six weeks progressed, they completed their assignments with less assistance from the instructor, but still through cooperative learning. Cooperative learning was used to help build students' confidence to eventually reach higher levels of thinking on their own. With the prescribed questioning, it was assumed that students would be able to ask and answer higher-level questions on a more frequent basis and would more easily understand the assignments.

To determine if treatment was effective, comparison of posttest scores between experimental and control group was made using an Analysis of Covariance (ANCOVA). ANCOVA makes adjustments in the posttest scores based on differences with the pretest scores. The software SPSS was used to analyze these data. Students' scores were then compared to a control group, where students were exposed to traditional teaching methods without the stress of Bloom's Taxonomy on learning.

Not only were the pretest and posttest scores examined, but also the students' questioning abilities and performance on the completion of projects (based on observations). Through observations during activities and completion of assignments, it was determined if the students needed more, less, or the same amount of guidance when completing future assignments. It was assumed that the activities and assignments completed toward the end of the six weeks would require less guidance from the instructor than those completed at the beginning of the six weeks.

# CHAPTER FOUR

# RESULTS

*Introduction*

The purpose of the study was to determine if asking students higher-level questions and completing higher-level activities would help them become better problem solvers. Throughout the six weeks, the researcher was also observing the experimental group's comments and questions, and determining if students asked higher-level questions and gave higher-level answers due to the questioning and activities. This six-week study involved an experimental group that received higher-level questions and activities, and a control group that received the same information through a more traditional teaching style.

Students' cognitive abilities were determined based on pretest and posttest results. The level assigned to each student was determined by the number of correct questions and the level of those questions. Data from the pretest and posttest found in the research was analyzed using SPSS software. Students' scores on the pretest and posttest for the control and experimental groups are included in Appendices G and H. An analysis of covariance was used on the data to account for differences in the groups. Results from ANCOVA, raw mean and standard deviation scores, and adjusted mean and standard deviation scores are presented in various tables that follow. A summary of the observations from the experimental group is also provided. The hypothesis—Will asking higher-level questions and doing higher-level activities in this mathematics classroom help students become better problem solvers and critical thinkers?—was shown to be significant. Table 2 shows the raw mean and standard deviation scores for both the control and experimental group.

TABLE 2

RAW MEAN AND STANDARD DEVIATION SORES FOR THE CONTROL AND EXPERIMENTAL GROUPS

| Group | Mean | Standard Deviation | N |
|---|---|---|---|
| Control | 3.6087 | 1.92446 | 23 |
| Experimental | 4.4762 | 1.63153 | 21 |
| Total | 4.0227 | 1.82347 | 44 |

Once the raw mean and standard deviation were found, then Levene's test for homogeneity of variance was analyzed. The results of Levene's test are included below in Table 3.

TABLE 3

LEVENE'S TEST FOR HOMOGENEITY OF VARIANCE

| F | df1 | df2 | p |
|---|---|---|---|
| .757 | 1 | 42 | .389 |

Levene's test was found not to be significant. Therefore, homogeneity could be assumed and further analysis could be run. The results of the ANCOVA test are shown in Table 4.

TABLE 4

ANCOVA RESULTS

| Source | Type I II Sum of Squares | Df | Mean Source | F | p | $\eta^2$ |
|---|---|---|---|---|---|---|
| Group | 13.329 | 1 | 13.329 | 4.330 | .044 | .096 |
| Error | 126.198 | 41 | 3.078 | | | |

The results from Table 4 show that F (1, 44) =4.33, p<.05 and eta squared is 0.10, thus making the results significant. Table 5 includes the adjusted mean and standard deviation for the control and experimental groups. The adjusted scores take into account any differences between the two groups.

TABLE 5

ADJUSTED MEAN AND STANDARD DEVIATION

| Group | Mean | Standard Error | 95 % Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Control | 3.468 | .375 | 2.710 | 4.226 |
| Experimental | 4.630 | .394 | 3.835 | 5.425 |

*Observations*

Through observations, the researcher gathered various statements and questions from students throughout the six weeks. Some of their sample statements and questions are included below:

Beginning of six weeks:

- I do not get this.
- I do not understand any of this.
- The answer is two.
- I do not know why it works; it just does.
- What is the answer?
- What did you write that for?
- Why can't we do something we already know?
- Can we just skip this because it is too hard?

- What does this even mean?

End of six weeks:

- I actually understand this.
- Can I teach it to them because I actually get this?
- This is easy and it makes sense.
- I prefer stem-and-leaf plots over bar graphs because I can see more about the data that way.
- This is a closer estimate because I rounded this and then I could do it in my head.
- I like to simplify on one side, and then move things to the other side of the equals.
- Can we have more time to finish this because I am working really hard on it?
- Why does this work like that?
- Could I do it this way too and still get the same answer?
- What is the difference between these two ways to solve?

CHAPTER FIVE

# DISCUSSION

## *Discussion of Data*

Results from the data suggest that by incorporating higher levels of Bloom's Taxonomy through questioning and activities students will score higher on tests, thus making them better problem solvers and critical thinkers. Results showed significance when incorporating the higher levels of Bloom's Taxonomy. More students in the experimental group than the control group showed growth in their cognitive abilities from the pretest results to the posttest results.

Students in the experimental group may have performed better than the control group because of the variety of activities and instructional strategies. This is consistent with Kenimer and Morgan (2003) and their discussion of active learning and the use of activities. They seemed to enjoy those activities that required more of their participation. These activities seemed to motivate the students more than traditional teaching methods.

The experimental group may have also performed better because of the personalization of those activities. They could relate to some of the activities, and many of the questions were related to the students and addressed where they could use the information later or why they might need to know it. This is consistent with what Heyworth (1979) had stated about the success of students with personalization in the classroom.

A final reason for better performance from the experimental group is that they were questioned harder and at higher levels throughout the six weeks. Since they were asked questions at higher levels for six weeks, it is only natural that they should be able to answer more of those types of questions than the control group. The control group was asked a few higher-level questions but not on a frequent basis, not enough to make a large impact on the students' cognitive abilities.

*Discussion of Observations*

Through observations of the experimental group during the six-week period, students' comments became more positive. At the beginning of the six weeks, the students, overall, were negative about math and were not confident in themselves. Toward the end of the six weeks, they were saying they could do the activities and answer the questions, and that it was easy. Confidence is very important to have in math. Many of the students gained a great deal of confidence through the six weeks.

Students' questioning improved by the end of the six weeks as well. At the beginning of the six weeks, questions were very low level, and often the students were just trying to get the answer, not caring why something worked or about the best way to solve a problem. They only cared about what they had to know for the test and how to pass it. Students began to ask higher-level, more thought-out, and detailed questions. These questions asked were helping students to understand math better and make better decisions about problems. Since the students understood the material better, they did not ask as many off-topic questions. Students were also answering questions with more explanations. They were not giving as many yes/no answers or just solutions; they were providing more reasoning for their answers.

*Limitations*

Attendance played a major role in the success of the students to raise their cognitive abilities. In the experimental and control groups, the researcher and teacher made every attempt to work with students who missed a class session. However, when a student did an activity outside of class time they did not have the benefit of working collaboratively with their peers. The student could do the activity but it was in a very different setting than the rest of the class.

Another limitation in this research study was whether students tried their hardest on both the pretest and posttest. It is impossible to account for this. Although the researcher emphasized to the students to try their hardest, there is no guarantee they did. Knowing this, students in both the experimental and control groups on either test could have potentially not done their best. If by chance they were not trying their hardest on that day, then the results for that day could be skewed.

*Future Research*

Future studies could look at incorporating Bloom's Taxonomy for a more extended period of time. A researcher could look at the long-range effect on students' cognitive abilities due to the incorporation of Bloom's Taxonomy. Students in this research study showed short-term growth; however, they did not have an opportunity to show long-term retention or application of the information presented in the six weeks.

Research findings in this study should influence the researcher, as well as other educators, to incorporate the higher levels of Bloom's Taxonomy on a more frequent basis. Even though long-term results were not shown in this study, the short-term results are very beneficial. By incorporating Bloom's Taxonomy more often, students do become better problems solvers and critical thinkers, as shown here proving that Bloom's Taxonomy is here to stay and that it influences students' scores on tests and students' confidence in math.

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APPENDICES

APPENDIX A

PRETEST/POSTTEST

## Pretest/ Posttest

**Which is the best verbal translation of the inequality?**

____ 1. $3n \leq 52$

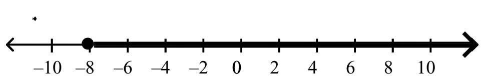
a. fifty-two is less than or equal to three times *n*
b. Three times *n* is at most fifty-two
c. The product of three and n is greater than or equal to fifty-two
d. Tripling fifty-two is less than or equal to three.

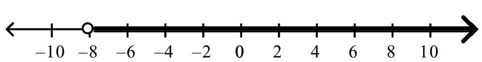
**List the process you would go through to graph the following on a number line.**

2. $d < 2$

**Can you make a distinction between the two graphs? If so, what conclusions can you make?**

3.




4. Tina can type at least 60 words per minute. Write an inequality to model this situation.

**Describe how you would solve the following inequality.**

5. $-\frac{x}{4} \leq 2$

**What would you recommend to be the next step to solve the problem? (Show the step.)**

6. $12x - 3x + 11 > 4x - (17 - 9x)$

   $12x - 3x + 11 > 4x - 17 + 9x$

7. What changes would you make to solve the following inequality?

   $y + \frac{3}{8} > 16$? Why?

$$y + \frac{3}{8} > 16$$
$$-\frac{3}{8} \quad -\frac{3}{8}$$
$$y > \frac{-13}{7}$$

Work:

$$\frac{16}{1} - \frac{3}{8} = \frac{13}{-7}$$

8. Your class hopes to collect at least 325 cans of food for the annual food drive. There were 132 cans donated the first week and 146 more the second week.

   **a.** Write an inequality that models this situation. Let *c* represent the number of cans of food that must be collected by the end of the third week for your class to meet or surpass your goal.

   **b.** How many cans are needed to meet or surpass your goal?

**Do you agree with the method used to solve the equation? Why or why not?**

9. $4\left|x + \frac{1}{3}\right| = 20$

$$\left|x + \frac{1}{3}\right| = 5$$

$$x + \frac{1}{3} = 5 \quad or \quad x + \frac{1}{3} = -5$$

$$x = 4\frac{2}{3} \quad or \quad x = -5\frac{1}{3}$$

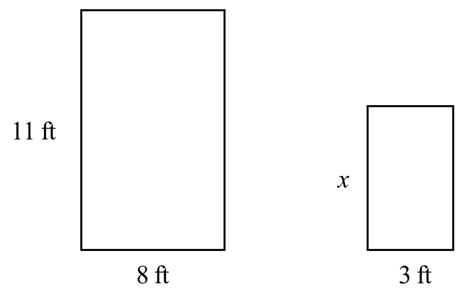
10. A 16-oz bottle of water costs \$1.44. What is the cost per ounce?

    **Solve the proportion.**

11. $\frac{w + 14}{4w + 6} = \frac{3}{4}$

**If the pair of figures is said to be similar. Then explain what it means to be similar.**

12.




Drawing not to scale

13. What percent of 20 is 18?

14. Distinguish the difference between odds and probability. You may give examples if necessary.

15. Eduardo solved $-4x > 120$ by adding 4 to each side of the inequality. What mistake did he make? Explain.

16. Suppose a classmate is having difficulty solving $4(x - 7) > 6x + 2 + 8x$ . Explain how to solve the inequality, showing all the necessary steps and justifying what you did to solve.

17. Explain why the equation $6|x| + 22 = 4$ has no solution.

18. Use estimation to decide whether 19.8% of 60 is closer to 12 or 14. Explain your reasoning.

APPENDIX B

SAMPLE CPS QUESTIONS

____ 1. Find the unit rate for number of parts manufactured per hour if 1630 parts are made in 6 hours. Round to the nearest integer.

a. 325 parts/h b. 272 parts/h c. 237 parts/h d. 291 parts/h

**Solve the proportion.**

___ 2. $\frac{x-8}{5} = \frac{2}{4}$

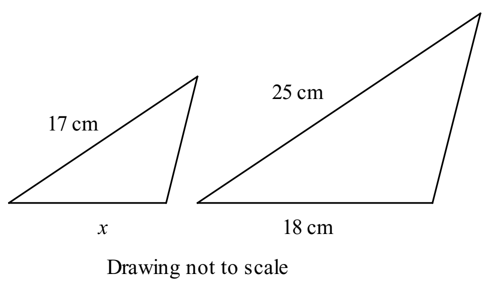
a. $\frac{9}{2}$ b. $\frac{5}{2}$ c. $\frac{21}{2}$ d. 18

____ 3. School guidelines require that there must be at least 2 chaperones for every 25 students going on a school trip. How many chaperones must there be for 80 students?

a. 6 chaperones
b. 40 chaperones
c. 3 chaperones
d. 7 chaperones

**The pair of figures is similar. Find *x*. Round to the nearest tenth if necessary.**

____ 4.




a. 12.2 cm b. 19.1 cm c. 26.5 cm d. 26 cm

____ 5. A map has a scale of 1 cm : 20 km. Two cities are 2.5 cm apart on the map. To the nearest tenth of a kilometer, what is the actual distance corresponding to the map distance?

a. 52.5 km b. 50 km c. 150 km d. 70 km

____ 6. Use the formula for simple interest, $I = prt$. Find $p$ if $I$ = \$313.42, $r$ = 2.5%, and $t$ = 3 yr.

a. \$3,426.73 b. \$4,429.67 c. \$3,761.04 d. \$4,178.93

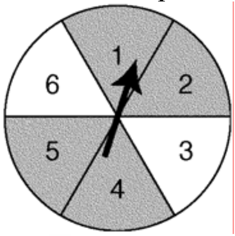
____ 7. During the month of February, Fabulous Feet Shoe Mart sold 50 pairs of red loafers. After an ad campaign to boost sales, they sold 60 pairs in March. Find the percent of increase in sales.

a. 12% b. 20% c. 15% d. 23%

____ 8. The circulation of a newsletter decreased from 5200 to 3140. Find the percent of decrease in circulation to the nearest percent.

a. 66% b. 40% c. 166% d. 6%

____ 9. Refer to the spinner below. Find *P*(even and not shaded).

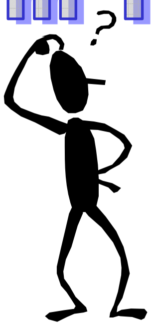



a. $\frac{1}{6}$　　b. $\frac{1}{3}$　　c. 0　　d. $\frac{5}{6}$

APPENDIX C

I'M THINKING OF A NUMBER…

# I'm Thinking of a number… what is it?



Name________________________

Solution Equation

1. I'm thinking of a number, I then… 1. 1.

add 8,

to get 21.

2. I'm thinking of a number, I then… 2. 2.

multiply by 2,

and add 3,

to get 15.

3. I'm thinking of a number, I then… 3. 3.

add 2,

and multiply by 3,

to get 18.

4. I'm thinking of a number, I then… 4. 4.

square the number,

and add 1,

to get 26.

Now what…

Create three “Thinking of a Number” problems similar to those shown above. Each should be unique and involve at least two operations. Be sure to write the solution and the equation. Show the work for solving the equation to prove that is the correct solution for what you were thinking.

Extra Credit

Create a problem that involves distributive property.

APPENDIX D

VERSATILES: ANSWERS ARE VARIABLE

## Answers Are Variable

**Find the line graph that represents the whole number solution sets for each of the inequalities below.**

$5m \leq 10$

Sharon has six baseball trophies, Mark has fewer trophies than Sharon.

$x - 5 < 17$

Wes is taller than twice the height of his dog, Atlas, who is 25" tall.

$\frac{b}{3} \geq 12.$

Michael has gone to fewer than one-fifth the 30 concerts Shelly has attended; but he has attended more than 3 concerts.

$b + 9 < 28$

$4t > 36$

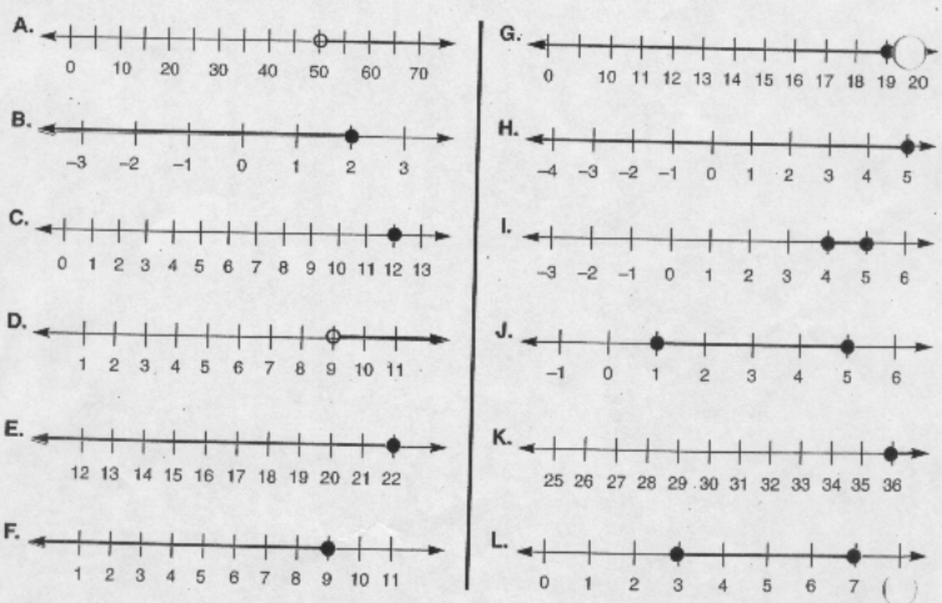
$x + 2x - 4 \leq 23$

$2a + 4 \leq 14$

Kasha's costume for Halloween had more legs than a human has, but fewer than a spider does.

Evan's rock collection includes as many specimens as Jan's dozen, but fewer than 13.

*Answer Box*




24

## APPENDIX E

## SHOPPING ACTIVITY

Teacher Directions:

Each student needs either a men’s page or a women’s page. Post the pictures and prices around the classroom for students to go shopping.

Student Directions:

Find all the appropriate items and fill them in on your answer sheet. When you find an item you need to figure out the sale price from the regular price and amount of discount. When you are done gathering all of the information, you need to determine what the best deal is when you buy one of each item. Answer the questions at the bottom of the page when you are done.

Men's Page Name___________________

| Item | Regular Price | Sale Percent | Discount Price |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

What is the best deal if you are buying 1 shirt, 1 tie, and 1 pair of shoes?

_______________________________________________________________

What is the total bill (excluding sales tax)?

_______________________________________________________________

What is the total bill with sales tax (7.3%)?

_______________________________________________________________

Women's Page Name ____________________

| Item | Regular Price | Sale Percent | Discount Price |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

What is the best deal if you are buying 1 shirt, 1 purse, and 1 pair of shoes?

______________________________________________________________________

What is the total bill (excluding sales tax)?

______________________________________________________________________

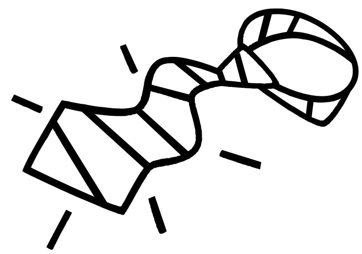
What is the total bill with sales tax (7.3%)?

______________________________________________________________________

Men’s Tennis Shoes (1)

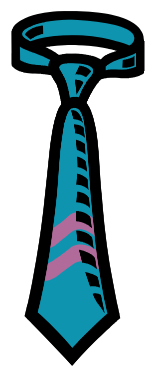
Regular Price: $65.00
Sale: 15%

Men’s Tie (2)



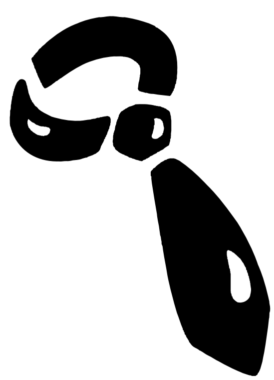
Regular Price: $22.00
Sale: 15%

Men’s Tie (1)



Regular Price: $18.00
Sale: 10%

Men’s Tie (3)



Regular Price: $25.00
Sale: 20%

Men's Sport Shoes (2)

Regular Price: $70.00
Sale: 30%

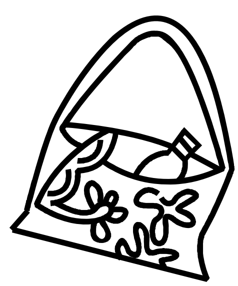
Men's Shoes (3)

Regular Price: $75.00
Sale: 25%

Women's Purse (1)

Regular Price: $32.00
Sale: 20%

Women's Purse (2)

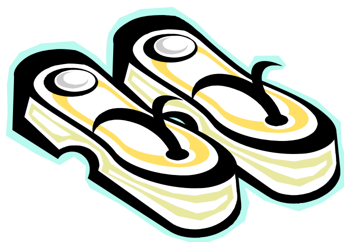


Regular Price: $39.00
Sale: 25%

Women's Purse (3)

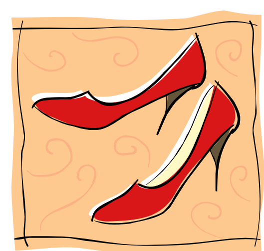
Regular Price: $28.00
Sale: 10%

Women's Shoes (2)



Regular Price: $60.00
Sale: 45%

Women's Shoes (1)



Regular Price: $55.00
Sale: 40%

Women's Shoes (3)

Regular Price: $30.00
Sale: 10%

Women's Shirt (1)

Regular Price: $25.00
Sale: 15%

Women's Shirt (3)

Regular Price: $40.00
Sale: 20%

Women's Shirt (2)

Regular Price: $55.00
Sale: 35%

Men's Shirt (1)

Regular Price: $30.00
Sale: 10%

Men’s Shirt (2)

Regular Price: $45.00
Sale: 25%

Men’s Shirt (3)

Regular Price: $40.00
Sale: 20%

APPENDIX F

M & M'S COUNT AND CRUNCH

# M & M's Count and Crunch

Names: ______________________________________________________________

**Part One**

1. Do NOT open your bag. Estimate the quantity of each color and the total number of candies in your bag. Also guess the percentage of the total that each color comprises. Record your results in the chart below.

| ESTIMATIONS | | |
|---|---|---|
| COLOR | NUMBER | % |
| Red | | |
| Brown | | |
| Yellow | | |
| Green | | |
| Orange | | |
| Blue | | |
| Totals | | |

2. Open your bag and count the actual number of each color and calculate the percentage.

| ACTUAL DATA | | |
|---|---|---|
| COLOR | NUMBER | % |
| Red | | |
| Brown | | |
| Yellow | | |
| Green | | |
| Orange | | |
| Blue | | |
| Totals | | |

3. Make a bar graph showing your estimations and the actual count of each color.

4. Make two pie charts, each representing the percentage of each color in the bag. The first pie chart will represent your estimations; the second is to represent the actual counts. Each sector of the pie chart should be proportional to the percentage it represents. For instance, if you are graphing 13% for yellow, then your yellow sector should measure 13% of 360 degrees.

ESTIMATIONS

ACTUAL DATA

**Part Two**

5. Find the mean of the data.

6. Find the median of the data.

7. Find the mode of the data.

8. Find the range of the data.

9. What is the probability of a red m & m?

10. What is the probability of a yellow or brown m & m?

11. What is the probability of a blue m & m?

12. Now place all of your m & m's back in the bag and do 50 trials of pulling a candy out and recording what color you draw. Determine how many times you actually pull out a blue candy. Record each draw in the chart.

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

13. How many times was a blue candy pulled out of the bag in the total 50 draws?

14. What is the percentage for how many times blue was chosen?

**Part Three**

13. Now predict the quantity of each color and the total number of candies in a one-pound bag.

| PREDICTIONS | | |
|---|---|---|
| COLOR | NUMBER | % |
| Red | | |
| Brown | | |
| Yellow | | |
| Green | | |
| Orange | | |
| Blue | | |
| Totals | | |

# APPENDIX G

## CONTROL GROUP RAW DATA

Pretest Results for Control Group

| **S#** | K5 | K10 | K13 | | C1 | C12 | C17 | | Ap4 | Ap8 | Ap11 | | An2 | An3 | An14 | | S7 | S15 | S18 | | E6 | E9 | E16 | | **Level** | **Level #** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1 | 1 | 1 | **3** | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 1 | **1** | 0 | 0 | 0 | **0** | **K** | **1** |
| **2** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **3** | 0 | 1 | 1 | **2** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | **K** | **1** |
| **4** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | **K** | **1** |
| **5** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 1 | 1 | **3** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | **An** | **4** |
| **6** | 0 | 1 | 1 | **2** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | **K** | **1** |
| **7** | 0 | 1 | 1 | **2** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | **K** | **1** |
| **8** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 0 | 1 | 1 | **2** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | **Ap** | **3** |
| **9** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **10** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 0 | 1 | 1 | **2** | 1 | 0 | 0 | **1** | **S** | **5** |
| **11** | 1 | 1 | 1 | **3** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | **K** | **1** |
| **12** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **Ap** | **3** |
| **13** | 0 | 1 | 1 | **2** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **14** | 0 | 1 | 1 | **2** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **15** | 1 | 0 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 1 | **2** | 1 | 1 | 0 | **2** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **An** | **4** |
| **16** | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | 1 | 0 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 0 | **1** | **S** | **5** |
| **17** | 1 | 1 | 1 | **3** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **18** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **19** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 0 | **1** | **S** | **5** |
| **20** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **21** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **22** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 0 | 1 | 1 | **2** | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | **S** | **5** |
| **23** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **Ap** | **3** |

Posttest Results for Control Group

| **S#** | K5 | K10 | K13 | | C1 | C12 | C17 | | Ap4 | Ap8 | Ap11 | | An2 | An3 | An14 | | S7 | S15 | S18 | | E6 | E9 | E16 | | **Level** | **Level #** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | **S** | **5** |
| **2** | 0 | 0 | 1 | **1** | 0 | 1 | 1 | **2** | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | **K** | **1** |
| **3** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | **E** | **6** |
| **4** | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **5** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | **An** | **4** |
| **6** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | **C** | **2** |
| **7** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 0 | **1** | 1 | 0 | 0 | **1** | **An** | **4** |
| **8** | 0 | 0 | 1 | **1** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **9** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 0 | 0 | 0 | **0** | 0 | 0 | 1 | **0** | 0 | 0 | 0 | **0** | **Ap** | **3** |
| **10** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **11** | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 1 | **2** | 0 | 0 | 0 | **0** | **S** | **5** |
| **12** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | **E** | **6** |
| **13** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | 1 | 0 | 1 | **2** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **Ap** | **3** |
| **14** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 0 | 0 | 0 | **0** | 0 | 0 | 1 | **1** | 1 | 0 | 0 | **1** | **Ap** | **3** |
| **15** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 1 | **3** | 1 | 0 | 0 | **1** | **S** | **5** |
| **16** | 0 | 1 | 1 | **2** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **17** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 0 | **1** | 1 | 0 | 0 | **1** | **An** | **4** |
| **18** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| **19** | 1 | 0 | 1 | **2** | 1 | 0 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 1 | **2** | 1 | 0 | 1 | **2** | **E** | **6** |
| **20** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | **C** | **2** |
| **21** | 0 | 1 | 1 | **2** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | **K** | **1** |
| **22** | 0 | 1 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 0 | 0 | 0 | **0** | **S** | **5** |
| **23** | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | **S** | **5** |

APPENDIX H

EXPERIMENTAL RAW DATA

Pretest Results for Experimental Group

| S# | K5 | K10 | K13 | | C1 | C12 | C17 | | Ap4 | Ap8 | Ap11 | | An2 | An3 | An14 | | S7 | S15 | S18 | | E6 | E9 | E16 | | Level | Level # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | **K** | **1** |
| 2 | 0 | 1 | 0 | **1** | 1 | 1 | 0 | **2** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **AP** | **3** |
| 3 | 1 | 1 | 0 | **2** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 4 | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | **K** | **1** |
| 5 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 6 | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 7 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 8 | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 9 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 10 | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 11 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 13 | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 14 | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 15 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 1 | 1 | **3** | 0 | 0 | 0 | **0** | **S** | **5** |
| 16 | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 17 | 0 | 1 | 1 | **2** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 18 | 0 | 0 | 0 | **0** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 19 | 0 | 0 | 0 | **0** | 1 | 0 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 20 | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 21 | 0 | 0 | 1 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |
| 22 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |

Posttest Results for Experimental Group

| **S#** | **K5** | **K10** | **K13** | | **C1** | **C2** | **C17** | | **Ap4** | **Ap8** | **Ap11** | | **An2** | **An3** | **An14** | | **S7** | **S15** | **S18** | | **E6** | **E9** | **E16** | | **Level** | **Level #** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | **E** | **6** |
| 2 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 0 | 1 | 0 | **1** | 1 | 0 | 1 | **2** | **An** | **4** |
| 3 | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 0 | 1 | **2** | 1 | 0 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | **E** | **6** |
| 4 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 1 | 1 | **3** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | **An** | **4** |
| 5 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 0 | 0 | 0 | **0** | 1 | 0 | 1 | **2** | **An** | **4** |
| 6 | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | **E** | **6** |
| 7 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | **An** | **4** |
| 8 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | 1 | 1 | 1 | **3** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | **An** | **4** |
| 9 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | **S** | **5** |
| 10 | 1 | 1 | 0 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 0 | 0 | 1 | **1** | 1 | 0 | 1 | **2** | **An** | **4** |
| 11 | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | **S** | **5** |
| 13 | 1 | 1 | 1 | **3** | 1 | 1 | 0 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 0 | 1 | **2** | **S** | **5** |
| 14 | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 0 | 1 | **1** | 0 | 0 | 0 | **0** | **C** | **2** |
| 15 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 0 | 1 | 1 | **2** | 1 | 1 | 1 | **3** | **E** | **6** |
| 16 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | **E** | **6** |
| 17 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 0 | 1 | 1 | **2** | 1 | 0 | 0 | **1** | **Ap** | **3** |
| 18 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | **E** | **6** |
| 19 | 1 | 1 | 1 | **3** | 1 | 0 | 1 | **2** | 0 | 1 | 1 | **2** | 1 | 1 | 1 | **3** | 0 | 1 | 0 | **1** | 1 | 1 | 1 | **3** | **E** | **6** |
| 20 | 1 | 1 | 1 | **3** | 1 | 1 | 1 | **3** | 0 | 1 | 1 | **2** | 1 | 1 | 0 | **2** | 1 | 0 | 1 | **2** | 1 | 0 | 1 | **2** | **E** | **6** |
| 21 | 0 | 1 | 1 | **2** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 0 | 1 | 0 | **1** | 1 | 0 | 0 | **1** | 1 | 0 | 0 | **1** | **K** | **1** |
| 22 | 0 | 0 | 1 | **1** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **K** | **1** |