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The Effect of Cooperative Learning on Test Performance

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THE EFFECT OF COOPERATIVE LEARNING ON TEST PERFORMANCE

THESIS

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by

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ABSTRACT

The purpose of this study was to determine if cooperative learning in the form of study games could have an effect on student test performance. The subjects were 96 eigth grade students at a suburban New York State school. The 96 students were divided into 4 classes of 24 each. The course that the students were enrolled in was physical science, which was a mandatory course at this particular school. The cooperative learning technique of utilizing games as a means of study was developed by Robert E. Slavin, at Johns Hopkins University. The particular series and steps of the games in this study were a spin-off of Slavin's work with a few different steps added. The games consisted of the teacher developing a list of questions and answers which were later transferred to flashcards by the students. The questions and answers pertained to the topic being studied and were the basis of the exam which followed. The students were divided into teams within the classroom and competed for points which were scored as a result of correctly answering the flashcard of the opposing team. For the purpose of analysis, an independent t-test was used to determine if there was a significant difference between the mean test scores of the

students who played the game (treatment group), and the students who did not play the game (non treatment group).

The treatment group and the non treatment group exchanged roles after 10 weeks, which consisted of taking 2 exams, where the treatment group became the non treatment group and the non treatment group became the treatment group. Statistical analysis was performed on each exam taken by the students during a total of 20 weeks. The results showed, in every exam, that the students who had participated in the cooperative learning experience obtained higher test scores than did those students not participating. On average the treatment group's test score mean was 5 points higher than the non treatment group's test score mean. In one case the treatment group's test score mean was 15 points higher than the non treatment group's test score mean.

Do not then train youth to learning by force and harshness, but lead them to it by what amuses their minds so that you may discover the particular bent of the genius of each.

-Plato

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CHAPTER ONE

INTRODUCTION

One of the most perplexing problems facing teachers is that of motivating students. Much research has been done relative to ways of increasing student motivation to learn in the classroom setting.

Hunter (1978) has identified six factors which affect student motivation. They are the degree of concern, tension or anxiety, feeling tone, interest, knowledge of results, rewards and success.

The degree of concern, tension or anxiety is based on the premise that if there is no concern, tension or anxiety, there will be no learning. The degree of concern is a facilitating factor providing it exists to a moderate degree. Too much concern may divert the learner's energy into dealing with the concern rather than focusing on the learning task.

Feeling tone centers on the environment. Is the environment pleasant, unpleasant or neutral? A moderate amount of pleasant or unpleasant tone will increase motivation while excessive amounts produce debilitating tension. Absence of feeling tone, or neutral feeling tones, tends to decrease motivation.

Interest, basically states that the more interest generated, the greater the learning dividends. A problem that may arise with interest is that if interest is too high, it can distract form learning. Factors influencing interest include personality, novelty, vividness, attractiveness, importance, fadishness and whether or not the task is enjoyable to the individual.

Knowledge of results is highly motivating. The feedback that comes directly after an attempt at learning and indicates what can be done to improve performance can be effective.

Rewards are viewed by individuals in different ways. One view is that the individual controls his own fate in accordance with his actions. Another view an individual might take is that he does not control his own fate but is controlled by outside forces. For example, a student may fail a test and attribute the failure to the teacher's dislike.

Of the six factors which affect motivation, student success is deemed the most essential. Bloom (1976) writes, " Success or lack of success in a school subject eventually is a major force in determining how the student feels about the subject and his desire to learn more about that subject " (Bloom, 1976 p. 127). Hunter (1976) suggests that the degree of difficulty is closely related to success. The learner must feel the task was significantly difficult but not too hard. Some considerations of Hunter's are that learning is sequential and learning should occur one step at a time with avoidance of overload.

To what do we attribute success or failure? Hunter believes that luck, native ability, task difficulty, and effort are the attributing factors. Much like the individual who attempts to play a sport, draw a picture, write a poem, or test his abilities at any given task, the more successful that individual is, the more likely he will want to participate.

In the school setting, the role of the student is that of a learner. The common method of measuring student learning is testing. If success generates motivation, and motivation breeds an eagerness to participate, then the student who is successful on tests should have a drive to fulfill his role, which is that of a learner.

The purpose of this study was to use a test-coaching technique in an attempt to improve student test performance. The hope being that success would breed success and students would be motivated to learn.

The method used for coaching was very similar to the Teams-Games-Approach(TGA) (Slavin, 1978). Team learning is described as "A method to promote major academic, and nonacademic goals such as improved basic skills, improved student self-concept, and better interpersonal/cross- racial relationships." (Slavin, 1978, p. 28). The teams-game-approach is used in the classroom to enhance and reinforce

concepts and ideas previously discussed in class. The games in the study are intended to increase student motivation and promote a basic understanding of the principles and concepts of science.

The team approach to learning is unique in that it rewards the group as opposed to rewarding the individual. Students are encouraged to reinforce each other, provide support for each other and to be less competitive. At the same time, individual students have an opportunity to succeed and gain recognition through the success of the group. " The particular combination of structural changes used by TGA follows directly from research in both social psychology and instructional gaming " (Leavy and Hollifield, 1980 p. 6).

The specific purpose of this study was to answer the question: Does participation in a team game review improve student test performance?

CHAPTER II

REVIEW OF THE LITERATURE

At the heart of effective teaching is the question, How can I keep my students actively involved in learning? Much research has been done in an attempt to find the optimal environment for learning to occur. Many strategies have been developed, and of these, many have been studied in depth. "From psychology, social psychology, philosophy, therapy, and other disciplines have come experiments designed to learn whether innovative teaching strategies produce the distinctive effects for which they are intended" (Joyce and Weil p. 13 cited in Joyce, Showers, and Rolheiser-Bennett, 1987). Teachers who are trying to obtain an environment which will motivate the student to pursue the goal of academic excellence are taking a large risk. It is not easy for a teacher to find a style which will increase student motivation, performance and time on task.

Everyone is satisfied when a student is doing well and is happy with school. It's when a child is failing and does not like school that questions are raised. Why is he failing? Why is it that he cannot learn this material? Is it too

difficult for him? If it is, the teacher should be able to take actions and adjust the material so it is at an appropriate level for the student. If the student is capable, but is just not passing, there is a problem.

Due to the great expansion of research in education and applied psychology (Rolheiser-Bennett, citied in Joyce, Showers, and Rolheiser-Bennett, 1986), data have been collected which provide an array of viable options for programs that can increase student learning (Walberg, cited in Joyce, Showers, and Rolheiser-Bennett, 1987, p. 13). School districts can now offer programs to teachers with the expectation that they will result in higher student achievement. One of these programs, termed cooperative learning, represents social models of teaching and has yielded noticeable effects, from modest to high, through the use of statistical analysis (Joyce, Showers, and Rolheiser-Bennett, 1987).

Basically, cooperative learning is allowing the students to work together in the classroom toward the goal of success (Johnson and Johnson, 1987). Cooperative learning can take on many forms from a lab exercise to a team debate. The one form of cooperative learning which was focused on in this study made use of educational games. It was basically a test-coaching technique in which games served as a method of review.

Is it possible that cooperative learning can increase motivation? Can it provide positive effects in test performance if used as games for review? Can cooperative learning motivate students to want to come to class, to spend more time on task, and most importantly, to *want* to learn?

Cooperative learning is a learning method designed to improve learning and positive relationships among classmates. It is intended to be used in the daily instructional curriculum and not as an extra-curricular activity (Slavin, 1986).

Research dating back to the 1800's indicates that students learn more, become more self-confident and tend to exhibit a mutual growth in the attitudes toward one another through the use of cooperative learning (Johnson and Johnson, 1987). Johnson and Johnson (1987) also suggest that in most cases, student motivation is increased by working in small groups.

Slavin (1986) suggests that for cooperative learning to be successful it must satisfy two criteria:

1. Groups must be rewarded as a group.
2. Group success must depend on individual learning.

Basing group success on individual learning ensures that the students are motivated to make sure every member of the group is learning (Slavin, 1986). Learning as a group is the back bone of cooperative learning. It is through the group that students help each other to learn by encouragement and reinforcement of success. The teacher, when assigning groups, designs them to ensure that there are different ability level students in each group, usually based on past academic performance. This motivates higher ability students to help lower ability students achieve so that the group can succeed. As a result, a major advantage of cooperative learning is that it enables students of all ability levels to improve (Slavin, 1986).

Cooperation is the key for group success. It is through cooperation that the group is able to achieve its goals (Jaques, 1984). In most cases, cooperation has to be learned, and once learned it will enable the student to better adapt to the world outside and after school. Competition, on the other hand, is found to be anti-productive by the students of the group. For example, when the task involves complex learning and problem solving skills, several psychologists have found that cooperation leads to higher achievement than competition (Davis, Laughlin, and Komorita, 1976). In a well structured cooperative learning setting, the students rarely make negative comments to one another and tend to discuss topics related to the material.

Many students have uneasy relationships with authority figures during their teens. They may have these feelings as a result of having to deal with their own identity crisis (Erikson, 1979). In cooperative learning students work together toward the goal of success in the classroom setting, relieving the stress associated with having to deal almost exclusively with the teacher, who in this case is the authority figure (Johnson and Johnson, 1987). As Slavin (1986) suggests, students can sometimes explain things better to other students than the teacher can. Working in the small peer groups may enable students to question and evaluate other's work more closely, forcing the students to relay conclusions more coherently (Johnson and Johnson, 1987). Johnson and Johnson (1987) add that cooperative learning is beneficial in the long run for students because it forces them to make and support conclusions they've drawn in a group of their peers. Donlan (1987) summarizes that when he allowed his students to work together on a project which was dull, tedious, and practically impossible to do alone, the students felt they learned more. Not only did they learn more, they also commented that the task was more enjoyable and that they had not cheated, but cooperated. Donlan's students add that if one cheats, he does not gain an understanding of the material he has just copied. In cooperative learning, all of the students obtain the same answers but at the same time gain valuable knowledge of the concepts.

Cooperative learning has yet another advantage and that is it fosters the growth of positive attitudes among people of different ethnic and racial backgrounds (Slavin, 1987). Research has shown that merely desegregating the classroom does not promote cross-ethnic or cross-racial relations. Cooperative learning can be used as a tool to develop programs which could have a positive effects on cross-ethnic and cross-cultural relations.(Sharan et al, 1984).

Gordon Allport (1954) formulated what has become the three basic postulates, or conditions, for counteracting effects of racial prejudice in social settings:

1. there must be unmediated inter-ethnic contact.
2. it must be occurring under conditions of equal status between members of various groups participating in a given setting.
3. it must be in a setting which officially sanctions inter-ethnic cooperation.

Allport (1957) wrote these conditions more than 30 years ago. Why is it that even today schools harbor prejudice and perhaps bitter feelings cross racially and cross ethnically? Cohen (1980), implies that traditional

classrooms are set-up not to promote any cooperative learning or cross-racial or cross-ethnic relations but are set up to promote individualization and disregard any of the benefits outlined in cooperative learning. Cooperative learning appears to have beneficial effects on learning and motivation in the classroom. What are some ways in which cooperative learning can be implemented into the classroom?

Since cooperative learning involves small groups, The small group can be used to make teams. Slavin writes," Being on a team, working toward a goal, can be one of the most exciting experiences in life."(Slavin, 1978 p. 7). Slavin (1978) asks two questions: How can we use teams to be effective in the classroom? Can the peer support for achievement, the acceptance of teammates, and the excitement team work brings be transferred to the classroom?

By making use of teams, the educator can set up a games approach to implement cooperative learning in the classroom. Games and simulations appear to be very valuable in developing professional communication and problem solving skills. They also aid in integrating learning at different levels and across disciplines, and in seeing other peoples's views (Jaques, 1984). The gaming structure was designed to achieve the humanistic goals of the 60's as well as the basic skills learning goals of today (Slavin, 1978).

There are three team techniques which have been studied and can be incorporated into gaming. They are:

1. Elliot Aronson's Jigsaw Method
2. David DeVries's Teams-Games-Tournament
3. Robert Slavin's Student Teams Achievement Divisions

The jigsaw method involves 6 member teams. The material to be learned is broken down into the number of team mates. Members of different teams who have the same sections of material to study form an expert group. The expert group studies only that particular section's material collectively. They then return to their team and teach the others their section. The teams are then quizzed on the entire set of materials. To do well on the quiz, the students have to listen to the speaker in their group. This is intended to motivate the students to support each other's work.

The jigsaw method has only been evaluated once. In the study, black and chicano students performed better than the controls in the traditional classes. White students ended up about equal (Lucker et al. 1976).

In teams-games-tournament, (TGT), the students are broken up into teams of 4 or 5. They study the lectured material together using worksheets. At the end of the week, team members compete in tournaments with members of other teams for points. They compete on skill exercise games against different

team members who are comparable in past academic performance. This allows all the students to have an equal chance of contributing to the team. The teacher writes-up a weekly newsletter highlighting winners.

TGT has been evaluated in ten studies involving nearly 3000 students. In all ten studies, TGT students learned significantly more than students in traditional study classes. TGT has been used in grades 3-9 in many different subject areas and in many different schools (DeVries and Slavin, 1978).

Student-teams-achievement-divisions, (STAD) is similar to TGT except the students take individual quizzes to make points for their team. Teams are designed by the teacher to incorporate members of varying ability levels into one team. The different levels of ability are based on past academic achievement scores. A team average is taken from the quiz and points are given to the teams which score highest. Dividing the teams into comparable academic ability level students allows the teams to be equal at the start and provides an opportunity for each member to help the team (Slavin, 1978).

STAD has been evaluated in 5 studies involving approximately 2000 students in grades 4-9. In all but two, STAD was significantly more effective in improving performance. In those two, STAD was equal. It was found the minority students had a greater increase from the control group than whites in the same study.

Other research in gaming (Kowalewski, 1986) indicates that through the use of games, students not only showed an increase in test scores, but more importantly, in motivation. He divided his class into teams and for 3 days used a gameshow-type approach for the students to study for a final exam. When the mean test scores were compared with those of eight other upper division courses, the mean difference was approximately 5 points in favor of the gameshow technique. The difference is slight and may be attributed to other variables besides the game. Kowalewski (1986) felt ,however, that there may have been more advantageous effects than just test scores. On a questionnaire, his students felt that they enjoyed the game, gained valuable review and also felt a desire to participate in class.

Cooperative learning has been studied in many different types of schools, rural, urban, suburban and in many different classes. Results obtained through the use of standardized tests are that certain forms of cooperative learning have been found to enhance student performance and academic achievement. These forms included the jigsaw method, teams-games-tournament, and the student teams achievement division (Slavin, 1986).

Research illustrates that cooperative learning is beneficial. It is important to refine the strategies used for implementing cooperative learning to obtain the most effective strategy to use (Johnson and Johnson, 1987). Teachers,

however, have seemed to move toward a more student independent learning mode which works directly opposite cooperative learning (Johnson and Johnson, 1987). Some teachers may feel that small group learning could be of great value to the students yet, many of these teachers find that they are not adequately qualified to handle the leadership role in these strategies and revert back to their roles as prime talkers (Jaques, 1984).

Different teaching styles may affect the cooperative learning strategy to use. The individual teacher, through experimentation, must learn which variables to control for in order to achieve optimal results (Johnson and Johnson, 1987). Johnson and Johnson (1987) suggest that teachers become more familiar with cooperative learning through research, and that the teachers should make an attempt to replicate in their classrooms the techniques used in cooperative learning.

What is the magnitude of effect that we can expect from teachers who use the cooperative learning strategies? For the highly structured cooperative learning environments, data obtained on standardized tests in the basic curriculum areas such as reading and mathematics, showed an average effect size of about 0.3 standard deviations, with some studies approaching half a standard deviation. On criterion-referenced tests the average is 0.5 with some

of the best implementations reaching an effect size of about one standard deviation (Rolheiser-Bennett, cited in Joyce, Showers, and Rolheiser-Bennett, 1987 p.17). "Research on cooperative learning is overwhelmingly positive, and the cooperative approaches are appropriate for all curriculum areas."(Joyce, Showers, and Rolheiser-Bennett, 1987 p. 17).

Cooperative environments have substantial effects on the cooperative behavior of the students, increasing feelings of empathy for one another, reducing inter-group tensions and aggressive and antisocial behavior, improving moral judgment and building positive feelings toward others, including those of other ethnic groups (Joyce, Showers, and Rolheiser-Bennett, 1987, p. 17).

CHAPTER III

METHOD

SUBJECTS

The study consisted of 96 eighth grade students in an upstate New York suburban middle school. The students were randomly assigned to 4 average level physical science classes. Physical science is a required course taken by all eighth graders. Each of the 4 classes had 24 students. Two classes were treated as the treatment group for the first ten weeks, while the other 2 classes served as the non-treatment group. After ten weeks, the roles of the classes were reversed. The treatment classes were treated as the non-treatment group and non-treatment group was treated as the treatment group.

PROCEDURE

In the study, the classes were treated identically in regard to mandatory assignments, material covered and method of presentation. Of the 4 classes in the study, 2 met during the morning hours and 2 during the afternoon hours. To control for the time of day classes met, the first treatment group consisted of a morning and an afternoon class. The first ten weeks of the study were labeled phase I. Phase I consisted of 2 classes, n = 48, receiving treatment and 2 other classes, n = 48, serving as controls. Phase I entailed the completion of two tests which took place at the 5th and 9th weeks. The tests were used as the indicator of performance and possible effects of the treatment.

The treatment consisted of dividing each class into 6 teams of 4 members. The teams were selected by the teacher. Team member selection was based on rank order with the top six academic achievers being captains. Once the captains were assigned, the rest of the students were placed in reverse order, for instance, the next highest academic achiever was placed on the sixth captain's team. Each team consisted of low, medium, and high performance students, as indicated by the quiz scores and were a mixture of males and

females. Diversifying the teams not only allowed each team an equal opportunity to win, but also gave the lower ability students a chance to be helped by the higher ability students. Emphasis was placed on working and doing well as a team. Through the team, students gain peer support, mutual concern and respect which are crucial for the teams to work.

Three days before testing the students were asked to form their groups. The students were then given 2 sheets of colored paper, each team a different color, and asked to cut them into twelve cards of the same size. The cards were to be used as flashcards. The teacher handed each team a question/answer sheet with eight questions and corresponding answers pre-written by the teacher. The students wrote the questions on one side of the flashcard and the answer on the reverse side. After completing this assignment, each team member was asked to make-up a question, either from his notes or from his text, relating to the material covered in class. The question and answer was then written on a flashcard leaving each team with a total of twelve questions on flashcards, 8 from the teacher and 4 from the team members. Using their team cards, time was given for each team member to quiz the other members within their team.

To ready the students for the game, the teacher assigned two opposing teams to a table. The students were arranged so that opposing teams were facing each other.

The responsibilities of each team's captain included sitting at the end chair of the table, holding the stack of team cards and starting the game. The game began with the flip of a coin to decide who would ask or receive the first question. The captain called heads or tails. Once a giver and a receiver was determined, the game was underway.

The asking team's captain asked the receiving team's captain the first question. It was important for the captain to make sure that his team mates did not see the answer, for if the player on the receiving team failed to answer the question correctly , the asking team could answer.

Once the correct answer was obtained, the captain who asked the first question gave the entire set of cards to the team mate to the right of him. The receiving team's captain then asked a question from his team's set of cards.

Generally, the person with the cards on the questioning team presented the question to the opponent sitting across from him. If that person did not answer correctly within 15 seconds, any member on the questioning team, signifying by raising his hand, answered. If the question was not answered correctly by

either team, the answer was divulged by the questioner. A point was given to the team giving a correct answer.

The procedure was repeated until all questions were asked twice. Each team was responsible for having a player/scorekeeper to keep track of the points.

Once the questions had been asked twice, the players remained seated and the cards rotated from table to table in a clockwise direction. By rotating the cards each player on each team was exposed to all of the questions from the teacher's original list as well as all the questions written by the students.

The test hypothesis being that the classes receiving the opportunity to play the game would perform better on the test, based upon test scores, than the classes that did not play the game.

CHAPTER IV

STATISTICAL ANALYSIS

NULL HYPOTHESIS: There is no statistically significant difference in test performance between those students using the team learning approach method and those not using the team approach.

The following t-test will determine if there is a statistically significant difference between the mean of the treatment group and the mean of the non-treatment group for phase I and II each containing two separate compultations of test scores labeled test A and test B. The t-test will be conducted at the unbiased 95% confidence level.

Using the independent t-test formula, the following results were obtained for phase I test A

$$t = A \div \sqrt{(((B \times C + D \times E) / (B + D)) \times (F + G))}$$

$A = \bar{X} - \bar{Y} = 79.96 - 74.52$

$B = n_x - 1 = 47$

$C = S\bar{x}^2 = 11.36^2$

$D = n_y - 1 = 47$

$E = S\bar{y}^2 = 13.35^2$

$F = n_x^{-1} = 48^{-1}$

$G = n_y^{-1} = 48^{-1}$

$t = 2.15$

FINDINGS: Since the t required was + or - 2.021, and since the t obtained was 2.15, we must reject the null hypothesis and make the assumption that the treatment did play a role in the increase of the student test scores in phase I test A of this investigestion.

Using the independent t-test formula, the following results were obtained for phase I test B.

$$t = A \div \sqrt{(((B \times C + D \times E) / (B + D)) \times (F + G))}$$

$A = \overline{X} - \overline{Y} = 77.27 - 62.27$

$B = n_X - 1 = 47$

$C = S_{\overline{X}}^2 = 11.9^2$

$D = n_Y - 1 = 47$

$E = S_{\overline{Y}}^2 = 17.19^2$

$F = n_X - 1 = 48^{-1}$

$G = n_Y^{-1} = 48^{-1}$

$t = 4.19$

FINDINGS: Since the t required was 2.021, and since the t obtained was 4.19, we must reject the null hypothesis and make the assumption that the treatment did play a role in increasing test performance in phase I test B of the investigation.

Using the independent t-test formula, the following results were obtained for phase II test A.

$$t = A \div \sqrt{(((B * C + D * E)\ (B + D)) * (F * G))}$$

$A = \bar{X} - \bar{Y} = 74.27 - 69.46$

$B = n_x - 1 = 47$

$C = S_{\bar{x}}^2 = 10.71^2$

$D = n_y - 1 = 47$

$E = S_{\bar{y}}^2 = 10.9^2$

$F = n_x^{-1} = 48^{-1}$

$G = n_y^{-1} = 48^{-1}$

$t = 2.18$

FINDINGS: since the t required was + or - 2.021, and since the t obtained was 2.18, we must reject the null hypothesis and make the assumption that the treatment did play a role in increasing student test performance in phase II test A of this investigation.

Using the independent t-test formula, the following results were obtained for phaseII test B.

$$t = A \div \sqrt{(((B * C + D * E) \ (B + D)) * (F + G))}$$

$A = \bar{X} - \bar{Y} = 73.65 - 67.85$

$B = n_x - 1 = 47$

$C = S_{\bar{x}}^2 = 11.99^2$

$D = n_y - 1 = 47$

$E = S_{\bar{y}}^2 = 13.34^2$

$F = n_x - 1 = 48^{-1}$

$G = n_x - 1 = 48^{-1}$

$t = 2.24$

FINDINGS: SInce the t required was + or - 2.021 and the t obtained was 2.24, we must reject the null hypothesis and make the assumption that the treatment had an effect on student test performance in phase II test B of this invesigation.

CHAPTER V

RESULTS

According to the results obtained in this study there was a statistically significant difference in the test scores between the treatment group and the non-treatment group. In phase I, both tests A and B, and in phase II, both tests A and B, the results favored the treatment group.

During phase I test A the treatment group received a test score mean of 79.96, with a standard deviation of 11.36. The non-treatment group received a test score mean of 74.52, with a standard deviation of 13.35. Test B, of the same phase, resulted in the treatment group receiving 77.27 as a test score mean, with an 11.9 standard deviation. The non-treatment group, on this test, received a test score mean of 62.27 and a standard deviation of 17.19.

In phase II test A of the study, the treatment group received a test mean of 74.27, with a standard deviation of 10.71, while the non-treatment group received a test score mean of 69.46, with a standard deviation of 10.9 on that same test. Test B of phase II resulted in the treatment group receiving 73.65 as a test score mean with a standard deviation of 11.13. The non-treatment group received a test score mean of 67.85, with a standard deviation of 13.34.

STATISTICAL PRESENTATION

The results of this study were obtained through the use of an independent t-test. The t-score requirement was obtained from a t-table using 47 degrees of freedom, at the unbiased 95% confidence level.

In phase I test A of the study, the t-score obtained was 2.15, with a t-required of + or - 2.021. As a result of these findings we must reject the null hypothesis and accept the experimental hypothesis that the treatment, cooperative learning, was instrumental in the increase of the test scores of the students in the investigation.

In phase I test B of the study, the t-score obtained was 4.19, with a t-required to be + or - 2.021. As a result of these findings we must again reject the null hypothesis and accept the experimental hypothesis that the treatment, cooperative learning, was instrumental in the increase of the test scores of the students in the investigation.

In phase II test A of the study, the t-score obtained was 2.18, with a t-required of + or - 2.021. As a result of these findings we must reject the null hypothesis and accept the experimental hypothesis that the treatment, cooperative learning, was instrumental in the increase of the test scores of the students in the study.

In phase II test B of this study, the t-score obtained was 2.24 with the t-required to be + or - 2.021. As a result of these findings we must reject the null hypothesis and accept the experimental hypothesis that the treatment, cooperative learning, was instrumental in the increase in test scores for the students in this study.

CHAPTER VI

DISCUSSION

The results of the study indicate a relationship between cooperative learning and test performance. The relationship gives evidence for a link between the use of cooperative learning and an increase in test performance. According to the literature review of cooperative learning, positive results would have been predicted. Using independent t-tests, analysis of phase I test A and test B, and phase II test A and B resulted in a statistically significant difference at the 95% confidence level in favor of the cooperative learning treatment.

Ambiguity did exist however between phase I test B and all other tests involved. In phase I test B the mean difference between the treatment and non-treatment groups was 15 test points. In all other tests, phase I test A, phase II test A, and test B the mean differences were 5.44, 4.81, and 5.8 respectivly. What accounted for this difference is unknown. The differences were found to be statistically significant in every test however, which left little doubt that it could have been due to chance.

Educationally, the difference between the treatment and non treatment groups may not have a great bearing on final grades received by the students, as the tests themselves only accounted for approximately 35% of the final grade.

If cooperative learning would have been used throughout the semester for all grades and the variation were still to exist, the final grade of the student may have increased half a letter grade between the treatment group and non treatment groups as seen by the five point difference. A greater degree of change would have been experienced had the 15 point difference existed throughout the semester between the treatment and non treatment groups.

There are different types of cooperative learning; the jigsaw method, teams games tournament and any other group learning activity which is used to promote student academic performance. Teachers attempting to use cooperative learning need to experiment with the different methods to find which best suits their individual teaching style and to control for the variables unique to their classroom.

The strategies and materials for use in implementing cooperative learning in the classroom are readily available. Researchers such as Johnson and Johnson invite teachers to write to them to obtain the materials necessary to start a cooperative learning program. Johnson and Johnson also encourage the sharing of results of cooperative learning studies.

Cooperative learning may involve more work on the part of the teacher, but the rewards out-weigh the extra time necessary for a well-structured, cooperative learning environment. Through the use of cooperative learning, the author of this study found that his students were more involved in class, spent more time on task, performed better on tests and seemed to enjoy class much more, as seen by the student disappointment expressed when the classroom environment was returned to a more traditional setting which included an individualized working structure.

Due to the limitations of time and data, this study can be viewed as a preliminary and not a conclusive study. For more conclusive evidence as to the effects of cooperative learning using the game technique, further studies would have to conducted which allowed for greater time and a larger sample.

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APPENDICES

APPENDIX A

PHASE I

TEST A

TREATMENT

score	frequency	score	frequency
100	1	79	3
98	1	78	2
95	2	77	2
94	3	76	1
92	2	74	1
91	1	71	1
90	2	70	4
89	1	69	2
88	2	68	1
86	2	67	1
85	1	66	1
82	3	65	1
81	2	64	1
80	2	63	1
		44	1

$\bar{X} = 79.96$ $S_{\bar{X}} = 11.36$

Table 1. a frequency distribution of test scores for the treatment group in phase I with mean and standard deviation.

PHASE I

TEST A

NON TREATMENT

score	frequency	score	frequency
98	1	74	3
96	1	73	1
94	1	72	3
90	2	70	2
88	2	69	3
87	1	68	1
86	1	65	1
84	1	64	1
82	2	61	1
81	1	53	1
80	3	51	1
79	5	42	1
77	3	38	1
76	3	37	1

$\bar{X} = 74.52$ $S_{\bar{X}} = 13.35$

Table 2. A frequency distribution of test scores for the non treatment group for phase I including mean and standard deviation.

PHASE I

TEST B

TREATMENT

score	frequency	score	frequency
94	4	74	2
92	3	72	2
90	2	68	3
88	4	66	4
86	2	64	3
84	3	62	2
82	4	60	1
80	4	58	1
78	1	54	1
75	1	52	1

$\overline{X} = 77.27$ $S_{\overline{X}} = 11.9$

Table 3. A frequency distribution chart of test scores for the treatment group for phase I test B. Included are the test score mean and standard deviation.

PHASE I

TEST B

NON TREATMENT

score	frequency	score	frequency
94	1	64	1
88	1	60	2
84	2	58	1
80	2	56	2
78	2	54	1
76	3	52	4
74	4	50	2
72	2	48	2
70	2	46	3
69	1	42	1
68	1	34	1
66	5	12	1
		10	1

$\bar{X} = 62.27 \quad S_{\bar{X}} = 17.19$

Table 4. A frequency distribution chart of the test scores for the non treatment group for phase I test B. Included are the test score mean and standard deviation.

PHASE II

TEST A

TREATMENT

score	frequency	score	frequency
95	1	73	2
93	1	72	2
91	2	71	2
90	1	70	4
87	2	69	1
86	2	68	5
85	1	67	2
84	2	66	1
83	1	63	1
82	1	58	2
80	1	56	2
78	5	55	1
76	1	53	1
75	1		

$\bar{X}$ = 74.27 $S_{\bar{X}}$ = 10.71

Table 5. A frequency distribution chart of the test scores for the treatment group for phase II test B. Included are the test score mean and standard deviation.

PHASE II

TEST A

NON TREATMENT GROUP

score	frequency	score	frequency
91	1	69	3
87	1	68	2
86	1	66	3
85	1	65	2
84	1	64	2
82	2	63	1
80	1	62	1
79	4	61	1
78	3	59	3
77	1	56	1
75	2	55	1
74	1	51	2
71	3	50	2
70	1	48	1

$\bar{X} = 69.46$ $S_{\bar{x}} = 10.9$

Table 6. A frequency distribution chart of the test scores of the non treatment group for phase II test A. Included are the test score mean and standard deviation.

PHASE II

TEST B

TREATMENT

score	frequency	score	frequency
94	1	70	5
92	2	68	4
90	2	66	2
88	1	64	3
86	3	62	1
84	2	60	1
82	2	59	1
80	3	58	2
78	4	56	1
76	2	54	1
74	3	48	1
72	1		

$\bar{X} = 71.94$ $S_{\bar{x}} = 11.99$

Table 7. A frequency distribution of the test scores of the treatment group for phase II test B. Included are the test score mean and standard deviation.

PHASE II

TEST B

NON TREATMENT

score	frequency	score	frequency
94	1	68	4
89	1	66	1
86	1	64	2
82	5	60	1
81	1	58	4
80	1	56	2
78	2	54	1
76	4	50	1
74	3	46	1
72	5	44	2
71	1	42	3
70	1		

$\bar{X} = 67.85$ $S_{\bar{X}} = 13.34$

Table 8. A frequency distribution chart of the test scores for the non treatment group for phase II test B. Included are the test score mean and standard deviation.

APPENDIX B

QUESTIONS FOR TEST ONE

Q- What is an amorphous solid?
A- A solid that will lose its shape under certain conditions

Q- What does Charles's law explain?
A- How temperature effects the volume that a gas will take up. The hotter it is, the more volume it will need.

Q- What is the difference between boiling and evaporation?
A- Evaporation only occurs at the top of a liquid. Boiling starts at the bottom

Q- Color, shape, size, density, and odor are all what kinds of properties?
A- Physical properties

Q- What are the melting and freezing points of water?
A- 0 C or 32 F. The melting point and freezing points are the same

Q- The properties that describe how a substance changes into new substances are called _____
A- Chemical properties

Q- What happens to the temperature during a phase change?
A- It stays the same.

Q- What is gravity?
A- The force of attraction between objects

Q- What are physical properties?
A- A property of a substance that can be observed

Q- What is boiling?
A- When particles of a liquid change to gas in the presence of heat.

Q- What is weight?
A- The response of mass to the pull of gravity.

Q- How is a chemical property different from a chemical change?
A- A chemical property describes the ability of a substance to change. A chemical change is the process by which the substance changes.

Q- What three phase changes involve the absorption of heat?
A- Melting, vaporization, and sublimation. Evaporation can also be used.

Q- What is sublimation?
A- A change from a solid directly into a gas.

Q- What is matter?
A- Anything that has mass and volume.

Q- What is mass?
A- The amount of matter in an object.

Q- The formula for density is _____
A- D = mass/volume

Q- Resistance to changes in motion is called _____
A- Inertia

Q- What force determines the weight of an object?
A- Gravity

Q- What is the mane given to a solid that loses its shape under certain conditions?
A- Amorphous solid

Q- Define Volume
A- An amount of space an object takes up

Q- What does Boyles law state?
A- The volume of gas changes with pressure. The more pressure, the less volume the gas takes up.

Q- How does the melting point and freezing point of water compare?
A- They are the same

Q- What is the definition of viscosity?
A- The resistance of a liquid to flow

Q- Is boiling water a physical or chemical change?
A- Physical

Q- What is a physical property of a pencil? What is a chemical property of a pencil?
A- 1. It's round or any other answer that describes what a pencil looks like.
2. Chemical property - it will burn

Q- What are the four phases of matter?
A- Solid, liquid, gas, plasma

Q- What two phase changes involve the release of heat?
A- Freezing and condensation

Q- Define volume
A- The amount of space an object takes up

Q- Which phase(s) of matter have a definite shape and volume?
A- A solid

Q- What is the phase change from a gas to a liquid called?
A- Condensation

Q- The tendency of an object to remain in motion or stay at rest unless acted upon by an outside force is called what?
A- Inertia

Q- What is a chemical reaction?
A- When a substance changes into another substance

Q- Define vaporization
A- Change from a liquid to a gas

Q- Define gravity
A- Force of attraction between all objects

Q- What kind of reaction, physical or chemical, takes place when wood is burning?
A- Chemical

Q- What are the differences between physical and chemical properties of matter?
A- The chemical properties describe the ability of a substance to change into another substance. Physical properties are those that can be observed.

Q- What is an example of a chemical property?
A- Flammability

Q- What has to be added in order for matter to change its phase?
A- Energy, usually in the form of heat.

Q- Does the density of a substance change as it goes through a phase change?
A- Yes

Q- As the temperature of a gas increases, the volume of the gas _____. Which law states this?
A- Increases; Charles's law

Q- If you heat a sealed can with a liquid in it, it will explode. Why?
A- Because as a substance is heated, it expands

Q- What would happen to a crystalline solid if it was dissolved and then brought back to a solid?
A- It would form crystals

Q- What is gravity?
A- The force of attraction between objects.

Q- Define matter
A- Anything that has mass and volume.

Q- The resistance of liquid to flow is called _____
A- Viscosity

Q- What does boiling point mean?
A- The temperature at which a substance boils.

Q- What does Charles's law refer to?
A- The volume of a certain amount of gas will change with it's temperature. The hotter it is, the more space it will need.

Q- What does condensation mean?
A- The change of a gas to a liquid.

Q- What is the difference between a physical property and a chemical property?
A- Physical properties can be observed

Q- How do physical and chemical reactions differ, as far as heat is concerned?
A- In chemical reactions, heat is always given off, in physical reactions, it is not.

Q- A change in matter from the liquid phase to the gas phase at the surface of the liquid is called _____
A- Evaporation

Q- What is the definition of freezing point?
A- The temperature at which a substance freezes

Q- What is flammability?
A- The ability of a substance to burn.

QUESTIONS FOR TEST TWO

Q- After a hypothesis has been proven true over a period of time, what can it become?
A- A theory

Q- What is the system of measurement is used by most scientists?
A- The metric system

Q- What tool is used to measure length, in the metric system?
A- A metric rule

Q- To protect glassware form an alcohol burner use _____
A- An asbestos screen

Q- An orderly, systematic approach to problem solving is called a(n)
A- Scientific method

Q- When a theory is accepted as true, a scientist may call it a _____
A- Law

Q- How many variables should an experiment have?
A- One

Q- What is the basic unit of length in the metric system?
A- A meter

Q- What tool is used to measure mass?
A- A triple beam balance

Q- If you are heating a test tube with liquid in it, where should it be pointed?
A- Away from you and others

Q- What is a proposed solution to a scientific problem called?
A- A hypothesis

Q- What is the name of the curve which liquid forms in a graduated cylinder?
A- Meniscus

Q- How is the experimental set-up different from the control set-up?
A- The experimental set-up has the variable

Q- A systematic approach to problem solving is the _____
A- Scientific method

Q- How many meters are in a kilometer?
A- 1000

Q- To find the volume of a liquid, or an irregular solid, what tool is used?
A- A graduated cylinder

Q- How do you test the odor of fumes?
A- Gently wave the fumes toward your nose

Q- In any experiment, what is the factor being tested called?
A- The variable

Q- Recorded observations, usually in the form of numbers, for example: length, time, or temp., are called what?
A- Data

Q- How many centimeters are in a meter?
A- 100

Q- What is the basic unit of volume in the metric system?
A- The liter

Q- What is the formula for the volume of a regular shaped solid?
A- $V = l \times w \times h$

Q- Is it safe to heat liquid in closed containers? Why?
A- No, because the container might explode

Q- At what temperature does water boil in the celsius scale?
A- 100 degrees

Q- What does the prefix kilo mean?
A- Times 1000

Q- How many millimeters are in a meter?
A- 1000

Q- The result of a laboratory experiment is called the what?
A- Conclusion

Q- What is the basic unit of mass in the metric system?
A- The kilogram

Q- What word is used to refer to temperature in the metric system?
A- Celsius

Q- What should you do when you are finished with an experiment?
A- Clean your work area

Q- A cubic centimeter is equal in volume to what other unit of volume?
A- A milliliter

Q- At what temperature does water freeze in the metric system?
A- 0 C

Q- How many milliliters are there in a liter?
A- 1000

Q- What is the name of the set-up that has the variable left out?
A- The control set-up

Q- How many grams are in a kilogram?
A- 1000

Q- When handling hot containers, one should use _____
A- Clamps

Q- What is density?
A- Density is the amount of mass per unit volume

Q- What a person uses his/her senses to make
A- Observations

Q- What is the first step in the scientific method?
A- Observations

Q- In a scientific set-up, what is the name of the set-up which contains the variable?
A- The experimental set-up

Q- The amount of matter in an object is called its _____
A- Mass

Q- What is larger, a milligram or a gram?
A- A gram

Q- What does the prefix centi mean?
A- 1/100

Q- What is the largest unit of length in the metric system?
A- The kilometer

Q- To find the volume of an irregular shaped object, what instrument would you use?
A- A graduated cylinder

Q- Why is it important to have a control set-up in your experiment?
A- So that if a reaction occurs in the experimental set-up, it would have been caused by the variable.

QUESTIONS FOR TEST THREE

Q- In this type of solid, the particles are arranged in a regular repeating pattern.
A- A crystalline solid

Q- What has to be added or taken away in order for a phase change to occur?
A- Heat

Q- How many milliliters are in a liter?
A- 1000

Q- What is the name of the set-up that has the variable left out?
A- The control set-up

Q- Because water is the combination of two elements, it is classified as a _____.
A- Compound

Q- What happens to the density of a substance as it goes from a solid to a gas?
A- It decreases

Q- What element has an atomic weight of 32.06?
A- Sulfur

Q- When one substance is dissolved in another it is called _____.
A- A solution

Q- Two or more elements chemically combine to form a _____.
A- Compound

Q- This is the name given to the central core of an atom.
A- Nucleus

Q- Is melting a chemical or physical change?
A- Physical

Q- What is the name of the element with an atomic number of 19?
A- Potassium

Q- How many centimeters are in a meter?
A- 100

Q- What phase of matter is the highest in energy?
A- Plasma

Q- What is the phase change from a solid directly into a gas called?
A- Sublimation

Q- At what temperature in celsius, does ice begin to melt?
A- 0 C

Q- The smallest part of an element is called _____
A- The atom

Q- If vaporization occurs at the surface of a liquid it is called _____.
A- Evaporation

Q- This is the name given to a substance that has two or mare substances mixed together, but not chemically combined.
A- A mixture

Q- What element has the chemical symbol Zn?
A- Zinc

Q- When no new products are formed, is it a chemical or physical change?
A- Physical

Q- The temperature at which water boils is its _____
A- Boiling point

Q- According to Boyle's Law, when pressure on gas increases, the volumes of the gas _____
A- Decreases

Q- What is mass?
A- The amount of matter in an object

Q- Matter is anything that has _____
A- Mass and volume

Q- How many grams are in a kilogram?
A- 1000

Q- What are atoms made up of?
A- Protons, neutrons, and electrons

Q- Matter containing only one kind of atom is called?
A- An element

Q- What is the atomic weight of the element with the atomic number of 8?
A- 15.999

Q- What is weight?
A- The response of something's mass to the pull of gravity

Q- What is the first step in the scientific method?
A- Observation

Q- What are the four classes of matter?
A- Elements, compounds, mixtures, and solutions

Q- What is inside the nucleus of an atom?
A- Protons and neutrons

Q- What is the name of the element with the atomic number of 6?
A- Carbon

Q- Is rusting a chemical or physical change?
A- Chemical

Q- As an astronaut goes into space, what happens to his/her mass?
A- Remains the same

Q- In an experiment, what is the name of the set-up that contains the variable?
A- The experimental set-up

Q- Volume is _____
A- The amount of space an object takes up

Q- What is a Homogeneous substance?
A- A substance that has the same material throughout.

Q- What is the formula for volume?
A- V = l x w x h

Q- A systematic approach to problem solving is _____
A- The scientific method

Q- How many meters are in a kilometer?
A- 1000

Q- What is the density of an object whose mass = 20g and whose volume = 2cc?
A- 10g/cc

Q- What phase of matter has a definite shape and volume?
A- A solid

Q- This type of solid will lose its shape under certain conditions
A- An amorphous solid

Q- Because of its resistance to flow, Heinz ketchup has a high _____
A- Viscosity

Q- In any experiment, this is the factor being tested
A- The variable

Q- This type of substance has different material throughout, it can be called a _____ substance
A- Heterogeneous

Q- A _____ is made of only one kind of material and has definite properties
A- Pure substance

Q- Which element has an atomic weight of 200.59?
A- Mercury

Q- Is boiling water a physical or chemical change?
A- A physical change

Q- What is the name given to the temperature at which a liquid starts to change to a solid?
A- Freezing point

Q- What is inertia?
A- The tendency of an object to remain in motion or stay at rest until acted upon by outside forces.

Q- This phase of matter has a definite volume but no definite shape.
A- A liquid

Q- This is the name given to the factor being tested in an experiment
A- The variable

Q- How does the melting point an freezing point of water compare?
A- They are the same

Q- What is the smallest particle of an element that has the properties of that element?
A- The atom

Q- This is the name given to the class of matter that cannot be broken down by ordinary chemical means.
A- An element

Q- Would chopping wood be a chemical or physical change?
A- Physical

Q- What element has an atomic weight of 196.967?
A- Gold

Q- Particles are large and can be easily separated. What class of matter has these properties?
A- A mixture

Q- Would air be homogeneous or heterogeneous?
A- Heterogeneous, it has many gases mixed together

QUESTIONS FOR TEST FOUR

Q- An atom has what kind of charge?
A- Plus and minus

Q- How do the number of different charges usually compare in an atom?
A- They are equal

Q- Neutral charge means _____
A- No charge

Q- If matter is charged, what kind of electricity would it have?
A- Static electricity

Q- A characteristic of static electricity is that it _____
A- Does not flow

Q- Electricity is _____
A- When electrons move from one place to another

Q- What are three methods of charging?
A- Friction, conduction, induction

Q- When the number of electrons are greater than protons, what kind of charge would there be?
A- A negative charge

Q- Positively charged atoms have _____
A- More protons than electrons

Q- When an object is rubbed, what happens to its electrons?
A- It loses them

Q- When an object gains or loses electrons it _____
A- Develops an electrical charge

Q- The area surrounding a charged particle is its
A- Electric field

Q- The strength of electric fields depends on _____
A- The distance between the particles

Q- What is friction?
A- The rubbing together of two objects

Q- When there is direct contact with an object, and the electrons flow from one object into another it is called _____
A- Conduction

Q- What are conductors
A- Materials that allow electric charge to flow through them

Q- What are insulators?
A- Materials that do not allow electrons to flow through them

Q- When an object acquires an electric charge through the rearrangement of its electrical charges it is called _____
A- Induction

Q- A dry cell changes chemical energy into _____
A- Electrical energy

Q- Where do electrons leave in a dry cell?
A- The minus terminal

Q- What is current electricity?
A- The flow of electrons

Q- What is the path for moving electrons called?
A- A circuit

Q- What kind of electricity do we use to light our homes?
A- Current electricity

Q- What makes up the largest portion of the inside of a dry cell?
A- Chemical paste

Q- To flow, electrons need _____
A- A complete path

Q- All matter is made up of _____
A- Atoms

Q- Atoms are made of _____
A- Protons, neutrons, and electrons

Q- Which subatomic particles have electric charges?
A- Protons and electrons

Q- An instrument used to detect electric charge is a(n)_____
A- Electroscope

Q- This can be quiet, or accompanied by a spark
A- An electric discharge

Q- This is in the form of a large static electric discharge
A- Lightning

Q- What are lightning rods?
A- Metal rods put on top of buildings to ground electricity

Q- In order for electrons to flow, they need a _____
A- Path to follow

Q- What is electric current?
A- The flow of electrons through a wire

Q- What is the unit used to measure current?
A- Amperes

Q- What is the instrument used to measure amperes?
A- An ammeter

Q- The opposition to the flow of electricity is _____
A- Resistance

Q- The symbol for resistance is _____
A- R

Q- Wires made of good conductors have _____ resistance.
A- Low

Q- What is static electricity?
A- When electrons move from one place to another and remain at rest

Q- This force pulls objects together
A- Force of attraction

Q- The force of attraction exists between _____
A- Oppositely charged particles

Q- This force pushes objects apart
A- The force of repulsion

Q- The force of repulsion exists between _____
A- Particles of the same charge

Q- Like charges _____; unlike charges _____
A- Repel; attract

Q- Why does a battery die?
A- The chemical paste dries out

Q- Where is the negative terminal on a flashlight battery?
A- On the bottom

Q- What is the abbreviation for alternating current?
A- A.C.

Q- What is the abbreviation for direct current?
A- D.C.

Q- In which current are the electrons flowing in one direction?
A- Direct current

Q- To make 100 minus charges neutral, you need _____
A- 100 plus charges

Q- Which subatomic particle has a positive charge?
A- The proton

Q- Wires made of poor conductors have _____ resistance.
A- High

Q- What law does A = V/R represent?
A- Ohm's law

Q- What is another name for a dry cell?
A- A battery

Q- What is in the central core of a battery?
A- A carbon rod

Q- What charge does the central core of a battery have?
A- A positive charge

Q- What type of circuit has one continuous path?
A- A series circuit

Q- In what type of circuit allows one light to go out while the others stay lit?
A- A parallel circuit

Q- Which subatomic particle has a negative charge?
A- An electron

Q- In a parallel circuit, each light is on a different _____
A- Branch

Q- Which subatomic particle has no charge?
A- A neutron

APPENDIX C

TEST CHAPTER ONE " EXPLORING PHYSICAL SCIENCE "

1. A systematic approach to problem solving is called

   A) Einstein's theories
   B) the scientific method
   C) experimental set-up
   D) control set-up

2. How many meters are in a kilometer?

   A) 1000
   B) 100
   C) 10
   D) 1/1000

3. To find the volume of a liquid or an irregular solid, what tool is used?

   A) a scale
   B) a triple beam
   C) a graduated cylinder
   D) a metric ruler

4. How should you test the odor of fumes?

   A) smell them directly form the container
   B) gently wave the fumes toward your nose
   C) open the lid of the container just a little and smell it
   D) put a flame near the fumes to see if they are toxic

5. In any experiment, what is the factor being tested called?

   A) the guinea pig
   B) the variable
   C) the testing factor
   D) the experimental component

6. What is the standard system of measurement used by scientists called?

   A) the English system of measurement
   B) the metric system
   C) the scientific scales system
   D) the American system

7. Recording observations, usually in the form of numbers, for example: length, time, or temperature are called?

   A) results
   B) conclusions
   C) information
   D) data

8. How many centimeters are in a meter?

   A) 10
   B) 100
   C) 1000
   D) 1/10

9. When a scientific theory has been tested many times and is accepted as true, scientists may call it a(n)

   A) law
   B) hypothesis
   C) theory
   D) conclusion

10. What is the basic unit of length in the metric system?

A) kilometer
B) foot
C) inch
D) meter

11. The scientific method

A) is an approach to problem solving that always results in a correct answer
B) is a systematic approach to problem solving
C) is used by everyone who tries to solve a problem
D) of problem solving starts with a conclusion

12. A theory is

A) developed when a scientist sees something that cannot be explained.
B) stated before any experiments can be performed.
C) what most people believe to be true
D) the most logical explanation of events that occur in nature.

13. A hypothesis is formed

A) before the problem is stated
B) before an experiment is done
C) after the conclusion is stated
D) after analysis of data

14. A conclusion may be stated

A) immediately after the problem has been identified
B) after obtaining the results of an experiment
C) only after an experiment has been run over and over again to insure accuracy
D) after several qualified scientist agree

15. A measure of volume in the metric system is the

A) liter
B) kilogram
C) meter
D) gram

16. A unit of length in the metric system is the

A) liter
B) kiloliter
C) kilometer
D) gram

17. The prefix kilo means

A) ten
B) one hundred
C) one thousand
D) one million

18. The prefix milli means

A) one-tenth
B) one-hundredth
C) one-thousandth
D) one-millionth

19. Volume is

A) a measure of mass
B) a measure of length
C) a measure of quality
D) a measure of how much space an object occupies

20. You are conducting an experiment to determine if putting an additive in gasoline will improve gas mileage. All cars are identical, and the gasoline used in each car is the same. The car used as a control contains

    A) one part gasoline and one part additive
    B) nine parts gasoline and one part additive
    C) two parts gasoline and one part additive
    D) only gasoline

21. The volume of an object measuring 10 cm in length, 5 cm in width, and 2 cm in height would be

    A) 100cm
    B) 100cm squared
    C) 100cc
    D) 1000cc

22. Density is

    A) volume per unit mass of a substance
    B) total volume of a substance
    C) mass per unit volume of a substance
    D) total mass of a substance

23. When antifreeze is added to water, the freezing point of the water

    A) remains the same
    B) is raised
    C) lowers then raises
    D) is lowered

24. In constructing a graph, the space between intervals must be

    A) in direct proportion
    B) in inverse proportion
    C) equal
    D) anyway you want

25. The curved surface of a liquid in a container is called

    A) the abscissa
    B) the meniscus
    C) the ordinate
    D) convex

26. In measuring a liquid using a graduated cylinder, read the milliliter marking at the

    A) bottom of the curved surface
    B) place where the liquid is highest
    C) at the side
    D) point you wish to use

27. When heating a test tube, with liquid in it, you should

    A) hold it straight up
    B) cork the top
    C) point it away from you and others
    D) look down it to see when it starts to boil

28. The tool used to measure the mass of an object is

    A) a graduated cylinder
    B) a triple beam
    C) a metric ruler
    D) a celsius thermometer

29. The tool used to measure the volume of an irregular shaped object is

    A) a graduated cylinder
    B) a triple beam
    C) a metric ruler
    D) a celsius thermometer

30. The tool used to measure the length of an object is

A) a graduated cylinder
B) a triple beam
C) a metric ruler
D) a celsius thermometer

31. The tool used to measure the temperature of a liquid is

A) a graduated cylinder
B) a triple beam
C) a metric ruler
D) a celsius thermometer

32. How is the experimental set-up different from the control set-up?

A) the experimental set-up has no variable
B) the experimental set-up has one variable
C) the experimental set-up has two variables
D) the control set-up has one variable

33. A hypothesis that has been tested more than once can now lead to

A) a law
B) a theory
C) a conclusion
D) a headache

34. What is the freezing point of water in the metric system?

A) 32 C
B) 32 F
C) 0 C
D) 0 F

35. What should you do when you finish an experiment?

A) leave the area set up for the next person
B) clean up the area
C) make sure you have all of your data
D) all of the above

36. A cubic centimeter is equal in volume to what other unit of volume?

A) gram
B) milligram
C) liter
D) milliliter

37. To protect glassware from an alcohol burner, use

A) only glassware with protective ends
B) an asbestos screen
C) the glassware far enough from the flame so that it doesn't touch
D) flame retardant glassware

38. How many variables should an experiment have?

A) none
B) one
C) two
D) it doesn't matter

39. What is the formula used to find the volume of a regular shaped object?

A) D = M/V
B) V = l x w x h
C) V = m x w x h
D) you need a graduated cylinder

40. At what temperature does water boil in the celsius scale?

A) 212 C
B) 100 F
C) 100 C
D) 212 F

41. When handling hot glassware, you should use

A) rubber gloves
B) a paper towel
C) clamps
D) your bare hands

TEST TWO "PROPERTIES OF MATTER"

1. Matter is anything that has

   A) mass and volume
   B) weight and specific gravity
   C) weight and gravity
   D) mass and weight

2. General properties of matter include

   A) mass
   B) volume
   C) density
   D) all of the above

3. The mass of an object

   A) remains the same
   B) varies with altitude
   C) varies with gravity
   D) changes with air pressure

4. Mass can be measured in

   A) liters
   B) grams
   C) cubic centimeters
   D) meters

5. Weight is

   A) a measure of the density of an object
   B) always equal to the mass of the object
   C) the response of mass to the pull of gravity
   D) described as the amount of matter in an object

6. The amount of space an object takes up is its

   A) density
   B) weight
   C) mass
   D) volume

7. Density is

   A) mass per unit volume
   B) weight and gravity combined
   C) volume per unit mass
   D) the total amount of matter in an object

8. The density of an object with a mass of 20g and a volume of 10cc is

   A) 2g/cc
   B) 0.5/cc
   C) 200g/cc
   D) 10g/cc

9. Some examples of physical properties are

   A) mass and weight
   B) color, shape, hardness
   C) volume and density
   D) all of the above

10. Solids have

A) a definite shape but no definite volume
B) a definite volume but no definite shape
C) a definite shape and a definite volume
D) neither a definite shape nor a definite volume

11. An amorphous solid

A) has no definite shape or volume
B) is arranged in a regular, repeating pattern called a crystal
C) has no definite volume
D) will lose its shape under certain conditions

12. Liquids have

A) a definite shape but no definite volume
B) a definite shape and a definite volume
C) a definite volume but no definite shape
D) neither a definite shape nor a definite volume

13. Viscosity is the

A) tendency of a liquid to take the shape of its container
B) resistance of an object to a change in its motion
C) tendency of a liquid to take a definite shape
D) resistance of a liquid to flow

14. What phase of matter is the highest in energy?

A) solid
B) liquid
C) gas
D) plasma

15. What is the phase change from solid directly to a gas called?

A) melting
B) sublimation
C) evaporation
D) vaporization

16. If vaporization occurs at the surface of a liquid, it is called

A) sublimation
B) evaporation
C) condensation
D) freezing

17. An example of a chemical change is

A) burning paper
B) mixing alcohol and sand
C) dissolving sugar in tea
D) melting ice

18. When a substance is undergoing a phase change

A) the temperature goes up
B) the temperature goes down
C) heat is either absorbed or given off but the temperature remains the same
D) heat is either absorbed or given off and the temperature changes

19. According to Boyles's Law, when the pressure on a gas in an enclosed container increases, the volume of the gas

A) decreases
B) increases
C) remains the same
D) explodes

20. Mass is

    A) a measure of the amount of matter in an object
    B) the response of mass to the pull of gravity
    C) a measure of specific gravity
    D) related to the pressure of the air

21. The properties that explain how a substance changes into other new substances are called

    A) nuclear properties
    B) electric properties
    C) chemical properties
    D) physical properties

22. An example of a chemical property is

    A) the ability to burn
    B) any change of phase
    C) the actual burning of a substance
    D) the size of the substance

23. Changes in which no new kinds of matter are produced are called

    A) chemical changes
    B) nuclear changes
    C) physical changes
    D) exothermic changes

24. In _____ solids, the particles are arranged in a regular, repeating pattern called a crystal.

    A) amorphous
    B) crystalline
    C) melted
    D) concrete

25. What has to be added in order for a substance to undergo a phase change?

    A) plasma
    B) heat energy
    C) matter
    D) all of the above

26. What happens to the density of a substance as it goes through a phase change? From A solid to A gas.

    A) it increases
    B) it decreases
    C) it remains the same
    D) increases then decreases

27. As the temperature of a gas increases, the volume of the gas

    A) increases
    B) decreases
    C) remains the same
    D) enters the twilight zone

28. Which law is discussed in question #27?

    A) Einstein Law
    B) Boyle's Law
    C) Law of gravity
    D) Charles' Law

29. How does the melting point and freezing point of water compare?

    A) one is 0 C and the other is 100 C
    B) they are both 100 C
    C) they are both 0 C
    D) they cannot exist at the same temperature

30. What kind of change is boiling water?

A) physical
B) chemical
C) supernatural
D) spiritual

31. What two phase changes involve the reduction of heat?

A) freezing and melting
B) freezing and sublimation
C) freezing and condensation
D) sublimation and condensation

32. The tendency of an object to remain in motion or stay at rest unless acted upon by an outside force is called

A) gravity
B) weight
C) inertia
D) lazy

33. The temperature at which a liquid turns into a solid is called

A) condensation
B) freezing
C) sublimation
D) freezing point

34. Four liquids have the following densities: A = 1.0g/mL, B = 1.2g/mL, C = .36g/mL D = .34g/mL. In what order would the liquids form layers from top to bottom if they were carefully placed in a container?

A) a,b,c,d
B) b,a,d,c
C) d,c,a,b
D) c,d,a,b

35. Which of the following have weight?

A) solids
B) liquids
C) gases
D) all of the above

36. The ability of a substance to change into another substance is a(n)

A) chemical change
B) chemical reaction
C) chemical property
D) none of the above

37. Which of the following does not belong with the other three?

A) digesting food
B) dissolving sugar
C) rusting
D) leaves changing color

38. Has a definite volume but no definite shape

A) solids
B) liquids
C) gases
D) none of the above

39. Vaporization occurring at the surface of a liquid is

A) condensation
B) evaporation
C) boiling
D) sublimation

40. The comparison, or ratio, of the mass of a substance to the mass of an equal volume of water is

A) specific gravity
B) gravity
C) density
D) inertia

41. The particles of a compound are most strongly held together when it is in the state of a

A) solid
B) liquid
C) gas
D) plasma

42. Which of the following involves only physical changes?

A) the sublimation of snow
B) digesting food
C) rusting iron
D) burning wood

43. Which of the following would cause a solid to change to a gas?

A) arranging the particles in a repeating pattern
B) increasing the attraction between the particles
C) bringing the particles closer together
D) adding heat energy to the particles

44. Has no definite volume and no definite shape

A) solid
B) liquid
C) gas
D) none of the above

45. An orderly, systematic approach to problem solving is a(n)

A) experiment
B) conclusion
C) scientific method
D) dimensional analysis

46. In any experiment the factor being tested is the

A) data
B) control
C) hypothesis
D) variable

47. A graduated cylinder is calibrated in

A) milliliters
B) liters
C) grams
D) degrees celsius

48. Each side of a regular solid is 5 cm long. What is the volume of the solid?

A) 100g/cc
B) 150g/cc
C) 125g/cc
D) 25g/cc

49. What happens to the volume of water when it freezes?

A) it increases
B) it decreases
C) it remains the same

50. Inertia is dependent on the objects

A) viscosity
B) mass
C) phase
D) size

TEST THREE " THE DIVERSITY OF MATTER "

1. What are the four classes of matter?

   A) elements, compounds, solutions, and pure substances
   B) elements, solutions, pure substances, and mixtures
   C) pure substances, mixtures, solutions, and compounds
   D) elements, compounds, solutions, and mixtures

2. A substance which has the same material throughout is a(n)

   A) homogeneous substance
   B) heterogeneous substance
   C) both of the above
   D) none of the above

3. A substance which has different material throughout is a(n)

   A) homogeneous substance
   B) heterogeneous substance
   C) both of the above
   D) none of the above

4. Two or more elements chemically combine to form

   A) mixtures
   B) compounds
   C) solutions
   D) pure substances

5. Two or substances mixed together, but not chemically combined form a

   A) mixture
   B) compound
   C) solution
   D) pure substance

6. When one substance dissolves in another it is called a

   A) mixture
   B) compound
   C) solution
   D) pure substance

7. A _____ is made of only one kind of material and has definite properties.

   A) mixture
   B) compound
   C) solution
   D) pure substance

8. What is the smallest particle of an element that has the properties of the element?

   A) an atom
   B) a neutron
   C) a proton
   D) an electron

Identify each of the following below as either
A - mixture, B - solution, C - compound, D - suspension,
E - element.

9. Cannot be broken down into anything else.

10. Particles can't be filtered out.

11. Combinations of two or more substances not chemically combined.

12. Are homogeneous mixtures.

13. Similar to solutions, but particles can be seen.

14. All substances are made from these.

15. Formed when one substance dissolves in another.

16. You cannot see the individual particles.

17. If left undisturbed, all particles will finally settle to the bottom.

18. Substances can be separated by physical means.

19. Are made of atoms.

20. Each has its own symbol.

21. Contains solvents and solutes.

22. Can be separated by sifting or filtering.

23. Can be classified as either metal or nonmetal.

24. You cannot see clearly through this.

25. A combination of two or more elements.

26. The smallest part of this is a molecule.

27. Particles do not lose their physical characteristics.

28. These are represented by chemical formulas.

29. These are found on the periodic table.

30. This one is not one of the four classes of matter.

Identify each of the following below as either A - mixture, B - solution, C - compound, D - suspension, or E - element.

31. Water

32. Muddy water

33. Air

34. H_2SO_4

35. Helium

36. Mixed nuts

37. Salt water

38. 14 carat gold

39. Alloys

40. Sand

Identify each of the following below as either A - physical change, or B - chemical change.

41. chopping wood

42. burning paper

43. melting

44. iron rusting

45. no new products formed

46. water boiling

47. silver tarnishing

48. leaves changing color

49. condensation

50. sublimation

51. The substance that is dissolved in a solution is the

A) solvent
B) solute
C) aqueous solution

52. The substance which does the dissolving is the

A) solvent
B) solute
C) aqueous solution
D) all of the above

53. If something is soluble, it can

A) self distruct
B) be sold
C) dissolve something
D) be dissolved

54. When a solvent is holding all of the solute that it can, it is said to be

A) happy
B) a glutton
C) saturated
D) unsaturated

55. The most widely abundant solvent that we know of is

A) acid
B) milk
C) gasoline
D) water

56. An unsaturated solution would be able to hold

A) more solvent
B) less solvent
C) more solute
D) less solute

57. All of the following will increase the rate of dissolving except

A) crushing the solid into a powder first
B) increasing the temperature of the solvent
C) stirring or shaking the mixture
D) adding cold water

58. In order to separate the substances in a solution, you should

A) sift and filter the solution
B) heat the solution until is evaporates
C) remove the substances by hand
D) click your heels together 3 times and wish

59. Solutions can be

A) liquid
B) gaseous
C) solids
D) all of the above

60. Atoms are made up of

A) protons only
B) protons and neutrons only
C) protons and electrons only
D) protons, neutrons, and electrons

61. The center of an atom is called the

A) nucleus
B) neutron
C) electron shell
D) electron

62. A nucleus has

A) protons only
B) protons and electrons
C) protons and neutrons
D) protons, neutrons, and electrons

63. What is the formula used to find the volume of a regular solid?

A) D = M/V
B) V = l x w x h
C) V = m x w x h
D) need a graduated cylinder

64. At what temperature does water boil in the celsius scale?

A) 212 C
B) 100 F
C) 212 C
D) 100 C

65. How is the experimental set-up different from the control set-up?

A) the experimental set-up has no variables
B) the experimental set-up has one variable
C) the experimental set-up has two variables
D) the control set-up has one variable

TEST FOUR " ELECTRICITY EXAM "

1. An atom has what kind of charge?

   A) no charge
   B) minus charge
   C) positive

2. How do the number of different charges usually compare in an atom?

   A) there are more negative than positive charge
   B) there are more positive than negative charges
   C) the negative and positive charges are equal

3. If something has a neutral charge, it has

   A) no charge
   B) a plus charge
   C) a minus charge
   D) the + and - are not equal

4. If matter is charged, what kind of electricity would it have?

   A) current electricity
   B) flowing electricity
   C) static electricity
   D) matter cannot be charged

5. To make 100 plus charges neutral, you need

   A) 50 plus and 50 minus charges
   B) 100 minus and 50 plus charges
   C) 100 plus charges
   D) 100 plus charges

6. Objects of the same charge _____; while objects of different charges _____

A) attract; repel
B) repel; attract
C) repel;repel
D) attract; attract

7. A dry cell changes chemical energy into

A) positive energy
B) static electricity
C) electric energy
D) light

8. In a dry cell, where do electrons leave?

A) the plus terminal
B) the minus terminal
C) both terminals
D) neither terminals

9. Current electricity is

A) the flow of electricity
B) the path of electricity
C) a type of circuit
D) has high resistance

10. A path for moving electrons is

A) an electroscope
B) a battery
C) a wire
D) a circuit

11. What is inside of a battery that allows electrons to flow?

A) a carbon rod
B) zinc
C) chemical paste
D) all of the above

12. To flow, electrons need

    A) wire
    B) insulators
    C) a complete path
    D) resistance

13. All matter is made of

    A) atoms
    B) carbon
    C) organic substances
    D) none of the above

14. Atoms are made of

    A) protons neutrons
    B) protons and electrons
    C) protons, neutrons, and electrons
    D) neutrons, and electrons

15. Which subatomic particles have electric charges?

    A) protons and negatrons
    B) neutrons and protons
    C) protons neutrons
    D) protons and electrons

16. An instrument used to detect electric charge

    A) an electrostatic generator
    B) a lightning rod
    C) an ammeter
    D) an electroscope

17. Can be quiet or can be accompanied by a spark

    A) an electric discharge
    B) lightning
    C) alternating current
    D) direct current

18. Metal rods put on the top of building to ground electricity are

    A) useless if made of aluminum
    B) best if made of ceramic
    C) useless no matter what they are made of
    D) used to protect against lightning

19. Methods of charging include

    A) friction and conduction
    B) electrical discharge
    C) induction
    D) A and C

20. When electrons move from one place to another and remain at rest, it is

    A) an electric current
    B) current electricity
    C) an electron couch potato
    D) static electricity

21. Wires made of poor conductors

    A) are used in houses
    B) have high resistance
    C) have low resistance
    D) aren't used at all

22. An insulator is

    A) a poor conductor
    B) a good conductor
    C) usually a metal
    D) none of the above

23. What charge does the central core of a battery have?

    A) positive
    B) negative
    C) neutral
    D) mastercard

24. Electricity is

A) created by nuclear fission only
B) when electrons become positively charged
C) when electrons lose their charge
D) when electrons move from one place to another

25. The unit used to measure current is

A) Ohms
B) volts
C) amps
D) watts

26. The instrument used to measure amperes

A) an electroscope
B) an ammeter
C) an ampmeter
D) a voltmeter

27. The opposition to the flow of electricity

A) repulsion
B) resistance
C) amperes
D) induction

28. The symbol for resistance is

A) R
B) I
C) V
D) S

29. This force pulls objects together

A) repulsion
B) force of attraction
C) force of like charges
D) conduction

30. The force of repulsion exists between

A) oppositely charged particles
B) particles of similar charge
C) it does not exist at all
D) students and homework

31. The force of attraction exist between

A) oppositely charged particles
B) particles of similar charge
C) it does not exist
D) students and school lunch

32. When there is a greater number of electrons than protons, the particle has

A) a neutral charge
B) a positive charge
C) a negative charge
D) a nervous disorder

33. The strength of electron fields depend primarily on

A) the number of protons
B) how many electrons it loses
C) its electric field
D) the distance between the particles

34. The area surrounding a charged particle is

A) it turf
B) its electric current
C) its electric field
D) its aura

35. When an object gains or loses electrons it

A) gains or loses protons as well
B) cannot lose electrons
C) develops an electric charge
D) looks in the lost and found

36. Positively charged atoms have

A) more electrons than protons
B) fewer protons than neutrons
C) more protons than electrons
D) no protons and no electrons

37. Friction

A) is caused by the rubbing together of objects
B) produces heat
C) can cause a static electric charge
D) all of the above

38. Materials that allow electric charge to flow through them are

A) insulators
B) transformers
C) conductors
D) none of the above

39. When an object acquires an electric charge by the rearrangement of its electrical charges, it is by

A) conduction
B) induction
C) friction
D) luck

40. Why does a battery die?

A) its terminals burn out
B) it explodes
C) the chemical paste dries
D) heat burns it out

41. Where is the negative terminal on a flashlight battery?

A) at the top
B) on the bottom
C) on the side
D) there isn't one

42. Alternating current is

A) abbreviated as AC
B) when the electrons move forward and back very rapidly
C) use in most homes
D) all of the above

43. A closed path for electrons to follow is

A) an electric circuit
B) necessary for electricity to flow
C) usually in a series or parallel set up
D) all of the above

44. What circuit has one continuous path?

A) a parallel circuit
B) a series circuit
C) an open circuit
D) none of the above

45. If one light goes out, the others stay lit in

A) parallel circuit
B) a series circuit
C) an open circuit
D) none of the above

46. A disadvantage of a parallel circuit is

A) if one light goes out, they all do
B) it takes much more equipment to set up
C) switches cannot be added
D) lights receive different amount of energy

47. In which current are the electrons flowing in one direction?

A) series
B) parallel
C) direct
D) alternating

48. If an object gains electrons, it will have a

A) negative charge
B) positive charge
C) neutral charge
D) none of the above

49. What is voltage?

A) the amount of electricity flowing in a circuit
B) the number of electrons passing a point in one second
C) a unit of resistance
D) measure of electricity available to move electrons

50. What is the density of an object whose mass is 45g, its height is 10cm, width is 5cm, and volume is 5cc?

A) 10g/cc
B) 3g/cc
C) 9g/cc
D) 5g/cc