A study of games in senior high school mathematics classes

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A STUDY OF GAMES IN SENIOR HIGH SCHOOL
MATHEMATICS CLASSES

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DEDICATION

To my wife Geraldine, whose inspiration and courage have been a real asset to me.
ABSTRACT

A STUDY OF GAMES IN SENIOR HIGH SCHOOL
MATHEMATICS CLASSES

Purpose

The purpose of this study was to determine the significance of recreational games in the senior high school mathematics classes and how they can be used as instructional devices or aids in a teaching-learning situation. The researcher was interested in achieving two specific purposes:

1. Collecting mathematical games that will motivate, stimulate, and arouse the interests of the math students at R. E. Lee Institute in Thomaston, Georgia.
2. To determine the effectiveness of the mathematical games in the classroom at R. E. Lee Institute.

Method and Procedures

The subjects were fifty senior high school students. In both classes, the games and recreational activities were used as instructional aids. The subjects were exposed to the games as an aid during the class period. Competition was placed in high esteem.
Results

A student-opinion questionnaire was administered and scored according to the following levels of agreement: strong level of agreement; moderate level of agreement; and disagreement. Over 70 percent of the subjects highly agreed that the construction of the various manipulatives enhanced their interest level in the mathematics class. There was 25 percent of the subjects who responded with a moderate level of agreement. Four (4) percent responded with a level of disagreement.

There were five questions that were related to the implementation of the mathematical games and recreational activities in the classroom. To these questions, over 65 percent of the subjects responded with a strong level of agreement. There was over 33 percent who responded with a moderate level of agreement. Only 1 percent of the subjects disagreed.

Conclusion

The findings in this study led to the following conclusions:

1. There is an observable change in student interest in mathematics after the implementation of mathematical games and recreational activities.

2. Reactions of the subjects demonstrated that mathematical games and recreational activities are efficient instructional tools, are fun, remove pressure, encourage peer
teaching and are nonthreatening evaluation of learning.

3. The results of this study suggest that with more time spent with the subjects, the use of games and recreational activities would prove to be even more successful at motivating, stimulating, and arousing student-interest in mathematics.

Recommendations

On the basis of the findings of this study, the writer made the following recommendations:

1. Putting a halt to dull and dreary mathematics classes should be a major educational goal for the mathematics teacher.

2. Mathematics teachers should continue to use whatever methods that are necessary to turn their students on (educationally).

3. Mathophobia during this era of Neo-Progressive education can be obliterated if all parties concerned would lend a helping hand (principals, department supervisors, teachers, students, and parents).
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CHAPTER I

INTRODUCTION

Rationale

Contemporary modes of living and educational trends have caused a need for a mathematical educational environment that would jolt former mathematicians right out of their wits. Lack of attention and motivation have been and presently are continuous problems within the mathematics classes. However, there is a brighter side to mathematics which has convinced many educators that the subject can be projected differently. This enlightenment has maneuvered its way into the classroom via games and recreational activities. This has impelled the writer to research pertinent sources in order to collect and develop some games and recreational activities and to determine ways that they can be implemented in a high school mathematics classroom situation.

Is it feasible to determine which games or recreational activities will sufficiently meet the demanding task of grasping and holding the attention of the daydreamer and so-called slow learner while simultaneously serving as reinforcement mechanisms for the students who are able to cope with the ego-
threatening atmosphere? Before an attempt is made to answer that question, an educator will have to assess one's own teaching situation and establish a clear concept of mathematics. The writer believes as C. H. McDowell, that:

Mathematics (Abstract) deals with pure figures, order form, or extent regardless of any material or other content.

Mathematics (Applied) is using abstract mathematics with its forms, extents and orders together with observations of things connected with human life or experience.

In support of these statements, the writer reviewed some literature on the construction and usage of games and recreational activities in senior high school mathematics classes that are exemplary of abstract and applied mathematics.

Sources of Games

Carefully selected games can help students win at mathematics. Mathematics games and recreational activities are generally collected from three main sources: teacher-made, student-made, and commercial-made.

Teacher-made games are constructed by the instructor. They are designed to motivate and stimulate the learner in mastering basic facts and acquiring skills already introduced. In addition, the use of teacher-made games is one of many effective ways to initiate individualization in the mathematics

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classroom or to increase the degree of individualization.

Student-made games are also used. Realizing the talents and abilities of senior high school students, it becomes a challenge to invite these students to demonstrate their creative imaginations by designing mathematical games that will provide enrichment for the learner and help span the gap between mathematics and its applications. These games can be used as a means of evaluating the mastery of the topic involved. Most students are intrigued by mathematical games and puzzles and are willing to spend a considerable amount of time on them. The resulting learning experiences can be both challenging and entertaining. Construction of games contribute to a student's enjoyment of mathematics because they are fun.

Commercial games are games which are specifically for teaching, and are available for a variety of subjects. Commercially made games on the senior high school level such as Equations, Euclid, and Tuf are among the few games available to reinforce basic facts and skills in geometry, intermediate algebra, trigonometry, and analysis. It is necessary, therefore, to design new materials.²

²Sisters John Frances Gilman, D. C., Joan Rowe, D. C. and Mary Frances Hildenberger, D. C., "Games in Senior High Math Classes," The Mathematics Teacher, 69, No. 8, (December 1976), 657.
Evolution of the Problem

The need for a new approach to mathematics education has undoubtedly evolved out of a time when the mathematics' classroom atmosphere was teacher-centered. The students were fed information like human computers. This type of rote arithmetic is a tedious and difficult branch of mathematics and has proven to be a poor starting point for most students. The next step in the process was that of weeding out the human computers from the low achievers and non-achievers. Therefore, with the former poor instructional method, one can nearly always plot a bell shaped curve as far as mathematical achievement is concerned.

Most people dislike—or fear—mathematics. Somehow a vast majority of the population has come to believe that mathematics must be difficult, unpleasant, and mysterious. Even people who are good at mathematics and use it every day are comfortable only to a point. Jerrold Zacharias, noted physicist and educator, calls the problem "mathophobia": a fear of mathematics.³

What caused this mathophobia? The answer to this question dwells within the walls of many wooden and brick structures called schools. Many instructors in conventional curriculums believe that mathematics is an exact science and there is only one right answer to a problem. This philosophy often left the students feeling uneasy and unsure of themselves. These instructors have not given serious thought

³Mitchell Lazarus, "Rx for Mathophobia", The Education Digest, 21, (November 1975), 7.
to the steps or procedures the student uses to arrive at an answer whether it is right or wrong. The emphasis should not always be put on the correct answer. More consideration can be given to the child for what he does.

Many adults say they liked mathematics "until we did so-and-so in school"—until they were exposed to some topic that seemed particularly difficult. But did the enjoyment of mathematics ever return after the hard topic was past? Almost never. The dislike is usually irreversible.4

This aversion is likely to be found in most mathematics curriculums today. This, of course, is tragic because students are dependent upon the skills taught in previous grades—like a climber depends upon the steps of a ladder—in order to ascend it successfully. Therefore, one can generally conclude that trouble in any year of mathematics, for any reason, is nearly certain to spell trouble in the following years.

Another factor that has caused people to develop mathophobia is the frequent lack of any meaningful connection between the mathematics that they are taught and its relationship to their personal lives. The mathematics that they do learn is almost forgotten when they leave school and enter society.

Perhaps, the most valid element of having a dislike for mathematics stems from the students' acceptability of their parents' attitudes about the subject. Hence, negativism begets negativism. For example, many parents seem unconcerned about

4Ibid.
their children's failure in mathematics simply because they themselves were never good at the subject. Therefore, the children are most definitely going to sense this feeling and react accordingly.

The writer has concluded that a loss of interest in mathematics is a waste both to the individual and to society. With this conglomeration of problems in mind, the writer reiterates that there is a dire need for a change in the mathematics classroom. It needs to come alive with diversions and excitement. Consequently, there is definitely a place for instructional games and activities in the mathematics classes in the senior high school.

The Purpose of the Study

The purpose of this study was to determine the significance of recreational games in the senior high school mathematics classes and how they could be used as instructional devices or aids in a teaching-learning situation. The researcher was interested in achieving two specific purposes:

1. Collecting mathematical games that will motivate, stimulate, and arouse the interests of the math students at R. E. Lee Institute in Thomaston, Georgia.

2. To determine the effectiveness of the mathematical games in the classroom at R. E. Lee Institute.
Limitations

Some limitations of this research study were:

1. Absenteeism. Many of the uninterested and unmotivated are the students who are frequently absent from school.
2. The students were not randomly selected. Therefore, the findings were only applicable to the students in the writer's mathematics class at R. E. Lee Institute.

Definition of Terms

The significant terms as they related to this study are as follows:

1. Mathophobia - A fear of mathematics.5
2. Reinforcement games - Games that are designed to assist learning of basic facts and acquiring skills in applying concepts already introduced.6
3. Instructional devices - A variety of games and materials used to improve learning and instruction in the classroom.7
4. Learning - Changes in behavior due to experience; knowledge or skill acquired by instruction or study.8
5. Teacher-made games - Games that are designed by the classroom teacher to help the students to achieve a workable knowledge and provide enrichment for the learner. They serve as a means of evaluating the mastery of specific skills.9

5Ibid.
6Ibid., The Mathematics Teacher, 69, 657.
8Webster's Seventh New Collegiate Dictionary, (1965).
9Ibid., The Mathematics Teacher, 69, 657.
6. **Motivation** - The presentation of content intended to promote student involvement in learning.¹⁰

7. **Student-made games** - Games that are constructed by the ninth, tenth, eleventh, and twelfth-year students.¹¹

8. **Attention** - The act or state of attending especially through applying the mind to an object of sense or thought.¹²

9. **Educational game** - A learning alternative requiring manipulation of knowledge and concrete objects to reinforce or extend a previously taught concept or skill.¹³

10. **Individualized Instruction** - All those activities and processes involved in the actual implementation of the individual curriculum. Specifically, it means providing content and processes at the appropriate times for students, either through teacher prescription or student choice.¹⁴

11. **Effectiveness** - Student responses on the questionnaire and grades on test scores.

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¹⁰Ibid., *Instructional Aids in Mathematics*, p. 110.

¹¹Ibid., *The Mathematics Teacher*, 69, 660.

¹²Ibid., *Webster's Seventh New Collegiate Dictionary*.


¹⁴Ibid., p. 3.
CHAPTER II

REVIEW OF RELATED LITERATURE

Although secondary school students share similar age ranges, there remains a greater range of individual differences. The individual's daily habits were developed in his past, but continue to determine the trend of his present behavior. The wise teacher makes use of these behavior influences in order to implement the proper teaching technique that will reach each student. Ernest O. Melby writes:

It is common for teachers to deplore the lack of motivation for school learning shown by many pupils, but many such teachers do not realize that they are themselves daily contributing to this lack of motivation by doing things that darken the self-image of their pupils.¹


The History of Mathematical Devices in the Senior High School Mathematics Classes

Early in this century, mathematics was taught to meet the religious and commercial needs of the time. This utilitarian focus has never quite disappeared from the mathematics classrooms. During these early years, textbooks were composed of sums and rules. Educators placed much emphasis on
rote memorization of facts. Little or no attempts were made to explain the rules or show any relationships among the procedures that were used. These textbooks became the format for future textbooks in the senior high school mathematics classes.

During the nineteenth century, Pestalozzi, a Swiss educator, made lasting contributions to the development of the mathematics classroom. This educator believed that students should be introduced to mathematical symbols and processes in a concrete fashion. He placed great emphasis upon objects and pictures to help motivate students to understand fundamental ideas before drill was undertaken. This philosophy led many educators to believe that the foundation of all knowledge was to sense the impressions of the learners.

The Child Study Movement of the 1920's researched the mathematics classroom environment in terms of what was conceived to be the needs and interests of students. The mathematics classes were integrated with instructional devices, incidental learning, and mathematical games and puzzles that became the Progressive Education Movement of this era. This movement made a vital contribution to all educators by calling attention to the motivations of the learners.²

The underlying philosophy of instruction of mathematics is to use mathematical games as a structured segment of the cultural heritage rather than as a tool kit of rules,

formulas, and assorted avenues of symbols.

Education via mathematical games is not a new idea, but it seems to be increasing in popularity. Through the evolution of time, patterns of mathematical games have been developed to make basic understanding, as well as significant manipulation, a fundamental responsibility of all levels of instruction.

As educators began to focus upon the structures of mathematics, new instructional techniques were being developed by researchers across the country. Many of the new instructional trends had to do with the teaching of mathematics in a senior high school. Through research, educators have developed devices which are designed to help meet the needs of students in the senior high school mathematics classes.\(^3\)

The successful orbiting of Sputnik by the Soviet Union was responsible for the development of new instructional devices in both the elementary and secondary school.\(^4\) The National Science Foundation as well as a number of private foundations made available millions of dollars to schools and educators to create modern instructional devices in order to motivate and stimulate the student's desire for an understanding of mathematics.

During the decade beginning with 1958, there were rapid

\(^3\)Ibid., p. 2.

and radical changes in the senior high school mathematics classrooms which educators have described as a revolution in mathematics. The meetings of the National Council of Teachers of Mathematics and the Association of Science and Mathematics Teachers drew large numbers of senior high school mathematics educators eager to learn the new instructional methods and how to teach the new concepts.

Many educators were unhappy with these new instructional methods because they had difficulty learning how to incorporate them into the mathematics classrooms and were frustrated by the emphasis on abstract mathematics that was wholly unrelated to everyday life. Nevertheless, as time passed, mathematics teachers, through in-service and pre-service programs, successfully gained enough knowledge of the new instructional techniques and mathematical devices in order to make their mathematics classes come alive. Since the inception of these new mathematical ideas and techniques, mathematics teachers have endeavored to make meaningful changes in mathematics classes.

**Why Games Are Used As Instructional Devices**

Whenever a student's desire for attention, recognition and peer status results in acts of misbehavior, the teacher must immediately take actions to resolve these problems. Mere disciplinary punishment will not be effective, because it only serves as a means of destroying any indication of rapport that
has already been established between the teacher and student. What alternative should the teacher resort to?

The writer prescribes as Robert F. Biehler, that:

You can minimize this sort of behavior by offering "legal" opportunities for gaining attention and satisfaction. Have the child compete against himself. Try to "dignify" all achievements by stressing improvement."

For example, an educator should present opportunities in which the student can try to surpass his own record. The educator should also present opportunities that will thrust the student into peer competition. These opportunities can best be stressed through the use of instructional games and recreational activities in the classroom.

Games and recreational activities can make a valuable contribution to a mathematical program. According to one writer, they can be used to:

1. Add interest to practice periods
2. Teach mathematical vocabulary
3. Teach mathematical ideas
4. Help students develop effective study habits
5. Provide motivation when beginning a new topic
6. Provide for individual differences
7. Promote the development of a positive attitude toward mathematics
8. Help students develop intuition in solving problems

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9. Give students an opportunity to exercise imagination
10. Summarize or review a unit.

Exposure to games and recreational activities should ordinarily be for brief periods.

Another writer, Muriel Schoenbrun Karlin, supports the prior statements with these words:

There are so many reasons for you to use games in your classroom— but we'll list only a few. First of all, they are excellent motivation. Children love them, and even recalcitrant learners will come to class to play. Secondly, there are games which are excellent teaching devices, and others which are good for reinforcing learning. Thirdly, games can be used to develop creativity and to produce critical thinking. The beautiful thing about games is that the children learn without even realizing they are learning.

Motivation: An Expressway to Learning Mathematics

The plight of the slow learner has long been recognized by mathematics educators. Unfortunately, however, for a variety of reasons, very little effort has been made on a national scale to cope with the problem of providing a sound mathematical education for these students.

The need to provide a meaningful mathematical environment for the low achiever is no longer debatable and is generally accepted by all leading groups. This research takes cognizance of the basic characteristics

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The slow learner, low achiever, and gifted can learn mathematics. Some just learn at a slower rate of speed than others. One key to adequate learning is proper motivation. The main purpose of instructional games is to actively involve each student.

Motivation is the very heart of the learning process. Adequate motivation not only sets in motion the activity which results in learning, but also sustains and directs it. Reflection, interest, effort, all the outcomes most desired by the teacher and most valuable to the pupil, spring into being with adequate motivation.\footnote{John J. Ryan, Educational Psychology, "The Learning Process," (New York: Barnes and Noble Books, 1970), p. 84.}

Mathematics teachers can trigger intrinsic motivation by making the subject matter meaningful to the learner. "Meaningfulness is defined in terms of the relationship between new learning and existing cognitive structure."\footnote{Guy R. Lefrancois, Psychology for Teaching, (Belmont, California: Wadsworth Publishing Company, Inc., 1975) p. 130.}

With intrinsic motivation, the interest is within the activity and this captivation binds the student to his work. The writer believes that the most logical way to achieve intrinsic motivation in the mathematics classroom is through the use of games designed to project purposeful activity.

Extrinsic motivation, however, is called by this name
because it is external to the learning activity itself; it is not in any sense artificial; it must be built upon the foundation of some existing natural response or tendency; it must be intrinsic to the nature of the individual. Psychology has always recognized the existence of such drives as mastery or dominance, emulation or rivalry, desire for social approval, curiosity, and construction.\(^{11}\)

The mathematics teacher can easily implement games and recreational activities within the classroom that would cause these drives or tendencies to blossom. According to Frances Flournoy, the effective teacher of arithmetic seeks to use instructional procedures which aid the learner in gaining an understanding of basic ideas, laws, or principles of elementary mathematics, in developing proficiency in various skills and applications in accordance with ability; in developing intellectual curiosity, a discovery attitude, orderly thought, and creativity and flexibility in thinking; in gaining ability to analyze, to make judgements, and to generalize; and in developing a taste and an inclination for the subject and an appreciation of its role in our society.\(^{12}\) Although Flournoy's statements referred to elementary school students, the writer believes that they can be applied equally as well to secondary school students.

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\(^{11}\)John. J. Ryan, p. 85

Apparently, there are no simple solutions to the problem of motivating students to learn mathematics. However, the mathematics teacher who believes that the problem can be attacked and eradicated, will not hesitate to implement instructional aids for the primary purpose of promoting motivation.

**Fostering Interest in the Mathematics Classroom**

The most persistent of all motivational forces is that of personal interest. It is non-predictable and is both transitory and persistent. Because individual interests are so unpredictable, the total spectrum of activities undertaken may or may not stimulate or create an interest. Or conversely, to provide special times for all students to do individual mathematical activities may be as non-productive as to provide no time. These recreational activities of interest must be under the direction of an interested educator. They should be related to the motivation levels of the students involved. To spark the interest of every child involved, the mathematics teacher should keep in mind the growth patterns, emotional, physical, intellectual, and social aspects of the individual. In other words, the abilities, needs and interests of students must be considered in the design of the total mathematical learning environment.

Mathematical puzzles and curiosities should be viewed by educators and students as interesting activities. Puzzles
and curiosities are often useful to educators in maintaining student interest in mathematics classes and in some instances, averting potential discipline problems. Some problems or mathematical activities, such as the fallacies, emphasize mathematical principles. Still others are mainly exercises in logical thinking. The presentation of recreational activities may emphasize basic content and also provide students with a stimulating break from routine classroom activities.¹³

Students are often stimulated by mathematical contests that pit them against the educator or other peers in non-threatening situations and in a context in which they perceive they have a competitive position.

Student interest can be captured and learning facilitated when instructional devices are used in conjunction with an educator's presentations.¹⁴ These include such devices as the chalkboard and multicolor chalk, overhead and opaque projectors, geoboards, models, multibase blocks, and mathematical games and puzzles.

These devices must be used judiciously if they are to have sustaining impacts on students. In deciding whether to use instructional devices, mathematics teachers should consider two basic questions. Does it appear likely that they will help


¹⁴ Ibid., pp. 400-401.
students attain the desired objectives? Does their use represent an improvement over what the mathematics teacher might ordinarily do without the instructional devices? The mathematics teacher who decides to incorporate mathematical devices into the classroom should adhere to specific guidelines. All instructional devices to be used in a mathematics classroom should be reviewed before they are used. Secondly, the mathematics teacher is to indicate to the mathematics class the purpose for the activity.

Attention: A Link to Mastering Mathematics

Before an educator can ever dream of achieving motivation and interest in the classroom, he must first be able to captivate and hold the attention of the students.

The problem of student inattention weighs very heavily upon the learning situation. However, Albert A. Branca, states: "Strangely enough, the behavior that we call inattention in our everyday speech is really an extreme form of attention." When a teacher complains that a pupil is inattentive, it simply means that the pupil is focusing upon stimuli other than those the teacher wants him to attend. Therefore, the mathematics teacher who attends and adheres to the words of Branca will find himself presenting lessons in a manner that will sufficiently compete with other stimuli in the student's

environment.

These attention-getters must possess one or more of the following qualities or characteristics: size, intensity, movement, repetition, duration and/or contrast. The mathematics teacher needs to remember that the effectiveness of an instructional aid as a stimulus is the result of many factors or conditions working together.

Comprehension As a Goal In Mathematics

Everyone needs objectives to facilitate the attainment of desired goals. Through careful researching and organizing of this study, the educator has made several decisions regarding the expectations of outcomes from the use of the mathematical devices and how these expectations can best be accomplished. In addition, true growth in manipulating the mathematical devices means increasing understanding of the principles of mathematics, and also increasing facility in using them.

When plans are carefully constructed, the mathematics teacher is likely to accomplish established goals. These organized plans give the mathematics teacher a better opportunity to help students understand the structure and utility of mathematics and to see how various concepts,

principles, and skills are related.

One advantage the mathematics teacher can derive from well-planned mathematical activities is better projection as an organized and concerned leader interested in the development and progress of students. Students are apt to respect an educator who projects stability, knowledge of subject, and concern.

Ideally, mathematics teachers hope that students will master all the content in a given mathematical situation. This goal is seldom realized, however, and mathematics teachers must judge what content to emphasize. Students realize that they cannot master all the content and they, too, must judge what to emphasize in their mathematical surroundings. Unlike the mathematics teacher who bases judgment on experience and a broad knowledge of mathematics, students usually cast their lot in accordance with what they perceive the teacher feels is important. Because students are generally perceptive and educators generally construct tests that fairly well reflect what they have emphasized in the mathematics classroom, educators' judgments and students' guesses are not totally incongruous. Therefore, it makes sense to indicate to students their responsibilities in relation to the content being studied with objectives carefully organized by the mathematics teacher through his own professional judgments based on his experience and education. With these ideas and thoughts in mind, the mathematics teacher feels that desirable comprehension,
attitudes of interest, and a desire to develop new understanding has been accomplished through the use of mathematical devices in the mathematics classes.

**Creativity and Reinforcement**

Creativity is that type of work which provides the student with varied, interesting, and worth-while activities by participating in which he grows in the acquisition of certain desirable learnings. The writer defines desirable learnings as being those knowledges, skills, abilities and appreciations that will enable the student to adjust himself to present and future environments. These learnings are social, emotional and physical, as well as mental.16

The educator believes that creativity gives better opportunities for the development of the total personality of the student in relation to his environment and it provides opportunities for growth through the use of mathematical games. Creativity will include the development of such qualities as originality, cooperation, ability to follow as well as to lead, persistence of worth-while tasks, habits of facing reality and accepting responsibility, and the proper appreciation of the opportunities offered by society.

Some students seem so much more creative than others

that we may think they were endowed with creativity where others just weren't. This statement is not true. Creativity is a way of thinking and acting that is natural to the makeup of the human species. It is a style, an ability, that has been nurtured in some students and squelched in others. All students can be creative. Much of the interest and value of mathematics comes from creativity. The mathematics educator should encourage students to use the creative-type situations to deal with alternative solutions in life.¹⁷ Creativity will provide opportunities for pupils to explore their interests and abilities through mathematical games. The students will be given freedom to participate in planning learning activities and to choose activities of interest to them. The writer strongly suggests that flexibility be implemented in the methods of creativity in order for it to be most effective.

A basic generalization concerning learning asserts that rewarded behavior is more likely to recur. This generalization is sometimes referred to as the law of reinforcement. In reference to this principle, Watson made the following observation:

This most fundamental law of learning has been demonstrated in literally thousands of experiments. It seems to hold for every sort of animal from earthworms to highly intelligent adults. The behavior most likely to emerge in any situation is that which the subject found successful or satisfying previously in a similar

situation. No other variable affects learning so powerfully. The best planned learning provides for a steady, cumulative sequence of successful behaviors.  

Reinforcement, then, must occur in a context that insures success and benefit from effort. Furthermore, correct responses can be promoted by reinforcing and by rewarding desired responses. In the psychological literature, a reinforcer is defined as any stimulus that increases the probability of a response. Usually, positive reinforcers consist of some sort of reward. In teaching mathematics, this may be self-satisfaction from mastering a task, grades, praise from peers, teachers, or parents, recognition from the school authorities, or special privileges or prizes. These forms of reinforcement can serve as means of motivating the learning of skills.

Reinforcement games are designed to assist learning of basic facts and acquiring skill in applying concepts already introduced. Some games combine two or more of these classifications, but usually one mode dominates. Mathematical games and recreational activities act as positive reinforcers when used as a supplement to the regular curriculum.

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18 Cooney, Javis and Henderson, pp. 188-190.
Individualized Instruction in the Mathematics Classroom

The term individualizing is the educational rallying cry of the 1970's just as structure of the disciplines was a rallying cry of the 1960's. Part of the reason for the drive toward individualization lies in the pressure teachers feel from within and without to improve the quality of their activities in school. Teachers have taken various steps to meet the need for change and improvement. Many teachers have acceded to the demands of parents, pupils, and other critics to personalize the school by instituting individualized programs for pupils.

Teachers who initiate such individualized instruction, improve the quality of schooling for their pupils. Many teachers may hold that they are acting in accord with accepted beliefs regarding personalization. Yet, the hidden effects of such individualization may conflict with other beliefs the teachers hold.

To understand the hidden effects of individualization, it is helpful to realize that the thrust for individualizing came mainly as a response to criticism directed at our schools. By instituting an individualized program, teachers try to meet many of the demands of the pupils and other critics. Teachers cite the educational literature which proclaims the virtues of individualization. Teachers declare that their response will eliminate the dull group lessons, the pace that is
too slow for the superior pupils, the uniformity in teaching across age and ability levels, and the complete dependence on the teacher for deciding what to do almost every minute of the school day.

Many attempts to provide for individual differences have centered upon grouping, assignment variation, and variation in the levels of procedure rather than individualized instruction for each student in the class. However, it might be a bit impractical for a teacher to try to work with twenty-five to thirty students, each at a different place all the time.

The authors of the book, Mathematics: Strategies of Teaching, favor instruction which is three-pronged. At appropriate times, emphasis would be upon large group instruction (whole class); at other times, upon small groups. Relating then to either full class activities or the work of small groups would be individualized instruction. They also suggest that the amount of time devoted to each of these three types of activities—large group, small group, and individual study—will vary.¹⁹

For instance, some teachers choose to devote much more time to large group and individualized instruction, using grouping rather infrequently and sporadically throughout the year. Other teachers choose to make greater use of grouping and open-ended assignments. Whatever decision that the individual teacher actually does is dependent upon the age and

¹⁹Buffie, Welch and Paige, p. 209.
maturity of his students, the students' work habits, materials available and the teacher's own resources and organizational ability.

Mathematics teachers must envision how well mathematical games relate, overall to the class organization, total class instruction, and individualized instruction. Individualizing the mathematics classroom and using other instructional devices can be incorporated into a class lesson at any point during a basic unit of study.

The approach to individualization in the mathematics classroom proposed here requires skill, experience, and tolerance for uncertainty. To personalize teaching is a complex and demanding task. There is no push button we can press to bring about a panacea.

Applied and Abstract Mathematics

Many educators feel that academic games in the classroom are a lot of non-sense and a waste of time. The primary purpose of these types of games is the development of patterns, creativity, and a more positive attitude toward the use of mathematics. Consequently, the predominant theme pervading each mathematics class experience should embrace the idea that students should be free to make discoveries and exercise their individual appreciation and achieve understanding of mathematical principles. These games should harbor traits that will involve the students in making associations, analyses,
approximations, problem-solving decisions, and critical judgments. The variety and flexibility of these games also provide motivation and stimulation, not only to hold the students' interest and challenge their ability to think and reason, but to increase their capabilities in accurate computations dealing with real-life situations. For example, problems such as buying and selling, building a house, managing budgets, and income tax forms are worth noting here.

"Abstracting" is a cognitive activity that occurs when an individual becomes cognizant of a pattern, or a set of similarities among differences." Mathematical games contribute to a student's enjoyment of mathematics because they motivate the student to improve his basic skills. A well-structured game enables the students to become more efficient in using the fundamental operations in various number systems.

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CHAPTER III

METHODOLOGY

This study was designed so that it would provide some experiences that would enable a mathematics teacher to develop games and recreational activities in the senior high school classroom for the purpose of motivating, stimulating and arousing interest in mathematics. The problem in this study was to determine the effectiveness of constructing and implementing mathematical games and recreational activities within the senior high school mathematics classroom.

The games are the result of extensive research from the following sources: commercial activities, teacher-made activities, and student-made activities.

Description of Games

Commercial Games

Tuf

This is a competitive game, for 1-4 players, based on forming number sentences or equations. It can be played on

1See Appendix D
any level of expertise, from simplest equations on up to Ph.D. Simultaneously, each player works on the face up numbers of his/her own set. Actually, Tuf is 6 games in one: starting with a basic version, "plug-in" rules make the game more sophisticated. The rule book shows players how to increase complexity of play by introducing fractions, decimals, exponents, powers, fractional and negative roots.

**Checkermatics**

Here's a new slant that not only makes checkers more legitimate than ever in the classroom, but also gives students reinforcement and enrichment in their math concepts and skills. Created by Clifford Boatner, a Quincy (MA) school teacher, each level of Checkermatics consists of 15 checkerboards with math problems and, of course, checkers (transparent, colored discs - 200 each of 2 colors). There are enough materials to keep the whole class playing at one time. The rules are variable. Here's one simple method of play: After a player makes a jump, he solves the problem under the checker he has taken from his opponent, and the solution to the problem is his score for that move. Variations of the game may consist of doing the problem "from whence you came" or "where you land." Each checkerboard has been carefully designed so that both players have an equal chance. The backs of the boards are "blank checkerboards" for students who want to make up their own Checkermatics games. The boards are 21.5 cm square, .20 cm thick, and the playing surface is coated. (Reverse sides)
Chess for Juniors

An excellent means of introducing chess into your classroom, since it can be used both by advanced players or beginners. In addition to a standard set including fine-grade plastic chessmen, this game includes 32 specially designed directional pieces which show the various moves allowed by each piece printed directly on the piece. The playing board is 47 cm x 47 cm. Game rules are included.

Equable

A new stimulating "cross number" game, played like the old favorite Scrabble, that develops mathematical skills. Players gain practice in addition, subtraction, multiplication, and division as they build mathematical equations across or down. Equable provides fun and challenge for players of any age. Young children can form simple equations; more advanced "mathematicians" can form complex equations utilizing fraction and decimal tiles. The game comes complete with a brightly colored folding board, plastic tiles, tile racks, and instructions.

Mastermind

This game was recently awarded "Game of the Year" in England. It is an exciting new game that involves logical thinking and tests deductive ability; it requires using given information and eliminating irrelevant information. For 2 players: "challenger" sets up a line of 4 colored pegs behind
a shield; opponent has up to 10 moves to deduce the color and exact position of the hidden pegs. Object is to duplicate the hidden pegs in the fewest attempts. Sturdy plastic decoding board (24 cm x 13 cm) comes with 72 pegs in 6 colors, 40 key pegs in black and white, and instructions.

3-D Tic-Tac-Toe

The object of this game is to place 4 pegs in a straight line, either horizontally, vertically, or diagonally on the vertical plane. There are 76 possible ways of winning. The game, for 2 to 4 players, is simple to play even for primary-aged children, but it also can entail sophisticated strategy. The transparent, 6" square playing surfaces and the design of the structure lend themselves to easy sighting. Instructions are included.

Qwik-Sane: An Intriguing Topological Puzzle

This game is an intriguing topological puzzle that will challenge and delight those of all ages who like solitaire games that call for careful reasoning. QWIK-SANE calls for concentrative effort while luring the player in pursuit of an intriguing objective. Careful attention together with real patience will eventually enable almost any player to work this puzzle, and to solve the problem in the precise manner required.

Cutting Corners

In this life-simulation game players earn and spend
money while keeping a checkbook record of the exchanges. Each trip around the board represents a one-month time span. Players encounter regular monthly expenses (utilities, food, auto, medical, taxes, etc.). The variability of real-life income and expenses is simulated by throwing the dice to determine the amounts earned or spent. Players may also take a chance on the special "Cutting Corner" lanes named School, Inheritance, Court, and Stock Market which offer large gains but also involve the risk of large losses. The game, which may be played by 2-6 players, consists of a colorful, heavy-duty playing board, dice, markers, and checkbook record sheets.

The Real Numbers

This five-game kit prepares beginners for playing EQUATIONS. The equipment comes clipped to a ballpoint pen, handy for play anytime that two or three minutes are available. REAL NUMBERS provides fun in dealing with real, rational, irrational, integer and natural numbers.

Equations: The Game of Creative Mathematics

This five-game kit provides practice in elementary arithmetic operations (addition, subtraction, multiplication, division, exponentiation, and radicals) in a variety of numerals bases (decimal, octal, binary, etc.).

Percento

This bingo game set stresses the relationships among fractions, decimals and percents by requiring players to
convert numbers from one form to another. The set includes directions for six different bingo games, class sets of playing cards, calling squares, master cards and markers. The teacher's guide includes a review of the arithmetic processes which are used.

In Order

This game kit contains 14 different games at 14 levels of difficulty. Every game consists of a deck of 42 cards, each card having a numeral. Players are dealt eight cards each of which they must place in a rack in the order dealt. Then by replacing various cards in the rack, they try to be the first to get their cards ranked so that the numerals are in decreasing order from front to rear. In order to do this, students must learn that one number can be represented by many numerals. The games, which may be played by up to 4 students, reinforce such concepts as: counting numbers, multiples of four, addition, subtraction, multiplication, division, fractions, decimals, percent, area, and metric linear measure. The equipment necessary for assembling this kit is scissors, string, and scotch tape.

On-Sets: The Game of Set Theory

This 30 game kit provides practice in elementary set theory concepts (union, intersection and difference of sets, complement of a set, set-identity, set-inclusion, and the null and universal sets) while encouraging favorable attitudes
towards mathematics.

**Neurotic Nines**

This intriguing puzzle consists of nine plastic cubes with a number on each side. Several different tasks designed to challenge a variety of skill levels are suggested.

**Euclid**

This non-graded card game is designed to help teach basic geometrical concepts. It consists of two decks of cards. One deck contains 103 possible solutions and the other deck contains 36 geometry problems. The players pick a particular geometry problem card and then try to match it with the corresponding solution cards using the rules of rummy.

**Numo**

This game kit contains 26 different bingo games at 26 different levels of difficulty. Because the games are based on chance, the same student does not win all the time. Little reading is required, and each game is over in less than five minutes. A maximum of seven students may play the games which reinforce such topics as: addition and subtraction facts to 18, multiplication and division facts to 81, equivalent fractions, and metric measure.

**Wff 'N Proof: The Game of Modern Logic**

This 21-game kit starts with games that can be mastered by six-year olds and ends with games that will challenge adults.
It provides practice in abstract thinking and an opportunity to learn some mathematical logic.

**Tri-Nim**

This is a game for complete strategists. Decades of experience in exploring the mathematical strategic implications of nim-like games have gone into the design of this kit.

**Tac-Tickle A Challenging Game of Pure Strategy**

This 8-game kit sharpens the wits and stimulates learning. These are pure problem-solving games like chess, checkers, and tic-tac-toe. Tac-Tickle compares in complexity and depth of reasoning with tic-tac-toe about as chess compares with checkers.

**Touchdown**

Teams move the ball up and down the game board field and have all the scoring possibilities found in football. An addition, subtraction and multiplication game.

**Configurations**

Based on concepts from the geometry of incidence, this kit is a series of intriguing mathematical and geometric puzzles that will challenge and delight those who enjoy careful reasoning. The game contains two puzzle boards, 15 geometric figures, 50 reverse-draft numerals, especially designed for easy placement and pick-up on the mats, and a poly zip-bag for keeping numerals intact.
Mileage Rally

This stimulating game, which may be played by 4-6 players, reinforces basic arithmetic skills. Assuming the roles of professional race drivers, the players must use multiplication and division to determine distance and fuel consumption, and addition and subtraction to compute total mileages and fuel used. Each game contains a colorful game board with driving cards and playing pieces. The teacher's guide contains specific objectives and complete directions.

 Strikes 'N' Spares

Bowlers figure a way to roll the highest score in ten frames. Multiplication, addition, or subtraction steps are performed in each frame.

Logix

This electronic computer is a working model of the real thing. It includes all the necessary parts, including over 370 components and an illustrated 112-page instruction book; assembly requires no soldering. This computer allows students to write their own programs and includes 50 programs such as playing games against an opponent, matching wits against the computer, predicting the weather, mathematical calculations, solving mysteries, laws of sets, cybernetics, translations, airline booking, computerized telephone call routing, computerized chess, diagnosing illness, and music!
Puzzles for Pleasure

A collection of 102 puzzles whose solutions require careful thinking with only simple, if any, mathematical solutions.

Brain Puzzlers Delight

A treasury of unique mind-stretching puzzles which offers the pleasures of discovering solutions through use of ingenuity, imagination, insight and logic. The fascinating, entertaining puzzles are arranged in order of difficulty; the solutions with full explanations are at the end of the book.

Teacher-Made Games

Basketball

An interesting basketball game can transform a drab review session into a lively, enjoyable, and educational game. Necessary equipment includes nothing more than a chalkboard, chalk, erasers, and some ingenuity.

A basketball court is drawn on the chalkboard. Choose a score-keeper, a time-keeper, and a referee. Divide the group of players into two teams, or have captains choose the players for their respective teams. Captains will assign the order in which players solve problems for their team. The score-keeper and time-keeper step to the chalkboard where they can better follow the progress of the players. The referee prepares to

See Appendix D
read the problems to members on the teams.

When the game is started, the captain of each side sends his first player to the chalkboard. The referee gives them a problem to solve. The player who first solves the problem correctly advances to the midpoint of the court. If the other player has his answer correct, but finishes later, he remains on the court, but does not advance; if his answer was incorrect, he must take a seat and the next player on the side replaces him.

A second problem is given. If the player who is at the midpoint of the court solves the problem first and correctly, he makes a basket and scores two points for his side. After scoring a basket, both players on the court take their seats; the next player from each team goes to the chalkboard. When a player is forced to take his seat because of an error or technical foul, the captain of the opposing side takes the next problem, which if he solves correctly counts as one point.

If a player or student is out of order at any time, prompts, talks, or otherwise causes a disturbance, a personal foul is called and the player of the opposing side takes the next two problems, which each count one point if solved correctly.

The time-keeper must note carefully which player finishes a problem first. The referee decides if the problem is done correctly. All players must begin play from the end
of the court opposite their goal. The team scoring the most points wins the game. A series of games may be played for a small trophy.

**Scoring 50**

Two people can play this game. One player begins by taking a number not greater than 6. The second player can add to the first number, any number not greater than 6. This continues until exactly 50 is reached. The player that reaches 50 first is the winner.

**Chalkboard Relay**

In order to conduct a chalkboard relay, the group is divided into teams of equal numbers. The captain of each team is given a piece of chalk. On a given signal, the leaders go to the chalkboard and do assigned problems, returning with the chalk for the next member of the team when finished. This procedure continues until everyone on a team has solved a problem. Correctness, neatness, and good order are factors in determining winners. Any errors in the work may be corrected by succeeding players. Teams may be disqualified for talking or disorderliness.

**Winging Wild Geese**

Arrange the nine digits on the chalkboard in an angle representing a number of wild geese in characteristic flight formation. Let the digits occur in random order and let the order be changed occasionally. Members of the group use any
number from 2 to 9 as a bullet. If the bullet is 7, the geese can be winged by naming in rapid succession the products of 7 and the numbers representing the geese.

The bullets and/or the geese can be changed to two-digit numbers. Similar changes can be made to cover addition, subtraction, multiplication, and division of whole numbers, fractions, and decimals. For example:

\[ \begin{array}{cccc}
2 & 4 & 16 & 67 \\
5 & 5 & 9 & \\
4 & 2 & 3 & \\
8 & 1 & 4 & \\
1 & 7 & 8 & \\
\end{array} \]

Around the Circle

Digits or numbers can be arranged in the form of a clock face on the chalkboard. The size of the numbers used depends upon the desired difficulty of material to be covered. A digit or number is placed in the center; it can be changed at random. The object is to perform the indicated operations accurately and as rapidly as possible. The game can be used for drill on any of the fundamental operations; whole numbers, fractions, and decimals may be used.

Card Game

An interesting card game can be made by constructing a set of twenty-four cards that include the numbers from one to
six. Four cards are numbered one, four are numbered two, and so on. Two players can play the game. Each player is dealt twelve cards.

Players take turns playing the cards. The value of the cards are added each time a card is played. The player that scores exactly 50 is the winner, or a player who goes over the count of 50 is the loser.

**Penny Game**

Twelve pennies are placed on a surface. Two players take turns removing pennies from the group. Not more than four pennies can be taken at one time by a player. However, a player may take one, two, or three pennies. The player taking the last penny is the winner. The game can also be played with the player taking the last penny being the loser.

**Teaching Fractions**

The concept of fractional unit is sometimes difficult for students to comprehend. The following game and its variations are very helpful in conveying such concepts as (1) fractional units of the whole; (2) the relationship between proper fractions, improper fractions, and mixed numbers; and (3) the addition and subtraction of fractions.

The material includes a game board and spinner. All the materials are drawn on regular paper, cut out, and mounted on stiff cardboard. Tokens for each player are made. The arrow is mounted to the playing board with a pin, fastener,
or rivet.

To play the game, all players place their tokens on start. The first player spins the arrow and must move his or her token the number of spaces indicated. Once a player completes a move, the next player takes a turn. The first player to reach "finish" wins.

One variation is to use two identical spinners with numbers and a spinner that contains operation symbols. The student has to add or subtract the two selected numbers and move the resulting number of spaces. If the problem is subtraction, the player subtracts the smaller from the larger (introducing the order concept). To add further interest to the game, a referee can be given a grid containing all possible answers to the questions. The player who gives an incorrect solution loses a turn.

Two Sides To Zero: An Arithmetic Game With Integers

This game deals with addition, subtraction, and multiplication of integers and is intended for two players. The equipment for play is as follows:

1. A section of the number line between -32 and 32 with the integers marked. Above the number line are two tracks for the two runners.

2. Two runners (or counters), one for each player.

3. A number disc with a pointer. On the disc the integers between -4 and +4 appear. (This disc can easily be made from cardboard, with a popsicle stick as the pointer).

Directions:

At the beginning of the game, both players take runners
and place them on their tracks above 0. The players then agree on a number (or are given one by the teacher); for definiteness we shall suppose the number is 17. Each game then consists of two rounds. In the first round one player aims to reach +17 and the other -17; in the second round they interchange goals.

Each player in turn (1) obtains a number from the disc by "flickering" the pointer; (2) chooses which operation, addition, subtraction, or multiplication, will give the most advantageous result when the number obtained from the disc is combined with the number below the player's current position; and (3) moves the runner accordingly.

A round is finished when a player lands exactly on the agreed number. If the pointer lands in the shaded area or on the line separating two integers, the player spins the pointer again.

**Geoboard**

The geoboard is a popular device for developing a variety of geometric and arithmetic patterns in mathematics. It frees the child from the static pictures and diagrams of the traditional paper-and-pencil activities. When children are able to "stretch" a rectangle, form squares of many different sizes, and transform one shape into another, they have a feeling of creating their own geometry. With an aroused interest, children are more apt to sense patterns and shapes that occur in their own explorations.
Concentration

The rules for this game are similar to the rules for the television game. A "concentration" board is needed. On a large piece of cardboard, rule off a number of squares (or rectangles). The number will depend on the ability and grade level of the class the teacher is teaching. The examples used will depend on the kind of drill the teacher wants to provide. Suppose a teacher wants to drill students on equivalent fractions. Then each individual square on the board is covered with a blank piece of cardboard that can be put in place by a pin located on top of each piece of cardboard. Each square is identified by an ordered pair of numbers. Two or three students at a time can play the game. The student who is chosen to begin calls out a particular ordered pair such as (2,1). The teacher then uncovers that square. The student calls out another ordered pair, such as (1,4), in order to find an expression that is equivalent to the first expression. In this particular case the student has a matching pair so continues for another turn. If the student does not get a matching pair, then the next student takes a turn. The game continues for as long as the teacher wishes and the student with the most matched pairs is the winner.

Not only are students being drilled, in this case, on equivalent fractions, but they are also learning about ordered pairs and graphing. Many other concepts besides the one illustrated in this paper could be used with this game.
Zero: An Addition Game with Integers

Zero is a game that can be played by any junior or senior high school student who has received initial instruction in the addition of integers. Besides giving a student practice in the addition of integers, the game also develops the concept of "opposite" and helps students improve their problem-solving strategies.

The game is played much like rummy, using a special deck of integer cards. The object of Zero is for a player to get three cards whose numbers have an algebraic sum of zero. Two to four students can play the game with one deck of cards.

To play the game the deck of integer cards must first be prepared. Forty-two cards are needed (3" x 5" index cards work fine). Two cards are prepared for all integers from -10 to +10, including 0. The card for -10 is pictured below:

```
-10

-10

-10

01- 01-
```

To start play, each player draws a card from the deck. The player who draws the highest card is designated the dealer. The dealer shuffles the deck and deals three cards, one at a time, to each player. Those cards not dealt out are placed face
down in the middle of the playing area to make a blind deck. The top card of the blind deck is turned face up next to it. Play begins with the player on the dealer's left.

If players do not have three cards adding to zero, they draw either the face-up card or the top card from the blind deck. They then discard a card face up. If left with three cards having a sum of zero, a player says "Zero" and lays down the cards. If the player does not have zero, play continues to the left until a player gets zero.

Players can draw only the top card from either of the stacks. Zero must be achieved with exactly three cards.

When a player has zero, the play continues to the dealer so that all players have the same number of turns.

Play ends for hand at the end of a round in which one player has a zero. At the end of a round, all players add up their score, and the deal for the next hand passes to the person on the previous dealer's left.

There are two ways to calculate the score. One way is to have players find the sum of the absolute values of the three cards in their hand; their score is the sum. Another way is to find the algebraic sum of the three cards; the score is the absolute value of the sum. The person who had zero has a score of zero for that hand. The game can end either when a time limit is reached, such as two minutes before the end of the class, or when any player has reached a predetermined score, such as 50.
Tic-Tac-Facto

Materials needed: 1. Call cards with feasible polynomials to be factored.
2. Player cards with factors of the given polynomials.
3. Markers that are circular shaped with X's and O's on them.

Rules:

Before the game begins, students are to be given player cards with factors of a given set of polynomials and markers with either a set of X's or O's on them. After the cards and markers are distributed, the teacher should explain that the object of the game is to cover three factors in a column, row, or diagonal. This is to be accomplished by the following rules:

The teacher will draw at random a call card from a box or some other feasible container and read aloud the given polynomial. Then each pupil should factor the proposed polynomial completely and cover the factor on his card that is an apparent factor of the polynomial. The teacher should write the factors of each polynomial in order to save time in checking a prospective winner's card. This continues until a player has either a column, row, or diagonal covered. The player who accomplishes the desired objective should say, "Tic-Tac-Facto," and present his card to the teacher for a final check. If the covered factors are identical to three factors of any of the proposed polynomials, then the participant holding this card is declared a winner and a new game begins.
In order to create more games of this type, more polynomials should be selected and player cards made.

Cross-Number Puzzles

Wilherding has written about one very definite objective to be achieved through the use of cross-number puzzles.

The following remarks have been taken from one of her articles:

It is very difficult to stimulate the interest of junior and senior high school students in review of the fundamental processes of arithmetic. If the review is given in traditional "deadly" drill, few objectives of the review are accomplished. Answers are written unenthusiastically and the same errors appear which the drill is attempting to correct. Number games which stimulate such review in the elementary grades are too childish for the "sophisticated" high school students.

A good review of the fundamental processes is the cross-number puzzle. The cross-number puzzle differs from the cross-word puzzle only in that it uses numbers instead of words. Not only is such a number puzzle a good review of fundamental processes, but it is an excellent motivating factor in the teaching of arithmetic.³

Suggestions for construction of original puzzles:

1. Select a topic. Beginners had best select a topic of a general nature, such as general review, rather than specific subject area, such as finding the percent of a number. The more specific the subject area, the more likelihood of difficulty in completing a useful puzzle.

After experience is gained by making puzzles of a general nature, the beginner might try more specific areas such as

whole numbers, fractions, decimals, percent, measures, etc. After still more experience, the neophyte can try specific areas such as addition of whole numbers, multiplication of fractions, division of decimals, finding a number when the percent of it is known, etc.

2. Choose a block for the puzzle. While a uniform puzzle block, such as a square, is easy to construct, the block is not limited as to size or shape. Until experience is gained, however, it seems logical to begin with a square block. As a starter, the number of cells should be limited to thirty-six, forty-nine, or sixty-four cells; or squares with six, seven, or eight cells, respectively, on one side. Puzzles with one hundred cells can be attempted after experience has been gained by constructing smaller puzzles.

3. Shade in cells. Shade in cells in the puzzle block so that the block is broken into small groups of cells. The unshaded cells are the cells to be filled in with the digits of the answers to the problems making up the vertical and horizontal items. Each digit of an answer will occupy one cell. The number of cells extending in a horizontal or vertical direction will usually vary from one to six. The desired number of cells in a group will depend on the topic that the puzzle is designed to cover. For example, a puzzle on whole numbers would likely include all manner of groups from one to six or more cells, with most groups providing for 3 and 4 digit answers; a puzzle on finding the
percent one number is of another would likely include groups of one, two, and three cells, with most groups providing for 2-digit answers.

The cells may be shaded in according to a symmetrical pattern. The symmetrical pattern serves a dual purpose; it provides a design that most people find pleasing and it enables the person constructing the puzzle block to plan for the number of items to be used while in the act of shading the block. The number of items can be planned by working with a quarter or a half of the block, then shading in the other half, or three quarters, to complete the symmetrical pattern.

Care should be taken in shading cells to see that the puzzle block does not consist of too many or too few groups, and that the number of cells in a group vary in keeping with the selected topic.

4. **Number the groups of cells.** Number the groups of horizontal and vertical cells so that each group of cells has a number. Place the number in the upper left hand corner of a cell. Start with the uppermost horizontal line of cells and number consecutively the first cell of each horizontal and vertical group. Proceed from right to left and from the first horizontal line of cells to the second. Every horizontal group of cells will have a number in the leftmost cell that follows a shaded cell or is adjacent to the left side of the puzzle block. Every vertical group of
cells will have a number in the uppermost cell that follows a shaded cell or is below the top side of the puzzle block.

5. **Number the items for the horizontal and vertical columns.**

Indicate the numbers of the horizontal and vertical columns of items below the puzzle block. The numbers in the horizontal column should correspond with the numbered horizontal groups of cells; the numbers in the vertical column should correspond with the numbered vertical groups of cells. Room should be provided after and between the numbers in the horizontal and vertical columns to write in the problems or questions whose answers will be written in the correspondingly numbered groups of cells. A second sheet of paper will likely be needed to provide sufficient room.

**Example:**

<table>
<thead>
<tr>
<th>Across</th>
<th>Down</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Sum of 538 and 1697</td>
<td>b. Product of -4 and -7</td>
</tr>
<tr>
<td>e. Product of 7 and 45</td>
<td>c. Subtrahend when minuend is 940 and difference is 569</td>
</tr>
<tr>
<td>g. Difference between 1020 and 149</td>
<td>d. Third power of 8</td>
</tr>
<tr>
<td>h. Square of 18</td>
<td>e. Addends whose sum is 11</td>
</tr>
<tr>
<td>i. Digits whose sum is 6</td>
<td>f. Divisor when dividend is 4228 and quotient is 302</td>
</tr>
</tbody>
</table>
k. Square root of 676  h. Difference between 901 and 572
l. Cube of 9  j. Factors of 105
n. Digits whose product is 35  m. Number whose factors are 2, 2, 3, and 23
o. Quotient when dividend is 322 and divisor is 23
p. Fourth power of -5  o. Square root of 18,496
s. Minuend when subtrahend is 55 and difference is 79
t. Number whose factors are 2, 3, 7, and 11
v. Dividend when divisor is 29 and quotient is 34
w. Subtrahend when minuend is 5260 and difference is 1774

Student-Made Games

Math Marbles

I got the idea from the game of marbles. The objective of the game is to shoot all twenty-five marbles into the six holes in two minutes. If this is not accomplished,
the team must answer the number of questions or problems as there are marbles left.

The game consists of two teams with two players, and twenty-five marbles. Your points are scored by the number of the question that you answer: For example: 1. \((x + 2)(x - 2)\) and 2. \((a - b)(b - a)\). If you answer number 1 correctly, you would receive 1 point; if number 2 is answered correctly, you would add 1 plus 2 and receive a total of 3 points for your score.

Susan A. Ellington

Math Mountain Climber

The object of this game is to get the mountain climbers off of the mountain. There should be two contestants for each game. Each contestant must strive to be the first to get his mountain climber off of the mountain. In order to move the mountain climber, each player must answer an algebra question correctly. With each correct answer, a player can advance five spaces. The player whose climber reaches the bottom of the mountain first wins.

Andy Parrish, Sheri Hudson and Julie Johnston

Algebra Match Game "79"

The format for this game is similar to the television game show, "Match Game P.M. However, this is an algebra game and the players will have to match answers.

There should be nine participants in total; two players,
a panel of six, and a host. The object of the game is to try to match the panel's answers with one's own (the players). This game is designed to test the students' knowledge of algebra.

PROCEDURE:

1) The players will be questioned.

2) The player's answers will be written on an orange answer sheet.

3) Both players will receive ten sheets of paper.

4) The panel must write their answers on different colored answer sheets. (Ten sheets each)

5) The players will choose from two sets of questions. (Set A and Set B)

6) The game will be played two rounds.

7) The player who has matched all of the panel after two rounds, or the player with the most points at the end of the game will win.

OPTION:

The game can be played with a bonus round with a token being given as a prize. The winner can choose three players from the panel to give him an answer for the bonus blank. The player can accept one of the panelist's answer, or he can give his own answer to the question--as based upon his knowledge of the subject matter. If the player can get one of the three possible answers correctly, he can receive the token.

Stephanie Atwater

Algebra Yahtzee

Algebra Yahtzee may be played by two, three or four
persons. It can also be played solitaire, trying for the highest possible score.

The object of the game is to obtain the highest score for one or more games. The player with the highest score wins. This game consists of the following equipment: 1 dice cup, 1 set of 5 dice with exponents from $x^1$ to $x^6$, and 1 Algebra Yahtzee score pad.

In each turn a player may roll the dice up to 3 times in order to obtain a scoring combination. After rolling the dice, he must place a score or a zero in one of the boxes in the vertical column under the game he is playing. The game ends after 13 rounds, when all scoring boxes have been filled.

TO PLAY:

1. To determine who goes first, each player places all five dice in the dice cup and rolls out all the dice. The player rolling the highest total starts the game. Play then goes clockwise.

2. In each turn a player is allowed a maximum of 3 rolls of the dice, although he may stop after the first or second roll.

   A. For the first roll he must roll all 5 dice. The 5 dice are placed in the cup, the cup is shaken and the dice rolled out.

   B. For the second and third rolls, the player may pick up any or all the dice and roll again. He need not declare what he is trying to make (what box he is trying to score in) and may change his mind at any time.

   C. The dice are final after the third roll and must be scored. If not one of the scoring combinations (Aces, twos, threes, fours, fives, and sixes; 3 of a kind, 4 of a kind, full house, small straight, large straight, Algebra Yahtzee, and chance) then a zero is placed in one of the scoring boxes.

Nancy Raybon
Wheel of Chance

The idea for this game was gotten from the television game show, "Wheel of Fortune." This is an algebra game. The object of the game is to be the first contestant to complete an equation by first spinning the wheel to obtain a specified amount of money, and then guessing the proper equation terms that would lead to a player's ability to complete the given equation. The first player who is able to guess the entire equation wins the game. The players are not allowed to guess the given signs; however, they can be bought for a specified amount of money. A maximum of five players can be used. They are 3 contestants, 1 emcee, and 1 host/hostess.

Nancy Raybon, Rob Maxwell and Cindy Rogers

Math Croquet

Math Croquet is played just as outdoor croquet. Instead of using balls as in outdoor croquet, you use a coin. Two players can oppose each other, or partners can play against partners. A coin is flipped in order to determine who plays first. The player then follows the lines by thumping the coin. If you miss your shot through the wicket, the next person can begin to play. Each player gets only one chance to thump his/her coin through the wicket except on the first turn when two thumps are needed. The first player to get all the way around the board wins the game. This game stresses the im-
portance of angles. If a player strays from the line of the angle, he/she can't continue to play the game until he/she gets back on it.

Debbie Bell

**Effectiveness of Games**

The data collected for this study were related to an observable change in attitude and interest of senior high school mathematics students. An analysis was done based on the percentage distribution of the responses to the student-opinion questionnaire. The statements were grouped according to their relationship to the student interest which was acquired after the development of the games. The statements were also grouped according to their relationship to the student interest which was acquired after the implementation of the games.

The survey was applied to a specialized population of the R. E. Lee Institute's Mathematics Department in Thomaston, Georgia. There were twenty-one girls and twenty-nine boys. Therefore, there was a total of fifty subjects in the entire population studied.

**Analysis of Students Responses**¹

**Strong Level of Agreement**

There were four questions related to the students'

¹See Appendix C
interest in the construction of the games and recreational activities. There was a strong level of agreement on all four questions. The level of agreement on the four questions ranged from 34 percent to 100 percent (see table I). The range of responses to the four questions indicates that out of the fifty students surveyed, over 70 percent of the students strongly agreed with the four questions. More specifically, data revealed that of all the students surveyed, there was a 100 percent level of agreement in answering the following item: I liked making the games and recreational activities.

There was a 34 percent level of agreement among the students in answering the following item: Making these games helped to improve my math skills. There was a 72 percent level of agreement among the students in answering the following item: I would like to participate in making other math games and recreational activities in the future. The last item in this category elicited a 76 percent level of agreement among the students: I liked the idea of making the math games and recreational activities during the regular class time.

A positive response to the foregoing questions was interpreted to mean that the subjects were interested in the construction of the games. The fact that over 70 percent of the students surveyed agreed with the statements indicate that a substantial majority of students do in fact take a positive point of view in respect to math games.
### TABLE I

ANALYSIS OF RESPONSES CONCERNING THE STUDENT INTEREST IN THE CONSTRUCTION OF THE MATHEMATICAL GAMES AND RECREATIONAL ACTIVITIES BY LEVELS OF AGREEMENT

<table>
<thead>
<tr>
<th>LEVELS OF AGREEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>1. I liked making the games and recreational activities.</td>
</tr>
<tr>
<td>2. Making these games helped to improve my math skills.</td>
</tr>
<tr>
<td>3. I would like to participate in making other math games and activities in the future.</td>
</tr>
<tr>
<td>4. I liked the idea of making the math games and activities during the regular class time.</td>
</tr>
</tbody>
</table>
Moderate Level of Agreement

A moderate level of agreement was recorded for three of the four items. The levels of agreement ranged from 24 percent to 48 percent. An analysis of the data revealed 48 percent of the students agreed with this statement: Making these games helped to improve my math skills.

There was a 28 percent level of agreement on the following item: I would like to participate in making other math games and activities in the future. There was a 24 percent level of agreement on the following item: I liked the idea of making the math games and recreational activities during the regular class time.

The finding was interpreted to mean that 25 percent of the students agreed, to some extent, with the writer's idea.

Disagreed

A level of disagreement was recorded for only one of the four questions. There was an 18 percent level of disagreement on the following item: Making these games helped to improve my math skills.

This finding indicates that 18 percent of the students perceived the making of math games as not contributing to the improvement of math skills.
An Analysis of Responses Concerning the Students' Interest in Math After the Implementation of the Manipulatives

Strong Level of Agreement

There were five questions which related to the students' interest in math after the implementation of the games and recreational activities. There was a strong level of agreement on all five of the items. The strong level of agreement on the five items ranged from 32 percent to 92 percent (see table II). The range of responses to the five items indicates that of the fifty students surveyed, over 65 percent agreed with the five items.

There was a 32 percent level of agreement among the students in answering the following item: After using the games, my attitude and interest have changed in mathematics. There was a 60 percent level of agreement among the students in answering the following item: Games should always be used in the classroom.

There was a 64 percent level of agreement among the students in answering the following item: The use of math games in class motivated and stimulated me to want to learn more math.

There was a 78 percent of agreement among the students in answering the following item: Class interest was captured by these games. There was a 92 percent level of agreement among the students in answering the following item: I do suggest the use of math games to other math teachers.

A positive response to the foregoing questions was in-
### TABLE II

**ANALYSIS OF RESPONSES CONCERNING THE STUDENT INTEREST IN MATH AFTER THE IMPLEMENTATION OF THE MATHEMATICAL GAMES AND RECREATIONAL ACTIVITIES**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Strongly Agreed</th>
<th>Moderately Agreed</th>
<th>Disagreed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. After using the games, my attitude and interest have changed in mathematics.</td>
<td>32%</td>
<td>64%</td>
<td>4%</td>
</tr>
<tr>
<td>2. Games should always be used in the classroom.</td>
<td>60%</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>3. The use of math games in class motivated and stimulated me to want to learn more math.</td>
<td>64%</td>
<td>34%</td>
<td>2%</td>
</tr>
<tr>
<td>4. Class interest was captured by these games.</td>
<td>78%</td>
<td>20%</td>
<td>2%</td>
</tr>
<tr>
<td>5. I do suggest the use of math games to other math teachers.</td>
<td>92%</td>
<td>8%</td>
<td></td>
</tr>
</tbody>
</table>
terpreted to mean that the students were interested in and motivated by the use of the games in class. The fact that over 65 percent of the students surveyed agreed with the statements suggests that the students' interest level was enhanced by the implementation of the manipulatives.

**Moderate Level of Agreement**

A moderate level of agreement was recorded for all five items. The levels of agreement ranged from 64 percent to 8 percent. The data revealed that 64 percent of the students agreed with this statement: After using the games, my attitude and interest have changed in mathematics.

There was a 40 percent level of agreement on the following item: Games should always be used in the classroom. There was a 34 percent level of agreement on the following item: The use of math games in class motivated and stimulated me to want to learn more math. There was a 20 percent level of agreement on the following item: Class interest was captured by these games. There was an 8 percent level of agreement on the following item: I do suggest the use of math games to other math teachers.

The fact that over 33 percent of the students surveyed moderately agreed with the foregoing statements suggests that the mathematical games had a positive impact on this set of students, also.

**Disagreed**

A level of disagreement was recorded for three of the
five items. There was a 4 percent level of disagreement on
the following item: After using the games, my attitude and
interest have changed in mathematics. There was a 2 percent
level of disagreement on the following two items: The use of
math games in class motivated and stimulated me to want to
learn more math. Class interest was captured by these games.

The fact that only 1 percent of the students surveyed
disagreed with the statements is compatible with the large
percentage who responded positively and corroborates the over-
all positive attitude that students have toward these games.

The fifty subjects in the study were given three pre-
tests and three post-tests. Tables III and IV are presented
and analyzed to determine the effectiveness of the use of the
mathematics games in the classroom during the instruction
period.

**Improvement of Grades and Test Scores**

Table III shows that of the fifty subjects, 31 failed
pre-test 1, 25 failed pre-test 2, and 29 failed pre-test 3.
(See table III). Table IV shows that of the fifty subjects, 9
subjects failed post test 1, 8 subjects failed post test 2, and
only 4 subjects failed post test 3. (See table IV). This
comparison shows that there was a significant improvement in
the subjects test scores and grades.
# TABLE III

**PRE-TEST SCORES**

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### TABLE III (CONT.)

**PRE-TEST SCORES**

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### TABLE IV

**POST-TEST SCORES**

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### TABLE IV (CONT.)

**POST-TEST SCORES**

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CHAPTER IV

SUMMARY, CONCLUSIONS, DISCUSSION, RECOMMENDATIONS

Summary

The purpose of this study was to determine the significance of recreational games in the senior high school mathematics classes and how they can be used as instructional devices or aids in a teaching-learning situation. The researcher was interested in achieving two specific purposes:

1. Collecting mathematical games that will motivate, stimulate, and arouse the interests of the math students at R. E. Lee Institute in Thomaston, Georgia.

2. To determine the effectiveness of the mathematical games in the classroom at R. E. Lee Institute.

The subjects were fifty senior high school students. In both classes, the games and recreational activities were used as instructional aids. The subjects were exposed to the games as an aid during the class period. Competition was a top priority.

A student-opinion questionnaire was administered and scored according to the following levels of agreement: strong level of agreement; moderate level of agreement; and disagree-
ment. Over 70 percent of the subjects strongly agreed that the construction of the various manipulatives enhanced their interest level in the mathematics class. There was 25 percent of the subjects who responded with a moderate level of agreement. 4 percent responded with a level of disagreement.

There were five items that were related to the implementation of the mathematical games and recreational activities in the classroom. To these questions, over 65 percent of the subjects responded with a strong level of agreement. There was over 33 percent who responded with a moderate level of agreement. Only 1 percent of the subjects disagreed.

Conclusion

The findings in this study led to the following conclusions:

1. There is an observable change in student interest in mathematics after the implementation of mathematical games and recreational activities.

2. Reactions of the subjects demonstrated that mathematical games and recreational activities are efficient instructional tools, are fun, remove pressure, encourage peer teaching and are nontthreatening evaluation of learning.

3. The results of this study suggest that with more time spent with the subjects, the use of games and recreational activities would prove to be even more successful at
motivating, stimulating, and arousing student-interest in mathematics.

Discussions

The success of a classroom game, like any instructional or technique, is highly dependent on how it is used. If the game is to play the roles described above, the following factors should be considered.

1. The game to be used should be selected according to the needs of the class. The basic criterion is that the game makes a unique contribution to learning—a contribution that cannot be attained as well or better by any other material or technique. The material involved should be closely related to that of the regular classwork. Specifically, the game selected should involve important mathematical skills and concepts; and major emphasis should be on the learning of these concepts or skills rather than on the pleasure of playing the game.

   During the game situation, all students must be participating. Even though only one person is working on a certain problem, every team member must be responsible for its solution. Games must also avoid extreme embarrassment for the person who cannot solve a problem. Whenever possible, students should compete with other students of equal ability.

2. The game should be used at the proper time—that is,
usually during the regular class period when the ideas or skills are being taught. There are other times, however, when games promote learning in an otherwise difficult environment. Many teachers prefer to use games before a vacation or during days of heavy absence due to athletic games, storms, concerts, or excursions. Usually, games should be relatively short so that pupils do not lose interest.

3. The game must be carefully planned and organized so that the informality and excitement of the setting does not defeat its purpose. Before the game begins, the participants should be briefed on the purpose of the game, the rules, and the way to participate. Often the students can establish ground rules, so that everyone (including the teacher) may enjoy the activities. "Coaching" should not be allowed. The loss of points for breaking rules is usually sufficient to maintain appropriate behavior.

4. The participants in the game must accept the responsibility of learning something from the game. Follow-up activities such as discussions, readings or tests will emphasize this responsibility. The teacher will need to evaluate the results by asking himself how successful the game was in promoting desired learning.

Games appropriate for learning mathematics are limited only by the ingenuity of students and teachers. They can convert almost any practice lesson into learning games by choosing; teams, participating as individuals
or teams, and keeping score. Most of the common parlor games or athletic games can be adopted for use in a mathematics class at any level.

Recommendations

On the basis of the findings of this study, the writer makes the following recommendations:

1. Putting a halt to dull and dreary mathematics classes should be a major educational goal for the mathematics teacher.

2. Mathematics teachers should continue to use whatever methods that are necessary to turn their students on (educationally).

3. Mathophobia during this era of Neo-Progressive education can be obliterated if all parties concerned would lend a helping hand (principals, department supervisors, teachers, students, and parents).
APPENDIX A

Photographs of the Mathematical Games
and Recreational Activities
Instructor Walls Inspects Math Games

Walls' 'Formula' Is Hard Work

By JEAN MORRIS

"If you've ever wanted something very much and were willing to make sacrifices over a long period of time to get it, then you will understand what R. E. Lee teacher Robert Walls is doing."

For over a year, he has been making trips to Atlanta University in Atlanta on Monday and Wednesday nights, and during the summer months, up to four or five trips a week. His goal is his Ed S in Math, and he is in the process of fulfilling the requirements and qualifications that will enable him to pick up his degree on May 21.

While all this work is going on, he is also working fulltime as a math instructor at Lee. Wouldn't you say that a job and a half were plenty for anyone?

"SOME PEOPLE HAVE asked me if this will be my last post-graduate degree that I'll want to work toward," Walls reflected. "I tell them that for now it is. However, after I get rested and back on a normal schedule again I wouldn't be too surprised if I didn't decide to go back for one or two more," he laughed.

Walls is a hard-working (obviously!), likeable man, born in Sparta and educated in that area through high school. He then attended and was graduated from Savannah State College and went on to Fort Valley State College for advanced study.

AFTER THAT, it was on to Mercer University at Macon to earn a master's degree and also to Atlanta University for study prior to this course of study he's embarked on now.

Walls is married to Geraldine Smith Walls, a reading teacher at North Thomaston School. They have a godson, David Vinson, who is a sophomore at Savannah State.

At this particular time in Walls' course of
study, he is engaged in writing his thesis as part of his course requirements. The title of the thesis, which he selected and a committee approved, is "Games In The Senior High School Classes."

The subject was okayed with several stipulations. One was that he (Walls) must construct and complete a number of the games himself, and that he must involve his students in the game development process as well. Commercial games were to be collected as another part of the requirements.

So, individual students and groups of students in his classes were assigned the work of inventing and building successful and meaningful "math games" as a learning process.

AN ALMOST UNBELIEVABLE number of different games and ideas surfaced as a result of those assignments. On the February 16 cut-off date, there were around 55 games on display.

At home, in his after-school hours, Walls has completed around eight or nine teacher-made games, and has a collection of over 35 commercial games at hand.

Of course, the student-constructed games were all with the instructors assistance and approval.

BUT THIS ISN'T all.

Robert Walls must include in his thesis a complete list of instructions for each game and how it was constructed. And he must give an oral report to a committee around April 1 on the material in his thesis.

The chapter on the construction of the games and the accompanying instructions will be Chapter Three in a thesis that will consist of four or five chapters. A great deal of time-consuming work.

WALLS BEGAN HIS teaching career at Beach Senior High School in Savannah. He stayed there for a short time before coming to

Bo Cloud, Debbie Bell, Lynn Brown, Keith Renfroe With More Games
Thomaston to teach at Drake High School. He was there for five to six years before moving to R. B. Lee Institute in 1970, and he has been there ever since.

"I really enjoy the teaching profession," explains Walls, in discussing the hours he spends with his students and on lesson planning and advanced study in his field.

"Of course, all my additional study has been in the field of mathematics because that's where my interest is. It's always been a very exciting area of study to me," Walls explained.

This excitement shows in his pride in his students' work on the many Math Games that surround him in the classroom.

SOME OF THE games were constructed on or from objects that already existed. The "Wheel of Chance" was built on an old bicycle wheel. Also, a Yahtzee game has reconstructed dice that are made into algebraic expressions raised to exponential powers, instead of ordinary numbers. Many of the materials in the "Russian Roulette Wheel" were combined to form the game.

The games have all been displayed in Walls' room on the second floor of the Math Building on, beside and under a long table just to the left inside the door. They are an impressive sight and one that could entertain anyone for hours, if each game could be explored and played.

JUST TO MENTION a few of the other games, there is a Chart for Telephone and its problems that can be solved by decoding the messages. There is a Math Football Game, Math Checkerboard, Math Tic Tac Toe, Trig Around, Spin An Equation, Hidden Equation Game, Math Croquet, Math Baseball Game, Math Scrabble, Math Mountain Climber, three styles of abacus, Algebra Bingo (2 or 3), several Geoboards and Algebra Matching.

You see? Everything you could ask for is there. And there are many others, too.

It's quite clear why Lee Principal Kenneth J. Moore was very enthusiastic about the display in the Math Building.

Moore said, "It's a very impressive display of materials. The work is quite thorough and, to put it mildly, the work is outstanding."

WITH THIS KIND of praise, we had to see the display. And outstanding it is.

When we came for the interview, Walls was just taking up papers after a long test on a chapter on Income Tax Form Preparation.

"This is something they will have to deal with the rest of their lives. And if they can learn it now, it will save them lots of headaches in the future," Walls said in reference to the subject matter.

"A lot of people ask me if I wouldn't prefer college teaching, after I complete the work for this Ed S degree. I tell them that I like the high school students and that someone has to get them ready for college and further study," Walls said thoughtfully.

"Since I enjoy them so much, it might as well be me," he said, laughing.
Math Games At Lee Valued At $1,000

By LUCINDA DALLAS

“We want to change the traditional idea that math is hard. We want to show them (the students) that math is fun, motivating, as well as stimulating.” This idea along with a term paper entitled “Games in the Senior High School Mathematics Classes” prompted the students of Mr. R. E. Walls of R. E. Lee to create some very interesting instructional devices.

At the first of February, Mr. Walls assigned the pupils in his Algebra and Applied Business Math classes to create a game with their only guideline being “it must be related to math.”

The results are amazing. The display in Mr. Wall’s classroom includes such ingenious ideas as the Math Mountain Climber, Math Tic-Tac-Toe, Wheel of Algebra, Math baseball, Math football, Algebra Matching, Algebra Match Game ’79, Trig-Around, Math Password, Math dominoes, Math Checkers, Math Concentration, Trig Bingo, and an Algebra Russian Roulette Wheel. Also on display is a Math Yahtzee game which includes reconstructed dice of exponential powers. Cross word puzzles, flash cards, Math croquet, a wheel of chance, and hidden number games also appear. The students also produced several geo-boards and abacuses. An abacus is the ancient Egyptian counting device, man’s earliest calculator.

R. E. Lee Principal Kenneth J. Moore adds, “The workmanship is superb. If you think of the price of purchasing similar materials, I’d venture to say those young people have created $1,000 worth of equipment.”

Mr. Walls has had many visitors including R. E. Lee Junior High faculty and students, radio station WSFT, The Thomaston Times, Lee faculty and students, the City School Superintendent and his staff, and, of course, several curious parents. Anne Gower, Lee Art Instructor, said, “The learning games are most interesting and I was very impressed by the display.”

Eddie Hunt, one of Mr. Walls’ students, agreed that the games were a better approach to mathematics, “I enjoyed doing the work.”

Mr. Walls concludes, “The students have proven to me that they are concerned they have excellent ideas imbedded, they only need someone to bring these ideas out. Even the worst student has had excellent ideas in this project. Hopefully, these games will be useful to my students and all students within this system. The kids have been enthusiastic about constructing the various games.”
“Students Have Ideas
Imbedded . . . . They Only
Need Someone To Bring
Them Out.”
The students who participated in this research study were asked to express their personal views concerning the construction and the implementation of the mathematical games and recreational activities in their particular math classes at R. E. Lee Institute in Thomaston, Georgia. Their statements were as follows:

Making the games was fun. It gave some a chance to look into a new world of math. It was my first time having to do it. I think games should also be used for the kids who are just starting to school. It is just like listening to your mother read you a story when you were a little kid. Listening made you like to read, therefore, the games might make the kids like math.

Timothy Garland

Making a math game was the most interesting project I have been asked to do in school in a long time. It gave me a chance to use what I have learned in my own way. I think creativity is an important part of any individual's education.

I appreciate the chance we were given in Business Math, not only to use our creativity and skills, but to use it for the benefit of our grade. I enjoyed making the game with the knowledge that it would be graded on an individual basis and
not compared with anyone else's work.

Ann Corley

I think the games were a refreshing break from the regular way of teaching. People will listen better, I think, when they are doing something that's fun. Everyone likes games and with the games, you can understand mathematics better. The younger kids could get a head start at Algebra through the use of these games, if they wanted to. The games, in short, are refreshing and are a good way to teach. I would like very much to do another game. They're fun.

Kim Spires

I believe these games have helped many of the students learn more about different divisions of math. I think every math class should try making these games, because it would surely benefit the students. It also contributes to the learning of math and this would make it easier on them in later life.

Diane Dumas

The two games that I constructed took a long time and a lot of patience. Even though it took time and thinking, it was fun. If more time was available between working and school, I wouldn't mind doing it again.

Denise Akins

I feel that these games were worth all the time every-
one spent. They help you to understand and learn more in a fun way. I think they'll be appreciated in the years to come. Students love new and exciting ways of learning. Games will make them want to learn. I think that every student should have had a chance to make a game. Everyone will benefit from the games.

Robyn Burkette

I like doing these games and I also think the games are educational. They are fun and they help with many different areas of Business Math. If I had to do it all over again, I would do it because it gives you the feeling of creativity when you make something with your own hands. These games are interesting and it took time to create them. I liked the idea from the start to finish.

Howard Rogers

Using different types of math to invent your own games is fun and is a great learning experience, especially in the area of algebra. Games also helps in learning new terms related to math. It gives everyone a chance to design his own game. It will make students have a greater interest in math if they can play a game to learn new techniques of math.

Paula Sutton

Math games can be constructed in many different forms and ways, however, it doesn't matter how they are constructed. If the goal is achieved for the purpose of the game, the form
or way is not that important.

The more creative a teacher can be in making his or her class enjoyable for learning, the more the student will be enhanced to learn. I believe that more audio-visual aides should be used in the higher grades as well as the lower.

Marian V. Daniel

I think the games were very interesting because they showed how math could be fun and how it could be easier understood. It also showed, by the way the games were built, whether or not students were interested in building them or interested in math at all. I think it would be an interesting tool for explaining math fundamentals.

Chuck Coogler

Making and thinking up games were good experiences. It did take time and a lot of effort. I guess it's because I'm lazy and I didn't care about doing it. For someone very creative, it would be fun. It was fun this time, but I wouldn't want to do it again. Playing the games and learning from them will definitely be more fun than making them. It makes math more interesting and easier to learn for students rather than just sitting in class listening to the teacher talk.

Lisa Singer

Making the math games was really fun. It helped me to refresh my memory of how to solve equations that I have already had in Algebra I and II, and Geometry. It takes a little
time to solve the equations and to think about the answer in relation to the game. Being as creative as I am, I really enjoyed the time I spent in making all seven of my games. I would enjoy doing it again, as far as that goes. Making games shows the great talent that a person has and I feel that everyone has a talent and should share that talent with other people.

Angella Franko

In my opinion, the idea of games to help students learn, is a good one. The usual classroom work can have a tendency to get dull. The games will break the monotony of everyday classroom work. The students will learn a great deal and have a good time in the process. If the students won't abuse this privilege, it would most certainly be to their advantage.

Levonne Rhodes

I think my games, as well as the other games, were great. I enjoyed making them and I would like to do it again in about two months or so. Most of the games were very interesting. The games should make all students love math. In making my games, I really had a lot of fun and I really did have to think.

Tammy Garner

I enjoy doing the work very much. I believe people can learn more by making games and doing what they like. I
think it makes learning math easier.

Eddie Hunt

I enjoyed making the games and feel that doing this was beneficial to the class as a learning aid. I learned about a lot of games that I didn't know existed. I benefitted from the games because I had to go back and give myself a review of the different types of problems and equations in order to use them in the clues of the games. These games help sharpen your math skills and some even make you think quickly because you have to give quick responses. I think creative activities like this should be put to use more often in schools because it makes learning more interesting. When it becomes interesting to learn, then most people will try harder.

Lynn Brown

Making this game, Concentration, was fun for me and it seemed like everyone enjoyed doing it. I think it requires some thought to be able to play the game and its just the thing to get kids to enjoy algebra. Playing the game makes it fun to use your knowledge of algebra. I think games are great ways to make algebra, or for that matter, any other subject interesting and fun. These games also strengthen your comprehension and learning ability. Its a real treat from the regular routine.

Jeff Blankenship

Making my Hidden Equation Puzzle has been a real learning experience. I find it hard to try to learn something when
you simply don't like it. When we started building these games, it was fun, and now that we've started playing them, I've found that I have a more positive mental attitude toward algebra.

Our group also made a game. We got the idea from the TV game show, PASSWORD. We call our game the same thing. We used algebra words from our book. Before we put any words in the game, we made sure we knew what they meant. This has helped me a great deal in that I learned the meanings of algebra words that I never knew existed.

Kathy Kennedy

I like my game because I enjoyed making it. It was really a change from the same old boring algebra class. I think it was a great experience for everyone and everyone enjoyed it. The other games in the class, that we've played, have been exciting. My grades have improved greatly since we started to use the games in class. I think all teachers should use this method because it is fun and it is a change of pace from everyday classwork. I really enjoyed making it and I would advise any teacher to use this method of teaching. When I get my teacher's degree, I will certainly use this method of teaching.

Nancy Rabon

The game I made was Math Checkers. I think that with the use of this game, my class and I, and other classes in the
years to come will be more acquainted with the fundamentals of algebra. It helped me and some of my friends to find out things that we didn't understand in algebra. It really was fun and I would suggest this method to all teachers whose students are failing, or are in need of help with algebra. I think that the students who are doing pretty good could be helped too. It would help them and make them better students in math.

This method got students interested in their work and into making games. Best of all, it was a neat trip when we all joined in as a whole to play. There were many different games to play. All of the games could be worked in Algebra, Math and Trig.

GO FOR IT!! IT HELPS!! Some games do more for you than others, but THEY HELP.

Linda Fortner
APPENDIX D

Sources of Games
99


1. Tuf
2. Checkermatics
3. Chess for Juniors
4. Equable
5. Mastermind
6. 3-D Tic-Tac-Toe


1. Qwik-Sane: An Intriguing Topological Puzzle
2. Cutting Corners
3. The Real Numbers
4. Percento
5. In Order
7. On-Sets: The Game of Set Theory
8. Neurotic Nines
9. Euclid
10. Numo
12. Tri-Nim
13. Touchdown
14. Configurations
16. Mileage Rally
17. Logix
18. Strikes 'N' Spares

Sister M. Pancratia Beil, O.S.B., "Basketball''
Yes, Math. Can Be Fun! ed. by Louis Grant Brandes (Portland,
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2. Scoring 50
3. Chalkboard Relay
4. Winging Wild Geese
5. Around The Circle
6. Card Game
7. Penny Game

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