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AUTHOR Pickens, Teresa Lynn
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ABSTRACT

This study evaluates the effectiveness of a mnemonic approach to teaching about the solar system to non-leveled Grade 9 students versus a traditional outline format. A mixture of 54 regular and special education students participated in the control group receiving facts about the solar system through lecture and transparencies and recorded the information into an outline format. The experimental group of heterogeneous students (N=47) received the same facts in lecture and recorded the notes into a mnemonic format. Findings indicate that the students receiving the mnemonic instruction enjoyed the change and would use it in the future. It is recommended that future studies be done on mnemonic strategies of instruction. (Contains 44 references.) (Author/DDR)

The Effectiveness of Teaching Mnemonics in the Study of the Solar System.

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Teresa Lynn Pickens

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Salem, West Virginia

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7/15/98
Date

Gaby van der Giessen — Thesis Committee Chair
Gaby van der Giessen
Director of Graduate Education

7/15/98
Date

Gary S. McAllister
Professor of Education

Date

John F. Curran
Professor of Education

Abstract

This study evaluated the effectiveness of a mnemonic approach to teaching about the solar system to non-leveled 9th grade students vs. a traditional outline format. A mixture of 54 regular and special education students participated in the control group receiving facts about the solar system through lecture and transparencies. Students recorded the information into an outline format. The experimental group comprising of 47 heterogeneous students received the same facts in lecture and recorded the notes into a mnemonic format of Mind Maps and Keyword sayings.

Pretests and posttest were administered to both groups and a t-test evaluated that little significant difference existed between the two groups, but concluded both methods were effective. The students receiving the mnemonic approach said they enjoyed the change and would use the methods in the future. It is recommended that future studies be done on mnemonic strategies of instruction.

Chapter One

Introduction

A proposal has been made that by the year 2000 science students of the U. S. will raise their achievement scores to be ranked first in the world (Congress, 1994). To achieve this goal, teachers are being asked to improve skills, strategies, and knowledge of the subject to better prepare the citizens of tomorrow (Congress, 1994). One possible learning strategy to be considered to improve memory is mnemonics (Encarta, 1996). Studies have recommended that more research be done to determine the effectiveness of mnemonic methods in the classroom (Johnson & Obi, 1997).

Research Questions

1. Is a mnemonic approach to learning about the solar system appropriate for science students?
2. Are mnemonic strategies equally as effective as a traditional outline format approach in science?

Hypothesis

H_0: No significant difference in achievement exists between students using mnemonic strategies and students using an outline format when studying facts about the solar system.

Limitations

1. This research was limited to all students currently enrolled in Thematic Science 9.
2. This research was done in a small town school with an enrollment of 647 students in grades 7 – 12.
3. Thematic Science 9 is not a leveled course.
4. This research included 97% of the ninth graders and any student who has previously failed ninth grade science. (E.M.I. and M.M.I. students are not included.)
5. All scores of students who participated in the study were used in compiling results.

Definition of Terms

1. Auditory learner- Any individual who learns by hearing new information (Manktelow, 1995-98).

2. Learning style- The way a person learns new information (Manktelow, 1995-98).
3. Leveled course- Students are selected and placed into certain classes with similar abilities based on teacher recommendation, G.P.A., tests scores and achievement levels.
4. Link-word method- Mnemonic device, that makes associations between things, also known as Keyword method. (Manktelow, 1995-98).
5. Memory- The process of storing and retrieving information in the brain (Encarta, 1996).
6. Mind maps- Mnemonic device used to show relationships among facts (Manktelow, 1995-98).
7. Mnemonics- A mechanical technique devised to improve memory involving the use of associations and various devices to remember particular facts (Encarta, 1996).
8. Number/Rhyme method- Mnemonic device that associates an item to the rhyme of a number (Manktelow, 1995-98).
9. Number/Shape method- Mnemonic device that associates an item with the shape of a number (Manktelow, 1995-98).

10. Visual learner- An individual who learns by seeing information (Manktelow, 1995-98).
11. Tactile-kinesthetic learner- Any individual who learns by doing and manipulating objects (Manktelow, 1995-98).
12. Thematic Science- A course title from Coordinated and Thematic Science (C.A.T.S.) that overlaps the instruction of Life, Earth and Physical sciences into one discipline.

Assumptions

1. The teacher constructed testing instruments were valid.
2. Tests will accurately evaluated the level of memory recall of facts about the solar system.
3. Students in the research groups were similar to students in other schools.
4. Students placed in the control group and in the experimental group was done by random selection.
5. Students had not previously been taught to use mnemonic devices.
6. Students put forth an honest effort during pretests, instruction, practice, application and post testing.

7. Students had not previously studied the solar system in depth.

8. The sample was adequate in size.

9. The sample was typical of ninth grade students.

10. The time frame was adequate.

Importance of the Study

The research from this study determined if mnemonic methods of instruction are appropriate and/or effective memory enhancers for students studying facts of the solar system.

Chapter Two

Review of Literature

Introduction

The students of today are being called upon by the nation to raise their academic performance to meet the standards of an increasingly competitive world (Congress, 1994). The 103rd Congress (1994) passed the Educate America Act that made the following proposal:

> By the year 2000, all students will leave grades 4, 8, and 12 having demonstrated competency over challenging subject matter including English, mathematics, science, foreign languages, civics and government, economics, arts, history, and geography (Sec. 102).

In order to achieve this major goal, one of the National Education Goals set up by the America Education Act declares the following objective be directed toward the Nation's teaching force:

> All teachers will have continuing opportunities to acquire additional knowledge and skills needed to teach challenging subject matter and to use emerging new methods, forms of assessment, and technologies (1994).

A Need for Change

The Educate America Act has place the request in writing for a change in the educational process to take place, and has included the necessary National Education Goals to be followed in the process (1994).

Based on the government's mandate, it is necessary for a change to occur in the instructional techniques across all grade levels (Rafoth et al., 1997). Rafoth's work focused on the necessary promotion needed to develop effective memory skills and study aids in the students of all ages.

This is not the first time a major change has been attempted in the learning process. Attention was sparked by the cognitive revolution beginning in the 1950's to switch the focus from behaviorism and knowledge acquisition causing more emphasis to be placed on the study of how information was processed (Meuller & Meuller, 1994). Hilda Taba, a curriculum theorist of the 1960's, also recognized the need for change in the area of how students are to be taught to learn, recall, and apply new information (Joyce & Weil, 1996).

As stated in the National Educational Goals, teachers must take responsibility in improving skills to meet the demands of the challenging task set before them (1994). Teachers play a major role in the dissemination of various strategies to stimulate interest, improve concentration, and enhance comprehension (Richards, 1997). Exposure to a variety allows the student to choose the appropriate method to achieve an optimal level of retention and memory recall (Howard, 1994).

Study of Memory

Memory is one of the most underrated faculties in the education system, and fortunately teachers are in the memory business (Kelly, 1997). Class performance and written exam success are dependent on the use of memory techniques and how the student processes information (Hamachek, 1990). "Memory is like a muscle - the more it is used, the better it gets. The more it is neglected – the worse it gets" (Manktelow, 1995-98). Based on this belief, individuals need strategies to enhance memory levels to compensate for forgetfulness. The following are believed to be reasons for forgetfulness: memory naturally fades over time; memories become distorted and change with the aging process; interference occurs when knowledge is gained; and individuals purposely repress certain events (Encarta 96, 1995).

Researchers theorize about the proper processes of memory and agree that continued work should be done on the physiology of the brain and memory storage (Encarta 96, 1995). Many researchers also agree that learning to learn is a major goal of the educational process (Joyce et al., 1996). All students have the ability to learn and must realize their potential if the U. S. is to prosper (Congress, 1994).

Introduction to Mnemonics

Many learning strategies are available for students to adopt and practice depending on their learning styles (Manktelow, 1995-98). Learning styles are important, but will be discussed later. One possible strategy for increasing memory is mnemonics (Encarta, 1996). A mnemonic is a word or phrase used to jog the memory to help recall information that would otherwise be difficult to remember (WWW Encyclopedia, 1996). Mnemonics work by forcing the individual to associate the information to be learned with something that is already familiar to the individual or with something that would be easier to remember (The Princeton Review, 1997)

History of Mnemonics

It is uncertain how far back mnemonic strategies date. It is known that prehistoric cave paintings of symbols and pictures have been discovered which are believed to depict the important events in a clan's history to be passed down through the generations (Encarta 96, 1995). Many symbols are used throughout the Bible to help individuals remember the importance of faith. For example, a cross is used as a symbol to represent the Christian way of life. It is written, "Take up the cross and follow Me" (Mark 10:21).

It is believed that early poets and balladeers formed the groundwork of rhyming in poetry. Their thoughts and songs had to be remembered because of the inability to record them. In order to keep the poem or ballad in their heads, they would rhyme the words at the end of the lines. This was done to ease the burden of memory (The Princeton Review, 1997).

Mnemonic Examples

In everyday life, individuals may use mnemonic strategies without being aware of them (Mankelow, 1995-98). For example, the "thirty days hath September" rhyme is used to remember the number of days in each month. "Spring forward, and fall back" helps to remind people the clock settings for daylight savings (Davis, 1997). "Lefty loosey, righty tighty" is a memory tool used to properly manipulate fasteners (Hargis, 1996). A way to remember how to spell arithmetic is using the first letter in each word of the phrase, "A rat in Tom's house might eat the ice cream (Hargis, 1996).

Many mnemonic devices are helpful in remembering the proper sequence of things (Hargis, 1996). For example, "Roy G. Biv" (Red, orange, yellow, green, blue, indigo, and violet) is used to remember the colors of the rainbow from the outside towards the inside, or "All cows eat grass" and "Every good boy does fine" are used to list the notes of music staff (Hargis,

1997). Another musical mnemonic saying, "Father Charles goes down and eats bananas" is the order of sharps on a scale. FCGDAEB (Davies, 1996)

Catchy mnemonic rhymes are used throughout the different content areas so students can remember information like, "In fourteen and ninety – two, Columbus sailed the ocean blue..." (The Princeton Review, 1997). The saying, "'I" before 'e' except after 'c', and in words that say 'a' as in 'neighbor' and 'weigh'" could be used daily in various classrooms. A good teaching tool for reading comprehension is "SQ3R" representing survey, question, read, recite and review. To insure a thorough questioning technique requires the "5W's" of who, what, where, when and why (Shaughnessy, 1990).

Memorization Tips

The task of memorizing new information to expand knowledge is a daily requirement that begins at birth (Joyce et al., 1996). Receiving, filing, and recalling information at will is essential for success and well being (Joyce et al., 1996). Students must accept the responsibility to learn new information to perform at a higher level (Congress, 1994). The following list consists of specific suggestions that will help students learn new information more easily: reduce distractions; identify strengths and

weaknesses; review frequently; avoid cramming; paraphrase, repeat, relate; study in the morning; get a tutor for help; maintain a healthy diet; ask questions; know academic limitations; and develop memory tricks to keep new information (Shaughnessy, 1990). Mnemonic devices are memory tricks that are introduced to help students obtain new information and apply that knowledge in problem-solving situations (Carney et al., 1993). The human memory uses images, colors, structure, sounds, smells, touch, and emotion to help make sophisticated interpretations about the surrounding environment. Mnemonics seeks to use all of these stimuli to increase recall (Manktelow, 1995-98). Another memorization tip is that mnemonic devices tend to be more effective when the students design them themselves, although it is thought provoking to see other people's mnemonic creations (Hargis, 1996).

Learning Styles

Each teacher and student must consider one important factor and that is to choose the proper mnemonic method that compliments the student's learning style (Manktelow, 1995-98). To determine a student's learning style, a teacher could discuss or describe the differing criteria of each style and have the student determine which best describes him or her. This could

be done orally or with a survey checklist (Ellis, 1996). Another alternative is for the teacher to monitor each individual and determine the learning style. The later would not be practical in a larger classroom setting with numerous students, although it could be done with time.

The first style is the visual learners who make up 65% of the population. This group relates most effectively to written information, such as notes, diagrams, charts and pictures. They must rewrite handouts or see notes being written on the chalkboard or overhead. They become frustrated during quick lectures. Visual learners can be identified as those who take reinforcement notes in the margins of printed handouts or in the book (Manktelow, 1995-98).

Specific characteristics a teacher could look for to help identify the visual learners in the classroom are the students who ignore verbal instructions unless they are watching the speaker's mouth (Ellis, 1996). These students tend to be good spellers; appear to be obsessive with their note taking; do well with the comprehension of graphs, maps, symbols and charts, and confirm their own actions by watching what others are doing (Ellis, 1996). When studying, visual learning students need a neatly kept area to reduce the distraction of clutter, and need reinforcement pictures with the material (Ellis, 1996).

The second style makes up 35% of the population and these people are referred to as auditory learners. This group learns best by hearing new information aloud. They excel during lectures remaining inactive in note taking until the conclusion of the presentation of material. These students may be poor note takers because note taking interferes with their listening. To study, auditory learners reread notes out loud to themselves (Manktelow, 1995-98).

Specific characteristics of auditory learners in the classroom are students who tend to be excessive talkers because of not feeling comfortable with silent moments and the need to have oral cues (Ellis, 1996). One suggestion Nancy Cheatwood Ellis (1996) makes regarding auditory learners is to create a quiet place to study so that the student can verbally recite the information to be learned. Providing a tape recorder to have them listen to themselves studying, or a study partner to read to, or have the partner read aloud to the student are other helpful hints for teachers to provide an optimal learning environment (Ellis, 1996).

The remaining 5% are known as the tactile-kinesthetic learners who learn by doing. These students learn more effectively when they are allowed to actually manipulate objects and greatly benefit from hands-on activities. Tactile-kinesthetic learning students learn efficiently through imitation and

practice. These students may appear as slow learners or underachievers because most information is not presented in a "learn by doing" format (Manktelow, 1995-98).

Target characteristics of tactile-kinesthetic students are those who seem to always be moving by rocking or leaning back in their chair, shaking their leg or foot, tapping their pencil or getting out of their seat. These actions label some students as hyperactive, as well as other cues such as touching everything, talking fast and with their hands or interrupting others as they talk (Ellis, 1996).

It must be understood that all mnemonic devices will not work for everyone, as each person has a combination of overlapping modalities for learning (Ellis, 1996; Manktelow, 1995-98). To be effective, mnemonic devices must appeal to individual learning styles and to the student. Auditory learners should design memorable sayings to recite. Kinesthetic learners should imagine performing or interacting with memory cues, and visual learners should make the memory tricks visually appealing (Manktelow, 1995-98).

Mnemonic Strategies

With learning styles considered, only four of many different methods of mnemonics will be discussed: Link Method, Number/Rhyme System,

Number/Shape System, and Mind Maps. Link-word method, also known as keyword, is the easiest technique to use when learning new information. The student makes associations or links between things that are known to things in a list to be learned. This is done by using the first letter of the word and using a familiar word to generate a phrase that will be easier to recall than the raw information in the list (Manktelow, 1995-8). It is often easier for the student to remember the keyword/s to help recall the less familiar information. Levin, Pressley and Miller, (1986) specialists in the field of learning, found this technique to be 50% more effective than the traditional rote methods.

Many phrases have been created as examples of the Link-word or Keyword method and one is, "Porky pig makes delicious supper on Christmas" (Davie, 1997). This statement uses the first letters of the seven Paleozoic Periods to generate an easier trigger to recall rather difficult information and places them in the proper order from youngest to oldest. (Permian, Pennsylvanian, Mississippian, Devonian, Silurian, Ordovician, Cambrian). An example used to remember the seven Levels of Classification of living things is, " Ken poured coke on Fran's good skirt" which stands for Kingdom, Phylum, Class, Order, Family, Genus and Species. To help remember the order of calculations in algebra is the saying,

"Please excuse my dear Aunt Sally" which represents parentheses, exponents, multiplication, division, addition and subtraction (Hargis, 1996). "No plan like yours to study history wisely", represents the houses of the British royal family in chronological order. They are Norman, Plantagenet, Lancaster, York, Tudor, Stuart, Hanover and Windsor (Hargis, 1996).

The Number/Rhyme System is a simple way to remember lists of items in a specific order by using a rhyme of the number and associating it with images (Manktelow, 1996). An example is One – bun, Two – shoe, Three – tree, four – door, five – hive, six – bricks, seven – heaven, eight – skate, nine – dime, and ten – hen. This method is for lists of ten or fewer, unless special rhymes are made for the later numbers.

This method works by imaging, describing or drawing the following items in the list: the first item on the list with a bun on top of it or it between a bun; the second item being kicked or stepped on by a large shoe; the third item sitting in or carved into a tree; the fourth item is on or getting slammed in a door, the fifth item in a beehive; the sixth item has a pile of bricks on top of it; the seventh item having wings or a halo or in the clouds; the eighth item riding on a skate; the ninth item on the face of a dime; and the tenth item being sat upon by a hen or a hen watching it being hatched from an egg. These images must be made vivid for the student to be able to recall, if not,

then another image should be created. This type of mnemonic method can satisfy all of the learning styles in the classroom by the students actually drawing, seeing and hearing the pictures described (Manktelow, 1995-8).

The Number/Shape System is similar to the Number/Rhyme System as both are best used for short lists of ten or less items and learning them in a specific order, which easily identifies if an item is missing (Manktelow, 1995-8). The Number/Shape method works by using the shape of the number and associating it within an image of the items (Manktelow, 1995-98). An example is the number 1 looks like a candle or spear. Image a spear through the first item. Number 2 looks like a swan with a long neck, so image the second item resting on the back or the mouth of a swan. The number 3 should be rotated 90 degrees clockwise and the item is drawn resting in the two pouches. The number 4 looks like a sail of a boat. A 5 looks like a meat hook or a seahorse facing the right. The number 6 may resemble a golf club swinging to hit an item. The number 7 looks like an edge of a steep cliff with the item balancing on it. The number 8 looks like a racetrack. The number 9 resembles a balloon with a string fling away with the item tied to it. The number 10 looks like a pond with a fishing pole beside it with the item hooked onto the end of the line.

Mind Maps are the last to be discussed. Mind Maps mnemonics are designed to improve note-taking skills, check for understanding, identify key information and do away with the traditional outline method. Mind Maps use a whole sheet of paper to show the relationship of the information in a summarized 2-dimensional diagram. They provide a unique study tool made by the student to glance over prior to a quiz or test (Manktelow, 1995-8).

Mind Maps are constructed by having a student read the text aloud and forming a class discussion of the facts. The students write the main topic in the center of the page and branching from it are the sub-topics and related information. The teacher constructs a Mind Map, as well, on the chalkboard or the overhead to follow as an example and to reinforce the student's work. It looks like an organized spider web when completed.

Mind Maps are very effective for Visual learners to see how the facts are interconnected as one of their strengths is reading charts. Tactile-Kinesthetic learners benefit by constructing a Mind Map using their hands and participating in the discussion of the material to find the key information. The Auditory learners satisfy their study needs by listening to the oral discussions and hearing the information read aloud by their peers or teacher.

Mnemonic Studies Found Effective

Numerous studies have been performed on mnemonic methods upon a wide range of students with varying abilities to determine the effectiveness in the classroom. Work has been done in all subject areas and with all ages of students from kindergarten to college. Most of the following studies prove to support the effectiveness of mnemonics by using a control group as a base for comparison to measure the differences in the experimental group who received mnemonic instruction in each case.

A study using a combination of 41 regular and special education students in junior high school found that both types of students in the experimental group significantly benefited from having content information presented to them in a mnemonic style. The students receiving mnemonic instruction recalled more information than the control group who received no special learning strategy (Bulgren et al., 1994). A similar study using 48 special education and regular students in the eighth grade by Letendre (1993), found students in the experimental group taught History facts preferred mnemonic instruction over traditional teaching methods of lectures, outlines, and handouts. The results of the tests given at the conclusion of the History unit showed students with and without learning

disabilities (L.D.) improved memory recall of facts over the students taught using a traditional non-mnemonic approach (Letendre, 1993).

Johnson and Obi (1995) focused their study on students with learning disabilities in the area of particular concern, spelling. Poor spelling skills create frustration for L.D. students. Researchers have found L.D. students to lack efficiency in their methods of information recall. Johnson and Obi suggests mnemonic strategies such as keywording, auditory memory and imaging be taught to all learning levels of students so to be helpful in improving spelling skills (Johnson and Obi, 1995).

Regular education students were the center of the following studies and proved mnemonic strategies to be successful in the classroom. Solvberg and Valas (1995) studied 107 six graders learning application skills in reading. The experimental group was taught using mnemonic-imagery, which teaches the student to create vivid and exaggerative images in their mind. The control group received no strategic method for reading. The group to remember more precise details from the passages was the mnemonic-imagery students of the experimental group. Deborah Best (1993) used a class of third graders taught mnemonic organization skills to prove successful by exhibiting better recall of items than another class who received no mnemonic organization training.

John Levin's research group (1992) pooled various ages of students to be divided into a control and experimental group. The target group to participate in the study comprised of 52 third graders, 75 fourth graders, 132 seventh graders and 162 eighth graders. Their experiment was to determine the effectiveness of mnemonic keyword method in vocabulary instruction to be exposed to the experimental group. At the conclusion of the study the results proved the students taught the keyword method achieved a higher level of vocabulary usage than those students in the control group who were taught to use sentence-context and free-study methods.

Frederick J. Brigham (1993) performed a study using 72 middle school students with learning disabilities. The work was done in the area of geography in teaching specific locations and relating facts on maps. The experimental group was given a mnemonic map with keywording and imagery pictures. The control group was given a traditional map and realistic pictures. Results showed the student performance of experimental group was unmistakably and considerably enhanced as compared to the control group performance.

In the area of education exists many students with varying abilities and needs. A continual research is sought to find an effective method or approach to improve the level of learning in students with special needs

(Letendre, 1993). Hearing-impaired children are an example of students with special needs. Parasnis and Conklin (1991) taught 18 deaf college students new English vocabulary words using the mnemonic keyword method. The control group in this study consisted of 13 deaf students learning the same vocabulary only using their own learning techniques. An immediate and delayed testing was done at the conclusion of the unit, and calculations showed a substantially higher recall of vocabulary and definitions by the experimental group both immediately and long-term as compared to the personal techniques used by the control group.

Gifted students are on the other end of the spectrum of students with special needs. A study by Rowlison and Merta (1993) focused on eight gifted minority students in elementary school studying World Geography facts. The study was broken into two phases, mnemonics and lecture. Both approaches were used to teach several lessons to the eight students, half the lessons were mnemonics and half were lectured. At the conclusion, tests on the World Geography material covered showed the mnemonic method to be more effective than the lecture method.

Remedial and non-remedial readers were the focus of Marcia Lipson (1994). A group of college students was assigned to a control or experimental group with both having remedial and non-remedial readers.

The experimental group was taught reading skills using mnemonic-imagery while the control group received no specific strategy instructions. The conclusion of the study showed that both remedial and non-remedial reading students taught to use vivid imagery scored substantially higher on comprehension tests than those who used no specific strategy (Lipson, 1994). This study reinforces a similar study done the previous year that had concurring results (Solvberg et al., 1995).

As documented in the above, many studies on mnemonics strategies exist and have proven the learning strategy to be useful, successful, and effective in a variety of ages, subjects, and learning levels. An endorsing study by Mastropieri's study team (1994) even proved that mild mentally impaired students could be taught content using a mnemonic approach and concluded that the students enjoyed the new type of instruction.

Perhaps the greatest mnemonic success case concerns Harry Lorayne, who is famous for memorizing entire telephone directories. He confesses to using a memory technique that enables him to recall names, phone numbers, and addresses (The Princeton Review, 1997). Another individual of deserving recognition is Dominic O'Brien, who is regarded as the memory champion in Tony Buzan's book, "Buzan's book of Genius". (Kirby, 1995). O'Brien's extensive mnemonic tactic has been published as The Dominic

System, and uses a confusing combination of code numbers, initials of famous people, and vivid images. Few have been able to mimic the process, but is said to be quite powerful if a large investment of time and energy is invested (Kirby, 1995).

Effective Mnemonic Studies in Science

A great deal of research has been done in the subject of science and results have found mnemonic strategies effective in increasing information retention in students, as shown in a study of the characteristics of North American minerals (Levin et al., 1986). Eighth graders taught the different qualifications between eight minerals using mnemonic instruction produced a higher level of recall than those not using a mnemonic approach. Fifty-three students with learning disabilities were taught several possibilities that may have caused the extinction of the dinosaurs. The students with mnemonic instruction recalled more reasons for extinction than students who learned by receiving direct instruction from the teacher (Scruggs et al., 1993). A study consisting of 136 college students studying plant classification proved that students using pictorial mnemony achieved at a higher level on immediate and delayed testing than students using a traditional means of learning (Levin & Levin, 1990).

Two emotionally disturbed sixth-graders were taught new science terminology using the mnemonic keyword method. The results showed mnemonic strategies, when adjusted to fit the needs of the student, can be effective in elevating the retention of science terms as well as increasing the desire to acquire new information (Nolan & Polloway, 1997). A study of thirty-seven middle school students with mild disabilities found that a positive impact was made with favorable results by the students taught new science terms using the keyword method of mnemonics verses a systematic approach taught to the control group (King-Sears et al., 1992). The compiled results from sixty-six different reports studying mildly to sever disabled students in the specific area of science recommends students with special needs be provided appropriate instruction, mnemonic strategies and hands-on activities (Mastropieri & Scruggs, 1992).

Mnemonic Studies Found Ineffective

Mnemonic methods have also been found to be ineffective in several studies for various reasons. A study by Chubb (1997) found most of the fourth graders in her target group receiving mnemonic lessons achieved the objective of 80% accuracy in learning to properly use the keyboard. However, poor effort put forth by a few students was the reason for failure

and the continuation of using the "hunt and peck" method. A study by Krinsky and Krinsky (1994) found that fifth grade students taught using peg-word mnemonics to learn lists of common nouns had an immediate incontestable effect by scoring higher on tests of recall. The study concluded though that the method provided no significant advantage of recall efficiency on a long-term basis, and many students suffered a greater level of forgetfulness than those students who received no mnemonic training (Krinsky et al., 1994).

A study by McCarville (1993) describes the limitations found to exist when using keyword mnemonics to help students learn new vocabulary. This study was aimed at remedial reading college students in language acquisition for the development of a broader vocabulary base and understanding. It concluded, the method does not teach the student application skills of the recalled information to new knowledge, as students had difficulty in using the new terms in everyday language.

Supporting Procedures

Mnemonic methods of instruction can only be effective in the classroom setting if presented with supporting procedures (Mastropieri & Scruggs, 1995). The teacher needs to provide a rationale, model the

strategy, provide verbal practice with feedback, and train the students to transfer the knowledge to other areas (Fulk, 1994). The key to making mnemonics successful is to make them memorable (Joyce et al., 1996). The following are tips to making mnemonics more memorable. Be positive and use pleasant images. Use humor by making the images funny. See the images in vivid color. Use all the senses. Exaggerate the size of important parts in the image to be remembered (Manktelow, 1995-8). Dominic O'Brien, World Memory champion, believes, "Image is the key to memory" (Hargis, 1996).

Conclusion

Mnemonics, if applied correctly, can make the task of learning new material more manageable (Chubb, 1997). A goal of the education system is to teach students to be independent thinkers who will contribute to society (Congress, 1994). A goal of teachers is to supply numerous learning techniques to the students that will help to achieve a higher level of thinking (Joyce et al., 1996). One such technique to be considered is mnemonics, which has been proven to be effective (Levin, 1992) and ineffective in the classroom (Wang et al., 1995). Regular education teachers have previously received an "F" rating for not effectively implementing or promoting the

mnemonic strategy in the classroom; however, special education teachers are found to be successfully applying the strategy and thus have received the letter grade of "A" (Levin, 1993). It is recommended that additional research be done to determine the effectiveness of mnemonic methods of instruction (Johnson et al., 1997).

Chapter Three

Methods

Research Questions

1) Is a mnemonic approach to learning about the solar system appropriate for science students in the ninth grade?
2) Are mnemonic strategies as equally effective as individual learning approaches in science?

Hypothesis

H_0: Students who learn about the solar system using mnemonic devices will achieve equally as well as students who use individual learning approaches.

H_1: Students who learn about the solar system using mnemonic devices will achieve higher tests scores than students using individual learning approaches.

Subjects

The target subjects of this study entering the ninth grade were randomly placed into Thematic Science 9 classes by a computer during the summer scheduling process. Many variables were considered when

choosing students and/or classes to be placed into the control group or the experimental group. The goal was to have a fair and equal representation of freshman with varying achievement levels included in both study groups prior to pretesting and instruction. Other variables included are the time of day, diet, age, male to female ratio, grade point average (G.P.A.) and Stanford Achievement Tests (S.A.T) scores

The control group designated in this project consisted of students enrolled in class periods 4 and 6 having 26 males and 28 females totaling 54 subjects. The experimental group consisted of 47 students having 19 males to 28 females forming periods 1 and 5. Each study group consisted of a morning class meeting prior to lunch, and an afternoon class meeting after lunch. The purpose of this arrangement was to insure fairness to both groups by equating the variables of rest and diet.

The ages of the subjects were compared at the time of the study in May of 1997. The average age of students in the control group was 15 years and 2 months old. The oldest student in the group was 16 years and 1 month, while the youngest was 14 years and 8 months old. A range of 1 year and 5 months existed within the age of control group individuals. In the experimental group, the average age of the group members was 15 years and 1 month old. A range of only 1 year and 1 month was created by the oldest

student of 15 years and 8 months, and the youngest member at 14 years and 7 months.

Grade Point Average (G.P.A.) was the next criterion considered in group assignment, which is a teacher evaluation of student performance in the classroom. The control group compiled a G.P.A. of 2.824 on a 4 point scale. The grades in the group ranged from 0.833 to 4.0. In the experimental group, students produced a 3.067 G.P.A. with a range of 1.385 to 4.0.

In the area of test evaluated averages, the control group performed at a higher level by compiling a National Percentage Rank of 72.48 on the Stanford Achievement Test Series, Ninth Edition on the Science sub-test. (The S.A.T. was administered prior to this mnemonic study.) The lowest performance was a 24% and highest was a 98%. The control group also registered a 6.44 on the National Stanine Ranking on a scale of 1-9. The average of the experimental group on the National Percentile Ranking was 70.72 in the science area with a range of 24% to 99%. The National Stanine Ranking was a 6.49 with a range from 3 to 9.

Design

The design of this study was to provide the same information about the solar system to two equal groups over a three-week period. The control group was given the information in a traditional style of lectures and transparencies as the student copies the information into an outline format. This style requires each student to apply individual techniques for learning. The experimental group was taught by writing the information in a mnemonic style of Keyword method and Mind Maps. A pretest and posttest were administered at the appropriate times and the scores were used to discover whether a correlation existed between mnemonic style of learning and individual learning styles of students.

Procedures

All students in 9th grade Thematic Science were given a 50 question pretest (Appendix C) prior to instruction on the solar system. During the three week span (½ a grading period), notes were administered covering the items on the test plus additional information about the solar system to create interest. Students were monitored on a daily basis for participation and attentiveness.

The control group of periods 4 and 6 was given information during lecture and from transparencies on the overhead projector. Each student was responsible to copy his/her own notes into an outline format onto paper. Each student's notes were checked at the conclusion of each lecture for completion, accuracy and comprehension.

The experimental group of periods 1 and 5 was given the same factual information about the solar system during discussion while using the overhead projector. Rather than placing the notes in an outline style, the class designed and agreed upon sayings to help them remember different listings of planet information. Appendix A is an example of one of the class period's Keyword method. Information regarding terminology, space crafts, satellites, and general facts about each planet was compiled onto a Mind Map using the overhead projector. A separate Mind Map was constructed for each planet at the time of instruction to show the connection of information. Appendix B is an example used for one of the classes.

During the course of instruction, supporting videos were shown and students in both groups participated in the same activities to add reinforcement and interest to the material. At the conclusion of instruction, a posttest was administered to both groups. (Appendix D)

Instrumentation

The teacher constructed pretest (Appendix C) and posttest (Appendix D) covered the material discussed over the three-week period of study. The test items included the following: 18 listing questions about the different order of the planets; 17 matching items dealt with terminology, spacecrafts and satellites; and 15 multiple choice questions that focused on general facts about the solar system.

The pretest and posttest were checked for correctness. The scores of the experimental group were compared to the control group by using a t-test to determine if the two groups scored equally. The results of the t-test determined whether mnemonic strategies are more effective and appropriate for science students learning about the solar system.

Chapter Four

Analysis of Data

Introduction

This study was designed to test the effectiveness and appropriateness of using mnemonic methods of instruction about the solar system using ninth grade Thematic Science students. The traditional lecture method and outline format of note taking was presented to the control group as compared to a mnemonic approach of Mind Maps and Keyword sayings presented to the experimental group. After a three-week period of instruction, pretest and post tests were taken, and data was compiled using z-values, P-values, and t-tests, a conclusion was formed to determine which hypothesis was correct.

H_0: Students who learn about the solar system using mnemonic devices will achieve equally as well as students using a traditional outline format.

H_1: Students who learn about the solar system using mnemonic devices will achieve higher tests scores than students using a traditional outline format.

Subjects

One hundred and one students in ninth grade Thematic Science who participated in this study took the same pretest prior to instruction on the solar system. At the conclusion of the pretest, a preliminary comparison of the randomly chosen control group and experimental group was made, and the following data was compiled.

Table One

Preliminary Comparison

Criterion	Control	Experimental
Total Students	54	47
Male to Female Ratio	26 : 28	19 : 28
Average Age	15 years, 2 months	15 years, 1 month
Age Range	16 years, 1 month	15 years, 8 months
Oldest to Youngest	14 years, 8 months	14 years, 7 months
Grade Point Average	2.824	3.067
G.P.A. Range	4.000 to 0.833	4.000 to 1.385
Stanford Achievement Test in Science	72.48%	70.72%
S.A.T. Range	98% to 24%	99% to 24%

Table One (Con't)
Preliminary Comparison

Criterion	Control	Experimental
Solar System Pretest Mean Score	20.407	23.298
Variance	49.718	57.866
Standard Deviation	7.051	7.607
Range of Scores	32	30
z-Value	-1.971	
Critical z	$\pm$1.960	
P-Value	0.049	
Significant value	0.05	

A hypothesis test for the mean of the two independent samples evaluated a P-Value of 0.0487, which falls below the 0.05 significant value. The test resulted in rejection of the null hypothesis because of the z-value falling outside the accepted area of $\pm$1.9600. The sample provides evidence

to reject the claim, as well. The groups were similar when compared prior the instructional unit of study.

Evaluation of the post test scores produced by both groups after the three-week instructional period showed great improvement when compared to the pretests. The following table shows the comparisons and results.

Table Two

Post Test Comparison

Criteria	Control	Experimental
Sample size	54	47
Mean	38.481	41.426
Variance	76.216	42.511
Standard Deviation	8.730	6.520
Range of scores	36	31
z-Value	-1.935	
critical z	±1.960	
P-Value	0.053	
Significant value	0.05	

Final analysis of the control and experimental group post test scores found the z-test compiled a z-value of –1.9352, which fell within the accepted area and thus fails to reject the null hypothesis. Acceptance of the null hypothesis concludes that no significant evidence of difference occurs between the two groups and the instruction styles. This sample does not provide enough evidence to reject the claim.

A final analysis in the study tested the hypothesis for the mean of the two dependent samples of pretest vs. posttest from the control and experimental groups. The final comparison and calculations are below.

Table Three

Hypothesis Test for the Mean of Two Dependent Samples

Criterion	**Control**	**Experiment**
Sample size	54	47
Difference Mean	18.07	18.13
Difference St. Dev.	8.795	6.996
t-Value	15.101	17.765
critical t	±2.006	±2.013
P-value	0.000	0.000
significant value	0.05	0.05

The control and experimental groups fell far above the accepted area of ± 2.0 despite the difference of means showing to be quite close with a value near +18. Both the null hypothesis and the claim were rejected in this evaluation.

The results provide no reason to reject the null hypothesis, as both groups achieved at an equal level regardless of the learning approach. Students of the experimental group, as well as the control group showed significant and nearly equal improvement on the posttest at the conclusion of the instructional unit.

Chapter Five

Discussion

The results of this study showed that no significant difference exists between student's scores taught in a mnemonic style verses the traditional outline format approach when teaching 9th grade Thematic Science students about the solar system. Both learning approaches proved to be effective by showing an improvement in student's scores on the posttest.

Students in the experimental group agreed that they enjoyed the change in note taking and studying with Mind Maps and Keyword sayings. When asked at the conclusion of the unit, most of students said they would use mnemonics when studying in other classes and in the future and requested that future units have similar instructional approach. The few students in the experimental group not in favor of a mnemonic approach claimed it required too much paper and was too much work in class.

Implications for Future Research

1) Provide and implement mnemonic strategies other than Mind Maps and Keyword sayings.
2) Alter the study period of three weeks to meet the needs of the course, material, students, teacher and grading period.

3) Allow students to choose between mnemonics and outline approaches of learning.
4) Show how mnemonic devices can be altered to be used in other discipline areas.
5) Conduct a study on mnemonic strategies comparing the sexes to see if males or females are more responsive.
6) In addition to comparing achievement, a future study might include a scale measuring how students feel about science.

Summary

This study finds both the mnemonic approach and the traditional outline format are effective and appropriate paths of instruction to use when teaching about the solar system in 9th grade Thematic Science. A teacher could choose either approach and, if implemented and reinforced properly, could guide students to successful learning, as well as to provide them with the tools for gaining future knowledge. This study was approached with a concern and desire to find a method of instruction that may improve student confidence and achievement in science, as well as to decrease the negative milestones that may exists in the paths of students with the idea that science is a cumbersome subject.

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Appendix A

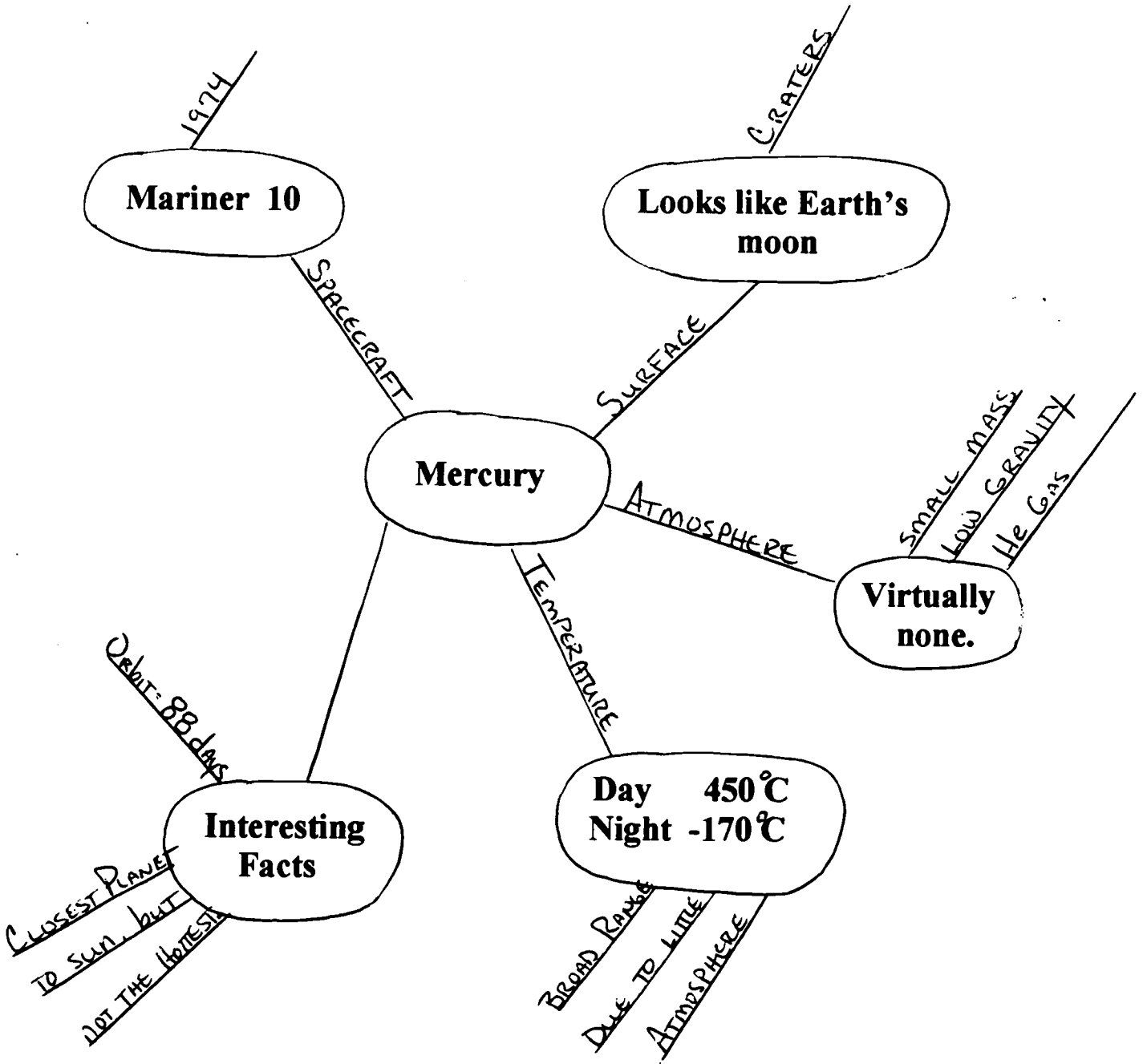
Keyword Method

Order of Planets From Sun Outward Currently.		Order of Planets From Smallest Diameter To Largest.	
Mercury	My	Pluto (.18)	Please
Venus	Very	Mercury (.38)	Make
Earth	Educated	Mars (.53)	My
Mars	Mother	Venus (.95)	Veggies
Jupiter	Just	Earth (1.0)	Extra
Saturn	Sat	Neptune (3.9)	Nutritious
Uranus	Upon	Uranus (4.1)	Using
Pluto	Pine	Saturn (9.5)	Strawberry
Neptune	Needles.	Jupiter (11.2)	Jam.

Appendix B

Mind Map

Planet Facts



Appendix C

SOLAR SYSTEM "PRETEST"

DIRECTIONS:

COMPLETE THE FOLLOWING PRETEST QUESTIONS OWN YOUR OWN PAPER. NUMBER YOUR PAPER 1-50. COMPLETE TO THE BEST OF YOUR ABILITY.

PART I. LISTING

1. – 9. LIST THE 9 PLANETS *IN ORDER* FROM THE CLOSEST TO THE SUN TO THE FARTHEST.

10. – 18. LIST THE 9 PLANETS *IN ORDER* FROM THE SMALLEST IN DIAMETER TO THE LARGEST.

PART II. MATCHING

TERMINOLOGY

CORRECTLY MATCH THE DEFINITION WITH THE PROPER TERM.

A) GALAXY	D) RETROGRADE	G) SOLAR SYSTEM
B) MILKY WAY	E) REVOLUTION	H) UNIVERSE
C) ORBIT	F) ROTATION	

19. CONTAINS MILLIONS OF GALAXIES OF VARIOUS SIZES.
20. MADE UP OF HUNDREDS OF BILLIONS OF STARS AND REVOLVING PLANETS.
21. THE BACKWARD ROTATION OF A PLANET.
22. ONE COMPLETE TURN OF A PLANET ON ITS AXIS TO INCLUDE ONE NIGHT AND ONE DAY.
23. AMOUNT OF TIME IT TAKES A PLANET TO MAKE ONE COMPLETE ORBIT AROUND THE SUN.
24. NAME OF EARTH'S GALAXY.
25. INCLUDES THE SUN, 9 PLANETS AND SATELLITES.
26. THE FIXED PATH TRAVELED BY OBJECTS AROUND PLANETS OR THE SUN.

SPACECRAFT

CORRECTLY MATCH THE PLANET WITH THE SPACECRAFT THAT EXPLORED IT.

27. EARTH
28. MERCURY
29. MARS
30. JUPITER, SATURN, URANUS and NEPTUNE

A) MARINER 10
B) APOLLO
C) VOYAGER 2
D) VIKING

SATELLITES

CORRECTLY MATCH THE SATELLITE WITH THE PROPER DEFINITION.

A) ASTEROID
B) COMET
C) METEOR
D) METEORITE
E) METEOROID

31. SPACE ROCKS THAT STRIKE THE EARTH'S SURFACE.
32. SMALLER SATELLITES THAT ORBIT SOME PLANETS OR THE SUN.
33. ROCKS THAT ENTER EARTH'S ATMOSPHERE.
34. PIECES OF ROCK FROM COMET'S NUCLEI OR ASTEROIDS.
35. CHUNKS OF ROCK AND ICE THAT FORMS A TAIL IN SPACE.

PART III. MULTIPLE CHOICE

CORRECTLY CHOOSE THE LETTER OF THE BEST ANSWER FOR EACH QUESTION.

36. IT'S THE ONLY PLANET THAT WATER EXISTS IN ALL THREE STATES OF MATTER.
A) MARS B) MERCURY C) VENUS D) EARTH
37. THE PLANET'S SURFACE THAT LOOKS LIKE EARTH'S MOON.
A) URANUS B) NEPTUNE C)MERCURY D) MARS
38. PLANET THAT IS THOUGHT TO BE AN ESCAPED MOON OF NEPTUNE.
A) JUPITER B) PLUTO C) URANUS D) EARTH

39. THE FARTHEST PLANET FROM THE SUN, TODAY.
A) NEPTUNE B) PLUTO C) URANUS D) SATURN

40. THE PLANET THAT WOULD FLOAT IF PLACED IN WATER DUE TO ITS LOW DENSITY.
A) MARS B) PLUTO C) URANUS D) SATURN

41. THE PLANET THAT WAS FOUND TO EXIST BY USING MATHMATICAL PREDICTIONS.
A) MARS B) PLUTO C) NEPTUNE D) SATURN

42. THE PLANET THAT IS CALLED "EARTH'S TWIN" DUE TO ITS DIAMETER.
A) VENUS B) MARS C) SATURN D) NEPTUNE

43. "OLYMPUS MONS" FOUND ON MARS IS THE LARGEST __?__ IN THE SOLAR SYSTEM.
A) CRATER B) MOUNTAIN C) STORM D) VOLCANO

44. THE PLANET AND ITS MOON ARE SO CLOSE TOGETHER THEY ARE TOUGHT OF AS THE "DOUBLE PLANET".
A) EARTH & MOON B) PLUTO & CHARON
C) MARS & PHOBO D) URANUS & MIRANDA

45. THE PLANET WHOSE REVOLUTION (YEAR) IS FASTER THAN IT'S ROTATION (DAY).
A) VENUS B) MARS C) PLUTO D) JUPITER

46. "THE GREAT RED SPOT" and "THE GREAT DARK SPOT" ARE THOUGHT TO BE LARGE ___?___.
A) CRATERS B) HOLES C) VOLCANOES D) STORMS

47. THE "ASTEROID BELT" IS LOCATED BETWEEN WHAT TWO PLANETS?
A) MARS & JUPITER B) EARTH & MARS
C) NEPTUNE & PLUTO D) MERCURY & VENUS

48. THE LAST KNOWN GASEOUS PLANET.
A) NEPTUNE B) PLUTO C) JUPITER D) URANUS

49. THE LACK OF OZONE IN IT'S ATMOSPHERE MAY BE THE REASON FOR THE LACK OF LIFE ON THIS PLANET.
A) VENUS B) MERCURY C) NEPTUNE D) MARS

50. THE GLOW AROUND A COMET'S NUCLEI.
A) TAIL B) AN ILLUSION C) COMA D) SUN'S REFLECTION

Appendix D

SOLAR SYSTEM "POST-TEST"

DIRECTIONS:

COMPLETE THE FOLLOWING POSTTEST QUESTIONS OWN YOUR OWN PAPER NUMBERED 1-50.

** COMPLETE TO THE BEST OF YOUR ABILITY.

PART I. LISTING

1. – 9. LIST THE 9 PLANETS *IN ORDER* FROM THE CLOSEST TO THE SUN TO THE FARTHEST.

10. – 18. LIST THE 9 PLANETS *IN ORDER* FROM THE SMALLEST IN DIAMETER TO THE LARGEST.

PART II. MATCHING

TERMINOLOGY

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35. CHUNKS OF ROCK AND ICE THAT FORMS A TAIL IN SPACE.

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CORRECTLY CHOOSE THE LETTER OF THE BEST ANSWER FOR EACH QUESTION.

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