Mnemonics, Yōdai, and Fractions

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MA Thesis
1993

ISBN 0-315-84896-0

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FACULTY OF EDUCATION

The undersigned certify that they have read, and recommend to the Faculty of Education for acceptance, a thesis entitled MNEMONICS, YODAI, AND FRACTIONS submitted by David F. DeVan in partial fulfillment for the degree of MASTER OF ARTS IN EDUCATION.

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Date:

Acknowledgments

Special thanks to my wife Jill, and our daughters Caitlin and Shelby, for their patience and encouragement. A great deal of thanks to B. Davis for his help and advice in managing the statistical aspects of the study. A multitude of thanks to B. Hanrahan for her help, time and advice in the completion of this study.

My interest in mnemonics can be traced back to 1986 working on coursework in models of teaching. This original curriculum project dealt with the more traditional fact mnemonics. Upon discovering an article dealing with process mnemonics I became intrigued, hence this current study.

Contents

Title	Page
1. Introduction	1
2. Memory	5
3. Mnemonic Devices	24
4. Mnemonics and Education	49
5. Yödai	66
6. An Experiment in Yödai	76
7. References	94
8. Appendix	103

Introduction

Why do I have to remember this?

A question heard all too often in classrooms everywhere. A question which can be very difficult to answer so that all students are happy with the explanation. As teachers, it is necessary for us to try to give the students varied and interesting ways to learn and remember new material. Material which is often changing at a rapid rate, so rapid in fact that it may be necessary for a teacher to be continually updating information banks to share with the students. In many cases today the teacher is learning with the kids.

The teacher must develop methods that entertain the children, methods that help the students remember. The teacher is competing with many things today that were non-existent a few years ago, such as video games and global television. Vocabulary has changed. Student interest has changed. However the school system is still very similar to what it was ten years ago, twenty or even thirty years ago. The teacher must adapt. The student must adapt.

Science and technology has been developing at an alarming rate in recent history. Computers can become obsolete shortly after they are developed. Purchasing a computer or other technology today may be disappointing because a new, much more powerful model than the original purchased will be available in a short time and the manufacturer does not give any warning.

Space technology is advancing faster than the average individual can keep pace. Man has been to the moon. Unmanned space craft have been to the furthest reaches of our solar system, sending information back to earth. Man has spent extended periods of time in space. Man may be visiting Mars within the next decade.

With all of these incredible advancements in Science, the human animal, in many respects, still remains a mystery to Science. Much experimentation has taken place, but the human mind still remains a mystery. People have theorized on the operation of the human mind, scientists have done extensive experimentation, but the process of finding answers to this type of research can be very time consuming and exhausting. Much research is often inconclusive and leads to further experimentation.

One aspect of the human mind, memory, has been the subject of much debate for centuries. Plato theorized about the memory dilemma hundreds of years ago. In more recent years, scientists have begun to examine in greater depth the operation of the memory. Cognitive psychologists and neurobiologists are working together to develop a greater understanding of our memory.

Memory appears to be with us from birth until the time of our death. Gazzaniga (1973) suggests that as early as three days into their life, infants are able to learn simple habits. This implies that they have stored information of previous experiences in their memory. Incredible! Yet, we do little to develop the human memory until, in many cases, we are out of school and realize the value of being able to remember things, even trivial items become items to be remembered.

Little information is understood about ways to improve the memory There are numerous methods available to help improve the memory, but the actual workings of these methods are still under experimental review as to their actual workings and their value to the learner as a method to enhance the memory

This paper shall examine some of the current research that is being conducted on memory. In addition, memory improvement techniques will also be examined with particular emphasis on mnemonic devices as aids to mer improvement. Mnemonic devices will be examined in relation to their implicatior education and teachers. A relatively unknown mnemonic device, Yodai, will be examined in particular detail, and will be subjected to classroom experimentatio

Memory

December 6th, 1917. Disaster struck Halifax, Nova Scotia early in the morning. Two ships collided in the narrowest section of the Halifax Harbour. Chapman (1992, 17) suggests that the survivors of this man made disaster remember in great detail the events of the day. The memories fade as the years go by, but these memories will never be forgotten

Most animals have the ability to remember things. If there were no memory for us as humans, things would be entirely different. Life as it exists today would be completely different. Memories are necessary for learning to take place. no memories, no learning.

In the work place, the managers are continually requiring the workers to remember things, sometimes things of great importance and sometimes things of lesser importance. It is expected that as humans we will remember things. If we cannot remember we are labelled mentally handicapped in varying degrees. Most animals are able to learn, therefore most animals are able to have memories.

Some creatures are just better at remembering things than others. The human animal has developed a very sophisticated memory system. How are we as animals able to remember that the Halifax explosion took place back in 1917? Most of us were not there. We have read or heard about the explosion, yet it remains a memory in many people's minds who are associated with the Halifax area. Why does this remain a memory? How are we capable of remembering this type of information?

Some individuals are able to dazzle others with their incredible feats of memory. They can easily take a list of a hundred items, memorize it, then recall all of the items in order or out of order and impress anyone who listens. Students in school are continually asked by the educators to remember many different things, things which may or may not be of interest or value to the students. Teachers all too often feel that if the information is part of their specific content area then it must be important, so the students must learn it. The teachers expect the students to learn, but often they do not teach them ***how*** to learn or ***how*** to remember

A computer can remember information by recording the information in a couple of ways, either of which can easily be explained. But what about the human mind, how does it record information? Why does some of the information that is put into memory disappear? Why do some memories remain as vivid today as when they were first put into the memory? According to Kohler (1947) memory can be broken up into a three part process:

ENCODING

STORAGE

RETRIEVAL

It is through this three part process that all memories are able to be recalled

The first step, ***encoding***, is the process of putting information into the memory. This can be done in a variety of different ways, using our senses. Most people will have memories of seeing different objects, visually encoding information may produce very vivid memories. Tactile memories are also present, as well as memories of smell, auditory stimuli, and taste

Joyce and Weil (1992, 163) suggest that the information which enters the short term memory does so through sensory input. Considering this input, the question would have to be answered as to which one of the senses would be the best way to get information into the memory. Gazzaniga (1973, 107) suggests the information entered acoustically will be remembered better than visual information. Roediger (1980, 564) suggests that pictures are remembered better than words. He suggests that words which are encoded into pictures will be remembered better than those which are not. As an example, imagine that you are reading a beautiful passage describing nature. The best way to remember this would be to imagine what the scene would look like, rather than just trying to remember the words as the description. Lorayne and Lucas (1974) would back this up, even extending it further to suggest that the imagery should be as bizarre and active as possible to create long lasting memory. McDaniel and Einstein (1986, 62) also support the contention that imagery leads to greater recall than any of the other senses. Nappe and Wollen (1973) agree that imagery is essential for the best memory. Katz (1983, 41) suggests that imagery skill can facilitate some types of learning and be detrimental to other types of learning. Perhaps it would be best to suggest that the sense that produces the best recall may differ from individual to individual, some people rely on imagery, while others may rely on acoustic information cues for memory to be effective.

The second stage of a memory is the ***storage*** process. It is at this stage that a memory is locked or etched into our brain. Everything that enters our brain from the encoding process becomes stored within our brain, the major difficulty with this however is bringing this information back into our current thoughts.

Bringing the information back to create a memory is the third stage in the memory process. This stage, the ***retrieval*** stage, may be the most difficult stage. If the information cannot be accessed after it has been stored, the information is useless to the user.

The memory process can easily be compared to the process of using a computer database. The first step in creating the database is the input of information through the keyboard, just as we use our senses for encoding This input of information is the encoding process, we are loading the information into the memory banks. The information is put into the computer and now it is necessary to store it. The computer can do this in a couple of different ways. But it is still the storage stage. The final stage for the computer is to give the information back to the user. This is the retrieval stage. It is through the retrieval stage that all of the stored information is available to the user. It is often this retrieval stage which causes the most difficulty for the user. If the user does not understand how to recall information from the database, the information is useless. The user, if skilled, can recall the information in many different ways, finding the most appropriate way for the current task. This would be much the same as researching information on compact disk. The user has key words and descriptors which can be used as aids to find the most appropriate articles on the subjects of the researched topics. The ability of the user allows for greater choice when picking information for use. The major problem for us and our memories will be with the recall or retrieval stage.

It has become fairly widely accepted that there are two types of memory. These being short term memory (STM) and long term memory (LTM).

The short term memory is just that, a temporary storage of items. These would be items that the user only needs to store for a short period of time, such as telephone numbers, grocery shopping lists, names of students who have not returned report cards, etc. It has been suggested that STM will last anywhere from ten to 20 minutes (Dranov, 1986, 220). After the time span for STM, the information is lost, seldom recalled again. Miller (1956, 84) suggests that STM is capable of storing, on the average, seven bits or chunks of information. A chunk is a group of related information. If this information is not rehearsed in some form, it is estimated that the information will not enter STM and will fade from memory within twenty seconds (Gazzaniga, 1973, 49).

STM is used constantly during the course of a typical day. We will use it for everything, from remembering that important phone number to remembering the color of hair of a person driving in a car next to you on the highway. Dranov (1986, 220) suggests that a person's short term memory is at its sharpest in the morning and becomes poor in the evening. Perhaps this would be because in the morning the inputs are relatively new and the brain is relaxed. All day new inputs are trying to get into the memory and the brain must try to deal with such a great number, thus the poor response of STM in the evening. Case (1985) suggests that the short term memory is severely limited and only a few storage and processing activities can be carried out at any given time. Case (1985) even goes as far as to suggest that a person's STM develops with time, a period of twenty or thirty can make a great deal of difference in STM of an individual.

The key to increasing short term memory is rehearsal. Without rehearsal, information in the short term memory will fade away within twenty seconds (Levine, 1990, 73). Rehearsal prolongs the life of the information in the STM, and it appears as if rehearsal helps with the transfer of information into the long term memory. Each time a chunk of information is rehearsed it lengthens the time the information will be remembered. Gazzaniga (1973, 53) suggests that the number of items or chunks we can store in our STM is limited by the length of time it takes us to rehearse.

With rehearsing being such a key aspect of both STM and LTM, the individual may realize three things. The first being that using rehearsal can increase memory performance, and second, rehearsal techniques can be developed and, third, the rehearsal technique can be varied depending on the information to be remembered, for example, phone numbers versus the faces of a group of ten new employees.

Rehearsal seems to help in the transfer of information from the STM into the LTM. But, what about the information that is put into the STM but doesn't get transferred into the LTM?

Gazzaniga (1973, 61) suggests that due to the constant sensory cues providing information to the STM, the information in the STM not transferred, gets pushed out by new information and becomes forgotten, much like a filing cabinet, when it becomes full, old information is discarded making way for new information to be stored.

Information which has been rehearsed can be transferred into the long term memory. It is because of the information stored in our long term memory that we are able to interact with our environment. Without LTM there would be limited interaction with the things around us, and there would be limited, or no, learning taking place. Items which are stored in the long term memory may be remembered for decades.

It is thought that after something has been committed to LTM by rehearsal it will be stored in one of three ways:

1. **semantically**
2. **accoustically**
3. **visually**

It appears that there is no limit to the amount of information that can be stored in LTM (Gazzaniga, 1973, 66). Much of the information that we store in LTM also seems to be stored in a categorical way. Associated items appear to be stored in the same area of the brain, in a hierarchical manner (*ibid.*). This idea of categories would fall into place with the notion of information being stored by meaningful associations as proposed by Ericsson and Chase (1982, 608).

Many people when asked about their own memory, often remark that they can remember some things better than others. We all can recall somebody who remembers all of the jokes they hear, and also the person who enjoys humor but cannot remember any jokes. One easy explanation of this is the notion of a primary effect and a recency effect (Gazzaniga, 1973, 88). The first items of a list, for example, get repeated more often during rehearsal than do the middle items, thus the primary effect, relying on rehearsal. The latter items of the list are remembered better because they are the last items to be committed to memory, hence the recency effect.

Interest in memory has skyrocketed. Many researchers are interested in finding out more about the process of memory and how it works. Memory is now, more than ever, being thought of as an active process, an activity, and a skill. It is thought that the more meaningfully you process something, the better you are going to remember it (Ericsson and Chase, 1982, 610). Brown (1986, D5) suggests that because of recent breakthroughs in the study of memory, LTM is now thought to consist of multiple memories. These multiple memories being:

1. **procedural**
2. **semantic**
3. **episodic**

The procedural memory is thought to help with simple tasks, and connections between stimuli and responses. The semantic memory enables the individual to learn facts and helps the individual to think abstractly. The episodic memory keeps tracks of a person's past experiences, allowing them to recall these experiences and to use them in the thinking process.

A summary of the many kinds of memory follows:

Kind of memory	**Description**	**Example**
Visual Memory	Memory for what you have seen	Remembering what someone looks like
Auditory memory	Memory for what you have heard	Remembering some directions you have

		heard
Sequential Memory	Memory for things in a certain order	Remembering the digits of a telephone number
Short Term Memory	Recent memory	Remembering something for a short time
Long Term Memory	Memory of things learned long ago	Remembering when your kids were born
Recognition Memory	Memory for knowing that something is familiar	Remembering you know someone when you see them
Recall or Retrieval Memory	Finding stored facts or skills when you need them	Remembering how to get home after work
Automatic Memory	Memory that occurs without thinking	Remembering how to write
Episodic Memory	Memory for things that happened in your life	Remembering the good times
Procedural Memory	Memory for how to do things	Remembering how to multiply
Motor Memory	Memory for how to move muscles	Remembering how to walk
Factual Memory	Memory for knowledge	Remembering names of the planets
Active Working Memory	Memory for keeping things together in	Remembering the directions for a

	your mind while you need them	report while you are writing it

Particular structures of the brain have been identified as having a role in the memory process. The hippocampus is the process center, where information from the STM is processed into the LTM. How this information is stored and processed is still unknown. It is felt that this storage and transfer of information has something to do with the sensory content and the emotional content of the information to be remembered.

The memories that are processed in the hippocampus to become long term memories are now transferred to the cortex of the brain. It is thought that these memories are stored in the cortex at sites which correspond to the senses. This thought is supported by the idea that certain things can trigger memories. These being things such as smell, sight (visual cues), auditory cues and emotions (Begley, Springen, Katz, Hager, and Jones, 1986, 48). One other structure of the brain which is thought to be involved in the memory process is the cerebellum. However it is unclear exactly what the role of the cerebellum is at this point in time

It is incredible how something which may only last a tenth of a second will be remembered for such a long period of time. How does the brain store these memories?

Lynch, Larson, Muller, and Granger (1990, 391) suggest that something happens chemically for memories to be formed in the brain. The brain is composed of nerve cells, called neurons. A sensory input occurs which the brain must record. The neurons are connected chemically by a substance called calpain. The calpain facilitates communication from neuron to neuron. The memory enters the brain as an electrical impulse, the calpain allows the impulse to flow from neuron to neuron. These connections form a synapse. All of the connections between the synapses form what is called a trace. The path that the electrical impulse takes is the trace. The memory trace is like a network of roads in a city, they are used to get from place to place. The memory trace follows a particular pattern, made up of all the nerve cells and synapses of that memory. The trace becomes the memory. The memory trace would be different for all of our different memories. The neurons and synapses can be used in more than one memory trace.

As much as research is continuing into the brain and how it functions, the research is very difficult and very slow. Much of the process of memory in the brain remains a mystery. It is impossible for researchers to simply open up the brain of a subject and carry out experiments Much research information comes from subjects who volunteer for the experiments; scientists rely largely on the study of memory deficits in subjects Alzheimer's disease, a degenerative disease of the brain, is an example of memory loss which has allowed researchers to develop more information about memory. Amnesia patients are also studied for information about memory loss and the entire process of memory A third disorder which is examined for information on memory loss is alcoholic Korsakoff's syndrome (Seligman, Hager, and Springen, 1986, 51).

Why does it seem that some people have exceptional memories and other people have poor memories? Visit any classroom and we will find a group of students who has what appears to be a varying degree of memory ability. Some students will remember to bring back all reports, permission slips, money, etc., while the teacher will be constantly hounding another group of students to get these things returned to the school. Some students tend to get all assignments completed on the due date, but again there is another group of students who constantly pass assignments in late. Ability of the students is not the problem here, but their memory; the information does not appear to be encoded in the minds of these students.

The major problems with memory are the retrieval of the memory and the encoding of the information for the memory. Going back to the original example of comparing memory to a computer database, if the computer operator knows how to use the database effectively there will be no problem retrieving any or all of the information in the database. However, if we give the database to a person who has little or no knowledge of the ways to retrieve information from the database, the information which is in the database is virtually non-existent, even though it is still in the memory banks of the computer. The exact same thing appears to be what happens to the memories that we have in our brain that cannot be accessed. We have not developed effective ways to retrieve the information. The person with the poor memory for some things will be deficient in retrieving that type of information, whereas the person who has a good memory for that item, will have good retrieval skills. Retrieval cues are still relatively unknown. There is some speculation that smell is a powerful retrieval cue (Morris, 1978, 157, and Begley, Springen, Katz, Hager, and Jones, 1986, 48).

Morris (1978, 159) also suggests that the retrieval problems may be a result of problems with the encoding of information in the brain. All students in a class receive the same input from a lecture, however, not all students get the same information out of the lecture. The encoding may have been the problem, which causes retrieval problems. A couple of reasons why the encoding process may have failed could be that there was insufficient time for proper encoding to take place. In classrooms this could often be the case. The teacher has an enormous amount of material in the content to be covered, and there is limited time to cover the material effectively if the teacher feels all of the content material is essential. The students with poor encoding skills may suffer, and the teacher may not understand why.

Another possible problem with the encoding of information could be that there is no apparent reason for the material to be remembered by the individual. The student in the classroom will agree with this wholeheartedly. The material is not meaningful to them so they pay little or no attention to what they are required to remember. Meanwhile, the teacher continues to present new material. How often in classrooms do the teachers get asked the question, 'Why do we have to learn this?'. The material is not meaningful to the student, so it becomes understandable why the chances of it being remembered are decreased. As an example, students may be required to learn the causes of the Second World War. Many students feel that information is irrelevant; the encoding that goes on is not sufficient to put those causes into their LTM. Lorayne (1974, 19) stresses the importance of attention to the material to be remembered, observation to what is going on, and concentration on the material to be remembered.

The third possible problem with retrieval stemming from the encoding process is trust. Sometimes we trust our memories to remember things when we do not put enough effort into the process. We feel that we should remember, but we don't. We trust our memories when we shouldn't.

Dranov (1986, 221) suggests that all memories are in the brain somewhere. Retrieval is again the key. Two theories are presented by Dranov (*ibid.*), the first of which suggests that the memory traces fade with time. If we do not use a particular memory trace for a long period of time the trace fades, eventually to be forgotten, or to be remembered as patches of somewhat related material. The second theory suggests that interference may be the reason the memory is not as vivid as it once was. This interference can be present because of a number of different reasons; for example, we tend to repress painful memories by overriding them with associated memories of less painful things. We generally have a tendency to recall unhappy memories when we are sad and pleasant memories when we are happy. Instead of remembering the death of a loved one we may tend to remember the loved one for the good things that they contributed to our lives

They are smart, they can remember everything! A phrase we often use to describe others with what seems to be an exceptional memory. Ericsson and Chase (1982, 608) suggest that individuals with expert or exceptional memory have the same memory as exhibited by all individuals. The expert or exceptional memory is there only because the individuals involved have gone through extensive practice to develop their memories. This practice also gives the individuals a greater knowledge base with which to associate new information which helps them considerably. This view was supported by Chase and Simon (1973) in studies of chess masters who could not give good recall of game boards out of the ordinary, but were exceptional with boards of their often used strategies. Ericsson and Chase (1982, 615) contend that exceptional memory is only a skill which is based on cognitive processes which have been learned and developed through extensive practice and experience.

Mnemonic Devices

Mnemonic means 'aiding the memory' (Higbee, 1977a, 59). Mnemonics refers to methods that can be used to aid the memory. Sometimes we narrow the definition down to include only techniques that are popular in memory training books. Mnemonics is really much broader than these books imply.

Mnemonics are sometimes thought of as tricks used by certain people to perform incredible feats of memory. This is entirely incorrect. Mnemonics, mnemonic methods, or mnemotechny have been around for many years. Hundreds of years ago there was little or no paper available to record information about history or to record large bits of related information, such as family histories. If there was no way of recording this material, someone who had the best memory must have been responsible for trying to remember the information that was necessary. This seemed to be the beginning of mnemonics. Yates (1966) gives credence to this and even gives examples of mnemonics dating back much further, citing that imagery mnemonics may have been used as effective memory devices for at least 2000 years, even bizarre imagery scrolls over 3000 years old have been found (Brown and Deffenbacher, 1975; Hoffman and Senter, 1978; Laver, 1977; and Rawles, 1977). The first celebrated modern mnemonist of which there is a record was Raimond Lulle, 1236 -1315 A.D. (Desrochers and Begg, 1987, 57). Desrochers and Begg (1987, 59) also suggest that renewed experimentation with mnemonics began in the 1970's. With the beginning of this experimentation a battle ensued which tried to decide if mnemonics were necessary or a valid part of the natural learning process. Jenkins (1971) suggested that mnemonics was a form of unnatural learning. Bellezza and Reddy (1978, 278) suggest that there is a strong correlation between natural learning and learning using mnemonic devices. Bellezza (1987, 38) furthers states that mnemonic devices should not be thought of as representing unnatural learning, but as useful techniques in the learning process.

The question that must be addressed though, is if mnemonics are so important as learning strategies, why are there not more people using these devices in present day society? Bellezza (1987) suggests that there are a couple of reasons why mnemonics are not in greater use. The first being, that at one time in history, recording of information to be passed from generation to generation was difficult, no paper or electronic recording devices were available, people used other methods to transfer information. Today we live in an information age, information is at our finger tips, books are easily available, computers can store incredible amounts of information, even personal computers using compact disc technology allow the user an incredibly large knowledge base. Information is constantly being presented to us on our television screens, sometimes information is being presented and we unknowingly are absorbing it. Individuals in society today do not feel they need to remember all of the bits of information that are presented to them, since information is readily available without remembering, provided they know how to access the information. The second reason mnemonics are not being used commonly in today's society is that to become truly effective it may require a great deal of time and effort for the user to be effective with any one of the techniques.

Mnemonic techniques can be categorized in two ways, *internal* techniques and *external* techniques. Internal techniques are those which go on inside the mind of the user; external techniques would be any technique which is used outside of the mind, but is used to help remember things. The following lists indicate some of the subordinate categories of the internal and external techniques (Minninger, 1985; Harris, 1977; Morris, 1978):

Internal Techniques:

link method

loci method

peg or hook method

acronyms, first letters

rhymes

phonetic method

keyword method

Yōdai

SQ3R (survey, question, read, recite, review)

External Techniques:

writing on the hand

leaving something in a special place (eg. paper on floor)

alarm clocks

setting to music

wrist watches

string on the finger

writing a note to yourself

calendars

getting someone else to remind you

knotted handkerchief

switching rings

turning a wrist watch backwards

identations in our writing

boxes around important text or diagrams

cue cards

watch on the wrong wrist

rubber band around your wrist

tipped lampshade

step-on-it

attach thing to something else (eg. rent cheque on coffee pot)

make lists

schedules

Also classified as <u>external</u> *mnemonic* devices would "be" what is *<u>here</u>*

also - bold

classified - larger font size

as - different font

<u>external</u> - underlined

mnemonic - italics

[illegible] - outline print

would - shadow

"be" - quotations

what - subscript

is - superscript

<u>here</u> - underlined and italics

Many people use their own form of mnemonics when reading printed material, such as highlighting the important material in a different color or using stars and asterisks as ways of indicating some material is more important than other material. If you talk to ten different students in the process of studying for final exams, the chances are you may find as many as ten different external mnemonic devices being used to help the students remember the material to be learned.

Fowler and Barker (1974) examined used college textbooks, ones which had been returned for resale after the completion of a course. They found that in 92% of the books there was a significant use of some emphasizing technique, ranging from highlighting to asterisks in the margin. In their study, Fowler and Barker (1974) also concluded that it is more effective for learners to be emphasizing their own material rather than using someone else's emphasized material.

Lutz and Lutz (1977) report on emphasizing techniques which are used in advertising to attract people's attention. These include such things as bright colors, catchy phrases, loud noises, movement, flashing lights in their displays, and virtually anything to attract your attention. If something attracts your attention the chances are then better that you will remember the product that the advertiser is displaying. If we stop and think about advertising, nearly everyone can remember a phase, jingle, or song from some form of advertising. These mnemonic devices work very effectively (Lutz and Lutz, 1977).

Kintsch and Bates (1977) did a study on a classroom lecture to see which information would be retained the best. The lecture was broken down into two parts, the content material and the aside information the lecturer would use to stress a point. The result of the study showed that most students remembered the irrelevant asides better than the content material of the lesson.

Many lectures that are remembered are those with lots of interesting examples. As well, the lecturer who mixes humor with the lecture may allow the listeners even greater chance of retention. Kaplan and Pascoe (1977, 64) suggest that humor will be very effective as an aid to retention as long as the humor is related to the concept. Lecturing a group about the benefits of not smoking and telling a joke about a horse will allow the listeners to perhaps remember the lecturer, but not the material. Telling a joke or humorous anecdote related to smoking would help the listeners with retention.

Minninger (1985, 30) gives a couple of exceptionally good examples of how to remember phone numbers. Many young people have often wondered why the numbers on a telephone also indicate letters, well here they can be put to good use:

327-5364 *becomes* DARK DOG

968-5683 *becomes* YOU LOVE

These examples are simple but very effective use of external mnemonic aids Minninger (1985, 60) suggests another wayfor quick and easy remembering of names. First, when introduced to someone, look at the person for distinguishing characteristics, both positive and negative. Second, listen to the name. Does it fit the characteristics of the person? It doesn't matter; as you are rehearsing the name, to see if it fits the characteristics, you are remembering it. Thirdly, as you hear the name try putting it into a category in your memory; categories could include such things as celebrities, occupations, brand names, rhymes, etc.. Dranov (1986, 220) strongly suggests that with names you should pay attention and concentrate, use your mind constantly.

Internal Techniques

Link method

The link method is one of the simplest internal mnemonic techniques. With this technique the user must mentally form a visual image of the items to be remembered, one at a time (Bower, 1970 and 1973). The image of the first item is then associated with the image of the second item. A chain of associations is being created. Lorayne (1974, 24) suggests that the more ridiculous the image in the persons mind or the association, the better the items will be remembered. For example, suppose you had to remember the following five items from a grocery list.

1. mild cheese
2. milk
3. spaghetti noodles
4. chocolate chip cookies
5. paper towel

The first step would be to visualize item one in a bizarre way, as an example a block of cheese sitting on the ice in a lake that is melting (*mild* cheese). To link the second item to the first, the melting ice is made out of milk. Item three is added, in the image of someone pushing a spaghetti noodle out to the cheese as a pole for life-saving so the cheese doesn't drown. The cookies then come flying into the picture as boats with rolls of paper towel on the rear side acting as the motor. The grocery list should be remembered because of the bizarre images and the association of each of the items. With this method the list could be as long as needed.

Lorayne (1974, 25) suggests when using the link method that you actually see the picture that you are visualizing in your mind, not the words which you have read. When visualizing the picture it helps to visualize items out of proportion with reality, put items in action situations, exaggerate the number of items, and substitute unexpected items for more common ones, such as nails to be used as cigarettes. Mueller and Jablonski (1970, 564) agree that using imagery and linking the items together is effective in aiding recall.

A version of the link method which can be effective allows the user to use a rhyme to remember a number of different items in a list. The rhyme could be the following, or something similar, which the user is comfortable with:

One is a bun

Two is a shoe

Three is a tree

Four is a door

Five is a hive

Six is sticks

Seven is heaven

Eight is a gate

Nine is a line

Ten is men

The user in this system simply remembers the rhyme; then for each list of things to be remembered the rhyme is recalled, put into some context, and associated with the items to be remembered. Using our original five item list, item one, the mild cheese would be pictured inside a bun, in for example, the context of a kitchen. Item two, the milk would be put into a shoe lying on the kitchen table. Item three , spaghetti noodles, would be hanging on a tree which is visible from the kitchen window. Item four, the cookies, could be flying through the door, as item five, the paper towels, are piled up in a corner of the kitchen in the shape of a bee hive.

If there are more than ten items in the list the user must change the context. The context could change in the example above from the kitchen to the backyard. The rhyme would be repeated with items placed outside in the yard.

The following story is an example of using the link method to help students remember the first ten elememts of the periodic table and their atomic number. The story, adapted from DeVan (1986), includes underlined words to help facilitate the learning process

The Journey

Suddenly the space craft began to vibrate rapidly Speed was beginning to become a problem for the tired space travellers On the screen there curiously appeared a huge video picture of a bun neatly printed on the bun was a message to the commander of the craft The message simply read, "Hi Drogen"

Drogen and his men were tired They had been traveling for what seemed like a millennium Drogen began to remember

The journey was filled with problems They began way back on the first stop The craft's mascot, lum, got carried away on the first planet they visited So carried away in fact that he attacked one of the inhabitants of the planet, stealing his shoe Drogen immediately yelled, "Heel lum", but the animal ran as fast as he could on all six legs Drogen ran after him

lum ran until he reached a high tree, refusing to come down A young inhabitant of the planet saw the antics going on and ran over to the tree Drogen, still some distance away, knew the danger to the child, the animal could be dangerous if not handled properly He yelled, "Lith lum alone", his broken english becoming evident Drogen got to the tree, lum came down, and the shoe was returned.

Eventually the group returned to the craft As they began to enter, lum collapsed at the door It appeared as if the food on the planet had not agreed with the creature Drogen, being the sympathetic individual he was, looked at lum in the door and mumbled, "You are bery ill lum" lum was carried into the craft by Drogen's men

Moments later the craft was ready for take off

Ignition

No!

Something was wrong! Drogen sent his second officer to investigate He crawled into the engine room, a hive-like container The problem in the hive was a clogged fuel line The second officer relayed the message to Drogen, "In the hive I need a drill to bore on the fuel line" All that Drogen had available were some sticks His tools were left at home The second officer was upset.

"Sticks!! What happened to the tools? Your gar been in the shop and I get sticks."

The problems were eventually solved and the craft resumed its journey After leaving the gravitational pull of the planet, Drogen and his crew put the craft on automatic pilot and decided to relax Drogen began to day dream All of his problems appeared to be over He felt like he was in heaven, sipping on his favorite drink, a nitro-gin He could envision his wife at the gate of their astro-pad waiting for his arrival On the top of the gate was a glass containing her favorite drink, oxyo-gin

These pleasant memories began to fade The craft was vibrating The line in the carpet in the next room was moving Drogen yelled, "Quick! Dee floor gin the next room." The second officer jumped He rounded up all of the available men in the next two compartments of the craft The men had to pit one knee on the floor to keep their balance The shaking stopped Drogen realized they were in an asteroid storm It would pass

Drogen suddenly stopped his day dreaming The screen in front of him indicated an all clear for landing The craft gently glided to the pad The problem filled journey was over

Higbee (1976, 3) suggests that the major flaw with the link method is that in order to recall any item down the list it is necessary to go through the whole list from the beginning, because each item leads to the following one. Foth (1973, 243) suggests that the system works well with visual imagery but will still work effectively with verbal associations as well.

Loci Method

The loci method is one of the oldest mnemonic methods according to Yates (1966). The method is very simple. The user simply remembers a number of familiar locations, locations that are part of everyday routine Next the user should make a mental image of items to be remembered in each of the locations, in the order that the items are to be remembered If we use our original list of five items:

1. mild cheese
2. milk
3. spaghetti noodles
4. chocolate chip cookies
5. paper towel

One of the easiest location scenarios to remember is a walk around your house or your neighbourhood, or the route that you take to go to work or school everyday. Using paths like these make it very difficult to forget the locations. If you choose a route that is unfamiliar, it would increase the chance that you are trying to remember the location as well as the item that you should be remembering. As an example, the path used could be the route through your house as you get up in the morning. On the table beside your bed you would picture a piece of mild cheese sitting there. On the floor beside the table you would visualize a carton of milk or a glass of milk. The spaghetti noodles would be in the doorway as you leave the room, followed by the chocolate chip cookies outside the bedroom in the hallway, and finally the paper towel is sitting in your way on the kitchen floor. This method should work well provided you stick with paths that are familiar. The length of the path will be determined by the number of items that you are trying to remember. The longer the list gets, the longer the path. The drawback with this system is that like the link you will tend to start at the beginning of the path each time you are trying to locate a particular number or item. To retrieve the items in the list all that has to be done is the user has to take a mental walk down the path where the items are stored, the items appear in just the places where you left them (Higbee, 1977a, 68).

Peg and Hook Methods

The peg method and the hook method are virtually the same thing. It briefly consists of the learner memorizing a list of peg or hook words or numbers. As with the link method, the rhyme, *one is a bun*, could be used, simply by making an association between the bun, number one and the item to be remembered. The problem here is finding words which rhyme with numbers above ten. This restricts the use of the peg method, so it is recommended that we use other peg words.

Another choice then is to use letters of the alphabet as the hook words, as shown here, adapted from Higbee (1977a):

A ape	**J** jack	**S** sock
B boy	**K** kite	**T** toy
C cat	**L** log	**U** umbrella
D dog	**M** man	**V** vane
E egg	**N** nut	**W** wig
F fig	**O** owl	**X** xray
G goat	**P** pig	**Y** yak
H hat	**Q** quilt	**Z** zoo
I ice	**R** rock	

The user would associate the item to be remembered with the hook word. Mild cheese would be associated with ape, an ape running away with the cheese. Milk would be associated with boy, a boy swimming in a lake full of milk, etc. The major problem with the peg method using the alphabet is the same as the link method, items would have to be recalled in order, since not many people would know the numerical sequence of all numbers of the alphabet.

People using the peg system generally recall twice as much as those not using a mnemonic system, when hearing a list of words once. Bugelski (1970) tried this with lists of ten words and the peg system proved valuable.

Acronyms

Acronyms are widely used by people, the majority of whom do not realize they are using mnemonic devices. Acronyms are simply putting together the first letters of the items you wish to remember. Morris (1978, 156) suggests one of the more common acronyms is:

ROY G BIV

This stands for the colors of the rainbow, and just looking at the letter allows most people to say the names of the colors:

red

orange

yellow

green

blue

indigo

violet

Other examples of acronyms, see if you can figure them out:

WHO

NATO

NASA

BEDMAS

HOMES

Anybody can use acronyms, it is just a case of taking a few minutes to figure out the first letters, then putting those in the form of a word and by repetition remembering the new, often, nonsense phrase.

WHO - World Health Organization

NATO - North Atlantic Treaty Organization

NASA - National Aeronautics and Space Administration

BEDMAS - Order of mathematical operations, brackets, exponents, division, multiplication, addition and subtraction

HOMES - The Great Lakes, Huron, Ontario, Michigan, Erie, and Superior

As mentioned, this method is widely used, people not even realizing they are using a mnemonic device.

Rhymes

As with the acronyms discussed above, many people use this mnemonic device and do not realize what it is. Anyone can make up a rhyme to try to remember information. A couple of the more common ones would be as follows (these are taken from memory, which reinforces their effectiveness, therefore no reference cited):

Monday's child is fair of face,
Tuesday's child is full of grace,
Wednesday's child is full of woe,
Thursday's child has far to go,
Friday's child is loving and giving,
Saturday's child works hard for a living,
Sunday's child is happy and gay.

Easy to remember, and a lot of people do remember the above, with minor variations, as well as the following:

Thirty days hath September,
April, June, and November,

All the rest have thirty- one.

And February has twenty-eight.

Except in a leap year, that's the time,

That February has twenty-nine.

Phonetic Method

The phonetic method is possibly the most difficult of the systems discussed thus far. The phonetic system is aptly described by Higbee (1977a) as a number to sound system. Each digit from 0-9 is assigned a consonant sound. These consonant sounds are then combined with vowels to turn numbers into words. The words are more meaningful, thus they are more easily remembered. The following chart, adapted from Higbee (1977a) and Lorayne (1974, 34) shows the digits, their equivalent consonant sounds and the memory aid associated with each.

Digit	Consonant Sound	Memory Aid
1	t,d,th	t and d each have one downstroke
2	n	two downstrokes
3	m	three downstrokes

4	r	last sound of four
5	l	Roman numeral for 50 is L
6	j, sh, ch, soft g	reverse of J resembles a 6
7	k, q, hard c, hard g, ng	7 sideways resembles a skeleton key, a k can be made with 2 sevens
8	f, v, ph	script f resembles an 8
9	b, p	both resemble 9 when inverted and/or flipped
0	z, s, soft c	Z = zero, C = cipher

Higbee (1977a) suggests that the consonant sounds are the important ones in this mnemonic system because different letters or letter combinations may take on the same sounds. If there is a double consonant it will take on the sound of only one of the consonants.

Examples:

table = 195

lumber = 5394

k<u>n</u>i<u>f</u>e = 28

<u>f</u>oo<u>d</u> = 81

To become effective using the phonetic method, the user must first learn the phonetic sounds in the chart above. The chart must be thoroughly learned so the user does not have to consult the chart. Higbee (1977a) suggests that this method can be used for two purposes, the first being to store in memory keywords, as you would with the loci method, the second as a method of storing numbers, coding them into words would make them easier to remember.

Keyword Method

Pressley, Levin and Delaney (1982) suggests that the keyword method is a two step procedure for remembering materials that can be associated. The keyword method was re-invented by Atkinson (1975). The origins can be traced back beyond 1975, but Atkinson (1975) began researching the method, again bringing it back into prominence. It is most commonly used for learning a second language (Paivio and Derochers

1979; Pressley, 1977a; and Raugh and Atkinson, 1975). It has been further refined over the years to be applicable to other learning situations. Miller, Levin, and Pressley (1980) successfully used the keyword method to help students learn verbs. Much research is continuing into the keyword method and its applications to the classroom (Levin, 1981; Delaney, 1978; and Levin et al, 1979).

In using the keyword method for foreign languages, a foreign word would be presented, as well as the English translation of the word. The user of the method must then select an English word which sounds like some part of the foreign word to be learned. This selected English word becomes the keyword. The user must then make some mental image of the keyword interacting with the English translation of the foreign word. There then are two links being made, a phonetic link and a visual image link (Bellezza, 1981, 259).

As an example of the keyword method, suppose that you were learning French as a second language. You are required to learn the word **pomme**, which translated, means **apple**. The first step would be to select an English word which sounds similar, in this case we choose **palm**. Palm is the keyword. A mental image must now be created which relates these. Imagine a bunch of apples in the palm of your hand. The two links have been made, and the learner should be able to remember the translation of the French word.

SQ3R Method

The SQ3R method stands for survey, question, read, recite and review (Morris, 1978, 157). The basics for this method require that the user survey the given information, look at it, read it, decide if it can be understood and if it should be learned. The second stage is simply to question the material, what is wrong, what is not understood, what can be done to improve the material. The third stage is to read the material again, this time for understanding, followed by the user reciting the material, either aloud or silently. Finally after all steps above have been completed, the user will simply review the material to fill in any missing gaps.

The SQ3R method has been adapted by many students and individuals as their preferred method of study. The results of the testing of these individuals can easily show that the method is certainly not one hundred percent effective.

Bellezza (1987, 41) suggests that there are two types of mnemonic devices, organizational mnemonics and encoding mnemonics. Organizational mnemonics organize and interrelate new information in memory so that it can be recalled at a later time. Bellezza (1982) suggests that organizational mnemonics include loci, link, and peg methods. Bellezza, Day, and Reddy (1983) examined encoding mnemonics, suggesting that these methods transform low imagery into more memorable images, then an organizational mnemonic is used to store the information in memory. Roediger (1980, 564) contends that concrete words are retained better than abstract words, thus supporting the keyword theory. Roediger (1980, 565) also suggests that mnemonic devices employing imagery can produce dramatic results.

Every mnemonic method described uses strong mental imagery. Strong mental imagery contributes to the effectiveness of mnemonic techniques. Individuals who wish to use mnemonics should be prepared to spend some time on their own in developing the technique which is the most effective for them, the one that they can use the easiest. Some techniques would be very useful for remembering a few items in a list, while if there is to be a large number of items to be remembered, then it would be wise to use another technique. Few of the mnemonics discussed in the above information help with the remembering of processes . Most appear to used for remembering facts and arrays of related factual information. Another technique which has not been discussed as of yet is Yödai. This technique addresses the posibility of process mnemonics

Mnemonics and Education

Do we have to remember this?

How many times in the course of a year do teachers hear this phrase? Students give the impression that it will take a great deal of effort to try and remember something that will be used for testing purposes. The students feel information that is discussed in class is for testing purposes only. The students should have an understanding of why they are learning particular information, rather than just being told that the information will be on the exam at the end of the term. Unfortunately, sometimes the reason the students have to remember the information is for the test or exam at the end of term, but that is for another paper.

Society seems to revolve a great deal around the automobile. The mechanic who keeps the car running dropped out of public school after grade nine, not because he/she couldn't do the work but because he/she was totally disinterested. The mechanic has spent a couple of years at a community college and a few years as a practicing mechanic. This mechanic who dropped put of junior high school has the ability, using only his/her memory ,to tell you all of the parts of a car engine. As a further extension of this, he/she can identify some of the small nuts and bolts of the engine by touch alone. He/she can give you an approximation of what is the problem with the car by listening to the sound of the motor. Why? How?

These people do not have an extraordinary memory, but are the students who were struggling because of a variety of different reasons with the school work. On the other hand we have people who seem to have incredible memory. People who can easily sit down and memorize a list of names and then recite all of the names in perfect order or in any order. Are there then two distinct types of memory, poor and exceptional.

Ericsson and Chase (1982, 610) suggest that there is no difference between people with a normal memory and those people with exceptional memories. They suggest that we all can develop exceptional memories

The key is practice and a strong desire to develop our memories. Ericsson and Chase (1982, 608) suggest that all of the so-called normal adults already exhibit a very skilled and exceptional memory in a field where they are already experts. Ericsson and Chase (1982, 608) suggest that there is a relationship between the level of skill an individual has in a particular field and the individual's ability to recall from memory items associated with that field, for example the mechanic, or the store clerk who remembers prices of hundreds of items on the store shelves

Ericsson and Chase (1982, 614) further suggest that there is a difference between the normal memory and the exceptional memory but the difference is in the speed in which the exceptional memory people can encode information and the successful storage of this information in the long term memory. The normal person has the opportunity to develop memory by learning these cognitive processes and through extensive practice Should the public school system be teaching these processes to the students?

Lorayne (1988) give a lot of reasons why individuals should try to increase the capacity of their memory. Included in this commercial book, Lorayne (1988) quotes a lot of business executives who feel development of a good memory is essential to the development of good business corporations. Lorayne (1988) suggests that the bizarre images must be used. These bizarre images take a great deal of creativity to develop, and creativity leads to success in today's business society. Lorayne (1988, 59) suggests that a trained memory actually teaches itself. It is necessary to use your imagination to form good strong associations, in so doing you are strengthening your imagination because you are using it, and this allows you to become more creative. Joyce and Weil (1992) refer to this strengthening of imagination as a major nurturant effect of the memory model in education.

In most classrooms today the use of mnemonics is not observed on a very large scale. Pressley (1982, 297) suggests that part of the reason we are not seeing an abundance of mnemonics used is the fact that many adults are not good at mnemonics. Thus role models for younger children are almost non existent. In our classrooms the role models are, as well, almost non-existent.

Most teachers feel over worked at the present time and do not feel it is necessary for the students to be taught mnemonics. Since role models are not there, no one takes charge and pushes mnemonics. Also, rote learning (BEDMAS) is discouraged by modern educational theory. Turnure and Lane (1987) suggest that mnemonics techniques must be taught, retaught, demonstrated and applied in many situations where they are expected to be utilized, simply because that is the way things are learned and that is the way most people master techniques

O'Sullivan and Pressley (1984, 277) suggest that we should give our students the opportunity for using mnemonics because if they are given the opportunity to see a strategy and see it being used, the chances then become greater that they will at some point see the strategy as being of value. Black and Rollins (1982,11) suggest that there is a positive relationship between knowing the value of a strategy and applying it. As adults we are often leery of trying new things because we are confident of the things used now. If we are required to change it is necessary to see some value as the result of the changes; otherwise, we are resistant to the change. A good example of this resistance to change is the school system. How many schools operate exactly the same way today as they did thirty years ago. The answer is most. Yes, the course content is changed a little, the methods of teaching have changed a little, there are even some teachers allowing students to work in groups, perhaps cooperative learning might be tried in more classrooms. But the changes are very slow. Teachers are often happy with the way things are going. The methods that they are using worked with them when they were in school, so these same methods should work with the students in school today.

Even though the role models are not there and we do not teach mnemonics, Pressley and Levin (1977, 54) suggest that some children do show use of mnemonics in their everyday patterns. These children are finding ways for themselves to learn, and mnemonic devices are developed. These children appear to be learning independently and developing in spite of the school systems which are not meeting the needs of all these students.

In the last few years the schools have opened their doors to all students. At the present time, all students, regardless of their age or abilities are permitted to attend the public school system. In any given class you may find students with exceptional needs as well as students who are gifted. In many classrooms these students are learning entirely different curricula or they are learning identical curricula, the teacher teaches to the middle stream of the students. The school is not meeting the needs of these students. School systems have tried mainstreaming and integration. Physically and mentally handicapped students are put into the same building as all other students and in some cases are permitted to attend the same classes as their peers. If they are in the same class they are most likely doing something totally unrelated to the curriculum that the student body is learning. If the class is having a lesson on causes of AIDS, the mainstreamed student is sitting at the back of the class cutting out pictures of people who are smiling and posting them in a scrapbook of some kind. Often these students with special needs are doing more important things (or are these things to keep them out of the class?) than the rest of the class, things such as running errands for the teacher, watering the flowers in the offices or running to the nearest store to get milk for the staff room, with a teaching assistant of course.

The latest endeavor of education is to provide an equal education to all students. This newest idea is termed inclusive education. All students in the class regardless of their ability are required to partake of the lesson's theme. No matter what the topic is that is being presented in the room, all students regardless of their ability are doing something related to the topic. As an example, if the students are working on the causes of the Second World War, the gifted students may be writing essays and researching what the actual causes of the war were, and some middle stream students will be preparing a poster of the causes, perhaps by cutting or pasting, or drawing, the lowest students in the class would be working on the same theme but simpler examples, such as the cause of a fight in the hallway, then presenting that information to all of the class in some form, for evaluation. This type of instruction is termed **multi-level instruction**. The hope is that this type of instruction catches on, to the benefit of **all** students in the public school system.

Collicott (1991, 219) suggests that the teacher must develop a framework for planning that allows for one main lesson with varying methods of presentation, practice and evaluation. Multi-level instruction is based on the premise that one lesson is taught to the entire class. Collicott (*ibid.*) suggests that the planning of the lesson allows for the individualization, flexibility and inclusion of all students in the class. The teacher must consider the learning styles of all students in the class, as well as involving all students through different levels of thinking. The use of Bloom's Taxonomy may be useful for this. The teacher must also realize that some students will need adjusted expectations, as well, the teacher must allow a choice in the way the students demonstrate the understanding of the concept. The teacher must accept the fact that the students are doing something different than ordinarily, the teacher must accept this as well as find ways of evaluation the students that take into account individual differences.

Collicott (1991, 220) suggests a four step process in developing a lesson for multi-level instruction, it will be adapted here as a six step process. The steps would be as follows:

1. Identify all students in the class and their different learning styles, written notes about each student and their learning styles, problems, etc. are very helpful.

2. Develop a team of four or five other teachers with different teaching backgrounds (different subject areas helps, as well as different grade levels). These teachers will collaborate on the remaining four steps.

3. Identify the underlying concepts of the lesson, in simple words so all students will understand them, in words that make the lesson meaningful to all of the students.

4. determine the method of teacher presentation, this may be by using a number of different methods for any one lesson so that all the students will benefit from the presentation depending upon their level of understanding. All students do not pick up information from a lecture, hands on activities will help, activities out of the ordinary, non-verbal assignments, etc.

5. determine the student, method of practice, allowing for variation

in assignments. All students will not have to write a ten page paper as practice, some students will, others would be required to draw a picture, write a song, make a video, etc.

6. determine the method of student evaluation, again the teacher must accept variation in the evaluation of students, much as in the practice session above. The students should be evaluated as individuals, not as part of the group. The teacher should have individual expectations as opposed to group or norm expectations

The following list gives the teacher examples of alternate ways of addressing steps five and six above:

use a larger room	charades
video	comics
presentation to others	presentation to class
music	tape recordings
group assignments	class assignments
murals	art
plays	posters
bulletin boards	ceiling murals
models	point form
collage	no assignment

newspaper article	T shirt display
guest speakers	verbal answers

The sky is the limit. The only constraints to this would be the creativity of the teachers and the learners. The collaborative approach helps generate ideas, ideas that may have worked in other class situations, grade levels, and subject areas.

What would multi-level instruction and mnemonics then share? Well, the two go hand in hand. The teacher is trying to reach all of the students and trying to get all of the students to remember many different types of information. The class range is from very poor students to very strong students Mnemonics can reach all of these students successfully. Multi-level instruction allows the students to learn in ways that the student learns best, as well as allows the student to express an understanding of what has been learned in many different ways. The use of mnemonics could play a vital role in the learning styles of many of our students

With the mainstreamed students, MacMillan and Meyers (1984, 59) suggest that it is time we get away from behavior modification training and start using mnemonics with our handicapped students. In the past we have used techniques such as precision teaching, direct instruction and programmed instruction with mainstreamed students. The time is now to look at mnemonics with these students. The idea that mnemonics can be used with exceptional students is supported by Danner and Taylor (1973) and Ross and Ross (1978). Turnure and Lane (1987, 354) support the use of mnemonics with exceptional children, but contend that more research will be helpful. At the present time there is a fair amount of research available on the use of mnemonics with exceptional children (Gersten, 1985; Mastropieri and Peters, 1982; and Mastropieri, Scruggs, Levin, Gaggney and McLoone, 1985).

Gifted children are also present in the regular classroom. Can mnemonics be of benefit to these children? Carrier, Karbo, Kinden, Legisa and Newstrom (1983) suggest that yes, mnemonics is a definite benefit to gifted students. With these gifted students mnemonics based on imagery is even more beneficial. Kosslyn (1976, 430) suggests that children often represent concepts in an imaginistic fashion. They are using mnemonics, but when they get into school situations these ways of learning are somehow put in the background. Again perhaps there is too much strength put into content by teachers. Sadoski (1985) suggests that imagery sometimes mediates children's execution of important tasks such as reading. Mnemonics would not be difficult to slip into the program since it appears that children are already using them. Pressley (1977b, 593) suggests that children's imagery skills continue to develop during the elementary school years

For the rest of the class mnemonics will be useful as well. Roediger and Weldon (1975, 564) suggest that successful mnemonics can probably be constructed for any retention test. These mnemonics could be both teacher generated or student generated. Snowman, Krebs, and Kelly (1980) and Krebs, Snowman and Smith (1978) support the use of mnemonics in the classroom, doing work with prose material. Both experimental studies suggest that training the students in mnemonic techniques leads to better understanding and retention of the prose material. Levin (1976,117) supports the contention that mnemonics is helpful with prose material.

Honeck, Sowry and Voegtle (1978, 23) contend that mnemonics may even be helpful understanding concepts. Delaney (1978, 308) suggests that mnemonics is helpful learning foreign languages. Bransford and Stein (1984) experimented with mnemonics and problem solving, suggesting that mnemonics can be useful with problem solving techniques.

Mnemonics seem to have some value for the students of all levels of achievement. At some point in their education students should be exposed to some of the different types of mnemonic devices. This would allow the students the opportunity to explore their own learning styles and enhance and improve those styles Students should be enlightened to mnemonics while they are still in school, not having to wait to learn about them as they approach university or enter the business world

Pressley, Levin, and Delaney (1982) stress that mnemonic techniques have important uses in education. Black and Rollins (1982, 17) suggest that there is a positive relationship between knowing the value of a strategy and its application. If our students do not know about the strategies that are available to them they are the losers Borkowski, Levers, and Gruenenfelder (1976, 784) suggest that a good strategy user knows how far the retrieval strategy can be stretched when they use it and still be effective for them. Clifford (1984) also suggests that users of strategies for memory know that personal effort can increase the success of that strategy.

Morris (1978) stresses that meaningful things are remembered easily, and bizarre images lead to better recall Mnemonic strategies provide ways of linking the disconnected.

Bellezza (1981, 251) argues that mnemonic devices are helpful in memorizing and remembering specific kinds of material. Knowing how to use mnemonic devices gives the students a sense that they can control their own memory processes The students become aware that there are easily learned strategies that produce readily accessible knowledge bases that can be further extended

Higbee (1977b, 149) suggests that with a knowledge of mnemonic the students will be able to memorize necessary routine things more efficiently. The use of mnemonics allows the student to better remember the facts Higbee (*ibid*) suggests that much school work still involves memory, not just insight, creative thinking or critical analysis. Mnemonics will not replace the basic psychological principles of learning, mnemonics uses these principles

The students will benefit from the use of mnemonics in the classroom The benefits of this will not only be visible in the students' academic performance, but will also stay with the students for a life time But what about the teacher, are there any benefits for the teacher by using mnemonics for themselves?

The benefit to teachers can be enormous. For a start that will provide the role models for all of their students; the students .ill see in practice some of what they are supposed to be learning. Too often the students see their teachers teaching, but seldom do they see teachers practicing. How often does a social studies teacher do map work, other than trying to find their way on vacation? How often do the students see the written products of English teachers? Is a science teacher really a scientist? If the teachers were using mnemonics, wouldn't that be a good learning model for the students?

Everybody likes to be called by their name. It takes many teachers weeks before that know the students by name. If the teachers were to use mnemonics they could easily learn the names of all of their students on the first day of school. The students would appreciate this, and respect would begin to be formed early in the school year. Teachers often tell their students that they must remember things from class, well' the teacher who makes a concerted effort with the names of the students is practicing the skills desired in the students behavior

Teachers often have busy schedules, many times they write down numerous meetings and appointments in their plan books, on calendars, etc. With the use of mnemonics they can easily remember all of their scheduled appointments without writing them down. Early morning, lunch, after school and evening are the free times for teachers. Mnemonics will easily allow the teacher to remember appointments on a weekly basis or even on a monthly basis.

Teachers need to know a lot of information about students and their progress. The teacher can develop mnemonics which allow them to associate students names with grades and save a lot of time and hassle when dealing with administration and parents.

The administration of a school is constantly giving the teachers notices, forms, papers, etc. to be sent home. Many teachers forget to pass out this information on the required day, or required time of day, mnemonics can help with this problem. School administration is constantly asking the teachers to fill out reports, information sheets, statistics, etc. Mnemonics could again be the answer for the teacher.

During class teachers often rely upon their plan books to refresh their memory. Students could see the teacher reciting information from memory, not constantly trying to find out the page number they have been working on.

Mnemonics allows the user a greater facility of mind. The individual who uses mnemonics enjoys remembering things, and likes to keep the mind exercised. Teachers will find the use of mnemonics to be beneficial, for sorting and retaining information.

Yödai

Yödai is a Japanese mnemonic device develcped by a Japanese educator, Masachika Nakane, for the teaching of math, science, spelling, grammar and English. Nakane developed this mnemonic technique to help remember principles, rules, and procedures. Nakane believed that everything is based on rules so it is necessary to remember and learn the underlying rules or theories.

Higbee and Kunihira (1985a) have studied Nakane and his yodai methods extensively, introducing these methods to North America Yodai translated means the essence of structure, which means it is a summary of a subject, what it is composed of, as for example, trigonometry is set into a rhyme sixty seconds long that explains all its' major principles. According to Levin (1985, 74), reducing a system of rules, principles, or procedures to its essential structure requires conceptual understanding, information reorganization and integration. Therefore yōdai mnemonics are both *unique* and complicated *in* addressing the structures to be learned as processes rather than facts.

Higbee and Kunihira (1985a, 58) suggest that Yōdai, now translated into English consists of a combination of verbal mediators. These verbal mediators would include such things as phrases, sentences, rhymes and songs. The verbal is mixed with visual images in yōdai. Students not only create a visual picture or use visual cues to help them remember, they also can use the verbal rhymes, songs, etc. Yōdai is all encompasing, compared to other mnemonics which may use either verbal or visual cues.

Levin (1985, 73) suggests that songs and rhymes do have a long lasting staying power. There are numerous rhymes that stick in the minds of most adults from their childhood, these rhymes do remind people of things and events. Yōdai seems to be capitalizing on this idea. Higbee and Kunihira (1985a, 58) suggest that there are three categories of yōdai mnemonics:

1. formulas and numerals
2. definitions, principles, concepts
3. process of problem solving

Higbee and Kunihira (*ibid*) suggest that mediators are readily available for learning and recalling information.

The verbal mediators consist of meaningful verbal chains They are presented and remembered in language that is familiar and simple for the user. Often yōdai mnemonics are set to music and sung to the tunes of common familiar tunes that the students would remember and enjoy In addition to the use of music for some items to be remembered, yōdai mnemonics may see an entire class recite a rhyme while one student records information on the blackboard.

Higbee and Kunihira (1985a, 62) suggest that one feature of mnemonics is that it creates interest and helps to motivate the students. In North American mathematics classes there is often a lack of motivation for the students. This lack of motivation causes a great deal of stress for the students and undoubtedly causes the overall scores for these students on test items to be low (Higbee and Kunihira ,1985a, 62) The lack of motivation and interest can cause a great deal of frustration in our students. Yōdai mnemonics appear to help with this aspect of the teaching of mathematics and science. Higbee and Kunihira (1985b, 78) suggest that using yōdai mnemonics may give confidence to the students by giving them successful learning experiences. This might increase interest which leads to the desire to succeed, exactly the things multi-level instruction is attempting to do as well. Yōdai mnemonics teaches information that is more meaningful, more interesting and more memorable.

Levin (1985, 74) suggests that yōdai mnemonics could possibly be the key to unlocking an individual students' independent learning potential, which further connects mnemonics to multi-level instruction. Pressley (1985, 69) suggests that using yōdai mnemonics has tremendous potential for improving the learning of content material with which children often experience difficulty. If we can make a subject such as math easier for the students it should be worth the effort.

Higbee and Kunihira (1985a, 58) suggest that yōdai mnemonics involves doing before understanding. A lot of our current content areas in North American schools are going in this direction with their curriculum. McFadden et al (1988) have developed a science program for use in junior high schools that often has students doing activities before they understand the concept. The students learn the concept in many cases by doing the activities. Levin (1985, 73) suggests that yōdai mnemonics are aimed at first teaching how to do something, then it gets into remembering the process. Levin (*ibid*) suggests that yōdai mnemonics may be better than other mnemonics because it deals with the processes involved whereas other mnemonics deal with the remembering of facts in most cases. Levin (1985, 74) even goes as far as to say that yōdai mnemonics may aid in remembering when to use other mnemonics. Higbee and Kunihira (1985b, 78) suggest that yōdai mnemonics do not have to replace understanding, but yōdai might precede, accompany, or follow understanding. They also suggest that using yōdai techniques might help in the learning process by allowing the students to learn the procedures more effectively by decreasing the attention required.

Higbee and Kunihira (1985a, 59) suggest that many of the graduate of Nakane's school in Japan have gone on to careers in medicine and engineering due to the interest that was generated in these fields by yōdai mnemonics. Higbee and Kunihira (1985b, 79) even suggest that students of yōdai mnemonics who were interviewed fifty years after graduation still remember the original songs and rhymes. Levin (1985, 75) suggests that yōdai mnemonics could be used to reduce the gender difference in math and science. Males traditionally have done much better in these areas

Using yödai mnemonics could reverse this trend, or at least start to make a difference in male and female attitudes because it allows for the presentation of math and science in enjoyable, non-anxiety producing contexts or environments.

Pressley (1985, 69) suggests that yödai mnemonics are based on a variety of mechanisms which are known to aid learning, especially with children. The first of these mechanisms relates to learning meaningful and familiar things. Learning is facilitated by relating new ideas or concepts to things which are already familiar to the learner. Yödai attempts to do this with the rhymes or songs, that refer to familair things. Abstract operations, such as we experience in mathematics classes, are better coded using concrete things. In other words we take abstract things and remember them by relating them to concrete things. Rohwer (1980) suggests that the best thinkers do not think abstractly but rely on concrete experiences and representations.

Levin (1985, 75) suggests a couple of possible problems with yödai mnemonics. The first of these being that the process could be hampered by slow retrieval, it would take the students more time to retrieve information, even though it has been remembered better. Also there is a lack of research on yödai mnemonics.

The technique has not caught on in North America. Possible reasons for this could be that the majority of information on yōdai is written in Japanese, which hinders a lot of researchers from continuing the studies. Of the little Yōdai experimentation that has been carried out, the language of communication has been primarily Japanese. In addition to this, the translation of most rhymes and songs from Japanese to English loses something. North American students have different interests from Japanese children, so in order to successfully develop yōdai techniques for North America the researcher has to almost re-invent the wheel.

Pressley (1985, 71) agrees, suggesting that yōdai mnemonics is a largely untested field of education, but he suggests that the teachers who expose their students to yōdai mnemonics will be providing those students with important cognitive tools. Kilpatrick (1985, 65) also criticizes yōdai mnemonics because it is largely an untested field. Kilpatrick (1985, 67) suggests that using yōdai simply postpones learning mathematics terminology. Unfortunately he feels this is bad. Is there any need to worry about when the students learn the correct terminology, as long as they do learn the terminology? Higbee and Kunihira (1985a, 62) question if it is even necessary for everyone in schools to know the correct terminology of mathematics. Afterall, how many of our students are going to need to communicate in the language of mathematics once they have left the schools. Kilpatrick (1985, 68) also suggests that some aspects of yōdai mnemonics may depend on Japanese culture and may not be adaptable. Kilpatrick (*ibid*) does suggest that yōdai mnemonics does have one very strong feature, it offers to the students the opportunity to vocalize the rhymes or operations that are being used. This alone is a very important feature of mnemonics, a feature which is seldom used in secondary math and science classes in North America.

Fractions evoke fear and apprehension in many junior high age students. These students have been exposed to fractions for at least five years, yet many still have a difficult time understanding or remembering the processes involved in working with basic operations with fractions. Just the mention of the word fraction in many classrooms causes anxiety among many students. A mental block develops. A hate for mathematics develops. A dislike for the teacher quickly overtakes some of the students.

What will happen if fractions are introduced to the students in a manner that is unique and different? Perhaps they would be better motivated to learn fraction problem solving. What if the teacher is able to present the concept of fractions in such a way that the students will not only find it interesting, but in a way that the students will be able to remember the concept of addition, subtraction, multiplication, or division of fractions? Yōdai is a mnemonic device that appears to help the user remember processes rather than facts, as is the case with most mnemonic devices.

Machida and Carlson (1984), experimenting with 12 and 13 year old Japanese students using yōdai rhymes to learn basic mathematics versus traditional mathematics found that yōdai techniques promoted the children's use of math procedures. The gains due to mnemonic instruction were good immediately and two weeks later.

Fennell (1993, 28) suggests that in an international survey completed in 1991, a random sample of 3000 students tested in 15 countries, Canada placed in the middle of the fifteen countries in math and Science. In Math Canada placed 9th, with an average score of 62%, and in Science Canada 9th, with an average score of 69%. Canada needs help in trying to pull up our average scores. In such a highly industrialized country such as Canada the showing in these surveys has been disappointing. Perhaps yōdai may be part of the solution, a new method to teach the basics with emphasis on process

Dempster (1993, 433) suggests that the schools in North America need to evaluate their curriculum. The amount of content that we are requiring our students to learn may be excessive. Dempster (1993, 437) suggests that exposing our students to less may help them learn more. Yödai allows the teacher to spend more time on one concept with the concept being learned better as well as increasing the retention rate of the learned material.

Mack (1990) worked with elementary students one on one for six weeks with fractions. The students were taught fractions in a way that made the fractions more meaningful to the students. Student performance increased when the fractions were related to more meaningful, real life situations. This is what yödai attempts to do, present material in a more meaningful way.

An Experiment in Yödai

Method

The subjects for this experiment consisted of 52 grade nine students, aged 14 and 15, from two heterogeneous groupings Two groups, each consisting of 26 subjects were chosen by randomly selecting students. The first group was selected as the control group by coin toss, the second group as the experimental group. Students in the control group were separated by class; as well, the experimental group was separated by class, giving a total of four groups, each group to receive three hours and twenty minutes of instruction.

A1	Control	12 students
A2	Experimental	13 students
B1	Control	14 students
B2	Experimental	13 students

Experimental groups (A2 and B2) received identical instruction using yödai techniques from the same teacher as the two control groups (Yödai lesson plans follow this chapter). When control groups A1/B1 received instruction, experimental groups A2/B2 were in a Macintosh Computer Lab working with Math Blaster Mystery™, a game to refine mathematics skill in solving word problems. Instruction consisted of five regularly scheduled consecutive forty minute Mathematics classes. At the completion of instruction for control groups A1/B1, groups switched, experimental groups receiving five sessions of yödai instruction and control groups receiving five sessions in the computer room working with Math Blaster Mystery™.

A1	Control	Instruction	Computer
A2	Experimental	Computer	Instruction
B1	Control	Instruction	Computer
B2	Experimental	Computer	Instruction

In the computer sessions there was no instruction, all students had received instructions prior to group separation by the same teacher used in all instructional situations. Supervision in the computer lab was carried out by available teachers in the building, changing from session to session.

All students were given a pretest, a test after instructional sessions three and four, and a post test, delayed until after two regular classes following completion of this experiment.

Yodai Experimental Groups

The yödai unit teaching fractions consisted of a total of five class lessons, each forty minutes long. The lessons follow a regularly scheduled class where the students were given a pretest of 20 problems with fractions using basic operations, addition, subtraction, multiplication and division

Day 1 Stages 1 and 2

Day 2 Stages 3 and 4

Day 3 Stages 5 and 6

Day 4 Stages 7,8 and 9

Day 5 Stage 10

Day 1

Stage 1 (10-15 minutes)

As students were settled into their seats they were introduced to yodai as an experimental lesson to help them remember the processes involved in how to complete problems with fractions. Prior to the beginning of the lesson, one class prior, students were required to complete a pre-test composed of twenty fraction problems, five each of addition, subtraction, multiplication and division. During the explanation overhead 1 was left on the overhead projector, giving the students a constant reminder of the topic. Samples of all overhead visuals for the Yodai lessons are to be found in the appendix of this text.

Stage 2 (20-25 minutes)

In the second phase students were introduced to the fundamental visual imagery for the unit. First they were asked to close their eyes and imagine that we were transported to a sunnier environment with an average daylight temperature of 30 degrees Celcius. As their eyes were closed, overhead 2 was placed on the projector. The students were asked to open their eyes and brainstorm as to what the picture was; very little prodding was needed by the teacher to convince the students that the picture was that of an X shaped swimming pool.

Next the students were asked to again close their eyes. As they did overhead 3 was placed on the projector. Students were again asked to open their eyes and brainstorm as to what overhead 3 represented. There was no argument as it was quickly decided to call overhead 3 a diving board with beach balls on top and below the board. Some students started to realize the significance of the second and third overheads, but the real significance was not discussed yet.

The class wa [illegible] en asked to discuss what they must do if they were given an all expense paid trip to the sunny destination of their choice. They agreed that in order to fully enjoy their stay they should be in shape. The quickest way to get in shape was to start running. At this point overhead 4 was introduced, the runner trying to get into shape before the big trip. Also discussed about the runner was that his uniform could be separated into two parts, the shirt and the pants. There could be numbers on the shirt, and they were told that there would be patches on the pants.

As reminders for the three overheads introduced during the lesson, copies of the overheads were posted on all four walls of the classroom. Students were still not informed of exactly what each of the overheads represented. Student motivation was becoming easy. All students appeared eager and interested to find out what was going to happen during the next class, which would follow on the next school day.

Day 2

Stage 3 (5 minutes)

Students were quickly shown the overheads from the previous class and reminded of the purpose of the lessons, to improve skills with fractions. The pool was a pool, the division sign was a diving board and beach balls, and the runner was the transporting device.

Stage 4 (35 minutes)

Two joggers were shown with an X between them as overhead 5. The students were told that the X between the two runners was to represent the swimming pool that they had been introduced to in the previous lesson. They were told then that because it was a multiplication problem they were to play the Multi-POOL Game. Overhead 6 was put on the overhead to indicate the Multi-POOL Game. To play the Multi-POOL Game the students were informed that they would have to learn a new rhyme, introduced to the students on overhead 7.

Pool shirts to shirts,

Patches to patches.

The students were required to copy the rhyme into their notebooks To help them further remember the rhyme they were required as a group in unison to recite the rhyme out loud three times At first there was some hesitation to do this, but when all students realized that all were doing it the hesitation dwindled. As a homework assignment the students were required to memorize the rhyme.

The teacher then went through a number of examples on the overhead with the students using different numbers of patches a. d different numbers on the shirts. For each problem the multi-pool game overhead was first presented, then a new overhead was used identical to number 7, but each had been previously prepared with numbers on the shirts and different numbers of patches, for example, see overhead 8

Students were then given six practice problems, separately on the overhead. The teacher was available for individual help, all problems were corrected before students were dismissed.

Day 3

Stage 5 (20 minutes)

Students had a quick review from last class. Next they were presented with overhead 9, indicating a division problem. The students were told (as the overhead changed to overhead 10) that they were going to play the DIVE-ide Game.

Overhead 10 was replaced by overhead 11 which introduced the DIVE-ide Game rhyme:

> Flip the fool
>
> Into the pool

Students were again required to write the rhyme in their notebooks, as well they had to recite the rhyme out loud in unison three time again. There was little or no hesitation this [illegible].

Overhead 11 was replaced with overhead 12, the same except the second runner has been flipped. Students are then told to play the Multi-Pool Game. The teacher ran through three prepared practice problems, such as overhead 13. Students followed the explanations, then they were given six practice problems to complete, with the teacher providing individual assistance where needed, then the practice problems were corrected.

Stage 6 (20 minutes)

The students were next given a test, Test 1, consisting of 10 mixed problems, 5 multiplication and 5 division.

Day 4

Stage 7 (5 minutes)

Students were quickly shown the overheads from last few classes to remind them. The students were then reminded that the purpose of these lessons was to improve their skills in operations with fractions. The pool was a pool, where all of the numbers could be brought together and totalled, much like a real pool where all parties involved get in and mix with all others in the pool. The diving board was a division sign, and the runner was the device used to transport all numbers.

Stage 8 (20 minutes)

Students were introduced to overhead 14, indicating that they were going to play the Match-Patch Game, a game where they would be adding or subtracting fractions using the runners they had become familiar with. The students were then exposed to overhead 15. This visual was left on for a couple of seconds, indicating addition of fractions. Overhead 16 quickly replaced this, being the same except for the rhyme which had been added.

Match the patches,
Don't take a chance;
Count the shirts,
And leave the pants.

The teacher would point to the shirts and pants as the rhyme was introduced. Students were required to copy the rhyme into their notebooks. In addition the students were required to repeat the rhyme out loud three times in unison. Students were also told to memorize the rhyme before the next scheduled mathematics class.

The teacher then performed a couple of sample fraction problems with the students viewing, as indicated in overhead 17. In each case it was stressed that the number of patches was identical. Students then performed six practice problems, which were subsequently corrected. Students then decided that they must know what happens when the number of patches on the runners is different.

Overhead 18 was presented, indicating a different number of patches, as well as the rhyme:

If the patches do not match,

Pool the other persons patch.

This rhyme tells the students that they must play the Multi-POOL Game with each runner, using the number of patches on the other runner. After using the Multi-POOL Game the student then uses the Match-Patch Game to find the solution.

Students were required to copy the rhyme into their notebooks. In addition the students were required to repeat the rhyme out loud three times in unison. Students were also told to memorize the rhyme before the next scheduled mathematics class.

The teacher then performed three sample fraction problems with the students viewing, as indicated in overhead 19. The students were then required to complete six sample practice problems with the teacher giving individual assistance.

An identical procedure was followed for subtraction of fractions as indicated above, using overheads 20 and 21 and the rhyme

Match the patches,

Don't take a chance;

Minus the shirts,

And leave the pants.

The teacher then demonstrated three examples of fraction problems with the students viewing, as indicated in overhead 22. The students were then required to complete six sample practice problems with the teacher giving individual assistance.

Stage 9 (20 minutes)

The students were next given a test, Test 2, consisting of 10 mixed problems, 5 addition and 5 subtraction.

Day 5

Stage 10 (40 minutes)

The final stage consisted of a post-test, comprised of twenty problems, five each of addition, subtraction, multiplication and division.

Control Group

Control groups (A1/B1) received identical traditional mathematics instruction from the same teacher, using the same classroom, and classroom materials as the experimental groups. This instruction began with an overview of fractions during day 1, what they represent and examples of where they would be used, then continued with instruction in multiplication (day 2) and division of fractions (day 3). Day 3 also had a twenty minute test on multiplication and division of fractions. Addition and subtraction were discussed on day 4, along with with a twenty minute test. Day 5 consisted of a forty minute test on all operations. No teaching aids were used, with the exception of an overhead projector to present practice problems and to aid in instruction examples. In all traditional instruction, students were taught using traditional terms: numerator, denominator and reciprocal. For each different mathematical operation the students were given six examples showing how to solve the problems, as well, the students were given six practice problems, the teacher was available for individual help during the practice problems, which were corrected before the students were dismissed.

Test scores for all subjects were analysed using Statview 512™

Results

A repeated measures analysis of variance was conducted with pre-test and post-test scores comparing the experimental group with the control group. The results of which are shown below in figure 1.

Anova table for a 2-factor repeated measures Anova.

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
GROUP (A)	1	40128.151	40128.151	2.521	.1188
subjects w. groups	49	780079.692	15919.994		
Repeated Measure (B)	1	10200	10200	15.919	.0002
AB	1	1004.308	1004.308	1.567	.2165
B x subjects w. groups	49	31395.692	640.728		

There were no missing cells found. 1 case deleted with missing values.

Figure 1

As the table indicates there was no statistical significance between the experimental and control group in pre or post test scores.

A one factor analysis of variance was conducted comparing experimental versus control group with each of the pre test scores, experimentalstage scores, and post test scores. No significance was found, but there appears to be movement towards statistical significance.

One Factor ANOVA X_1: GROUP Y_1: PRE TEST SCORES

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	1	14892.308	14892.308	1.607
Within groups	50	463315.385	9266.308	p = .2108
Total	51	478207.692		

Model II estimate of between component variance = 5626

One Factor ANOVA X_1: GROUP Y_1: Experimental Stage Scores

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	1	24057.243	24057.243	2.979
Within groups	49	395711.385	8075.743	p = .0907
Total	50	419768.627		

Model II estimate of between component variance = 15981.5

One Factor ANOVA X_1: GROUP Y_1: Post Test Scores

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	1	26914.537	26914.537	3.787
Within groups	49	348289.385	7107.947	p = .0574
Total	50	375203.922		

Model II estimate of between component variance = 19806.59

All four mathematical operations were examined individually to determine significance. Addition, subtraction and multiplication showed no statistical significance. Pre-test division scores did not produce significance between experimental and control group scores:

One Factor ANOVA X_1: GROUP Y_1: PRE DIV

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	1	1017.308	1017.308	1.484
Within groups	50	34280.769	685.615	p = .2289
Total	51	35298.077		

Model II estimate of between component variance = 331.692

However, post-division test scores showed significance between experimental and control groups:

One Factor ANOVA X_1: GROUP Y_1: POST DIV

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	1	2241.46	2241.46	5.047
Within groups	49	21762.462	444.132	p = .0292
Total	50	24003.922		

Model II estimate of between component variance = 1797.328

Discussion

The results contained herein are encouraging for teachers of mathematics and other disciplines where it is necessary for the students to learn concepts in addition to, or instead of, facts. Although yodai instruction did not produce significant results for the total experiment, it appears as if teachers should be looking at the method with increased interest. While both the experimental group and the control group scores increased, a trend appeared to be developing towards significance from the pretest, through the experimental stage to the post-test. A larger student sample could produce significant results, or more time spent on teaching yödai techniques could bring about significant results. If the results of student test scores can be increased it will be beneficial to all parties involved in the process of education. It is important to remember that the yödai was used as remedial work with the students who have been working with fractions for approximately five years.

Post division test scores showed statistical significance. Division of fractions is often one of the hardest concepts for the students to grasp. Yödai techniques would provide students with a better chance of success with this difficult concept

Teachers who decide to try the yödai method will find it necessary to move away from their traditional fraction instruction. Developing additional yödai material will be time consuming, but rewarding for the teachers involved. The reward for the teacher will be in the satisfaction of knowing that their students are receiving the best possible instruction for difficult subject material. Teachers would be encouraged to apply for educational leave of one form or another for time for professional development to develop methods and lesson plans for instruction using yödai techniques.

Further experimentation would be of value with yödai techniques. Of keen interest would be the long term value of using yödai techniques with students. The same students tested here could be tested in two or three months, or even years to determine if they remember the techniques or the process when solving problems with fractions. Also open for more research would be to decide the age group which would most benefit from the use of the yōdai fraction techniques. Should the technique be used with students who have already been exposed to fractions as in this experiment, or should the technique be used with students who are being introduced to the process of solving fractions for the first time in elementary school. Originally the technique was designed for use with students who were using fractions or concepts for the first time. Yōdai techniques can easily be adapted to different age groups by changing the characters involved, for instance, instead of using runners as with the junior high school students, the teacher could use alien creatures to interest the students. The teacher has the freedom to change, experiment and develop the techniques. The value of yōdai rests in the fact that the students can learn the technique to remember processes rather than simply facts.

Not measured in this particular experiment, but observed, was the amount of interest expressed by the students in this new, experimental process. Unknown though, is whether this interest and motivation was caused by the process itself, or simply the fact that it was something new and different for the students who have been taught using traditional mathematical techniques most of their time in school.

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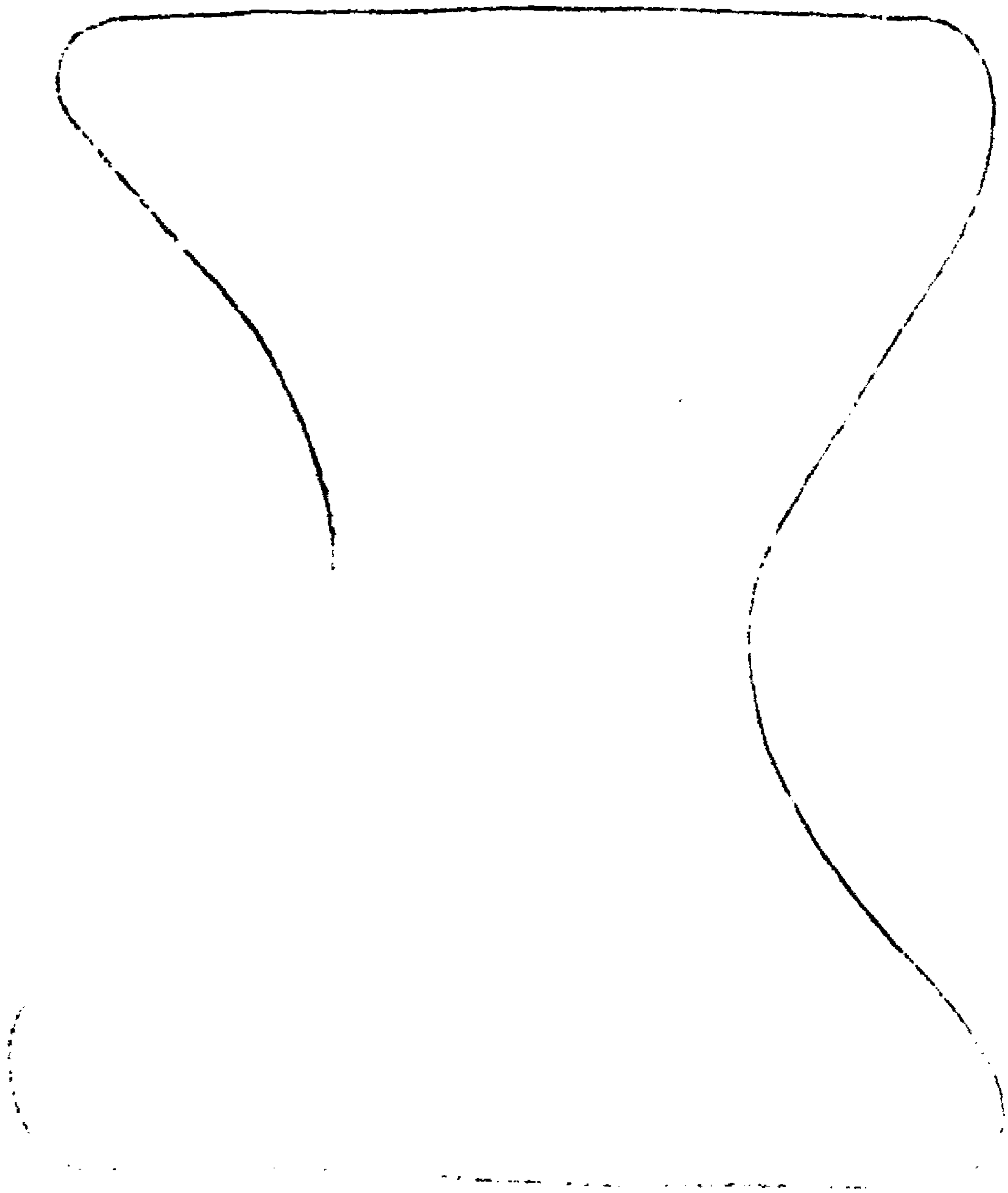
Appendix

Overhead #1

YŌDAI

Overhead #2



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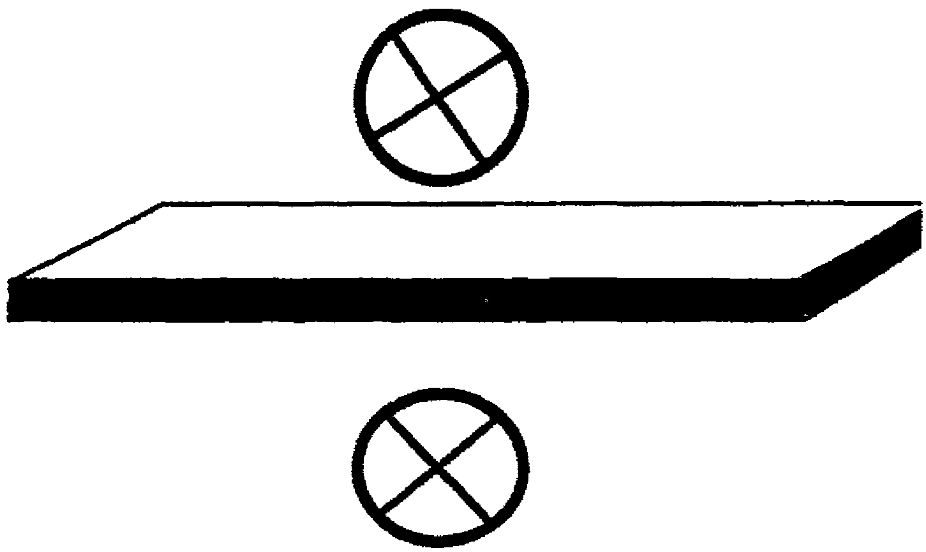

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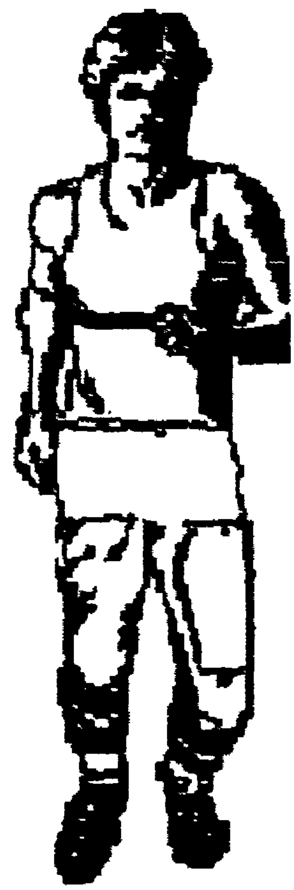

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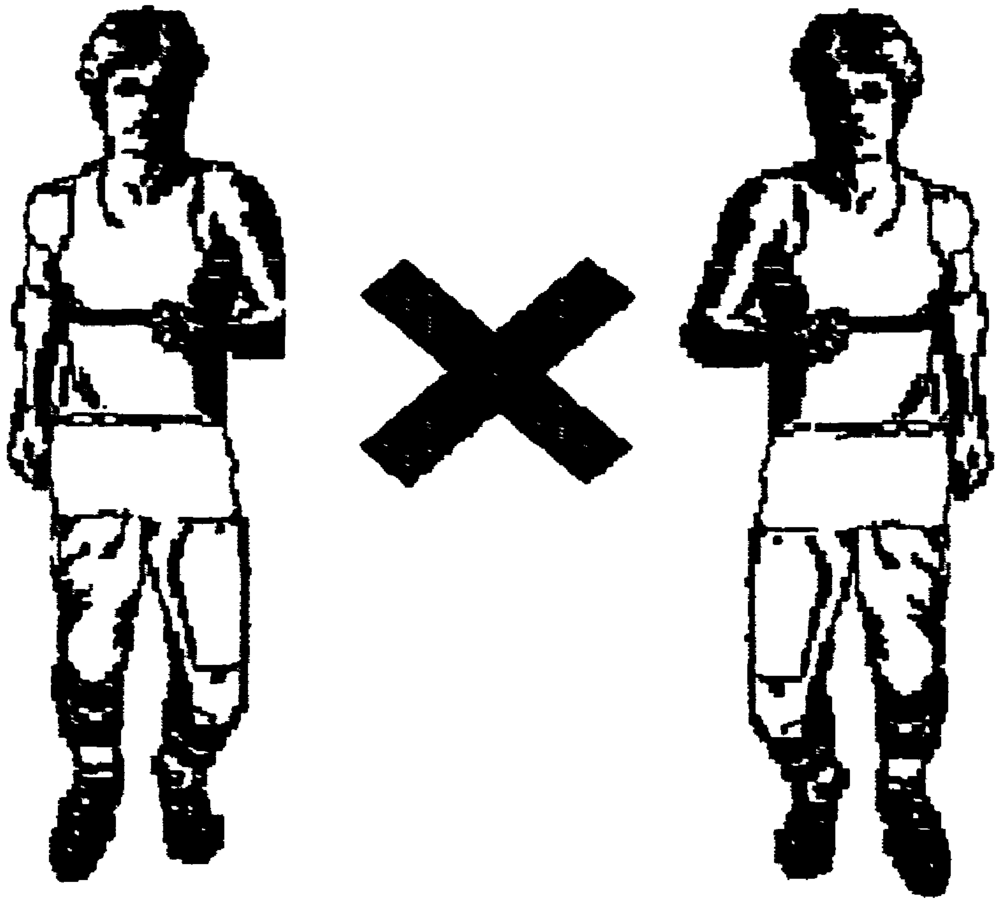
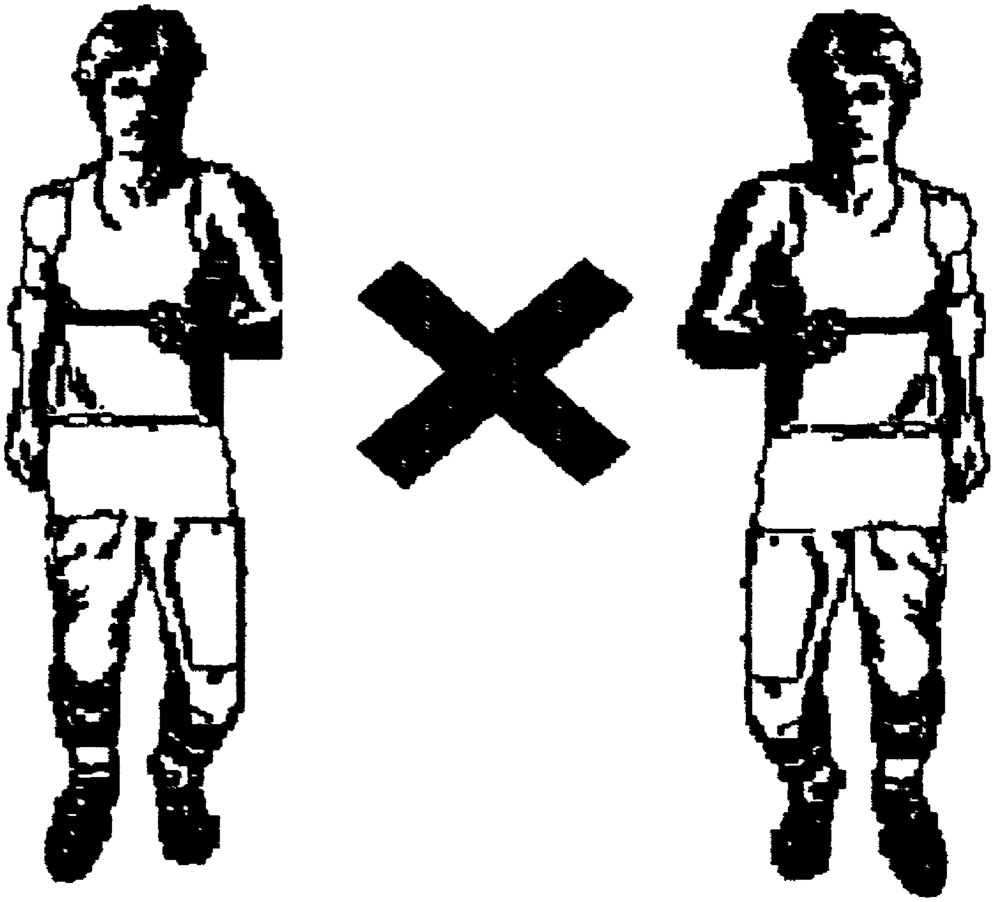


Overhead #6

Multi-POOL Game

Overhead #7

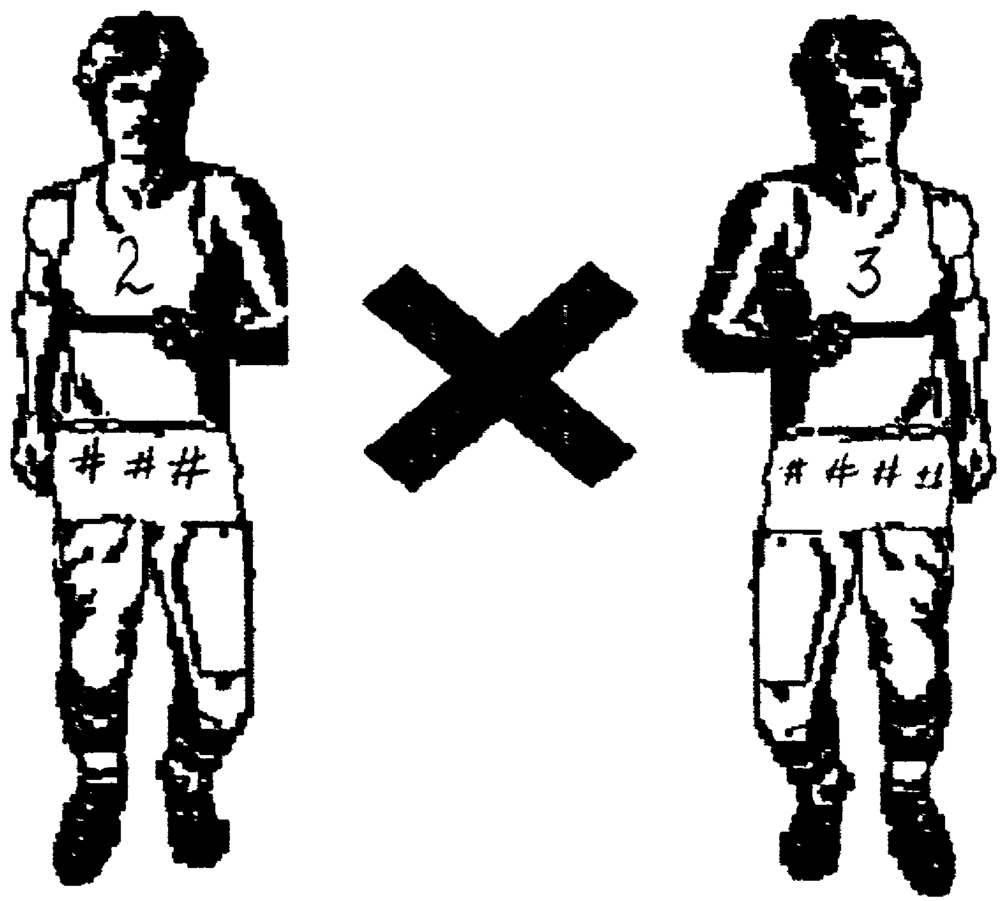
X



Pool shirts to shirts,
patches to patches.

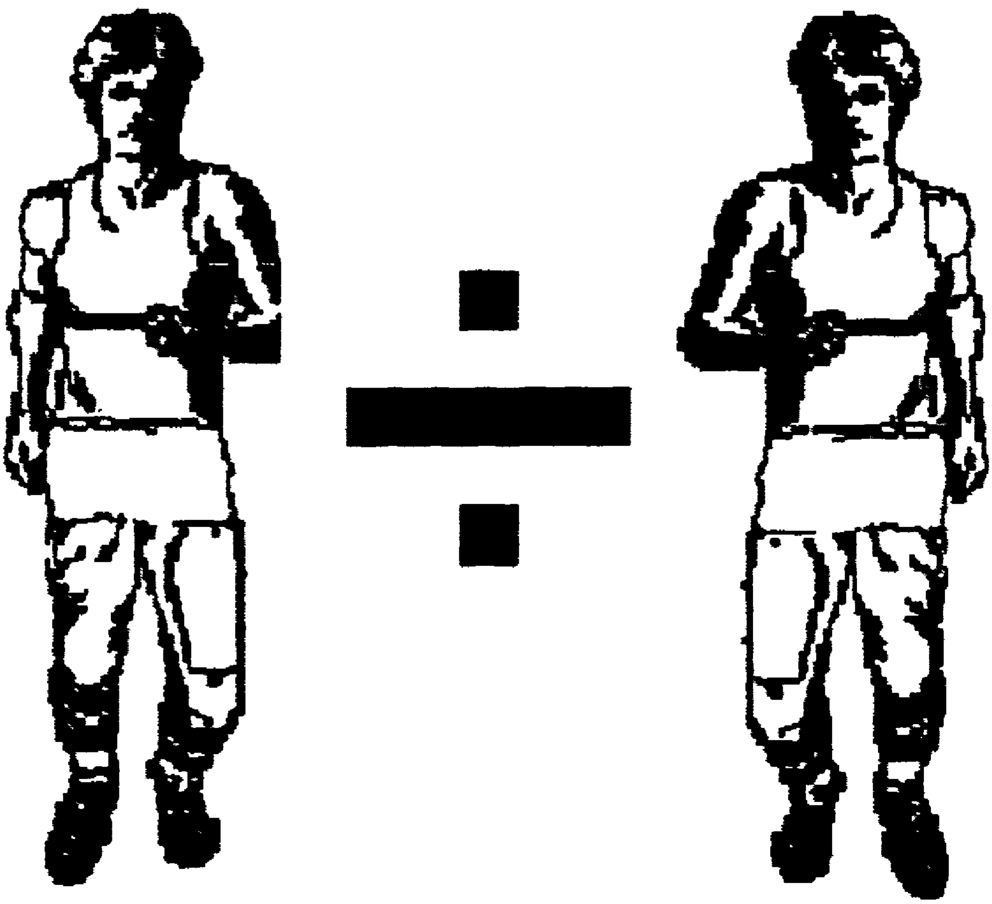
Overhead #8

X



Pool shirts to shirts, patches to patches.

Overhead #9

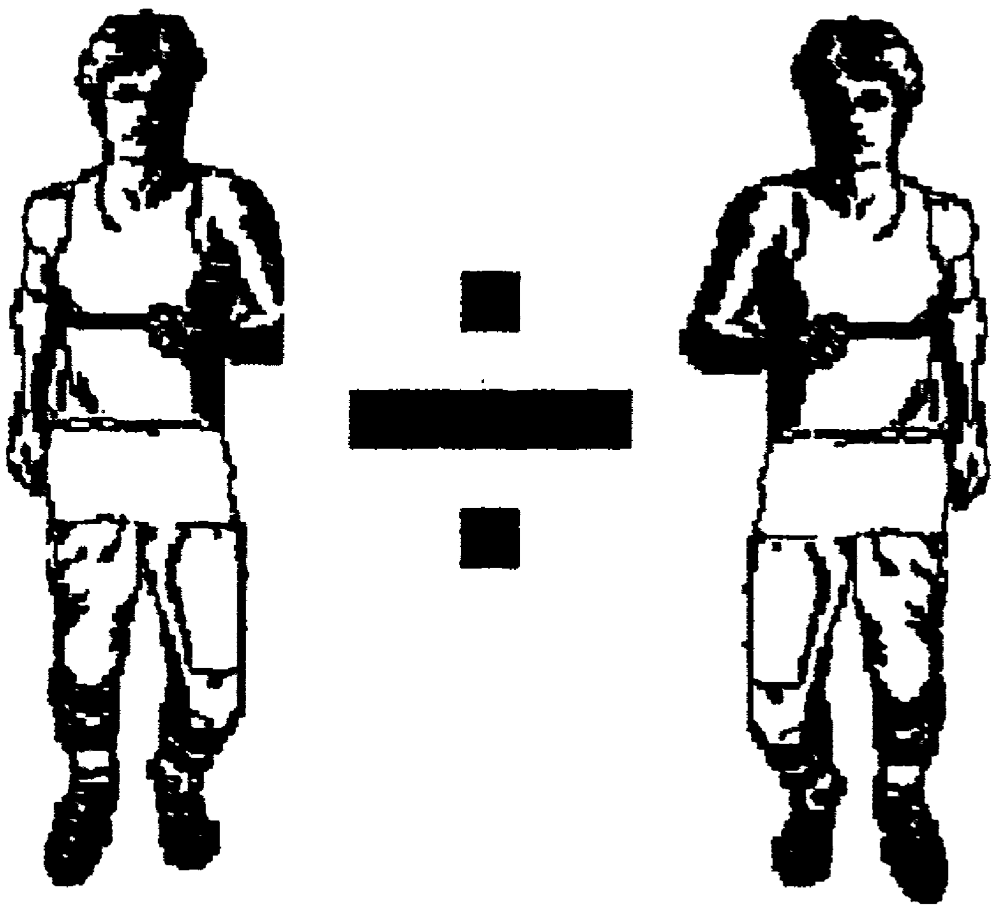


Overhead # 10

DIVE-ide Game

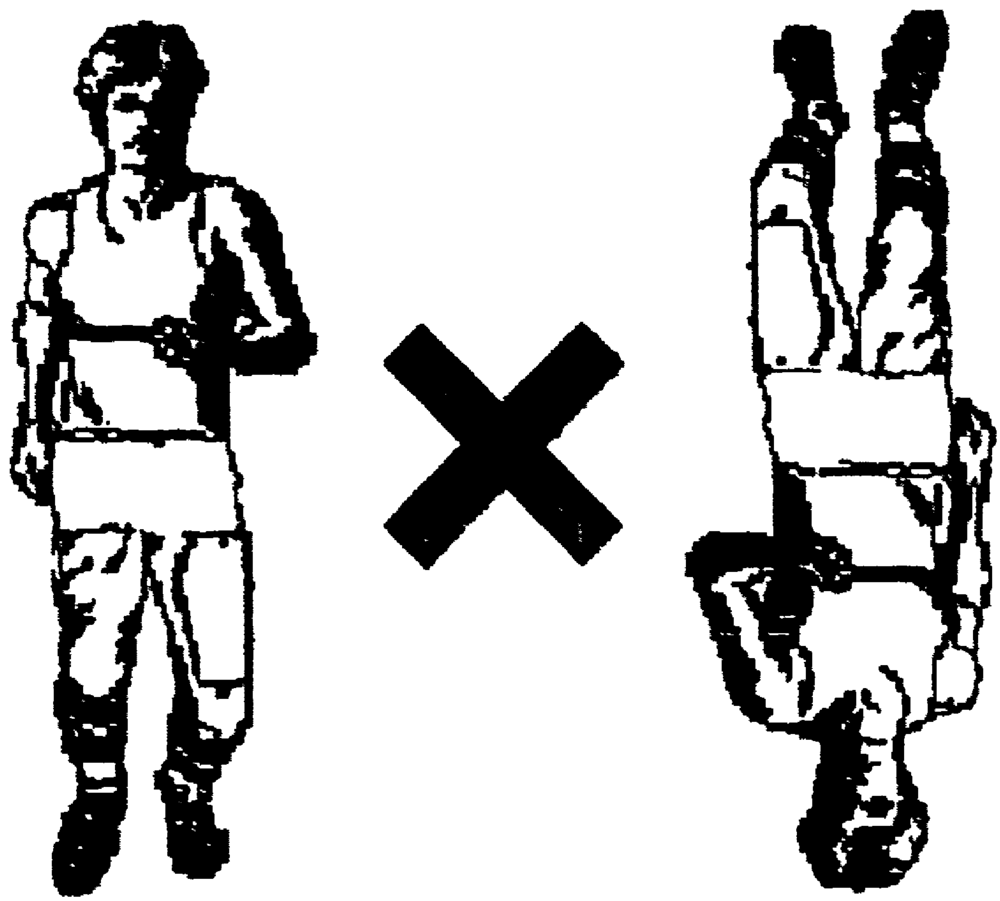
Overhead #11

÷



Flip the fool into the pool.

Overhead #12



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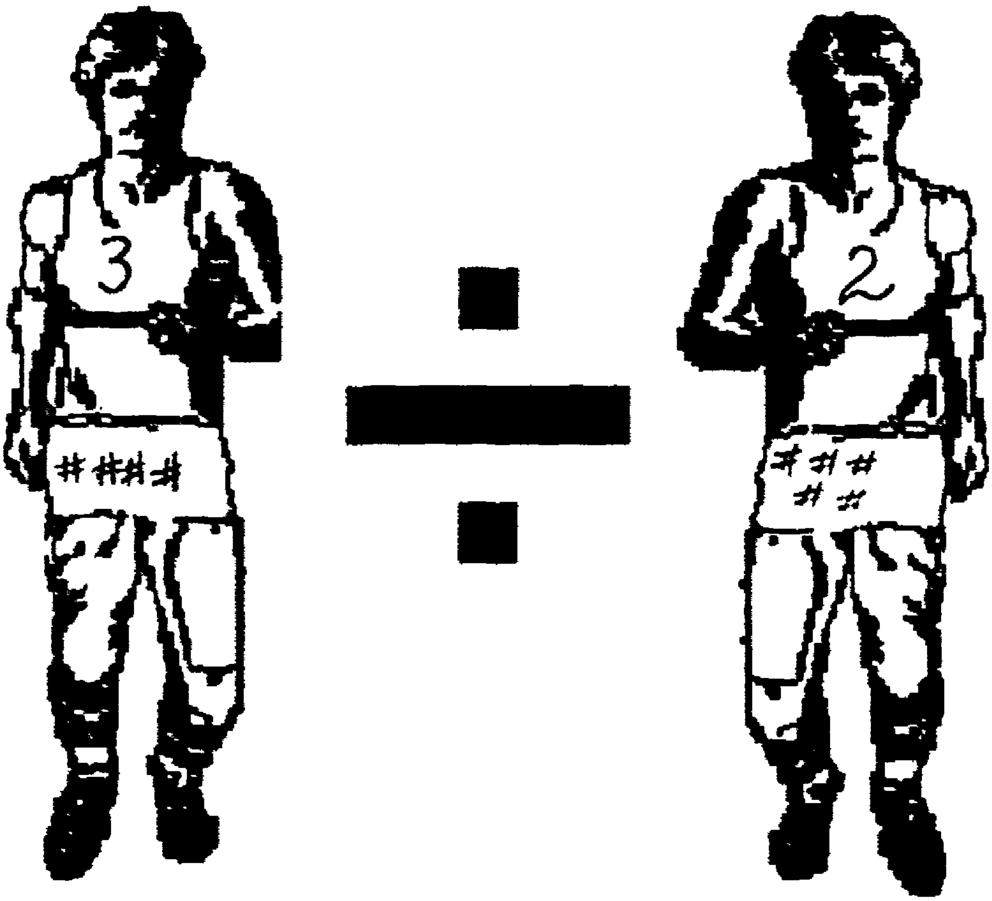
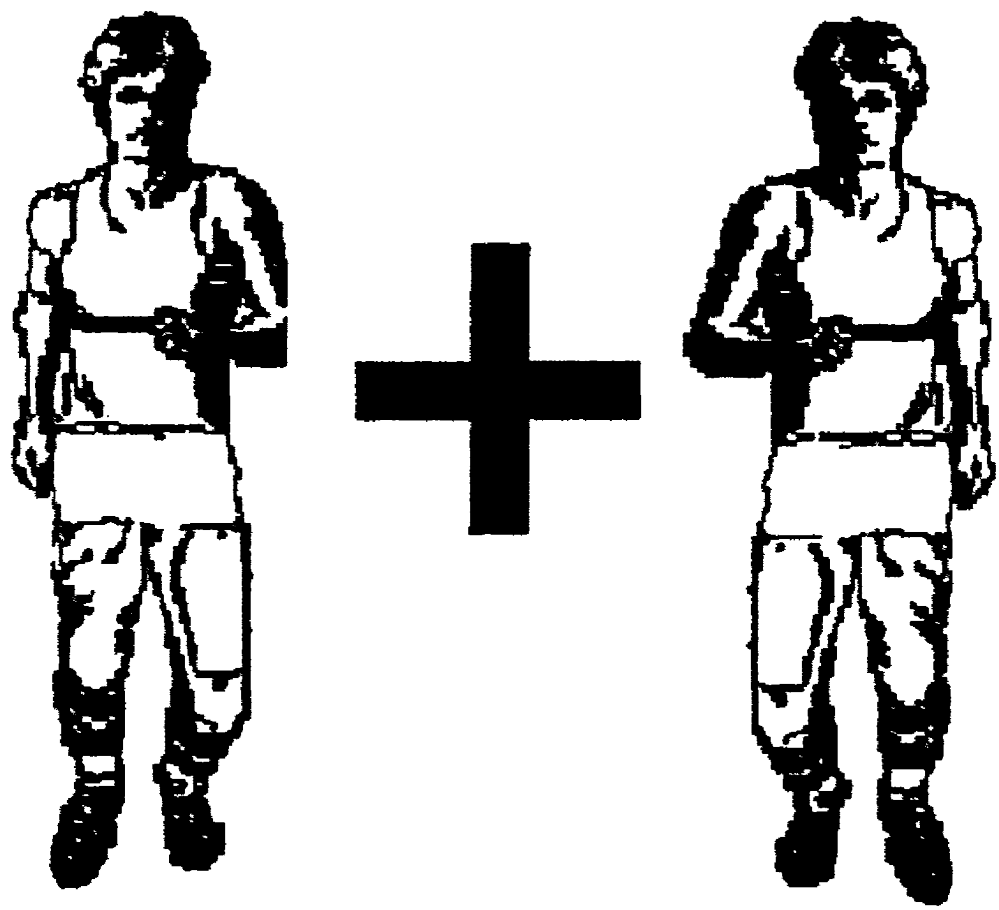


Overhead #14

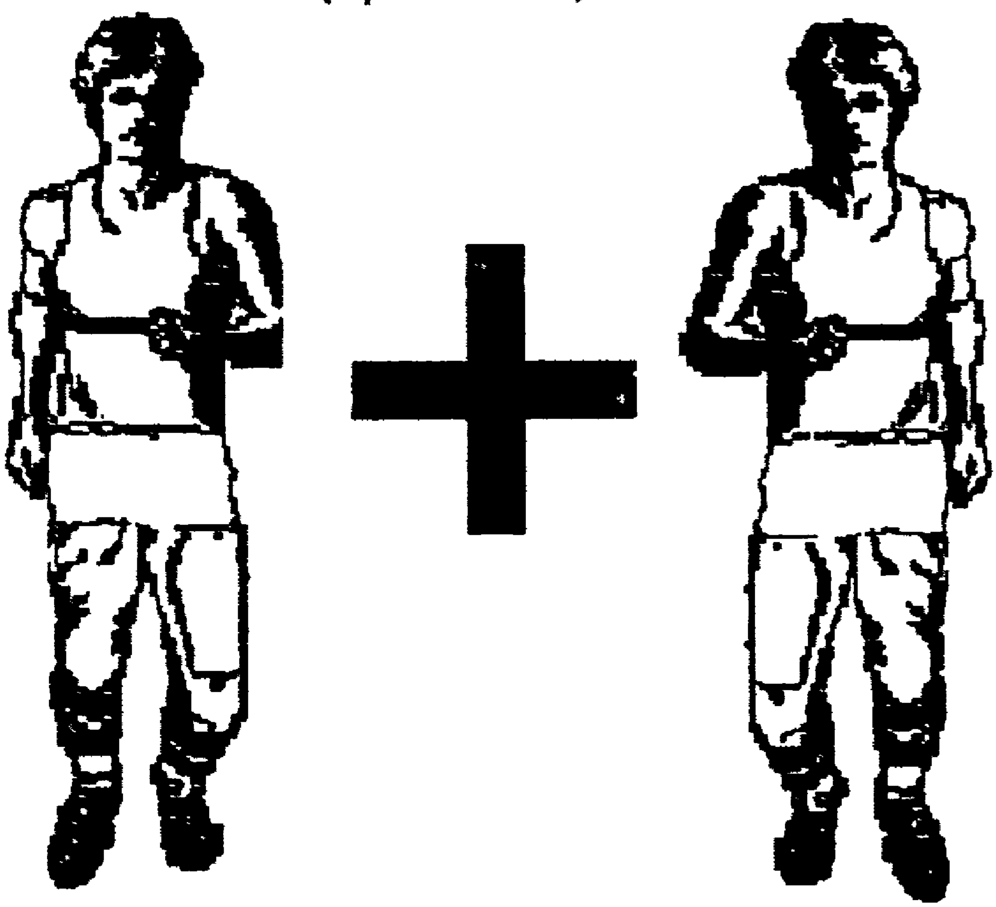
Match Partner Game

Overhead #15



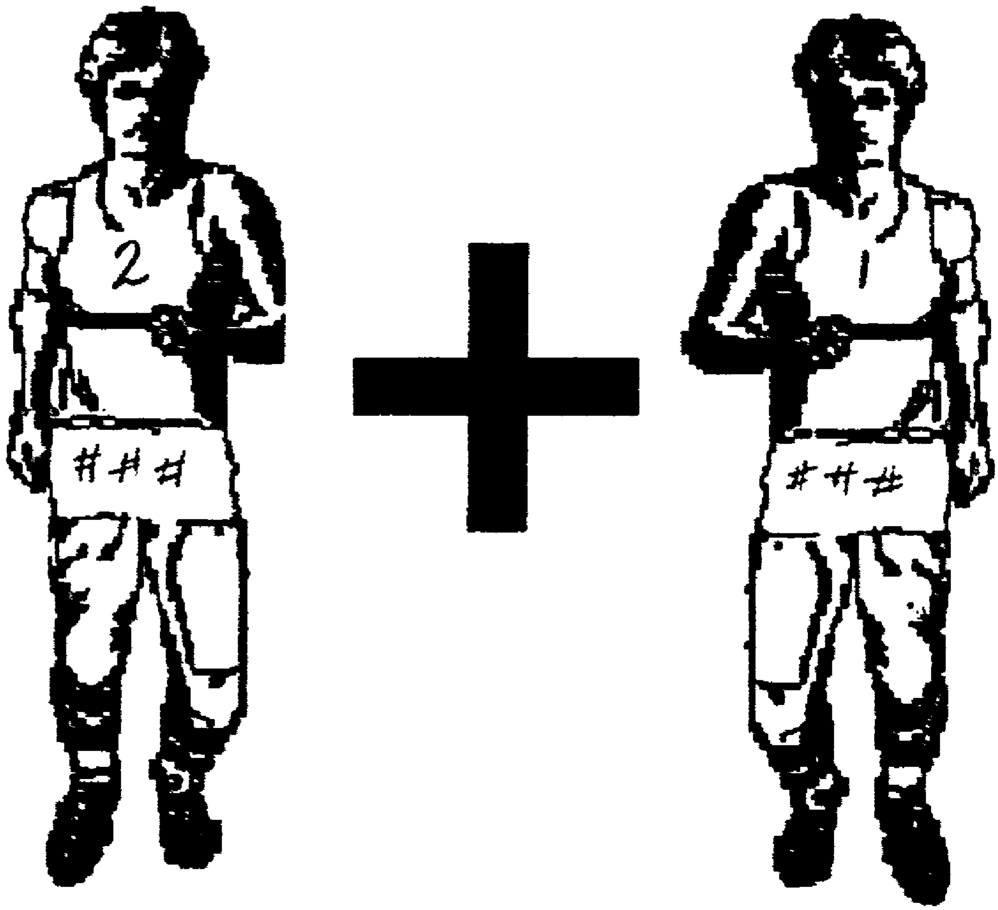
Overhead # 16

(Equal Patches)

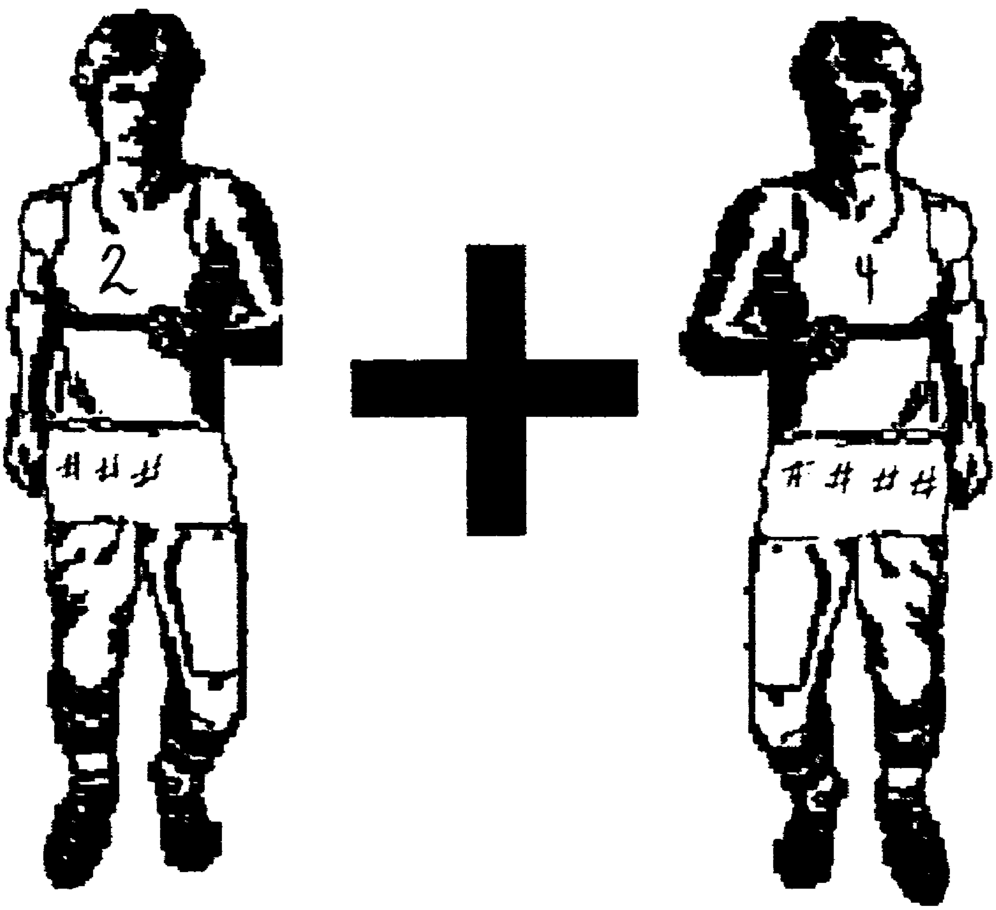


**Match the patches,
don't take a chance,
count the shirts,
and leave the pants.**

Overhead #17



Overhead #18



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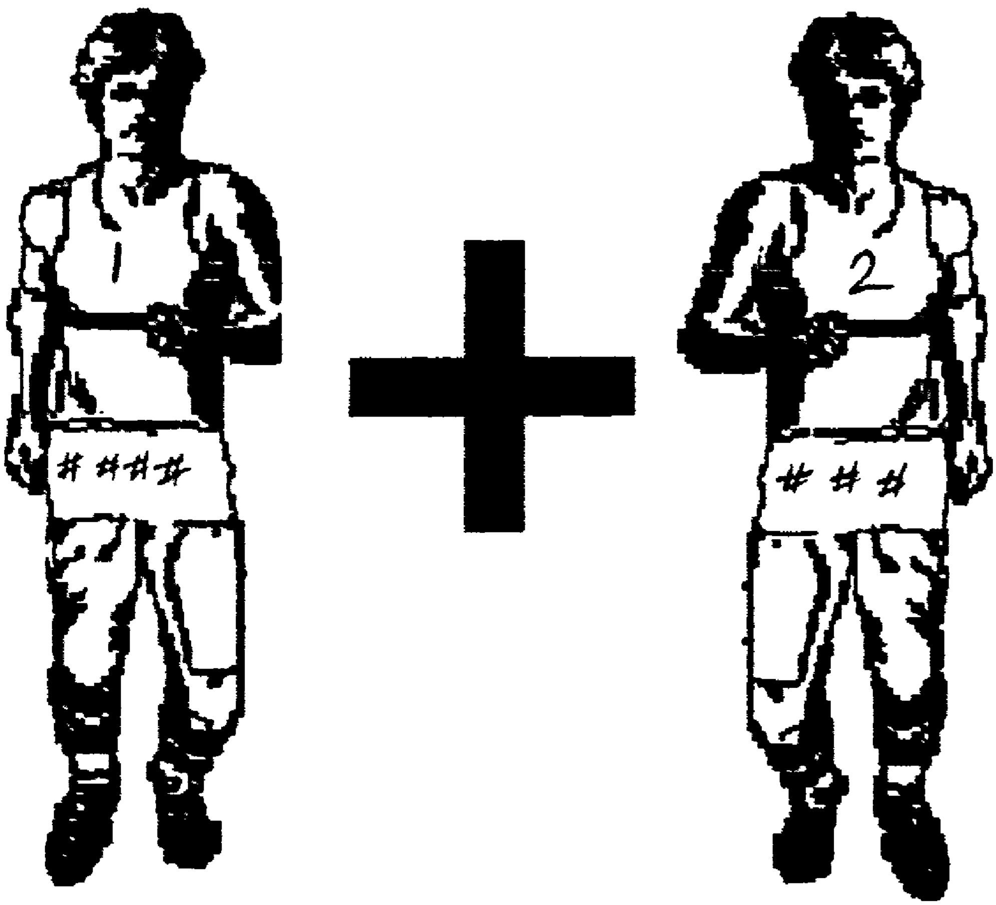
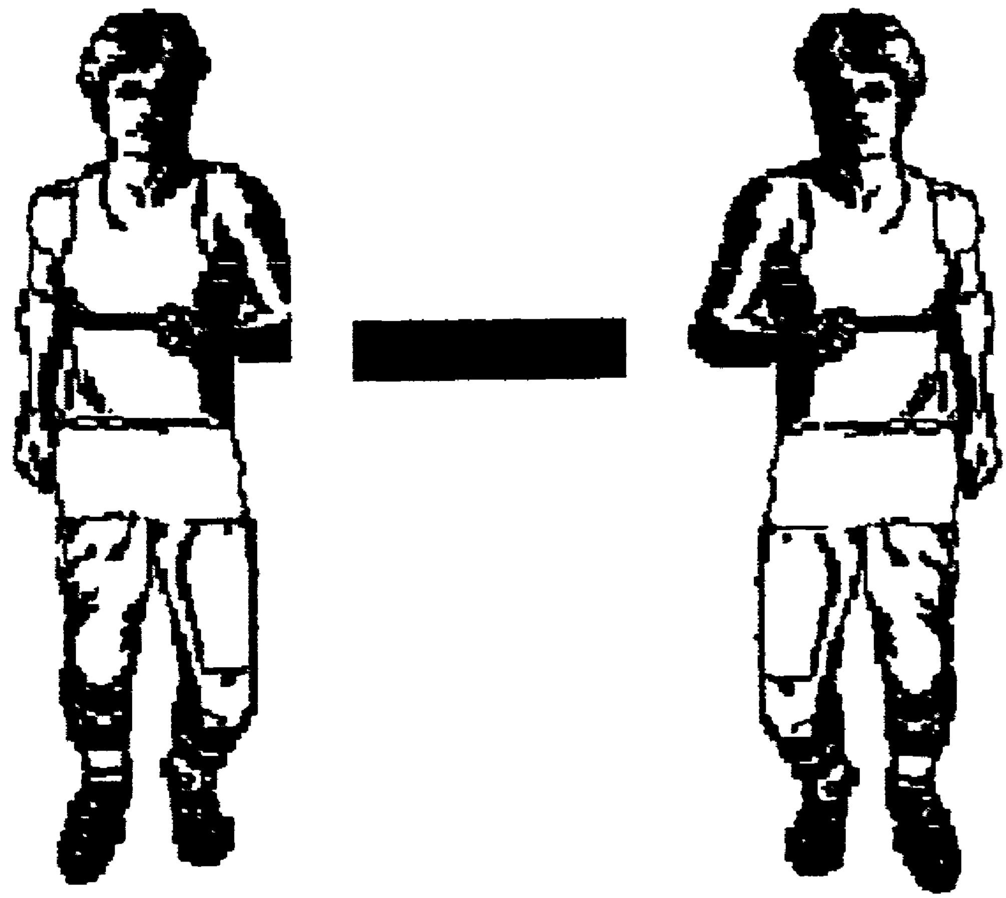
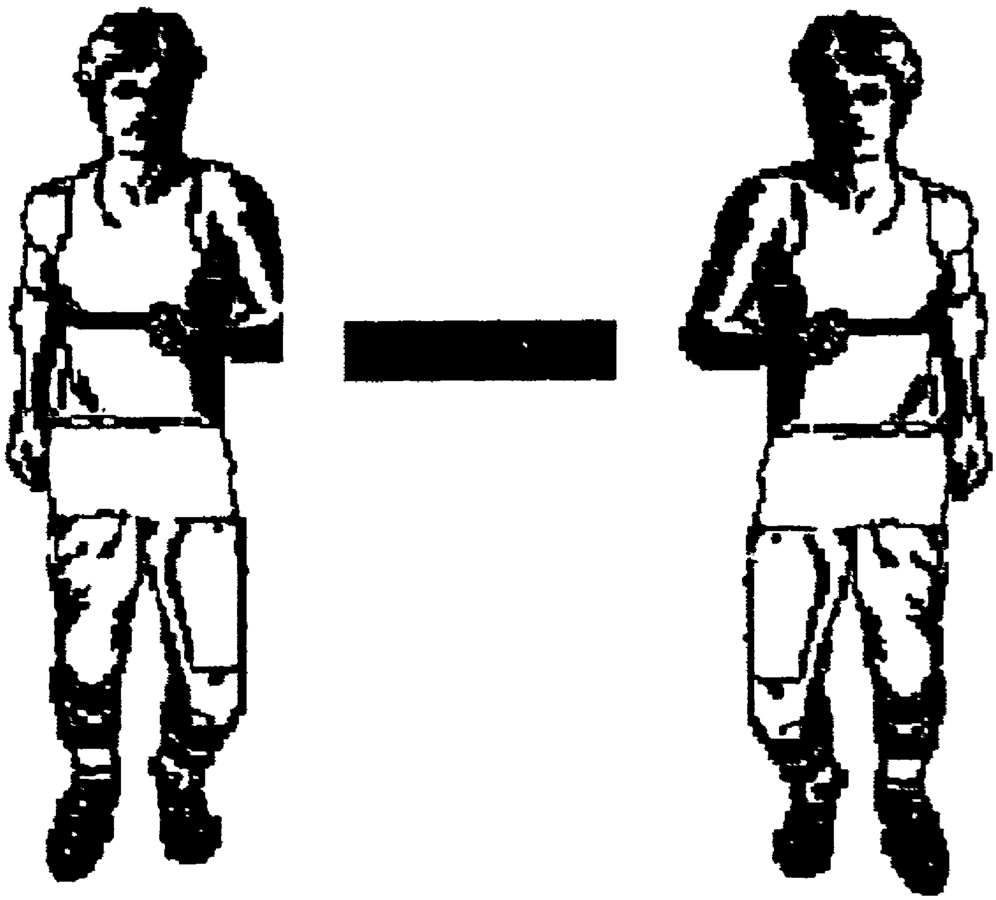


Overhead #20

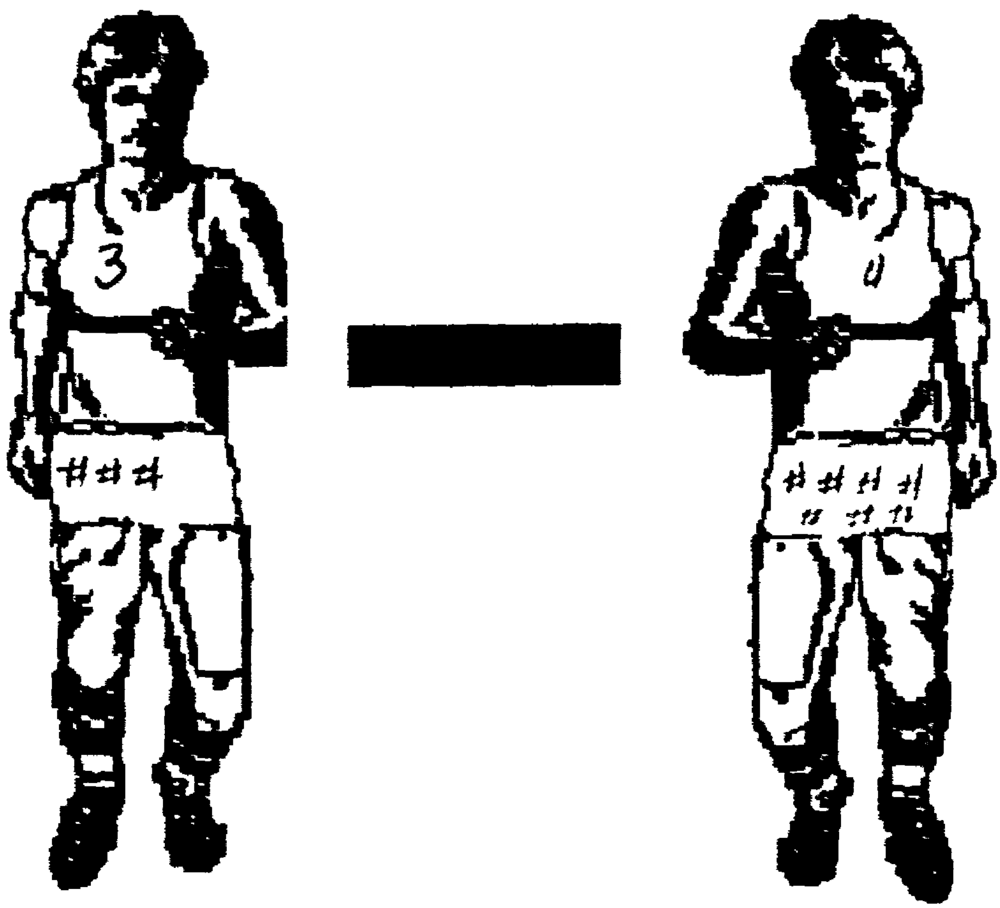


Overhead #21



Match the patches,
don't take a chance,
subtract the shirts,
and leave the pants.

Overhead #22



Fractions

All Operations - Pretest

Name:_____________

Class:_____________

a) $\frac{4}{7} \div \frac{2}{3} =$

b) $\frac{8}{9} - \frac{3}{7} =$

c) $\frac{3}{7} + \frac{12}{11} =$

d) $\frac{7}{9} \div \frac{1}{4} =$

e) $\frac{7}{9} \times \frac{3}{5} =$

f) $\frac{7}{6} - \frac{2}{9} =$

g) $\frac{5}{8} + \frac{2}{14} =$

h) $\frac{4}{5} \div \frac{2}{13} =$

i) $\frac{3}{4} - \frac{2}{5} =$

j) $\frac{3}{11} \times \frac{9}{12} =$

k) $\frac{2}{7} - \frac{1}{9} =$

l) $\frac{1}{5} + \frac{3}{7} =$

m) $\frac{3}{8} + \frac{11}{17} =$

n) $\frac{4}{7} \times \frac{6}{7} =$

o) $\frac{3}{8} \times \frac{9}{4} =$

p) $\frac{5}{6} \div \frac{2}{7} =$

q) $\frac{2}{3} + \frac{8}{11} =$

r) $\frac{2}{5} \div \frac{3}{13} =$

e) $\frac{6}{7} - \frac{2}{5} =$

f) $\frac{3}{12} \times \frac{6}{7} =$

Multiplication and Division (Test 1)

Name:

Class:

a) $\frac{4}{5} \div \frac{3}{7} =$

b) $\frac{3}{13} \div \frac{9}{7} =$

c) $\frac{5}{7} \times \frac{3}{7} =$

d) $\frac{11}{7} \div \frac{6}{7} =$

e) $\frac{7}{5} \times \frac{9}{3} =$

f) $\frac{1}{7} \times \frac{13}{15} =$

g) $\frac{3}{11} \div \frac{4}{7} =$

h) $\frac{8}{7} \times \frac{2}{16} =$

i) $\frac{7}{5} \times \frac{5}{7} =$

j) $\frac{7}{9} \div \frac{5}{19} =$

Fractions

Addition and Subtraction

Name: ____________________

Class: ____________________

a) $\frac{3}{5} + \frac{3}{6} =$

b) $\frac{7}{12} - \frac{8}{5} =$

c) $\frac{13}{6} + \frac{7}{11} =$

d) $\frac{3}{8} + \frac{6}{7} =$

e) $\frac{5}{4} - \frac{7}{5} =$

f) $\frac{2}{9} - \frac{1}{5} =$

g) $\frac{3}{10} + \frac{2}{11} =$

h) $\frac{7}{4} - \frac{6}{15} =$

i) $\frac{5}{7} - \frac{[illegible]}{5} =$

j) $\frac{6}{13} + \frac{6}{14} =$

Post Test-All Operations

Name:

Class:

a) $\frac{2}{3} + \frac{8}{7} =$

b) $\frac{6}{11} - \frac{2}{7} =$

c) $\frac{4}{8} \times \frac{10}{11} =$

d) $\frac{7}{9} \div \frac{1}{4} =$

e) $\frac{4}{5} \div \frac{5}{7} =$

f) $\frac{6}{7} - \frac{1}{5} =$

g) $\frac{3}{5} + \frac{3}{11} =$

h) $\frac{3}{5} + \frac{5}{12} =$

i) $\frac{4}{3} \times \frac{2}{5} =$

j) $\frac{5}{11} \times \frac{2}{9} =$

k) $\frac{5}{9} - \frac{2}{7} =$

l) $\frac{3}{11} + \frac{1}{4} =$

m) $\frac{4}{5} \times \frac{11}{12} =$

n) $\frac{6}{7} \div \frac{4}{5} =$

o) $\frac{2}{9} \div \frac{7}{8} =$

p) $\frac{3}{5} - \frac{2}{9} =$

q) $\frac{2}{7} \times \frac{3}{11} =$

r) $\frac{5}{9} - \frac{2}{11} =$

s) $\frac{2}{3} \div \frac{4}{7} =$

t) $\frac{2}{7} + \frac{1}{5} =$

Mnemonics, Yōdai, and Fractions

Signature of Advisor: ____________________

Prof. B. Hanrahan

Signature of Dean: ____________________

Dr. T. Piper