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Assistive Technology As A Cognitive Developmental Tool For Students With Learning Disabilities Using 2d And 3d Computer Objects

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ASSISTIVE TECHNOLOGY AS A COGNITIVE DEVELOPMENTAL TOOL FOR STUDENTS WITH LEARNING DISABILITIES USING 2D AND 3D COMPUTER OBJECTS.

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Dedication

This work is dedicated to my father who taught more than 30 years to those that were thirsty of knowledge and to my mother who always was helping the one in need. They taught me a basic principal of life, which is to help and teach the ones that needed the most. Their example encourages me to teach and help the ones that had been rejected by others and accepted a mission that others have avoided. (Quo Vadis Domine?)

To Caro and Felipe that are the two greatest motivations in my life. And to my beloved wife Yolanda that has unconditionally supported and encouraged me always in all my crazy endeavors.

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By

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Abstract

This study presented a theory in which assistive technology and body kinesthetic helped students understand concepts taught in the regular education classroom. The study included students already identified and diagnosed with a learning disability (LD). The research is based on cognitive theories that state that cognitive development could use alternative representation to have a deeper impact in the way Students with LD process information by activating different parts of the brain that are involved in the learning process. The study included students from 9th thru 12^{th} grades. Students were selected from the ones receiving services from the special education department (N=69). The current students receiving special education services identified with a learning disability are Forty-three. From this group students with LD thirty-four were selected to participate in the research (n=34). They were divided into 2 groups with the same number of students. One group formed the treatment group and the second one control group. A paired t–test was use as analysis tool in order to appraised the effectiveness of the treatment which is expected to have a significance difference ($p<.05$) on the students that received the treatment. The students will manipulate 2D and 3D objects using their body in a dynamic way. The objects will be projected on a surface on which the student will interact with it. The scope of this work will be constrained to mathematical concepts, but it could be applied to any subject taught at schools.

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Chapter 1 Introduction

1.1 Historical Perspective of Special Education

It was due to the civil rights movement that rights of the handicap population started to be considered an important legal issue. In 1954, Brown vs. Board of Education of Topeka, Kansas. (Friend & Bursuck, 2002) ruled in favor of providing equal access to education for minorities. Since then there have been several acts to ensure there is access to services provided by the federal government. (Friend & Bursuck, 2002)

Based on the principal of equal opportunity and equal access, disability rights activists saw the opportunity to include individuals with disabilities. Before this date there were already groups trying to fight the segregation that students with disabilities were experiencing. In 1972, Pennsylvania Association for Retarded Children v. Commonwealth of Pennsylvania ruled that all the individuals have the right to a free and appropriate education. The students that suffer from severe disabilities were institutionalized or stayed at home while the ones with less severe disabilities that did enroll in public schools were likely to dropout. (Friend & Bursuck, 2002)In 1973 section 504 of the Vocational Rehabilitation Act P.L. 93-112 ensured that entities or programs that were receiving federal funds did not discriminate against students with disabilities. (See the Rehabilitation Act of 1973)

It was not until the mid 70's when the Congress passed the Education for All Handicapped Children Act, better known as public law 94-142(P.L. 94-142) This law was the landmark that required the school districts to have a free and appropriate public education and least restrictive environment settings. (Friend & Bursuck, 2002)

In 1986, the federal laws extended the protection of individual with disabilities to include those from birth to age five. This law has been known has Public Law 99-457 (PL 99-457)

In the early 90's the Americans with Disabilities Act passed to make employment and public places accessible to the individuals with special needs, extending section 504 of PL 93-112. (Friend & Bursuck, 2002)The PL 93-112 act was amended several times before Congress changed it to the Individual with Disabilities Education Act of 1997 (IDEA '97) This act was again re-authorized in 2004 by Public Law 108-446 (PL 108-446) act and has been known as IDEA '04. Under the IDEA'04 Act the lawmakers and advocates tried to give an appropriate education to the student with disabilities by considering all the parts involved in the education of the student. By doing this, Congress tries to give a tailored education according to the needs of each student. A cornerstone of this legislation was the creation of a multidisciplinary team. This team included the parents or guardian of the student, regular education teacher, special education teacher, educational diagnostician, school administrator, and any other person that provides services to the student or that is involved on his or her education. Also the student could be in the team if is in the best interested of his education. This team shareed their opinion with the other members in a meeting in order to discuss the educational progress and concerns that any member could have concerning the academic progress of the student (PL 108-446)

1.2 Learning Disabilities Spectrum in an Educational Environment

A learning disability (LD) is defined as a neurological disorder that will affect the way the brain processes information; the distinctiveness of a student diagnosed with a learning disability is going to be echoed in a difficulty to read, write, organize ideas, spelling, reasoning, recalling facts ideas and information. National Institute of Neurological Disorders and Stroke Learning Disabilities Information, (NINDS, 2009) Under IDEA the definition for a specific learning disability is:

> *"A Disorder in one or more of the more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations."* (IDEA'04)

Under this type of disability, there is a wide range of specific conditions that could impair learning. The student diagnosed with a learning disability could experience one or more of these conditions. One of these impairments is dyslexia which is a language based disability that consists of trouble understanding written words it may also be referred to as a reading disability or reading disorder. (NINDS, 2009) Dysgraphia is defined as a writing disability in which a person finds it hard to form letters, write within a define space, inappropriately sizes spacing between letters and misspells words despite proper instruction. (NINDS, 2009)

Dyscalculia is defined as a mathematical disability in which a student has some kind of difficulty following steps or procedures to solve or decipher math related problems. (NCLD, 2009) Another kind of disability under the learning disable spectrum is when a student has difficulties understanding language despite normal hearing and vision. This is defined as an auditory and visual processing disorder. (NCLD, 2009) Non-verbal LD is defined as a neurological disorder that is originated in the right hemisphere of the brain. This problem affects

visual spatial, intuitive, organizational, evaluative, and holistic processing functions, (Thompson, 1996) Any learning disability will be more noticeable when the child starts attending an institutional environment, which would required him to develop specific cognitive skills.

Students with LD would struggle to develop skills according to the grade that he or she is enrolled and with respect to the majority of his age-peers classmates. The literature cluster of cognitive developemntal skills and the school grade gives the means to compare general education population versus the students with LD. The child with a learning disability would experience lacking of different skills according to the grade in which his enrolled. (NCLD, 2009)

Students with LD could start speaking later than his age peers, have pronunciation problems, handles basic vocabulary words, of have problems acquiring new words. In some students with a LD they are unable to or are slower to find the proper words, also the rhyming of words does not make sense to them. Children with LD could have trouble learning and recalling basic facts like numbers, alphabet, days of the week colors, shapes. Since the child has not developed his communication skills it would be easily distracted and could have trouble interacting with peers due to lack or weaknesses in verbal expression. This lack of communication skills makes following directions or routines difficult. Also, fine motors skills are weak or developing which makes writing and other academic tasks difficult. (NCLD, 2009).

1.2.1 Kindergarten thru Fourth Grade

In the early school years, the LD will be more noticeable. The children with LD could have problems learning the connection between letters and sounds. They could have problems with basic words (i.e. run, eat, want) Students with LD tend to make consistent reading and spelling errors including letter reversals (d / b), inverting letters (m / w), transportations (fault / left), substitutions (house / home) When the LD child starts working with numbers and math symbols, they also would experience difficulties. Representing number sequences in the right order could represent a challenging activity for them.

When working with arithmetic signs (+, -, x and /.), they may have problems relating these signs to mathematical operations required to solve mathematical expressions. Students with LD have shown that they are slow to remember facts and learn new skills. They rely heavily on memorization. Their behavior is often perceived as impulsive having difficulty to plan head, and having trouble learning about time. Their fine motors skills are still underdeveloped, which could be observed by an unstable pencil grabbing, also they could have poor coordination, unaware of physical surroundings, which makes them prone to suffer accidents. (NCLD, 2009)

1.2.2 Fifth thru Eighth Grade

Students with LD may experience reversing letter sequences (solid / soiled, left / felt). They are also slow learners when they deal with prefixes, root words and other spelling strategies. It is a common trait that student with LD will try to avoid reading aloud. They may struggle decoding word problems. Students with a LD would have difficulty with hand writing; they will present a tight pencil grip or light grip making them to avoid writing assignments. Students with LD would experience slow or poor recollection of facts. In the social environment

they would have difficulty making friends since they have trouble decoding body language and facial expression. (NCLD, 2009)

1.2.3 Nine Grade and Above

When the Students with LD gets into high school they typically continue to spell incorrectly and frequently spells the same word differently in a single piece of writing. It is very common that Students with LD avoid reading and writing tasks, they tend to work slowly. The student with a LD would have trouble summarizing, and miss reading open-ended questions on assessments. Also they may have a poor grasp of abstract concepts. (NCLD, 2009). It is common that students with LD show weak memory skills, paying little attention to details or focus too much on them. Students with LD also have difficulty adjusting to new settings. (NCLD, 2009).

1.2.4 Facts about Learning Disability

Fifteen percent of the U.S. children (1 in every 7 students) have some type of LD, according to the national center for learning disabilities. (NINDS, 2009) The most common disability for a learning disability student is reading. Eighty percent of the students with LD have reading problems. LD is considered hereditary, but there are also other environmental factors that can produce it. Ninety percent of the students will read normally if they receive help by the first year of elementary school, and seventy-five of children who receive help after the age of nine will have some kind of difficulty throughout their life. (NINDS, 2009)

1.3 Differential Instruction and Leaning Disabilities

Differential instruction is implemented to address the different learning styles of the students. The way differential instruction is achieved is by providing an opportunity to learn according to individual ability during each subject area.(Deshler,1996) **T**his is an effective approach for the students with learning disabilities of any type. These types of strategies are not only beneficial for the special education student but also for the general education students (Deshler,1996) Every teacher has a different approach when using differential instruction. There exist common teaching strategies among the different types of subjects.

According to Deshler (1996), teaching adolescents with learning disabilities requires the use of advance organizers for note taking and summarizing, peer tutoring, direct instruction, self evaluation and self regulation, classroom arrangement, seating charts, classroom environment, and educational aids. The classroom interventions need to focus on the strengths and not the weaknesses. Teachers that serve LD populations need to collect information about performance in school, and outside school. This could be achieved by interviewing the student, direct observation, educational and medical history. The parents of a LD student should be included in the team by the teacher making a teamwork which could monitor ongoing progress and learn the weakness of the student. This information will help understand the particular needs of the child, helping to set the appropriate strategies to deal with the disability. (Bender, 2002)

1.4 Differential Instruction for LD Using Assistive Technology

Before 1988 the use of assistive technology was not mandated until the Technology Related Assistance for Individuals with Disabilities Act of 1988 commonly known as the Tech Act. (P.L. 100-407) During the next decade, the federal government recognized the importance of this tool. (McMillan, 2003)

This act was amended by the Assistive Technology Act of 1998 (P.L. 105-394) by extending funds for the use of AT. Under the Individuals with Disabilities Education Act, 1990 (P.L. 101-476) IDEA'90, and 1997 (P.L. 105-17) IDEA 97 the implementation role was first outline the role of school districts implementing AT (IDEA'90) and afterwards for the consideration of implementation of AT in the IEP's of the student. (IDEA'97). IDEA '04 defines an Assistive Technology device in section 300.5 as:

> "Any items, piece of equipment or product system, whether acquired commercially off the shelf, modified, or customized — that is used to increase, maintain, or improve the functional capabilities of children with disabilities." (IDEA'04)

The use of technology should be balanced within every lesson. It can very tempting for teachers once they have access to technology to use it inappropriately or to sometimes abuse it. (Bender, 2007) Every technology has a specific propose in our lesson plan. According to the literature, teachers can use software for drill and kill exercises to help the student gain fluency in certain tasks (Bender, 2002) but there is a common misuse of technology by using it to fill up lesson plan. The use of assistive technology should balance out and in no way be used as a substitution for the regular instruction. As mentioned before the use of technology should give the student a save environment like a sandbox where through experimentation they will

understand the concept under study. (Bender, 2002)

1.5 Purpose

The purpose of this study was to investigate the effect of using 2D and 3D computer graphics which students with LD could manipulate using their body. These computer representations will be related to the current high school math curriculum of the state of Texas.

1.6 Hypothesis

Based upon research that states the possibility to develop new brain pathways, This research addressed the creation of brain pathways in students with LD. Individuals that suffer from brain degenerative illness (i.e. Alzheimer, Parkinson, schizophrenia diseases) experience cognitive problems very similar as students with LD when information is presented by a traditional methods, and in those cases has been possible to remediate their condition by presenting information in an alternative representations.

This research addressed the creation of alternative brain pathways in Students with LD by representing mathematical concepts using 2D and 3D computer graphics objects, which the student would manipulate and transform with their body in order to gain kinesthetic stimulus when manipulating such objects.

Chapter 2 Literature Review

2.1 Cognitive and Brain Development

Thanks to more powerful MRI (Magnetic Resonance Imaging) scanners, the brain activity can be observed with detail using a variation of an MRI called fMRI (Functional Magnetic Resonance Imaging). (Goldberg, 2002) This brain scanner is able to visualize the different parts of the brain being activated while the person is performing an activity. Using fMRI it is possible to observe that by age of six the brain is ninety-five percent of its adult size (Giedd, 1999) Inside the neo cortex or cerebral cortex which is also referred as “gray matter”. is where the cognitive process takes place. At the frontal part of the brain is where the judgment, organization, planning and strategizing processes take place. This function of the brain is also refers an executive function. (Sowell, 1999)

The maturation of the frontal part of the brain starts at adolescence. The maturation process of the gray matter peaks at about age eleven in girls and twelve in boys, which is about at the same time as puberty. After this maturation process, all the extra connections are eliminated (use it or lose it). This are that is located in the frontal lobe of the brain is the one that has change the most across human evolution. The brain experienced several developmental curves. The first wave of over production of interconnections occurs around the 18 month of life. In 2-year interval, the second wave is manifest by actual ticking of gray matter (Giedd, 1999)

The Corpus callous connects the two brains (left and right) and takes part in the creativity and ability to solve problems, higher type of thinking; it changes a lot throughout the childhood and adolescence. It has been observed to have different size and shape in many different illnesses that happen during childhood. Its size and shape it is more genetically controlled (Giedd, 1999)

The Cerebellum is believed to be very susceptible to the environment. It is the part of the brain that changes the most during the teen years. This area is not fully developed until the early 20’s. (Peterson-Badali & Abramovitch, 1993) The cerebellum is involved in the coordination of muscles, cognitive and thinking process. The cerebellum gives the ability to smooth out all the different intellectual processes to navigate the complicated social life of the teen with grace instead of lurching. Traditional thinking and leading thoughts maintain that physical activity could influence the activity in the cerebellum. Use it or lost it is the directive (Giedd, 1999) If the cerebellum is exercised and used both for physical activity but also for cognitive activities then it will enhance its development. (Zull, 2002) As suggested by Rumelhart (1993) the way the brain can be characterized like a computer with parallel processes running and with multi-information going from one brain area to another keeps this analogy in the area of functionality and not in the implementation.(Rumelhart, 1993)

The more complicated the activity the more we call upon the cerebellum to help us solve problems that require higher thinking such as like math, music, philosophy, decision making and social skills. The frontal lobe is the one that has changed the most across human evolution. (Giedd, 1999)

There are several differences between girls and boys in the frontal cortex. Different ages of unset, different symptoms, different prevalence and outcomes. Almost every mental illness in childhood is more in common in boys (e.g. autism, dyslexia, L.D, ADHD, and Tourette’s syndrome),(Giedd,2002) The only one that is more common in girls than boys is anorexia nervosa. These differences could explained by examining some of the clinical differences between the male and female brain. The male brain is bigger across all stages of development

(from 3 to 20) and the size of certain structures and their development path are different. (Lenroot, 2007)

The basal ganglia, is the part of the brain that helps the frontal lobe perform do executive functions.. This part of the brain is smaller when childhood illnesses are present, like ADD and Tourette's syndrome. It is larger in females than in males By having larger basal ganglia, females may be afforded some protection against these illnesses, Girls' brain mature earlier than boys (Lenroot, 2007)

The frontal part of the brain carries out functions of a CEO since it regulates the direction and makes the important decisions, such as modulating the mood, and analyzing the consequences of behavior. (Yurgelun-Todd, 2002) The Pre Frontal area plays a central role in complex mental processes that emerge as the child grows. Teens use the pre frontal area less than adults do. Teenagers read emotions different than adults. Females are more accurate in reading emotions than males, but female teenagers compared with male teenagers are not that distant from their contra part when reading emotions. The brain appears to grow just before puberty. A growth pattern of the developing brain keeps changing until the early 20, maturing at different times. Language acquisition declines after the age of 12 (Thompson et al., 2000) and the hippocampus takes an important part in explicit memory processes. The Dorso lateral prefrontal cortex is crucial for focal attention and working memory. The Ventro medial prefrontal region (Orbital frontal cortex), is involved in social cognition, attended communication, self regulation, response flexibility, auto biographical memory and self awareness. (Giedd,1999)

2.2 Brain Growth Maps

There are different stages in which the brain grows and develops in different areas. From age three to fifteen children have a growth of tissue throughout the whole brain. (Giedd, 1999) From three to six years, the frontal brain circuits grow faster. This brain region is in charge of regulating attention. From eleven to fifteen years, language systems are more active occurring further back in the brain and drastically decreasing the activity during the early teen years. Before puberty, children lose up to fifty percent of their brain tissue in their deep motor nuclei. (Thompson, 2000) This system controls fine motor skills such as writing, sports or piano. During the following years (fifteen and older), the brain develops new emerging capabilities which can be identified in laps of five years. These laps tend to start when children are 5 years old and continue every 5 years until the young adult reaches twenty years old. In every stage, the person gains ability of interpreting abstract concepts. Younger children cannot use abstraction flexibility. Therefore, the cognitive skills are reduced from abstract concepts to concrete instances and memorized definitions. (Giedd, 1999) From childhood to the teen years children become able to construct flexible abstract concepts, but have great difficulty relating two abstracts concepts.

At fifteen, the child has the ability to create a flexible relation between a pair of abstractions. Around their twenties, the young adult could build flexible relations between multiple abstract concepts, and at twenty-five, they can connect a system of abstractions. (Giedd, 1999)

2.3 Brain Modularity and Memory

In order to understand how the brain processes and interprets stimulus it is necessary to discuss cognitive functioning of the brain. The cognitive architecture of the brain is the one that determines what and how problems are solved. According to existing literature computational architecture is considered equivalent to cognitive architecture, (Lepore & Pylyshyn, 1999) Much of this ability is innate, but some of it could be acquired through maturation practice and other situations. Cognitive architecture and cognitive capacity are combined to determine what the subject could do. (Lepore & Pylyshyn, 1999) According to the definition, memory is a physical object that is present of some observer and that has features that the observer casually explains. (Lepore & Pylyshyn, 1999, p. 124) The memory retrieval theories discuss and expos how visual objects are individuated, accessed and used as the basis for memory retrieval (Kahneman & Treisman's, 1984, Kahneman, et al 1992, Pylyshyn, 1984a, 1994b,Wolf & Bennet, 1997) as cited by Lepore & Pylyshyn (1999). The fundamental proposal for the solution of "Process and Recovery problem" is possible only if it leaves a memory. Under this proposal, there are two principals. The first is named Asymmetry principal, that is the memory that processes leave on the objects, and the second is Symmetry principal, that is symmetry in the present is understood as having always existed.

Researchers defend a highly modular conception of mental architecture, which views the mind as composed of a large number of special-purpose information processing organs, or modules, that have been shaped by natural selecting to handle the shorts of recurrent information processing problems that confronted our hunter-gatherer forebears. The literature hypothesizes that when information is presented in the right way performance on reasoning tasks should improve dramatically (Lepore & Pylyshyn, 1999)

The modularity concept has two main ideas. The first one is that the mind consists of a large number of special purpose systems often "called modules "or mental organs. The second one is that these systems, like other systems in the body have been shape by natural selection to perform specific functions or to solve information-processing problems that were important in the environment in which our hominid ancestors evolved (Lepore & Pylyshyn, 1999) Cognitive scientists are typically referring to mental structures or components of the mind that could be invoked in order to explain various cognitive capacities. Very roughly, this means that modules are dedicated to solving restricted classes of problems in unique domains. For instance the claim that there is a visual module implies that there are mental structures which are brought into play in the domain of visual processing and are not recruited in dealing with other cognitive tasks.(Lepore & Pylyshyn, 1999)

Until recently, even proponents of modularity typically restricted themselves to the claim that the mind is modular at is periphery. For example, although the discussion of modularity as it is framed in cognitive science derives largely from Jerry Fodor's arguments in the modularity of mind (Fodor, 1983), Fodor insists that much of our cognition is sub served by non-modular systems. According to Fodor only input systems (those responsible for perception and language processing) and output systems (those responsible for action) are plausible candidates for modularity. By contrast, central systems (those systems responsible for reasoning and belief fixation) are likely to be non-modular. As Sperber (1994) has observed although this was probably not intended and has not been much noticed "modularity of mind" was a paradoxical title. According to Fodor, modularity is to be found only at the periphery of the mind. In its center bulk, Fodor's mind model is decidedly not modular.

The brain constructs hypotheses of the objects beyond the available information (Gregory, 1970) The stability-plasticity dilemma mentions that the brain needs some kind of stability to maintain continuity across time for expected and predictable inputs, at the same time the brain must have plasticity and agility to deal with sudden changes and unexpected inputs from the environment.(Grossberg, 1987)

2.4 Learning Theories and Brain Functioning of Students with LD

There are efforts to develop mathematical theories of learning. One of this modes is based in the classical conditioning model of error correction, where the subject is expecting an outcome according to the learned. This model depends on how the information is learned in order to predict the outcome and based on this will make the necessary changes in the model (change the weights). (Rescorla & Wagner, 1972)

These learning theories and algorithms are very useful to measure the cognitive capability and ability of subjects with degenerative brain illnesses like Parkinson disease Schizophrenia, (Dayan, Shultz & Montage1997, Schultz et al, 1997), (Shohamy, D. Myers, C.E. Onlaor, S. & Gluck.M.A 2004),(Poldrack,Clark,Pare-Blagoev, Shohamy, Creso-Moyano,Myers,Gluck, Nature 2001) and Alzheimer's disease(Gluck & Myers,1993) The researchers were able to create alternatives brain pathways by presenting the information in an alternative way that allowed then to achieve a cognitive performance regarding the ability of the brain to process the information using the brain paths used by subjects with no visible brain degradation. (Dayan, Shultz & Montage1997, Schultz et al, 1997) (Shohamy, D. Myers, C.E. Onlaor, S. & Gluck.M.A 2004),(Poldrack,Clark,Pare-Blagoev, Shohamy, Creso-Moyano,Myers,Gluck, Nature 2001), (Gluck & Myers,1993)

Zadina (2004) has suggested that he creation of alternative brain pathways using alternative representation helps any type student's learning styles. Currently there is a lack of research in this area that specifically deals with Students with LD.

2.5 Current Research

There are several governmental and private entities, like the NINDS and other institutes of the National Institutes of Health including the National Institute of Child Health and Human Development, the National Institute of Deafness and Other Communication Disorders, and the National Institute of Mental Health, that support research on learning disabilities. Current research avenues focus on developing techniques to diagnose and treat learning disabilities and increase understanding of the biological basis of learning disabilities. National Institute of Neurological Disorders and Stroke (NINDS, 2009) There is a lack in the current literature in addressing the use of manipulatives at high school grades during which time students are engaged in learning and applying more abstract concepts (Maccini, 2006)

There is a need for more research that explores the use of Assistive Technology (AT) with secondary students in math (Maccini, 2006) Math is one of the subjects where assistive technology is widely used from the use of manipulative objects to the use of specialized math software (Maccini, 2006) One of the devices that were explored is the use of a smart board which allows a direct interaction with a surface where the images (objects) are projected by a projector machine on a surface. This will allow a direct manipulation of different objects without using a keyboard or mouse. Students with a LD could get an advantage in developing more abstract cognitive abilities by using AT as a manipulative tool.

2.6 Summary

From all the literature reviewed it was hard to find interventions for high school students with LD using manipulatives in order to grasp more abstract concepts in areas like Math. This use of manipulatives helps us at lower grades create alternative means of representations to help the student understand concepts better. Unfortunately at high school level it is not efficient enough to represent the curriculum that the student is exposed to. As mentioned by Maccini (2006) although the general education teacher masters the math curriculum usually one does not use alternative means of representation. It was found that they were less likely to use any kind of accommodations or differential instruction as compared to the special education teacher. (Maccini,2006) The researchers found common empirical approaches to teach Students with LD like the use of calculators, extra time to complete assignments, the use of objects for conceptual understanding, organizational strategies and peer tutoring.(Maccini & Gagnon,2000) This is the main reason to use AT in this research, that is to have alternatives representations of the concepts.

Chapter 3 Methodology

3.1 Introduction

Approval and permission for the study and data analysis was obtained by the University of Texas at El Paso Review Board (UTEP IRB) prior to data analysis. Also consent was obtained from El Paso Independent School District (EPISD) and from the parents and kids that participated in this research.

3.2 Participants Demographics

The sample for this research were 34 students diagnosed with LD (n=34) (See Figure 1) These students were a subgroup of students receiving services from the special education department (See Figure 1) The students were from all four grades of high school. The class distribution was the following; 13 students were 9th graders, five were 10th graders, 10 were 11th graders and six were 12th graders (See Figure 2); 21 of these students were labeled as Limited English Proficient students (LEP) (See Figure 3) and finally the gender distribution was 25 males and nine females (See Figure 3)

3.3 Participants Selection and Groups Distributions

The selection of the participants with LD was made according to willingness of student's parents to allow them to take part in the research and also from the own students willingness to participate. Another factor was the feasibility of the student to attend the intervention sessions since a few of them were in an alternative school placement or did not have a regular class schedule.

Figure 1.Students in Special Education

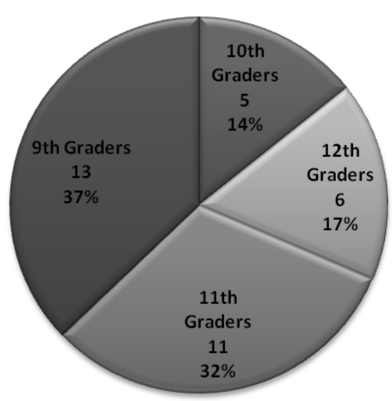

Figure 2.Student's Distribution by Grade

Figure 3.Language Learners (LEP) and Gender Distribution

The first step to create the control and treatment group was to specify and match as much as possible common characteristics between the students in the group. By doing the matching it was possible to have an evenly distribution of students with similar characteristics in each group. The first characteristic to match was the LD in math (Calculations and Reasoning). The second matching criterion was also under math disability, but only matching students that experienced just one disability in math (Calculation or Reasoning). The third criterion used was the individual IQ obtained from the Full Individual Evaluation (FIE) student's folder. The IQ ranges were obtained using the Woodcock-Johnson ® III tests. And a fourth matching criterion was the Quantile ® number that indicates how well the student understands mathematical concepts and

skills according to their current grade. A secondary criterion was used when the matching was still undefined by previous characteristics.

The secondary criteria for this study were current grade placement, LEP coding, gender, reading, writing, listening disabilities and Lexile ® score which matches the reader ability with the text difficulty.

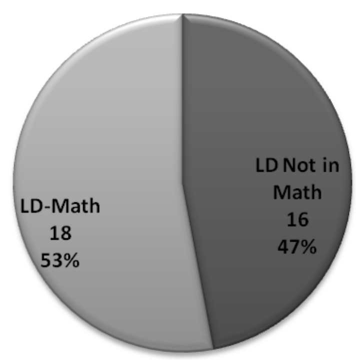

Figure 4.Pairing Students with LD in the Math Area

In this research, the most important criteria to pair the students were the ones related to the mathematical area, but the criteria could change depending on the area of interest to be matched. Using these characteristics 34 students were paired among them. 18 of them were paired using the criteria for LD in mathematics (See Figure 4) the participants were evenly divided into two groups of 17 students each. Each group had nine students with a LD in mathematics and the rest experienced a LD in other areas not related to mathematics (reading, writing or listening comprehension disability).

Once the matching pair was selected one of them was randomly assigned to one of the groups (Treatment or Control Group) and the other pair-student to the other group .The interventions were scheduled at different times during the normal hours of school. In order to schedule the small group interventions secondary factors were also considered for both groups. These factors were based on type of personality (e.g. Shyness), behavioral issues (e.g. Personal conflict with other students) and performance issues (e.g. reluctance to participate)

3.4 Lesson Planning

In order to identify mathematical content areas in which Students with LD were struggling, the researcher used scores achieved by the students in the district benchmarks assessments. These assessments are based on The Texas Essential Knowledge Skills (TEKS) for high school mathematics and on the Texas Assessment of Knowledge and Skills (TAKS) objectives from the standardized test of Texas. The TEKS are the student expectations that the student should acquire in the math curriculum classes. TAKS objectives and students' expectations (TEKS) were correlated between them. For those objectives on which the SD scores of $M_{\text{Sp.Ed. and}}$ $M_{\text{Gen Ed.}}$ were more than12 points of difference (SD >12), it was identified as an area of need for instructional intervention (See Table 1 and Table 2) The variance between these two groups shows the expected performance of special education students as compared with the general population.

Table 1 *General Education Benchmarks Average Scores*

Subject	Benchmark 1	Benchmark 2	Benchmark 3	Benchmark 4
Algebra I	41	37	40	51
Geometry	39	51	46	56
Algebra II	55	47	34	56

Table 2 *Special Education Benchmarks Average Scores (No Modifications)*

Subject	Benchmark 1	Benchmark 2	Benchmark 3	Benchmark 4
Algebra I	32	31	37	31
Geometry	29	44	37	40
Algebra II	36	46	20	31

Once the performance baseline was established by comparing general education benchmarks scores against special education benchmarks scores, it was decided on which objectives the interventions should be based. The scores attained during the benchmarks were analyzed by objective in order to identify those where the students in special education were struggling as compared with the students in general education.(See Table 3 and Table 4)

Table 3 *General Education Objective Averages Scores*

Subjects	1	2	3	4	5	6	7	8	9	10
Algebra I	54	48	45	50	61	55	60	55	26	51
Geometry	64	44	60	70	63	67	74	70	46	58
Algebra 2	50	68	61	62	70	43	64	55	26	40

Table 4 *Special Education Objective Averages Scores*

Subjects	1	2	3	4	5	6	7	8	9	10
Algebra I	41	44	35	34	85	55	63	72	30	47
Geometry	41	31	53	55	36	55	52	57	54	34
Algebra 2	50	70	53	52	27	34	58	55	30	43

Using the standard deviation (SD) as the degree of variance, 10 objectives were compared and categorized on three different levels (See Figure 5) and nine lessons were design and implemented. These nine lessons produced a total of more than three hundred interventions (306 interventions, 612 test samples) across the course of the study. According to their SD, three different groups of objectives were delimited. One group scored a SD of greater than 12 (SD>12, Objectives 5, 2 and 4) A second group scored a SD between less than 12 and greater than 9 (9< SD <12, Objectives 9, 6, and 3)

The third group scored a SD of less than 9 (SD<9, Objectives 1,10,8 and 7). (See Table 5) According to these assessments, five objective areas were selected and nine lessons plans were designed. (See Table 6)

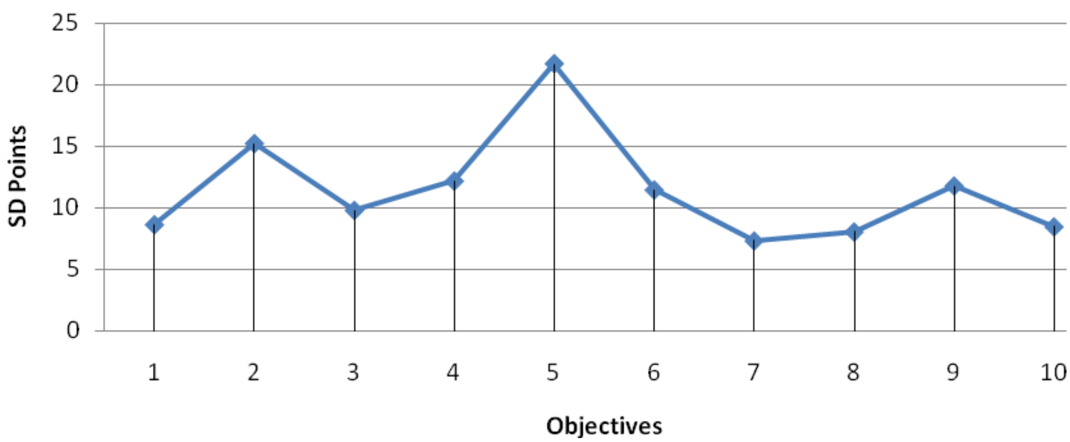

Figure 5 .SD vs. Objectives.

Table 5 *SD per Objective*

Objective	SD	Variance
5	21.66	469.2
2	15.21	231.38
4	12.17	148.18
9	11.78	138.68
6	11.45	131.1
3	9.8	96.18
1	8.64	74.8
10	8.47	71.05
8	8.06	65.07
7	7.33	53.77

Table 6 *Number of Interventions per Objective*

	Objectives				
	5	2	4	3	7
Interventions	2	2	2	2	1

From Table 6 we specifically identify the objectives and number of interventions that allowed us to have a broad perspective of the performance of the students at all levels of needs (High to low needs of mediations).The first 3 objectives (Objectives 5, 2, and 4) were identified as areas on which the students clearly needed some type of mediation. Objective 5 is related to quadratic and other non-linear functions. Objective 2 is about properties and attributes of functions and objective 4 allied to linear equations and inequalities. In this first level two interventions were done per objective. The second level which is almost at the middle of the table (medium need of mediations) is objective 3 which are linear functions and also two interventions were made for this objective. Finally objective 7 located at the bottom of the table (Low need of mediations), which is on 2 D and 3D representations. One intervention was performed for objective 7.

The questions for each objective were selected from items released from previous TAKS test and benchmark's by The Texas Education Agency (TEA). Questions are related to the selected objectives that were used. The duration of the interventions were designed to be in the range of 25 to 35 minutes long for all the small groups regardless of which group received the mediation. The numbers of questions per objective-intervention were the same for both groups. The number of questions for pretest and posttest varied from 2 to 4 depending in the complexity

of the objective and type of questions. Most of the interventions consisted of a mix of different classes from freshman to seniors. The use of a graphing calculator (TI-83) was encouraged in both groups. The use of the virtual manipulatives was only applied to the treatment group. The mediations steps were the same for both groups and follow the next process sequence.

3.5 Equipment Set-Up

Before each intervention was made, it was necessary to run a basic set up. This set up was to reconfigure and calibrate the applications and equipment used. Erase any notes from the board, reload the java or flash applications, reset the calculators, and calibrated the projector with the board surface.

3.6 Informal Assessment and Pretest

First, the students were asked to answer a quick survey (informal assessment) in order to help the researcher to fine-tune the interventions and, if needed, to evaluate external factors that could be affecting the experiment. The use of the informal assessment helped the researcher to delivered instruction using the same standards for the both groups involved. These standards were time on task, type of motivations (extrinsic or intrinsic), small group environment (No more than 4 students), and possibility to experiment possible answers (sand box environment). The result of having the same standards for both groups helped to increase the student’s performance by eliminating possible environmental distractions. The second step was to collect the survey and hand out the first set of problems identified as a pretest. After a fixed amount of time (8 to 12 minutes), the pretest was collected in order to start the intervention. No help was offered or given during the pretest. The students were encouraged to try to solve the problems using their own skills.

A total of 32 questions were given as a pretest to students in both groups during the nine interventions. Following the pretest, the control group received direct instruction related to the current objective. The treatment group received the instruction with the direct use and manipulation of 2-D and 3-D virtual manipulative.

3.7 Mediation

In the third step the types of intervention was divided into two different types, direct instruction (control group) and the instruction using and manipulating the projection of computer objects called virtual manipulatives (treatment group) The instruction for both types of intervention was about 10 to 15 minutes long. The direct instruction consisted of delivering the explanation of the objective by showing the students how to work out the problems and asking questions to check their understanding. The treatment instruction consisted of requiring the students to answer questions by using 2-D and 3D virtual manipulatives with their hands.

3.8 Posttest

The fourth and final step was to hand out a different set of problems with the same concepts as the ones seen in the pretest and interventions. A total of 32 questions were given as a posttest to students in both groups during the nine interventions. The problems were also from the items released and previous TAKS and benchmarks problems. The problems were related to the objective covered during the mediation. No help was offered or given during the posttest. The students were encouraged to try to solve the problems using their calculator and/or smart board if it was applicable.

3.9 Other Procedures and Evaluation

The Instruction was delivered by the same instructor to both groups and in different classrooms from the one where the students received their regular math instruction. Neither special accommodations nor modifications were added or offered to the students in any group. All of the problems used were catalogued according to TAKS objectives from the TAKS release items. The instruction was delivered by the researcher who is certificated in the state of Texas in Special Education (Special Education PK-12) and high school math (Mathematics 8-12). The Cycle of the procedure using AT is better observed in Figure 6.

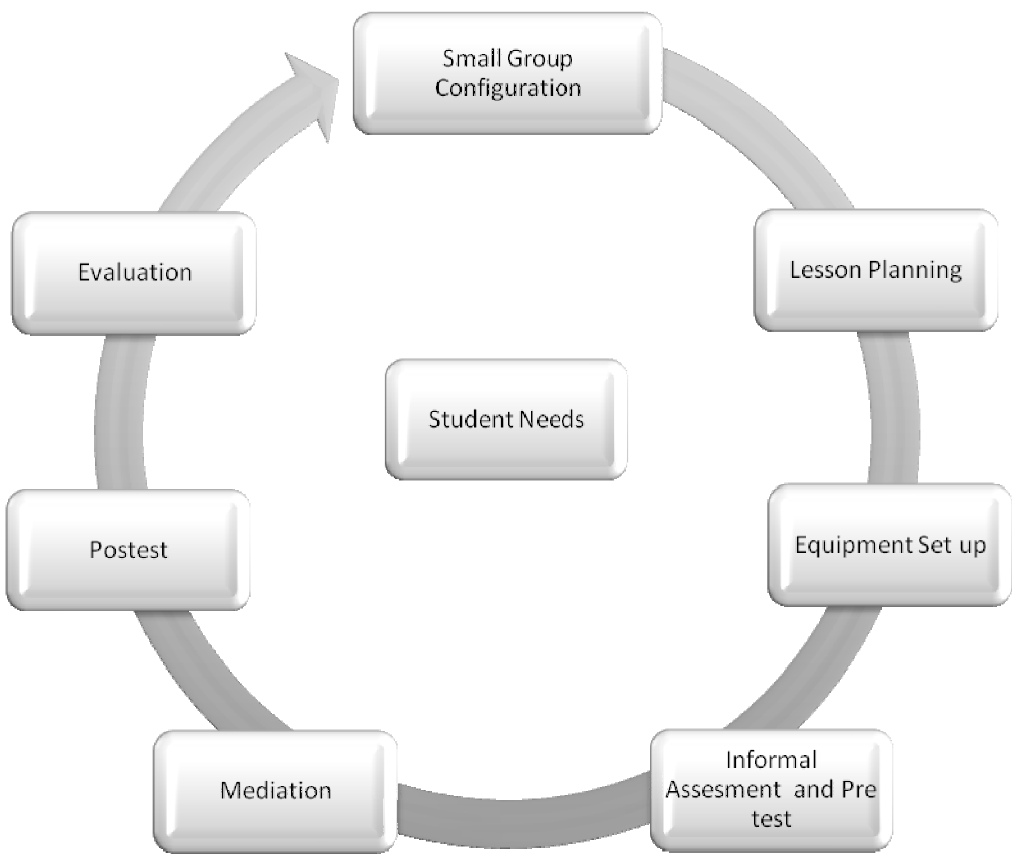

Figure 6.AT Intervention Heptagon

Some of the main motivation for all the students in the two groups were to take them out from their regular classes, the use of technology (AT), desire to perform better in their math class and avoidance to be in extra tutorial classes if they do not achieve the expectations required by state and/or federal standards .

3.10 Computer Applets

Different Java applets and flash files were used during the experiment, but all of them were evaluated according to their direct functionality related to this research. The first and most important it was that the applet should be directly related to the content objective to be teach.

The second condition was that the complexity of the topic that should be according to the current grade placement of the student, and the third condition is that the virtual manipulative should be a dynamic object that the student could manipulate it and transform it. (See Figure 7)

3.11 Statistical Analysis

Multi covariant analysis (ANOVA) was used to compare the means of the General education and the special education scores. This helped to decided on which objectives to base the interventions. After the pretest and posttest were computed several analysis were done. Independent T-Test were preformed to compare the control and treatment groups. Paired (dependent) T-Test with repeated measures were used to measure the effectiveness of the treatment. Three main comparisons were calculated. One was among the pairs of students with a LD in math, another among the ones with LD in other areas not including math and the third one among the control and treatment groups. In addition, ANOVA was used to compare the overall performance of the control and treatment group. For all the analysis made it was assumed that there was not a difference between the populations means. (H_0: $\mu_1 = \mu_2$)

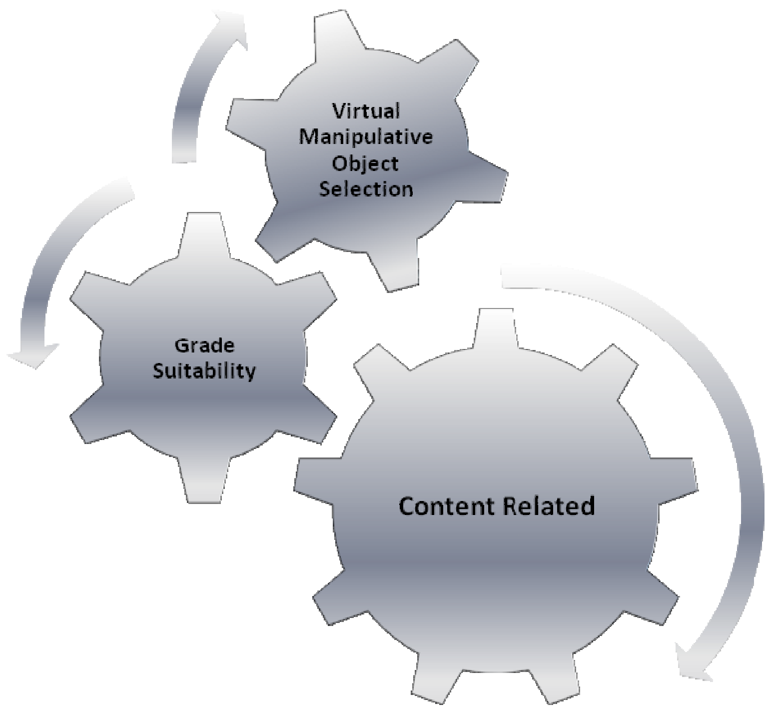

Figure 7.Model to Select a Virtual Manipulative Object

Chapter 4 Results

After the base line to measure the performance of students with LD was set up, it was possible to start doing statistical measurements and comparison between LD subgroups.

Independent measures analysis was used to compare the scores of the control group.($n_{Control}$=17) (See Table 8a) with the treatment group ($n_{Treatment}$=17) scores. (See Table 8b)

The control group received direct instruction as mediation while the treatment group received the treatment as mediation. From the independent T-Test analysis it was found that the group receiving treatment (*M*=29.04, SD=7.39) (See Table 9) was able to significantly improve their scores after the mediation as compared to the control group which received direct instruction (*M*=20.41, SD=7.09) (See Figure 8). This difference was statistically significant $t(32) = 3.48$, $p < .05$, d=0.8436.

An initial examination was made before running pair T-Test analysis using only the pretest scores to verify there was not a significance difference between the groups at the beginning of the interventions. ($H_0: \mu_1 = \mu_2$) For the pair T-Test analysis only the pretest scores were used. (*M*=7.11, SD=14.02) It was found there was not a significance difference between the two groups when comparing the pretest scores.(See Table 7a), $t(16)=2.09$, $p > .05$, r=0.4631

Paired T-Test was used to compare the scores of students with similar cognitive abilities and skills. Students with similar characteristics were matched up with a similar student in order to evaluate their scores. Two groups were created; the control group ($n_{Control\text{-}Pair}$=17) and treatment group ($n_{Treatment\text{-}Pair}$=17). The control group received direct instruction as mediation while the second group received the treatment as mediation. Using this analysis it was established that the mediation using AT (Treatment Group) increased their scores significantly as

compared to direct instruction (Control Group) by an average of *M*=8.63 and SD=10.74 (See table 7b). The increment was statistically significant, t (16) =3.31, $p<.05$, $r=0.6375$.

Table 7a Comparing All Students with LD Regardless of the Specific Disability (Pretest Scores)

	M	SD	Significance*
Pair			df=16
Treatment-Control Pair	7.11	14	t = 2.09
			r = 46.31%

*Note: p>.05

Table 7b Comparing All Students with LD Regardless of the Specific Disability (Gains)

	M	SD	Significance*
Pair			df=16
Treatment-Control Pair	8.63	10.74	t = 3.31
			r = 63.75%

*Note: p<.05

Table 8a.Treatment Group -Pretest and Posttest within Comparison

Treatment Group			
ID	Pretest	Posttest	D
1	50.00	90.63	40.63
2	25.00	53.13	28.13
3	28.13	59.38	31.25
4	37.50	65.63	28.13
5	34.38	59.38	25.00
6	31.25	56.25	25.00
7	28.13	53.13	25.00
8	21.88	56.25	34.38
9	31.25	50.00	18.75
10	9.38	53.13	43.75
11	40.63	78.13	37.50
12	31.25	62.50	31.25
13	53.13	84.38	31.25
14	37.50	59.38	21.88
15	28.13	59.38	31.25
16	40.63	56.25	15.63
17	25.00	50.00	25.00

Table 8b.Control Group Pretest and Posttest within Comparison

Control Group			
ID	Pretest	Posttest	D
1	25.00	35.94	34.47
2	28.13	46.88	18.75
3	37.50	59.38	21.88
4	43.75	56.25	12.50
5	43.75	59.38	15.63
6	56.25	84.38	28.13
7	28.13	50.00	21.88
8	34.38	50.00	15.63
9	43.75	53.13	9.38
10	50.00	62.50	12.50
11	56.25	68.75	12.50
12	43.75	59.38	15.63
13	37.50	59.38	21.88
14	37.50	65.63	28.13
15	34.38	59.38	25.00
16	43.75	68.75	25.00
17	37.50	65.63	28.13

Table 9 Independent Measures Comparison

	M	SD	Significance
Group			
Treatment	29.04	7.39	
			df=32
			t=3.8
			d=84.36%
Control	20.41	7.10	

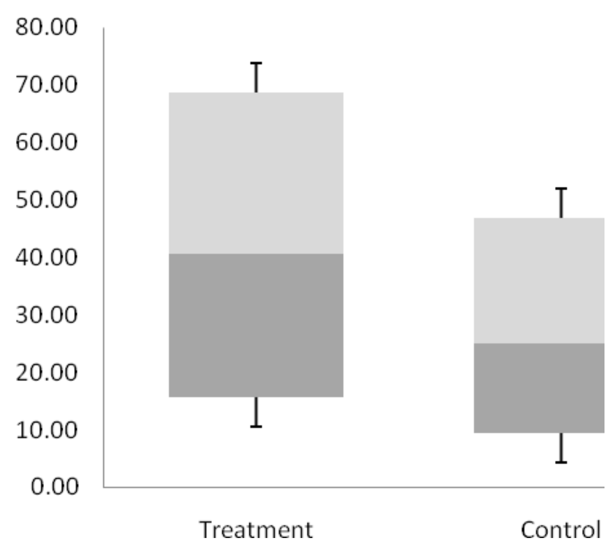

Figure 8.Treatment and Control Independent Measures Comparison

An initial examination was made before running pair T-Test for students with LD in math. The analysis used only pretest scores to verify there was not a significance difference between the groups at the beginning of the interventions. ($H_0: \mu_1 = \mu_2$) For the initial analysis using pair T-Test (LD math) only the pretest scores were used. (*M*=5.19, SD=12.54) It was found there was not a significance difference between the two groups when comparing the pretest scores. t (8)=1.42, $p>.05$, $r=0.4021$,(See Table 10a).

Using again the Pair (dependent) T-Test the math only subgroup was analyzed. The groups was created using students with a LD in mathematics. Students in the control group ($n_{\text{Control –LD math}}=9$) were paired with a student from the treatment group ($n_{\text{Treatment –LD math}}=9$) with similar skills and abilities.

It was established that the mediation using AT on the Treatment LD-Math Group increased the scores as compared to the mediation that used the direct instruction on the Control LD-Math Group by an average of *M*=8.67 with SD=6.4 (See Table 10b). The increment was statistically significant, t (8) =4.06, $p<.05$, $r=0.8205$.

Table 10a Pairing Students with a LD Math (Pretest Scores)

	M	SD	Significance*
Pair			df=8
Treatment-Control	5.19	12.54	t=1.42
			r=40.21%

*Note: p>.05

Table 10b Pairing Students with a LD Math (Gains)

	M	SD	Significance*
Pair			df=8
Treatment-Control	8.67	6.41	t=4.06
			r=82.05%

*Note: $p<.05$

For the initial analysis using pair T-Test (LD no math) only the pretest scores were used. (*M*=9.26, SD=16.11) It was found there was not a significance difference between the two groups when comparing the pretest scores. $t(7)=1.63$, $p>.05$, $r=0.5233$, (See Table 11a).

A final analysis was made using Pair (dependent) T-Test. The subgroups were formed pairing students with a disability other than mathematics. Students in the control group ($n_{Control-LD\ Other}=8$) were paired with a student from the treatment group ($n_{Treatment-LD\ Other}=8$) with similar characteristics. In this case, the matching criteria excluded students with LD in math.

It was established that the mediation using AT increased the scores for the treatment and control group. The increment was by an average of *M*=8.59 with SD=14.73 (See Table 11b). It was found that the increments on the scores does not represent significant difference, $t(7)=1.65$, $p>.05$, $r=0.5291$. Furthermore, by doing further analysis, it was found there was a strong correlation between the final gains made by each group, $r=-.81$, $n=8$, $p<.05$, two tails. (See Table 12)

In general, it was observed that in the subgroup of the students with LD in math, the segment with the highest gain (*M*=28.53) were the students with LD in both areas of mathematics (calculation and reasoning).

From the same subgroup (LD-Mathematics) the segment that made the second best gains (*M*=22.19) were students with disability in math calculations. Moreover, the third segment that is formed by students with a math reasoning disability made a gain of *M*=9.38. (See figure 9)

Table 11a Pairing Students with other LD than Math (Pretest Scores)

Pair	M	SD	Significance*
Treatment-Control	9.26	16.11	df=7 t=1.63 r=52.33%

*Note: p>.05

Table 11b Pairing Students with other LD than Math (Gains)

Pair	M	SD	Significance*
Treatment-Control	8.59	14.73	df=7 t=1.65 r=52.91%

*Note: p<.05

Table 12 LD vs. LD (No Math) Correlations

	Control	Treatment	Significance
Control		-.81	n=8
Treatment	-.81		r = -.81
			p<.05

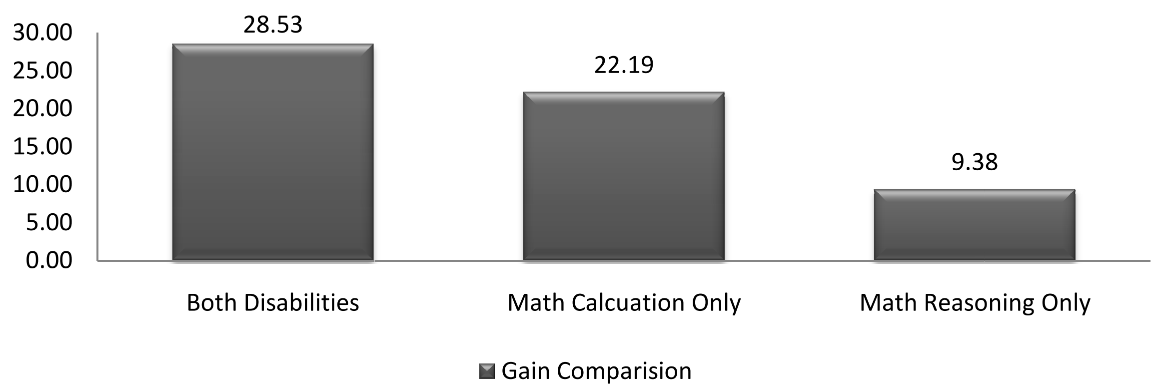

Figure 9.Gain Comparison in Students with LD in math

In addition, analysis of the variance (ANOVA) was made in order to evaluate the consistency of the treatment effects between groups (Control and Treatment groups). The first comparison was using repeated measures ANOVA between the Pretest and the Posttest scores (k=9) among all participating students (n=34). An analysis of variance indicated significant

difference in performance between the Pretest scores and Posttest Scores, F (8,264) =7.78, *p<.01,* η*=0.1907,*(See Table 13).

A second repeated measures ANOVA was performed to analyze the pretest and posttest scores between the treatment and control group.(See table 14) This test indicated a significant difference between the scores achieved by the treatment group as compared with the ones achieved by the control group. F (1, 32) =17.39, *p<.01,* η^2*=0.3523.*

Table 13 ANOVA Pretest vs. Posttest Scores

					Interventions					
										Significance
Measures										
	1	2	3	4	5	6	7	8	9	
Pretest										df=8
M	1.29	1.06	1.18	1.74	1.00	0.68	1.62	0.47	2.59	SS=264
SD	0.87	0.85	0.87	1.21	0.79	0.54	0.92	0.6	1.20	F=7.78
Posttest										η^2*=19.1*
M	2.29	2.03	2.62	2.24	2.18	0.71	2.68	1.85	2.76	
SD	0.76	0.90	0.85	1.16	0.87	0.58	0.84	0.86	1.02	

Note: η *is expressed as a percentage.*

Table 14 Pretest and Posttest Comparison between Treatment and Control Group

	Significance				
	f	df	SS	η^2	*p*
Source					
All Scores	17.39	1	32	35.23%	.000

Note: All Scores are defined as all Pretests and Posttest of the treatment and control group.

4.1 Discussion

4.1.1 LD versus LD

From the analysis results, we observed that that the mediation improved scores or adds gain to them. This performance improvement holds true for the control and treatment group in the overall category. We compared the scores of the two groups independently from each other, and also using pair comparison. The gains on the scores were expected since the educational environment was the appropriate for students with LD (e.g. small groups settings, differentiate instruction, focus on one objective at a time etc. etc.). After running independent T-Test we found that there was a significant difference between the control group and treatment group ($p<.01$), therefore we must reject the null hypothesis. ($H_0: \mu_1 \neq \mu_2$) From this result, we concluded that the mediation received by the treatment group was significant enough to increase the scores of the treatment group as compared to the score in the control group. Based on this we must say that the two groups received benefits from the mediation, but the group that received the treatment using body kinesthetic was the most beneficiated

4.1.2 Comparing LD Subgroups

When comparing students with LD in math the two groups (control and treatment) increased their scores. The group that made a significant gain was the treatment group. ($p<.0$) Therefore, we must reject the null hypothesis. ($H_0: \mu_1 \neq \mu_2$)

In addition, students with LD in other areas different to math created a second subgroup. Both groups (control and treatment) improved their scores after the mediation. In this comparison, there was not a statistical difference between the two subgroups of LD (control and treatment with a disability different to math). ($p>.01$) Therefore, we accepted the null hypothesis. ($H_0: \mu_1 = \mu_2$). The implications of this finding is that the group that received the

treatment addressing their specific disability would increase their scores significantly as compared to the group that receives some type of mediation not using the treatment proposed in this research. In addition, as we can see from table 12 the groups have a strong correlation between them, which means that they have the same tendencies.

4.1.3 Comparing Scores Using ANOVA

ANOVA was used to compared the performance of the students and evaluate the consistency of the treatment effects over the groups. It was found the there was a significant difference between the pretest scores and the posttest scores. ($p<.01$) Also from the ANOVA results analysis, we compared scores of the pretest and posttest by the two groups created (treatment and control groups). We found that there is a significant difference on the scores achieved by the treatment group. ($p<.01$) In both cases, the null hypothesis was rejected. ($H_0: \mu_1 \neq \mu_2$) This analysis helped us to evaluate the scores performance consistency in the treatment and control group between and within groups.

4.2 Conclusion

In our current education system, the way we measure the success of a student is by considering the product that the student is able to produce and deliver to the entity making the assessment. In which the classroom teacher or the federal government could represent the evaluator. If the product meets the expected standards we accept it as good, but if not we discard it. Currently the school districts use different types of software to pinpoint on which students the interventions should be done, and on which ones it should not be even considered it. Most of the times the special education students are among the group that is not consider for interventions due to their product deficiencies. The students in special education experienced a product deficiency (Naron, 1978; Wong, 1980) that usually forbids them to perform as required by the

curriculum standards. This inability of special education students may be due to intrinsic and extrinsic factors like the learning environment, inactive learner, learn-motivated as mentioned by Torgerson. (1997)

By doing this, we are “discarding” students that could achieve curriculum standards with proper mediations. Flavell (As cited in Reese, 1994, p. 111) ties this product deficiency to the Mediation Theory. Moreover, according to Reese & Lipsitt (1970) this mediation is about the implantation of an intervention in a process between the initial and final product (Reese & Lipsitt, 1970)

Analyzing the mediation implemented in this research which used multiple representations and direct kinesthetic interaction we proofed that it was beneficial for all the students, but it was statistical significant for those that received the treatment for the specific disability. ”Quod erat demonstrndum” (QED) that using alternative representations and direct student interaction (kinesthetic) creates new cognitive process that will improve student’s academic performance in a specific disability targeted by the treatment proposed in this research.

4.2.1 Implications in General Education

The use of this model could be limited by the cost of the equipment needed to execute the intervention-mediations. This can be offset by the benefits that could bring to all the students especially to those that struggle in specific areas like Mathematics or English.

Most of high schools programs included the used of some type technology in their lesson plan, therefore we can included the model proposed in this research into their curriculum. By doing this, we are distributing the cost of the equipment among a wider population that will bring the cost of the equipment to almost an insignificant cost per student. The cost benefit of the equipment is well justified by the increment in student’s scores.

4.2.2 Implications in Special Education

If we go from the specific to the general we can said that this model will work to mediate other types of LD. We must consider that the whole intervention should be plan according to the AT intervention heptagon, but more research should be done in other areas in order to generalized this model. This model presents a foundation to develop mediations in other areas in which students with LD struggle.

The use of this model will help students with LD to interact and understand more abstracts concepts by gaining sensory stimuli using their bodies. These sensory stimuli should be reinforced in the classroom in order to establish permanent neural pathways in the brain. By introducing these interventions in the students' IEP, we ensure that the student will have access to an accommodation that can be measure and observe. (e.g. Opportunity to use smart board for 25 minutes to reinforce curriculum 3 times a week) This type of intervention-mediation is flexible enough to fit the needs of the students that can be schedule according to the ability of the resources at their schools.

4.3 Limitations

In addition, in order to implement this mediation in the regular education classroom, a team conformed by general education and special education teacher should work together to decide how to implement these interventions in their classroom. Another limitation is that teachers that do not feel comfortable using technology could be reluctant to implement the model proposed in this research. More Research is recommend with populations that have a history of low performance in order to expand these findings to those groups.

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Appendix A SPPS Output Tables

Table A.1 Mean Comparison Between students in General and Special Education.

(Base Line Selection)

Objective 1 Objective 2 Objective 3 Objective 4 Objective 5 Objective 6 Objective 7 Objective 8 Objective 9 Objective10 * Educational Program

Educational Program		Objective 1	Objective 2	Objective 3	Objective 4	Objective 5	Objective 6	Objective 7	Objective 8	Objective 9	Objective10
Gen. Ed	Mean	56.00	53.33	55.33	60.67	64.67	55.00	66.00	60.00	32.67	49.67
	N	3	3	3	3	3	3	3	3	3	3
	Std. Deviation	7.211	12.858	8.963	10.066	4.726	12.000	7.211	8.660	11.547	9.074
	Variance	52.000	165.333	80.333	101.333	22.333	144.000	52.000	75.000	133.333	82.333
SpEd	Mean	44.00	48.33	47.00	47.00	49.33	48.00	57.67	61.33	38.00	41.33
	N	3	3	3	3	3	3	3	3	3	3
	Std. Deviation	5.196	19.858	10.392	11.358	31.214	12.124	5.508	9.292	13.856	6.658
	Variance	27.000	394.333	108.000	129.000	974.333	147.000	30.333	86.333	192.000	44.333
Total	Mean	50.00	50.83	51.17	53.83	57.00	51.50	61.83	60.67	35.33	45.50
	N	6	6	6	6	6	6	6	6	6	6
	Std. Deviation	8.649	15.211	9.806	12.172	21.661	11.450	7.333	8.066	11.776	8.456
	Variance	74.800	231.367	96.167	148.167	469.200	131.100	53.767	65.067	138.667	71.500

Objective 1 Objective 2 Objective 3 Objective 4 Objective 5 Objective 6 Objective 7 Objective 8 Objective 9 Objective10 * Math Class

Math Class		Objective 1	Objective 2	Objective 3	Objective 4	Objective 5	Objective 6	Objective 7	Objective 8	Objective 9	Objective10
Algebra 1	Mean	47.50	46.00	40.00	42.00	73.00	55.00	61.50	63.50	28.00	49.00
	N	2	2	2	2	2	2	2	2	2	2
	Std. Deviation	9.192	2.828	7.071	11.314	16.971	.000	2.121	12.021	2.828	2.828
	Variance	84.500	8.000	50.000	128.000	288.000	.000	4.500	144.500	8.000	8.000
Geometry	Mean	52.50	37.50	56.50	62.50	49.50	61.00	63.00	63.50	50.00	46.00
	N	2	2	2	2	2	2	2	2	2	2
	Std. Deviation	16.263	9.192	4.950	10.607	19.092	8.485	15.556	9.192	5.657	16.971
	Variance	264.500	84.500	24.500	112.500	364.500	72.000	242.000	84.500	32.000	288.000
Algebra 2	Mean	50.00	69.00	57.00	57.00	48.50	38.50	61.00	55.00	28.00	41.50
	N	2	2	2	2	2	2	2	2	2	2
	Std. Deviation	.000	1.414	5.657	7.071	30.406	6.364	4.243	.000	2.828	2.121
	Variance	.000	2.000	32.000	50.000	924.500	40.500	18.000	.000	8.000	4.500
Total	Mean	50.00	50.83	51.17	53.83	57.00	51.50	61.83	60.67	35.33	45.50
	N	6	6	6	6	6	6	6	6	6	6
	Std. Deviation	8.649	15.211	9.806	12.172	21.661	11.450	7.333	8.066	11.776	8.456
	Variance	74.800	231.367	96.167	148.167	469.200	131.100	53.767	65.067	138.667	71.500

Table A.2 LD Group Statistics using Independent T-Test (Final Scores)

Independedt T-Test LD vs LD

Group Statistics

	Student	N	Mean	Std. Deviation	Std. Error Mean
Percentace	control	17	20.4098	7.09602	1.72104
	treatment	17	29.0441	7.39219	1.79287

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Percentace	Equal variances assumed	.026	.873	-3.474	32	.001	-8.63430	2.48523	-13.69654	-3.57206
	Equal variances not assumed			-3.474	31.947	.001	-8.63430	2.48523	-13.69687	-3.57173

Table A.3 LD Group Statistics and Comparison using Paired T-Test

➔ T-Test LD Vs LD

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Control	20.4098	17	7.09602	1.72104
	Treatment	29.0441	17	7.39219	1.79287

Pair T-Test Pre test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Control	40.0218	17	9.02307	2.18842
	Pre Treatment	32.9141	17	10.49958	2.54652

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pre Control & Pre Treatment	17	-.027	.919

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre Control - Pre Treatment	7.10765	14.02489	3.40154	-.10329	14.31858	2.090	16	.053

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Control & Treatment	17	-.099	.704

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Control - Treatment	-8.63430	10.74338	2.60565	-14.15804	-3.11056	-3.314	16	.004

Table A.4 LD Group Statistics and Comparison using Paired T-Test for Students with LD only in Math

T-Test LDmath vs LDmath

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Control	19.8056	9	7.83420	2.61140
	Treatment	28.4744	9	6.33792	2.11264

Pair T-Test Pre test (Math)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Control	37.8489	9	10.05754	3.35251
	PreTreatment	32.6544	9	8.45818	2.81939

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pre Control & PreTreatment	9	.090	.818

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Pre Control - PreTreatment	5.19444	12.54712	4.18237	-4.45012	14.83901	1.242	8	.249

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Control & Treatment	9	.609	.082

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Control - Treatment	-8.66889	6.40668	2.13556	-13.59350	-3.74428	-4.059	8	.004

Table A.5 LD Group Statistics and Comparison using Paired T-Test for Students with other LD (No LD in Math)

Pretest No Math Disability

Pair T-Test No Math

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreControl	42.4663	8	7.58874	2.68302
	PreTreatment	33.2063	8	13.03974	4.61025

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PreControl & PreTreatment	8	-.162	.702

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PreControl - PreTreatment	9.26000	16.11439	5.69730	-4.21197	22.73197	1.625	7	.148

T-Test LD vs. LD (No Math Disability)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Scores	29.6875	8	8.83883	3.12500
	Scores	21.0938	8	6.62913	2.34375

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Scores & Scores	8	-.810	.015

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Scores - Scores	8.59375	14.72876	5.20740	-3.71980	20.90730	1.650	7	.143

➔ LD vs. LD (No Math)   Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
Treatment	29.6875	8.83883	8
Control	21.0938	6.62913	8

Correlations

		Treatment	Control
Treatment	Pearson Correlation	1	-.810*
	Sig. (2-tailed)		.015
	N	8	8
Control	Pearson Correlation	-.810*	1
	Sig. (2-tailed)	.015	
	N	8	8

*. Correlation is significant at the 0.05 level (2-tailed).

Table A.6 Pretest and Posttest Comparison using ANOVA

ANOVA Pre Vs. Post scores

Within-Subjects Factors

Measure: MEASURE_1

scores	Dependent Variable
1	Pre
2	Post

Descriptive Statistics

	Mean	Std. Deviation	N
Pre	36.4679	10.29257	34
Post	59.5194	11.75631	34

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
scores	Pillai's Trace	.860	203.031[a]	1.000	33.000	.000
	Wilks' Lambda	.140	203.031[a]	1.000	33.000	.000
	Hotelling's Trace	6.152	203.031[a]	1.000	33.000	.000
	Roy's Largest Root	6.152	203.031[a]	1.000	33.000	.000

a. Exact statistic

b.

Design: Intercept
Within Subjects Design: scores

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
scores	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept
Within Subjects Design: scores

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
scores	Sphericity Assumed	9033.295	1	9033.295	203.031	.000
	Greenhouse-Geisser	9033.295	1.000	9033.295	203.031	.000
	Huynh-Feldt	9033.295	1.000	9033.295	203.031	.000
	Lower-bound	9033.295	1.000	9033.295	203.031	.000
Error(scores)	Sphericity Assumed	1468.240	33	44.492		
	Greenhouse-Geisser	1468.240	33.000	44.492		
	Huynh-Feldt	1468.240	33.000	44.492		
	Lower-bound	1468.240	33.000	44.492		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	scores	Type III Sum of Squares	df	Mean Square	F	Sig.
scores	Linear	9033.295	1	9033.295	203.031	.000
Error(scores)	Linear	1468.240	33	44.492		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	156630.723	1	156630.723	784.504	.000
Error	6588.639	33	199.656		

(By Objective)

ANOVA Pre test Vs Post Test

Within-Subjects Factors

Measure: MEASURE_1

prepost	scores	Dependent Variable
1	1	Obj21Pre
	2	Obj22Pre
	3	Obj31Pre
	4	Obj32Pre
	5	Obj41Pre
	6	Obj42Pre
	7	Obj51Pre
	8	Obj52Pre
	9	Obj71Pre
2	1	Obj21Post
	2	Obj22Post
	3	Obj31Post
	4	Obj32Post
	5	Obj41Post
	6	Obj42Post
	7	Obj51Post
	8	Obj52Post
	9	Obj71Post

Descriptive Statistics

	Mean	Std. Deviation	N
Obj21Pre	1.29	.871	34
Obj22Pre	1.06	.851	34
Obj31Pre	1.18	.869	34
Obj32Pre	1.74	1.214	34
Obj41Pre	1.00	.778	34
Obj42Pre	.68	.535	34
Obj51Pre	1.62	.922	34
Obj52Pre	.47	.662	34
Obj71Pre	2.59	1.104	34
Obj21Post	2.29	.760	34
Obj22Post	2.03	.904	34
Obj31Post	2.62	.853	34
Obj32Post	2.24	1.156	34
Obj41Post	2.18	.869	34
Obj42Post	.71	.579	34
Obj51Post	2.68	.843	34
Obj52Post	1.85	.857	34
Obj71Post	2.76	1.017	34

Table A.6 Pretest and Posttest Comparison using ANOVA

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
prepost	Pillai's Trace	.897	286.145[a]	1.000	33.000	.000
	Wilks' Lambda	.103	286.145[a]	1.000	33.000	.000
	Hotelling's Trace	8.671	286.145[a]	1.000	33.000	.000
	Roy's Largest Root	8.671	286.145[a]	1.000	33.000	.000
scores	Pillai's Trace	.879	23.589[a]	8.000	26.000	.000
	Wilks' Lambda	.121	23.589[a]	8.000	26.000	.000
	Hotelling's Trace	7.258	23.589[a]	8.000	26.000	.000
	Roy's Largest Root	7.258	23.589[a]	8.000	26.000	.000
prepost * scores	Pillai's Trace	.746	9.555[a]	8.000	26.000	.000
	Wilks' Lambda	.254	9.555[a]	8.000	26.000	.000
	Hotelling's Trace	2.940	9.555[a]	8.000	26.000	.000
	Roy's Largest Root	2.940	9.555[a]	8.000	26.000	.000

a. Exact statistic

b.

Design: Intercept

Within Subjects Design: prepost+scores+prepost*scores

Table A.7a Pretest and Posttest Comparison using ANOVA

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
prepost	Sphericity Assumed	113.021	1	113.021	286.145	.000
	Greenhouse-Geisser	113.021	1.000	113.021	286.145	.000
	Huynh-Feldt	113.021	1.000	113.021	286.145	.000
	Lower-bound	113.021	1.000	113.021	286.145	.000
Error(prepost)	Sphericity Assumed	13.034	33	.395		
	Greenhouse-Geisser	13.034	33.000	.395		
	Huynh-Feldt	13.034	33.000	.395		
	Lower-bound	13.034	33.000	.395		
scores	Sphericity Assumed	178.353	8	22.294	25.408	.000
	Greenhouse-Geisser	178.353	5.922	30.118	25.408	.000
	Huynh-Feldt	178.353	7.362	24.227	25.408	.000
	Lower-bound	178.353	1.000	178.353	25.408	.000
Error(scores)	Sphericity Assumed	231.647	264	.877		
	Greenhouse-Geisser	231.647	195.423	1.185		
	Huynh-Feldt	231.647	242.940	.954		
	Lower-bound	231.647	33.000	7.020		
prepost * scores	Sphericity Assumed	35.170	8	4.396	7.775	.000
	Greenhouse-Geisser	35.170	6.196	5.676	7.775	.000
	Huynh-Feldt	35.170	7.785	4.518	7.775	.000
	Lower-bound	35.170	1.000	35.170	7.775	.009
Error(prepost*scores)	Sphericity Assumed	149.275	264	.565		
	Greenhouse-Geisser	149.275	204.462	.730		
	Huynh-Feldt	149.275	256.889	.581		
	Lower-bound	149.275	33.000	4.523		

Table A.7b Pretest and Posttest Comparison using ANOVA

Within-Subjects Factors

Measure: MEASURE_1

prepost	scores	Dependent Variable
1	1	Obj21Pre
	2	Obj22Pre
	3	Obj31Pre
	4	Obj32Pre
	5	Obj41Pre
	6	Obj42Pre
	7	Obj51Pre
	8	Obj52Pre
	9	Obj71Pre
2	1	Obj21Post
	2	Obj22Post
	3	Obj31Post
	4	Obj32Post
	5	Obj41Post
	6	Obj42Post
	7	Obj51Post
	8	Obj52Post
	9	Obj71Post

Between-Subjects Factors

		Value Label	N
TorC	0	control	17
	1	treatment	17

Table A.8a Pretest and Posttest by Groups Comparison using ANOVA

Descriptive Statistics

	TorC	Mean	Std. Deviation	N
Obj21Pre	control	1.24	.752	17
	treatment	1.35	.996	17
	Total	1.29	.871	34
Obj22Pre	control	.88	.857	17
	treatment	1.24	.831	17
	Total	1.06	.851	34
Obj31Pre	control	1.06	.659	17
	treatment	1.29	1.047	17
	Total	1.18	.869	34
Obj32Pre	control	1.29	1.160	17
	treatment	2.18	1.131	17
	Total	1.74	1.214	34
Obj41Pre	control	.88	.697	17
	treatment	1.12	.857	17
	Total	1.00	.778	34
Obj42Pre	control	.71	.470	17
	treatment	.65	.606	17
	Total	.68	.535	34
Obj51Pre	control	1.53	1.125	17
	treatment	1.71	.686	17
	Total	1.62	.922	34
Obj52Pre	control	.59	.795	17
	treatment	.35	.493	17
	Total	.47	.662	34
Obj71Pre	control	2.24	1.091	17
	treatment	2.94	1.029	17
	Total	2.59	1.104	34
Obj21Post	control	2.59	.712	17
	treatment	2.00	.707	17
	Total	2.29	.760	34
Obj22Post	control	2.24	.752	17
	treatment	1.82	1.015	17
	Total	2.03	.904	34
Obj31Post	control	2.47	1.007	17
	treatment	2.76	.664	17
	Total	2.62	.853	34
Obj32Post	control	2.24	1.200	17
	treatment	2.24	1.147	17
	Total	2.24	1.156	34
Obj41Post	control	1.94	.556	17
	treatment	2.41	1.064	17
	Total	2.18	.869	34
Obj42Post	control	.82	.636	17
	treatment	.59	.507	17
	Total	.71	.579	34
Obj51Post	control	2.76	.903	17
	treatment	2.59	.795	17
	Total	2.68	.843	34
Obj52Post	control	2.00	.707	17
	treatment	1.71	.985	17
	Total	1.85	.857	34
Obj71Post	control	2.65	1.169	17
	treatment	2.88	.857	17
	Total	2.76	1.017	34

.

Table A.8b Pretest and Posttest by Groups Comparison using ANOVA

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
prepost	Pillai's Trace	.930	428.291[a]	1.000	32.000	.000
	Wilks' Lambda	.070	428.291[a]	1.000	32.000	.000
	Hotelling's Trace	13.384	428.291[a]	1.000	32.000	.000
	Roy's Largest Root	13.384	428.291[a]	1.000	32.000	.000
prepost * TorC	Pillai's Trace	.352	17.393[a]	1.000	32.000	.000
	Wilks' Lambda	.648	17.393[a]	1.000	32.000	.000
	Hotelling's Trace	.544	17.393[a]	1.000	32.000	.000
	Roy's Largest Root	.544	17.393[a]	1.000	32.000	.000
scores	Pillai's Trace	.888	24.878[a]	8.000	25.000	.000
	Wilks' Lambda	.112	24.878[a]	8.000	25.000	.000
	Hotelling's Trace	7.961	24.878[a]	8.000	25.000	.000
	Roy's Largest Root	7.961	24.878[a]	8.000	25.000	.000
scores * TorC	Pillai's Trace	.236	.964[a]	8.000	25.000	.485
	Wilks' Lambda	.764	.964[a]	8.000	25.000	.485
	Hotelling's Trace	.308	.964[a]	8.000	25.000	.485
	Roy's Largest Root	.308	.964[a]	8.000	25.000	.485
prepost * scores	Pillai's Trace	.747	9.204[a]	8.000	25.000	.000
	Wilks' Lambda	.253	9.204[a]	8.000	25.000	.000
	Hotelling's Trace	2.945	9.204[a]	8.000	25.000	.000
	Roy's Largest Root	2.945	9.204[a]	8.000	25.000	.000
prepost * scores * TorC	Pillai's Trace	.414	2.208[a]	8.000	25.000	.062
	Wilks' Lambda	.586	2.208[a]	8.000	25.000	.062
	Hotelling's Trace	.707	2.208[a]	8.000	25.000	.062
	Roy's Largest Root	.707	2.208[a]	8.000	25.000	.062

a. Exact statistic

b.
Design: Intercept+TorC
Within Subjects Design: prepost+scores+prepost*scores

Table A.8c Pretest and Posttest by Groups Comparison using ANOVA

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		F	Sig.
prepost	Sphericity Assumed	428.291	.000
	Greenhouse-Geisser	428.291	.000
	Huynh-Feldt	428.291	.000
	Lower-bound	428.291	.000
prepost * TorC	Sphericity Assumed	17.393	.000
	Greenhouse-Geisser	17.393	.000
	Huynh-Feldt	17.393	.000
	Lower-bound	17.393	.000
Error(prepost)	Sphericity Assumed		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Lower-bound		
scores	Sphericity Assumed	25.928	.000
	Greenhouse-Geisser	25.928	.000
	Huynh-Feldt	25.928	.000
	Lower-bound	25.928	.000
scores * TorC	Sphericity Assumed	1.675	.105
	Greenhouse-Geisser	1.675	.127
	Huynh-Feldt	1.675	.105
	Lower-bound	1.675	.205
Error(scores)	Sphericity Assumed		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Lower-bound		
prepost * scores	Sphericity Assumed	7.811	.000
	Greenhouse-Geisser	7.811	.000
	Huynh-Feldt	7.811	.000
	Lower-bound	7.811	.009
prepost * scores * TorC	Sphericity Assumed	1.153	.329
	Greenhouse-Geisser	1.153	.334
	Huynh-Feldt	1.153	.329
	Lower-bound	1.153	.291
Error(prepost*scores)	Sphericity Assumed		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Lower-bound		

Table A.8d Pretest and Posttest by Groups Comparison using ANOVA

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
prepost	Sphericity Assumed	113.021	1	113.021	428.291	.000
	Greenhouse-Geisser	113.021	1.000	113.021	428.291	.000
	Huynh-Feldt	113.021	1.000	113.021	428.291	.000
	Lower-bound	113.021	1.000	113.021	428.291	.000
prepost * TorC	Sphericity Assumed	4.590	1	4.590	17.393	.000
	Greenhouse-Geisser	4.590	1.000	4.590	17.393	.000
	Huynh-Feldt	4.590	1.000	4.590	17.393	.000
	Lower-bound	4.590	1.000	4.590	17.393	.000
Error(prepost)	Sphericity Assumed	8.444	32	.264		
	Greenhouse-Geisser	8.444	32.000	.264		
	Huynh-Feldt	8.444	32.000	.264		
	Lower-bound	8.444	32.000	.264		
scores	Sphericity Assumed	178.353	8	22.294	25.928	.000
	Greenhouse-Geisser	178.353	6.159	28.959	25.928	.000
	Huynh-Feldt	178.353	8.000	22.294	25.928	.000
	Lower-bound	178.353	1.000	178.353	25.928	.000
scores * TorC	Sphericity Assumed	11.523	8	1.440	1.675	.105
	Greenhouse-Geisser	11.523	6.159	1.871	1.675	.127
	Huynh-Feldt	11.523	8.000	1.440	1.675	.105
	Lower-bound	11.523	1.000	11.523	1.675	.205
Error(scores)	Sphericity Assumed	220.124	256	.860		
	Greenhouse-Geisser	220.124	197.079	1.117		
	Huynh-Feldt	220.124	256.000	.860		
	Lower-bound	220.124	32.000	6.879		
prepost * scores	Sphericity Assumed	35.170	8	4.396	7.811	.000
	Greenhouse-Geisser	35.170	6.051	5.812	7.811	.000
	Huynh-Feldt	35.170	7.852	4.479	7.811	.000
	Lower-bound	35.170	1.000	35.170	7.811	.009
prepost * scores * TorC	Sphericity Assumed	5.190	8	.649	1.153	.329
	Greenhouse-Geisser	5.190	6.051	.858	1.153	.334
	Huynh-Feldt	5.190	7.852	.661	1.153	.329
	Lower-bound	5.190	1.000	5.190	1.153	.291
Error(prepost*scores)	Sphericity Assumed	144.085	256	.563		
	Greenhouse-Geisser	144.085	193.646	.744		
	Huynh-Feldt	144.085	251.265	.573		
	Lower-bound	144.085	32.000	4.503		

Appendix B Student ANOVA Profile (ANOVA Center LTD.®)

Figure B.1 ANOVA Profile General Education Student

8th Grade TAKS Needs Assessment Profile

STUDENT: CAMPUS 2008-2009: Jefferson High School

Administration Date: Spring '08 ID: Date of Birth: 10/09/1993 Sex: Female Ethnicity: Hispanic LEP - No

Program Participation ---- Title 1 - Yes Migrant - No Bilingual - No ESL - No G/T - No Special Ed - No

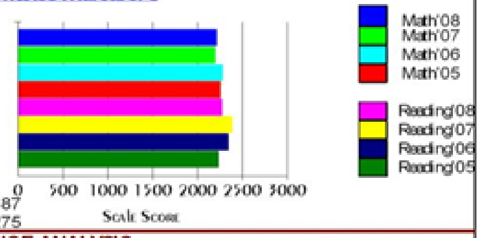
Current and Historical Performance Indicators

Test	2005 SS	2006 SS	2007 SS	2008 SS	Anticipated 2008 Scale Score
Math	2271	2291	2209	2226	2277
Reading	2247	2355	2400	2283	2464

Lexile® - 1070L Quantile® - 955Q

TAKS Outcomes

Math 08- Passed
Math 07- Passed
Math 06- Passed
Math 05- Passed
Reading 08- Passed
Reading 07- Passed
Reading 06- Passed
Reading 05- Passed



Science 08- Passed / 2187
Social Studies 08- Passed / 2275

OBJECTIVE LEVEL PERFORMANCE ANALYSIS

Instructional Areas Within Strike Zone

Math
- Obj. 3 Geometry and Spatial Reasoning — 85.7% Correct
- Obj. 5 Probability and Statistics — 75.0% Correct
- Obj. 6 Mathematical Processes and Tools — 80.0% Correct

Reading
- Obj. 3 Using Strategies to Analyze — 90.0% Correct
- Obj. 4 Applying Critical Thinking Skills — 87.5% Correct

Campus Response

Aberrant Objectives

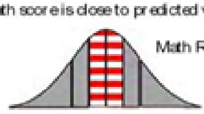
Student's objective performance was at least 1 standard deviation below campus performance on the following objectives

Math
No Objectives in this Category.

Reading
No Objectives in this Category.

RELATIVE PERFORMANCE ANALYSIS

Math score is close to predicted value



Math Residual is -0.47

Performed like other students with similar entry scores

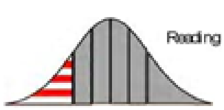
Initial Math Data Based Assessment ----GREEN

Mathematics

Interpretive Analysis (Confidence Level Relatively High)

- CONCERN LEVEL LOW-student scored well elsewhere-possible Positive Banding
- Regression to mean not a factor--check for a defined positive STASIS
- Check current performance to verify STASIS still in place
- Scenario Recommendation: SCHOOL DISCRETION
- Refer to school response to Scenario #3

Reading score is below predicted value



Reading Residual is -1.45

Performed much lower than other students with similar entry scores

Initial Reading Data Based Assessment ----GREEN

Reading

Interpretive Analysis (Confidence Level Relatively High)

- CONCERN LEVEL LOW-student is scoring much lower than projections predicted
- Moderate gain probability, regression to mean in your favor
- Gain more likely if previous STASIS can be established
- Scenario Recommendation: PSYCHO/SOCIAL
- Refer to school response to Scenario #1

IMPORTANT NOTE: All statements made in this document are based on statistical probabilities only and are not meant to imply definitive outcomes of any sort.

Figure B.2 ANOVA Profile Special Education Student (TAKS and TAKS A)

10th Grade TAKS Needs Assessment Profile

STUDENT: **CAMPUS 2008-2009:** Jefferson High School

Administration Date: Spring '08 **ID:** . **Date of Birth:** **Sex:** Male **Ethnicity:** Hispanic **LEP** - Yes

Program Participation ---- **Title 1** - Yes **Migrant** - No **Bilingual** - No **ESL** - No **G/T** - No **Special Ed** - Yes

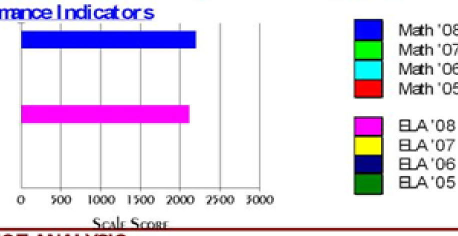
Current and Historical Performance Indicators

Test	2005 SS	2006 SS	2007 SS	2008 SS	Anticipated 2008 Scale Score
Math				2212	NA
ELA				TAKS-A 2127	NA

Lexile® - 1025L Quantile® - 1090Q

TAKS Outcomes

Math 08 - Passed
Math 07 -
Math 06 -
Math 05 -
ELA 08 - Passed
ELA 07 -
ELA 06 -
ELA 05 -
Science 08 - Passed / 2228
SS 08 - Passed / 2119



OBJECTIVE LEVEL PERFORMANCE ANALYSIS

Instructional Areas Within Strike Zone | | **Campus Response**

Math

Obj. 4 Linear Equations and Inequalities	60.0% Correct	____________
Obj. 7 Two- and Three-Dimensional Representations	60.0% Correct	____________

Language Arts

Obj. 3 Analysis and Evaluation	55.6% Correct	____________
Obj. 4 Revising and Editing	80.0% Correct	____________

Aberrant Objectives

Student's objective performance was at least 1 standard deviation below campus performance on the following objectives:

Math

No Objectives in this Category.

Language Arts

Obj. 1 Basic Understanding	50.0% Correct	____________

RELATIVE PERFORMANCE ANALYSIS

Mathematics

TAKS Math Relative Performance Analysis is not available for this student.

Initial Math Data Based Assessment ----GREEN

Language Arts

TAKS Language Arts Relative Performance Analysis is not available for this student.

Initial Reading Data Based Assessment ----BLUE

NOTE: All statements made in this document are based on statistical probabilities only and are not meant to imply definitive outcomes of any sort.

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Figure B.2 ANOVA Profile Special Education Student (TAKS and TAKS A)

TAKS Individual Report

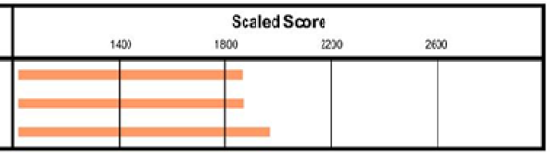
May 13, 2009

Report Options

School Name: Jefferson High School	**Teachers: All**
Grade: 12	**Ethnicities: All**
District Name: El Paso Independent School District - TX	**Ed Programs: All**
Exams: TAKS 07-08	**Course: All**
Rosters: 2008-2009 Semester 2	**Custom Groups: All**

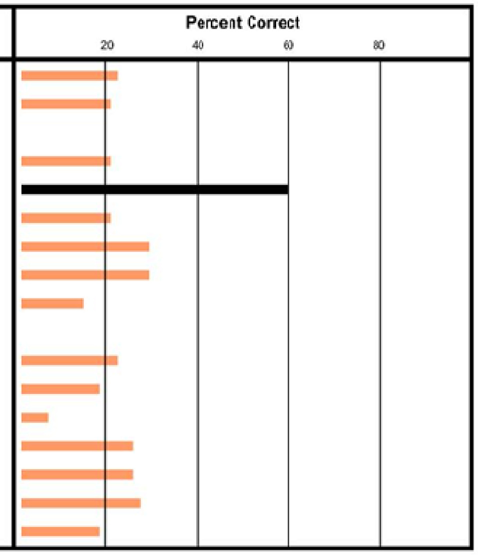
Subject Area Scores

	Administration	Met Standard	Commended	Scaled Score
Mathematics	TAKS 07-08	No	No	1858
Science	TAKS 07-08	No	No	1860
Social Studies	TAKS 07-08	No	No	1963



Objective Scores

	Administration	Raw Score	Percent Correct
Mathematics	TAKS 07-08	13	22 %
Functional Relationships	TAKS 07-08	1	20 %
Properties and Attributes of Functions	TAKS 07-08	0	0 %
Linear Functions	TAKS 07-08	1	20 %
Linear Equations and Inequalities	TAKS 07-08	3	60 %
Nonlinear Functions and Inequalities	TAKS 07-08	1	20 %
Geometric Relationships and Spatial Reasoning	TAKS 07-08	2	29 %
Two- and Three-Dimensional Representations	TAKS 07-08	2	29 %
Measurement and Similarity	TAKS 07-08	1	14 %
Percents/Proportions/Probability/Statistics	TAKS 07-08	0	0 %
Mathematical Processes and Tools	TAKS 07-08	2	22 %
Science	TAKS 07-08	10	18 %
Nature of Science	TAKS 07-08	1	6 %
Organization of Living Systems	TAKS 07-08	2	25 %
Interdependence of Organisms and the Environment	TAKS 07-08	2	25 %
Structures and Properties of Matter	TAKS 07-08	3	27 %
Motion, Forces, and Energy	TAKS 07-08	2	18 %



Appendix C Instruments

C.1 Informal Assessment

Informal Assessment

Date ____________

Start Time ________________

End Time ________________

Direct Instruction ___

Independent Practice ___

Total time ___

ID # ___ **Objective** ___ **Inter.#** _____ **Number of Students in the group** ____________ **Group C** **Group T**

General Attitude

1. Are you taking a math class? **Yes / No**

2. How Well are you doing in math? (Or did in the past)

Very bad				Very Good
0	1	2	3	4

3. How are you feeling Today?

Very bad				Very Good
0	1	2	3	4

4.Do you think you are going to be able to solve today's math problems

Not at all				Yes I'm Pretty Sure
0	1	2	3	4

5. Student Showed signs of anxiety? (Tapping feet, unrest behavior ,wet palms, stuttering etc) **Yes /No** **Describe it**

	Behavior during Intervention		
6. Student Asked questions during direct instruction?	**Yes /No**		
7. Student asked questions during independent Practice ?	**Yes /No**		
8. Student asked for Teacher support during Independent Practice?	**Yes/ No**	**8a. Student asked the Teacher to be praised?**	**Yes/ No**
9. Student asked for peer support during Independent Practice?	**Yes/ No**	**9a. Student asked peer(s) to Praised?**	**Yes / No**
10. Student made drawings or calculations before giving the final answer?	**Yes /No**		
11. Student Used calculator in order to verify / solve the problem?	**Yes /No**		
12. Student Used the smart board in order to verify / solve the problem?	**Yes /No**		

13. Student tried to guess the answer? **Yes/ no**

14. Student made mental operations to solve the problem? **Yes/ No**

	Not observed				Most of the Time
15. Student Used Overt Language Thinking?	**0**	**1**	**2**	**3**	**4**
16. Student Used Covert Language Thinking?	**0**	**1**	**2**	**3**	**4**

17. Student was able to solve how many problems?

0 1 2 3 Out of:_______

Comments

C.2 Excel Table Example (Criteria)

ID	First Name	D1	Math Calculation	Math Reasoning	IQ	Quantile	GR	LEP	Gender	Basic Reading	Reading Comprehension	Listening	Writing Expression	Lexile	Treatment/Control
26	Juan	LD	TRUE	TRUE	83	595	12	No	M	TRUE	TRUE	FALSE	FALSE	800	T
97	Johnny	LD	TRUE	TRUE	80	650	11	No	M	TRUE	TRUE	FALSE	TRUE	700	C

C.3 Excel Table Example (Total Scores)

ID	Name	Raw Score Pre	Pre	Raw Score Post	Post	Gain (Decimal)	Gain (%)
51	Melina	16	50.00%	29	90.63%	0.41	40.63

C.4 Excel Table Example (Scores per Objective)

ID	Name	D1	Obj. 2b			Obj. 3a		
			Inf.	Pre	Post	Inf.	Pre	Post
23	Charlie	LD	Yes	2	0	Yes	1	2
4	Carlos	LD	Yes	0	1	Yes	0	2

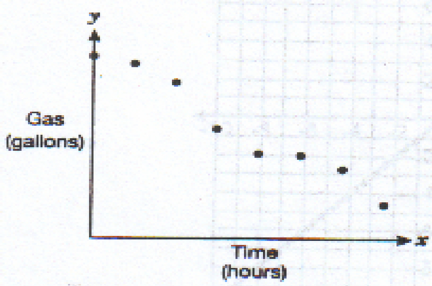
C.5 Pretest and Posttest Quesions

Pretest Questions for Objective 2 part a

(Note: All problems are based on TAKS items releases)

Question 17

John and some of his friends went waterskiing in his new boat. He made a table that showed the number of gallons of gas remaining at the end of each hour. The scatterplot below shows the gas that remained in terms of the hours that had passed.



Which of the following describes the correlation between the gas that remained and the hours that had passed?

A Positive correlation

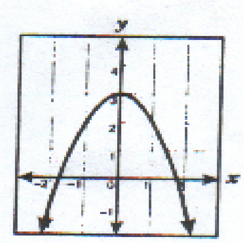
B No correlation

C Negative correlation

D Undefined correlation

Question 14

Which function is the parent function of the graph below?

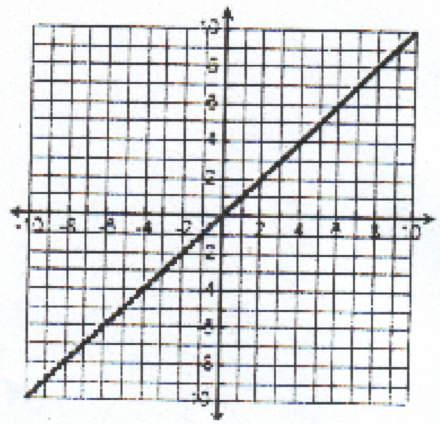


A $y = 2x$

B $y = x^2$

C $x = y^2$

D $y = x$



24 Which function is represented by the following graph?

A $y = x^2$

B $y = x$

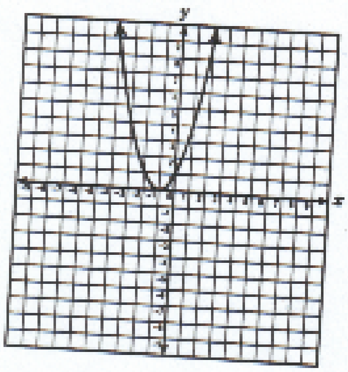
C $y = 4$

D $x = 2$

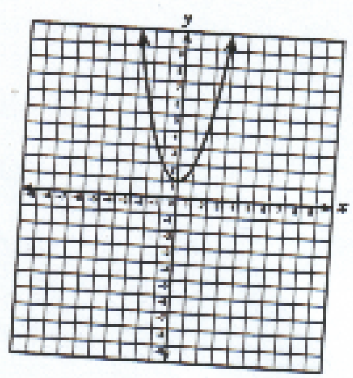
Posttest Questions for Objective 2 part a

1 Which graph below represents the parent function of a quadratic function?

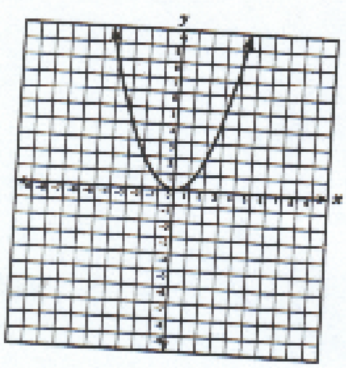
A



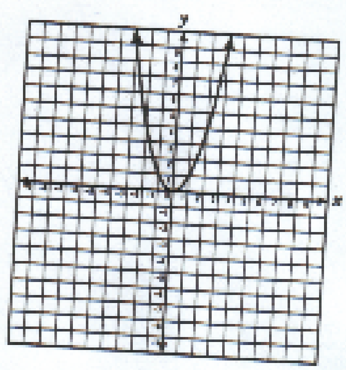
C



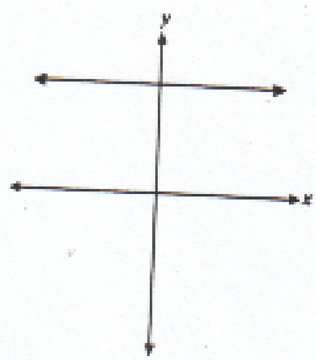
B

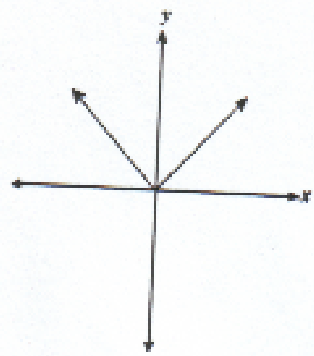


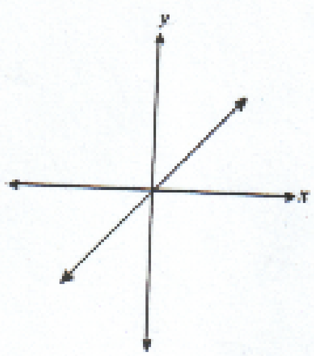
D

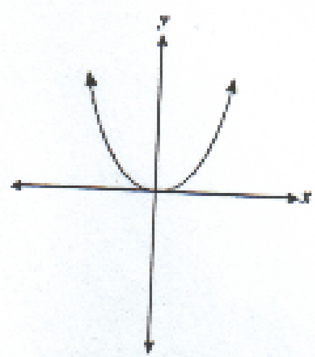


11. Which is the best representation of the function $y = x$?

A


C


B


D


12. Monica collected data on the ages and heights of a random sample of sixth-, seventh-, and eighth-grade students at her school. If she plots the data on a scatterplot, what relationship will she most likely see between age and height?

A A negative correlation

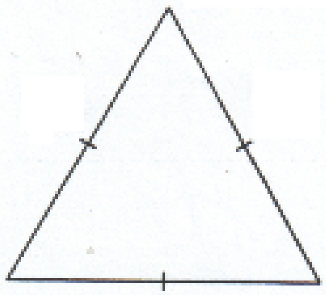
B No correlation

C A positive correlation

D A constant correlation

Pretest Questions for Objective 2 part b

2 The perimeter of an equilateral triangle is 36 meters or less.



Which set describes the domain for l, the length of one side of the triangle?

A $\{0 < l \leq 3\}$

B $\{0 < l \leq 6\}$

C $\{0 < l \leq 12\}$

D $\{0 < l \leq 36\}$

3 Given the function $f(x) = 3x^2 - 7$, what is the value of $f(-3)$?

A -25

B -34

C 74

D 20

Question 15

Eliza is enrolled in a public-speaking class. Each week she is required to give a speech of greater length than the speech she gave the week before. The table below shows the lengths of several of her speeches.

Eliza's Speeches

Week Number	3	4	5	6
Length of Speech (seconds)	150	180	210	240

If this trend continues, in which week will she give a 12-minute speech?

A 22

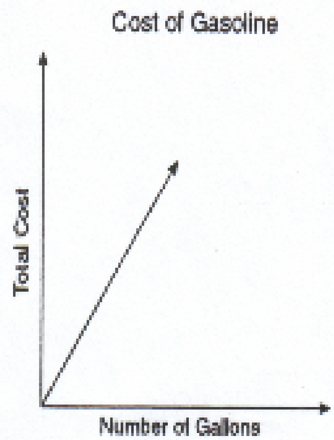
B 12

C 15

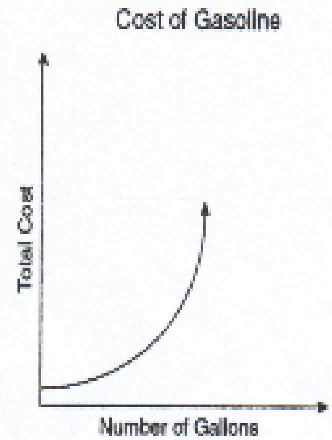
D 24

15. Identify the graph that best represents the relationship between the number of gallons of gasoline Mr. Johnson purchased at $1.49 a gallon and the total cost of his gasoline.

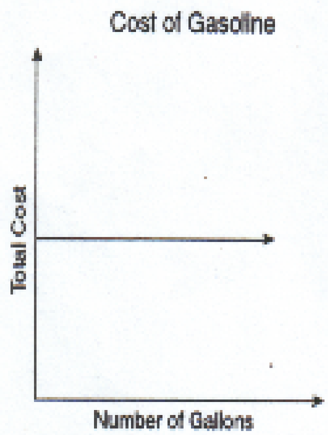
F



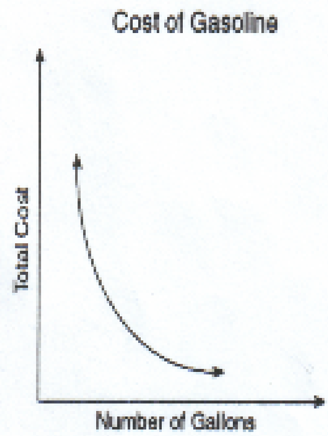
H



G



J



Posttest Questions for Objective 2 part b

Question 20

The following ordered pairs belong to the function $f(x)$.

$$(1, 2), (2, 8), (3, 18), (4, 32)$$

Which equation best describes this function?

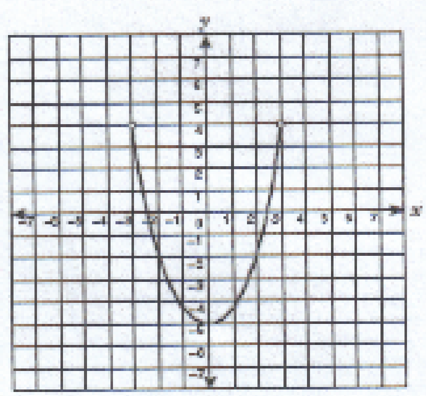
A $f(x) = x + 4$

B $f(x) = 8x$

C $f(x) = 2x^2$

D $f(x) = x - \frac{6}{x}$

7. What is the domain of the function shown on the graph?



A $-3 \leq x \leq 3$

B $-3 < x < 3$

C $-5 < x \leq 4$

D $-5 \leq x < 4$

14. The figures below show a pattern of dark tiles and white tiles that can be described by a relationship between 2 variables.

Figure 1

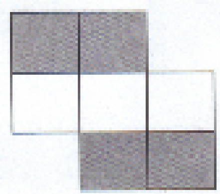


Figure 2

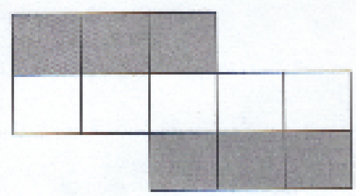


Figure 3

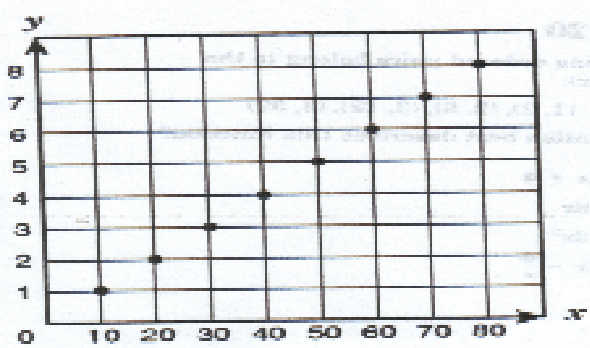
Which rule relates d, the number of dark tiles, to w, the number of white tiles?

F $d = 2w$

G $w = d - 1$

H $d = 2w - 2$

5. **Look at the graph below.**



Which is the best interpretation of this graph?

A Jorge earns $20 for each hour worked.

B For every 10 pieces of candy Stacey buys, she pays $1.

C For every 10 students at a dance, 2 teachers are needed as chaperones.

D A runner runs at a constant rate of 2 miles every 30 minutes.

Posttest Questions for Objective 3 part a

$$y = -\frac{3}{4}$$

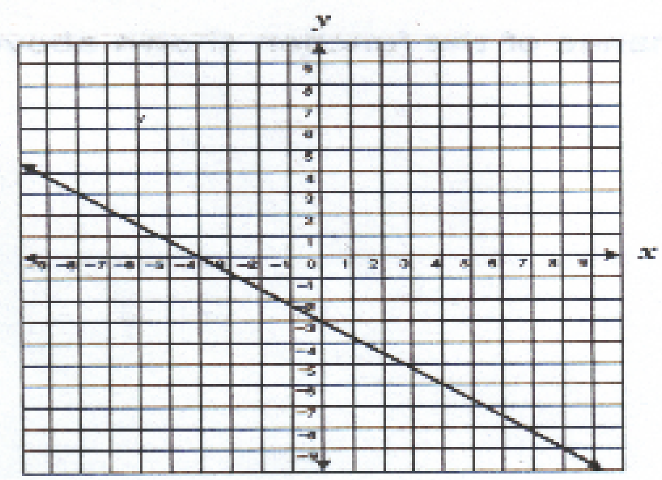
22 What is the rate of change of the function shown above?

A 0

B $\frac{3}{4}$

C $-\frac{3}{4}$

7. **What are the slope and *y*-intercept of the equation of the line graphed below?**



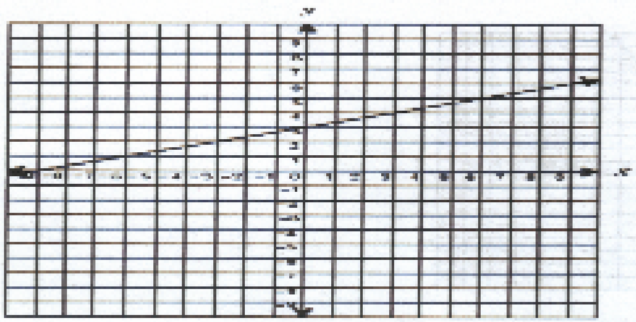
A $m = -\frac{3}{4}$, $b = -4$

B $m = -\frac{4}{3}$, $b = -4$

C $m = -\frac{4}{3}$, $b = -3$

D $m = -\frac{3}{4}$, $b = -3$

2. The graph of a linear function is shown below.



If the line is translated 2 units down, which equation will best describe the new line?

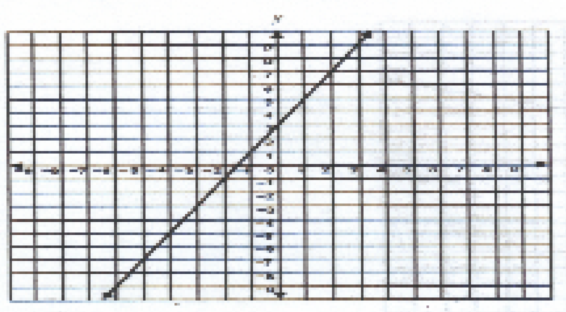
F $y = 3x + 1$

G $y = \frac{1}{3}x + 1$

H $y = 3x + 5$

J $y = \frac{1}{3}x + 5$

8. The graph of a line is shown below.



If the slope of this line is multiplied by −1 and the y-intercept decreases by 2 units, which linear equation represents these changes?

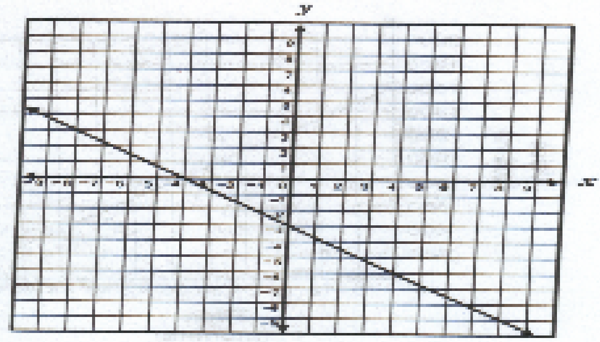
A $y = -2x + 1$

B $y = -x + 1$

C $y = -x - 1$

D $y = -\frac{1}{2}x - 1$

11. What are the slope and y-intercept of the equation of the line graphed below?



Slope of a line:

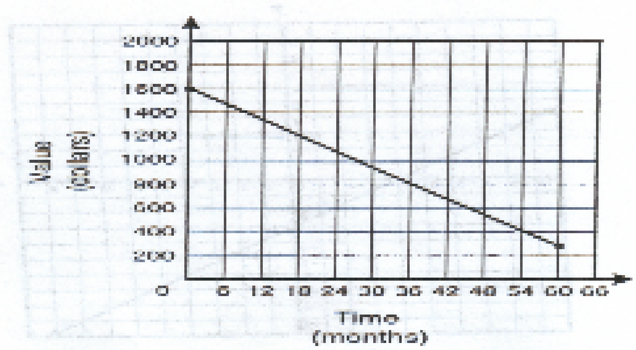
$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

A $m = 4$
$b = -8$

B $m = -\frac{3}{4}$
$b = -3$

C $m = \frac{1}{7}$
$b = 12$

38. The graph shows what happens to the value of a computer over time.



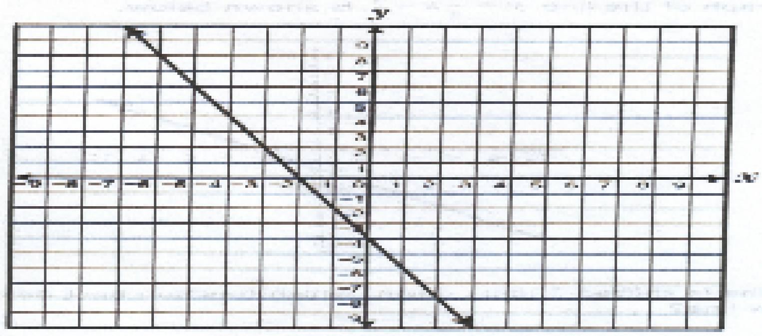
What can you conclude from the graph?

F The value increased over time.

G The value decreased over time.

H The value remained the same over time.

47. This is the graph of the equation $y = -2x - 3$.



Slope-intercept form of an equation:
$y = mx + b$

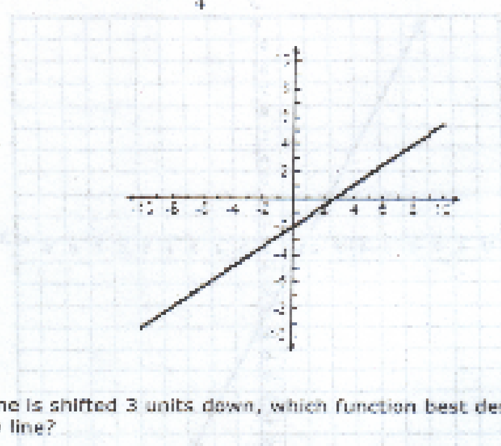
Which equation represents a line parallel to the line shown above?

A $y = -2x + 1$

B $y = \frac{1}{4}x - 3$

C $y = 6x + 4$

12 The graph of the line $y = \frac{3}{4}x - 2$ is shown below.



If the line is shifted 3 units down, which function best describes the graph of the new line?

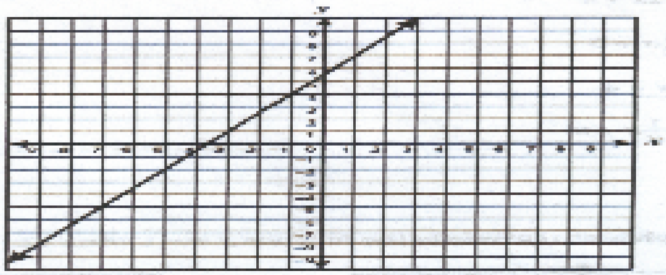
F $y = \frac{3}{4}x + 1$

G $y = \frac{1}{4}x - 1$

H $y = \frac{3}{4}x - 5$

Pretest Questions for Objective 3 part b

5. Which table best describes points on the line graphed below?



A

x	y
−7	−5
−3	−1
−1	4
1	7
3	9

C

x	y
−9	−8
−5	−2
−1	4
1	7
3	10

B

x	y
−9	−8
−2	−5
−1	4
1	6
3	10

D

x	y
−7	−5
−5	−2
−3	−1
7	1
10	3

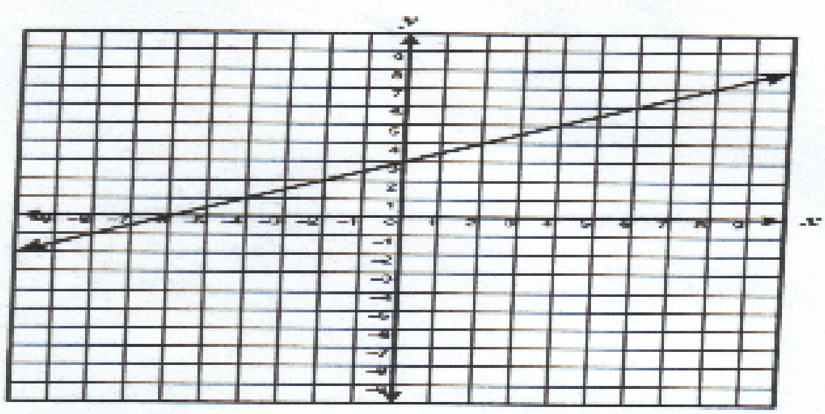
15. Which linear function best describes the graph shown below?

A $y = -3x + \frac{1}{2}$

B $y = \frac{1}{2}x + 3$

C $y = -3x - \frac{1}{2}$

D $y = \frac{1}{2}x - 3$



11. Which of the following describes the line containing the points (0, 4) and (3, −2)?

A $y = -2x + 4$

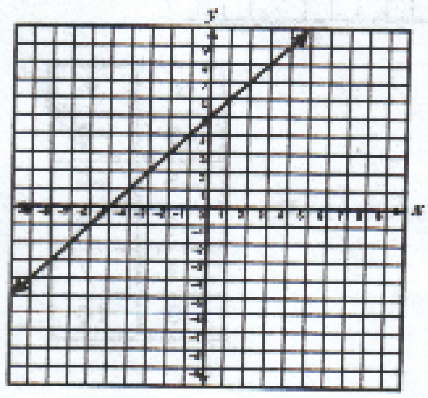
B $y = \frac{1}{2}x + 6$

C $y = 2x + 4$

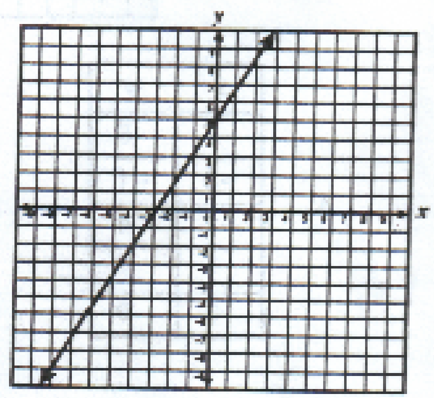
D $y = -\frac{1}{2}x + 6$

10. Which graph best represents the function $y = -1.75x + 5$?

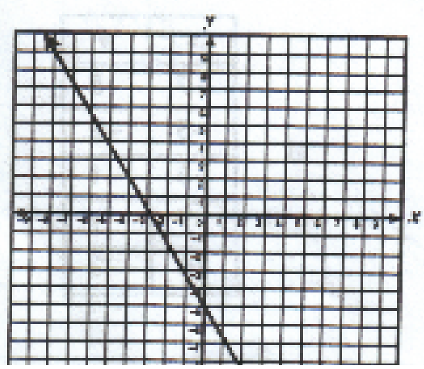
F



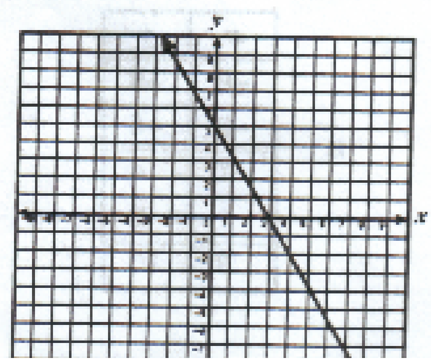
H



G



J



Posttest Questions for Objective 3 part b

5. Which of the following ordered pairs is the x-intercept or the y-intercept of the function $2x - y = 8$?

A (8, 0)

B (0, 4)

C (4, 0)

D (0, 8)

7. Which function includes the data set {(2, 4), (6, 6), (12, 9)}?

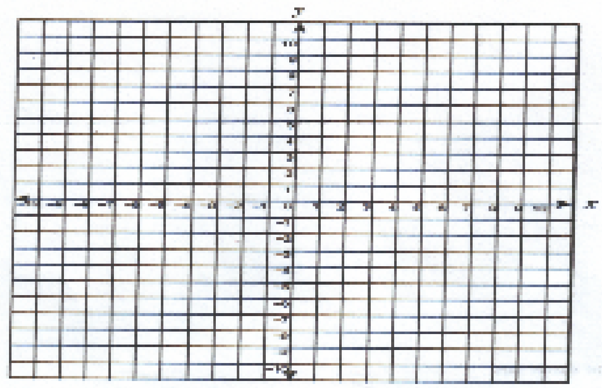
A $y = 2x$

B $y = \frac{x}{2}$

C $y = 2x - 9$

D $y = \frac{x}{2} + 3$

15. Which linear function includes the points (−3, 1) and (−2, 4)?



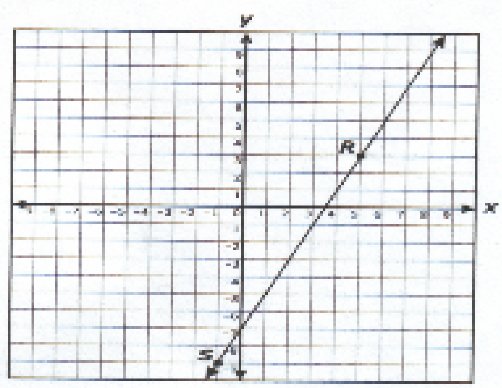
F $f(x) = 3x + 10$

G $f(x) = \frac{1}{3}x + 2$

H $f(x) = 3x - 6$

J $f(x) = -3x + 1$

3 Which linear equation represents the line passing through points *R* and *S*?



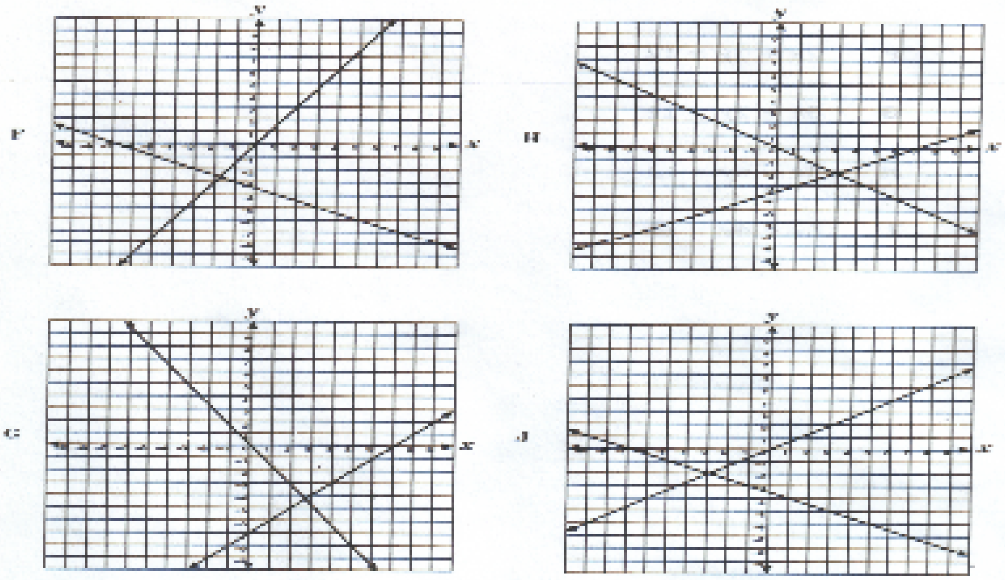
a) $y = 2x - 7$

b) $y = 2x + 7$

c) $y = \frac{1}{2}x - 7$

14. Which graph best represents a solution to this systems of equations?

$$2x - 3y = 0$$
$$x + 2y = -7$$



20 Which of the following equations has a *y*-intercept of 4 and an *x*-intercept of 6?

F $2x + 3y = 12$

G $3x + 2y = 12$

H $4x + 6y = 12$

J $6x + 4y = 12$

8. If $(x, -4)$ is a solution to the equation $4x - 5y = 8$, what is the value of x?

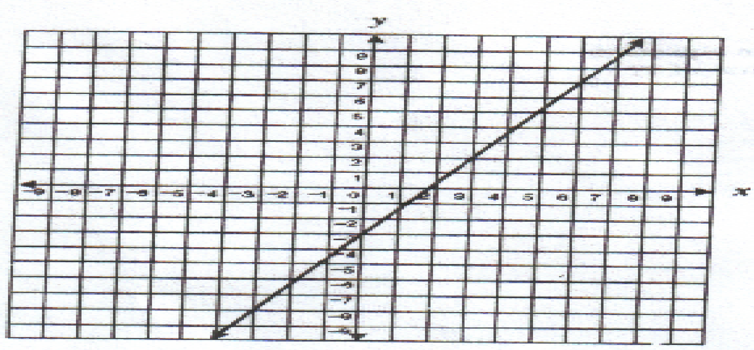
A -4.8

B -3

C 1.6

D 7

6. The graph of the equation $y = \frac{5}{3}x - 3$ is given below. Graph $y = x + 1$ on the grid.



What is the solution to this system of equations?

A $(0, 1)$

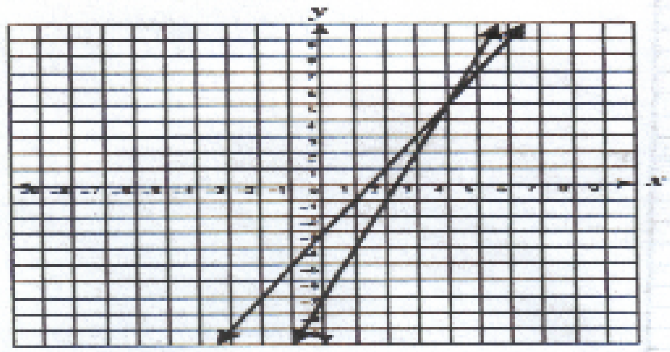
B $(5, 6)$

C $(6, 7)$

D No solution

Posttest Questions for Objective 4 part a

9. The graphs of the linear equations $y = 2x - 3$ and $y = 3x - 7$ are shown below.



If $2x - 3 = 3x - 7$, what is the value of x?

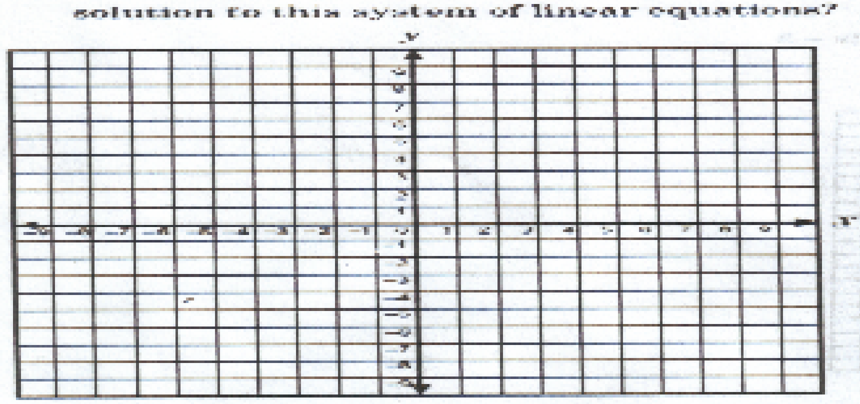
F 4

G 5

H 9

J 10

4. If the system of linear equations $2x + y = 1$ and $y = -\frac{1}{2}x + 1$ are graphed on the same coordinate grid, which of the following is the solution to this system of linear equations?



A (2, 0)

B (0, 2)

C (0.5, 0)

D Not here

13. **What is the value of y if $(3, y)$ is a solution to the equation $5x - 3y = 18$?**

F 3

G 1

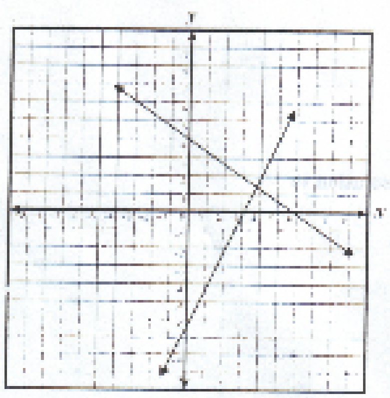
H −1

J −11

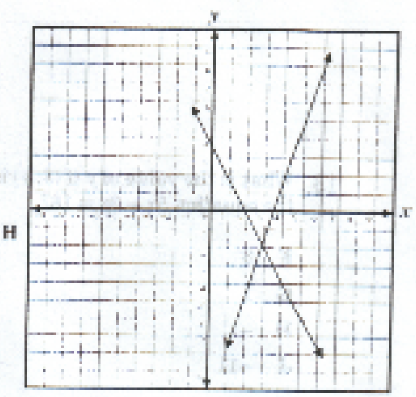
$$y = -x - 5$$
$$y = 2x + 4$$

20 Which graph best represents a solution to the system of equations above?

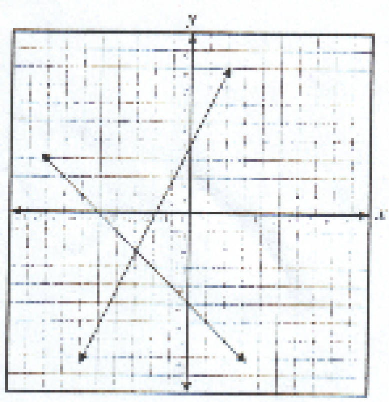
F



H



G

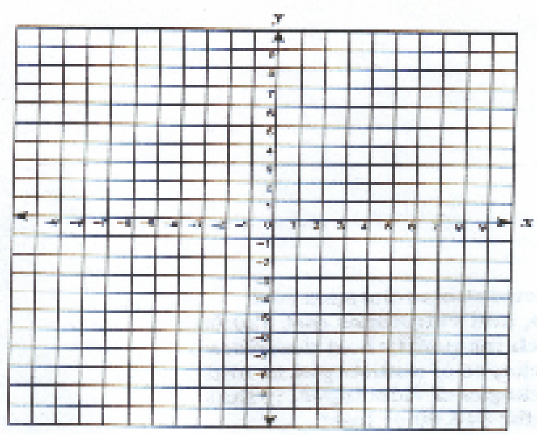


Pretest Questions for Objective 4 part b

11. **At Northwest Electronics audiotapes cost \$5.00 per package, and videotapes cost \$10.00 per package. Which inequality best describes the number of packages of audiotapes, a, and the number of packages of videotapes, v, that can be purchased for \$45.00 or less?**

- **F** $5a + 10v < 45$
- **G** $10a + 5v \le 45$
- **H** $5a + 10v \le 45$ •
- **J** $10a + 5v < 45$

12. Valerie purchased x tubes of lipstick at \$4 each and y bottles of nail polish at \$2 each. She spent less than \$12, not including tax. Use the grid below to graph the inequality $4x + 2y < 12$.

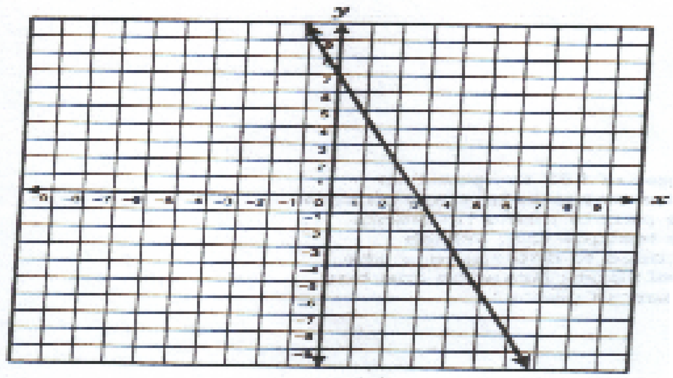


Which point represents a reasonable number of lipsticks and bottles of nail polish that Valerie purchased?

- **A** (1, 5)
- **B** (2, 3)
- **C** (1, 3) •
- **D** (2, 2)

Posttest Questions for Objective 4 part b

1 The graph of the linear equation $y = -\frac{5}{2}x + 7$ is shown below.



Which coordinate pair is in the solution set of $y < -\frac{5}{2}x + 7$?

A (4, −3)
B (1, 2)
C (5, 6)
D (0, 7)

4. Brandon has a budget of $58 to spend on clothes. The shirts he wants to buy are on sale for $9 each, and the pair of pants he wants costs $21. All prices include tax. Which inequality could be used to determine *s*, the maximum number of shirts Brandon can buy if he also buys the pair of pants?

F $21s + 9 < 58$

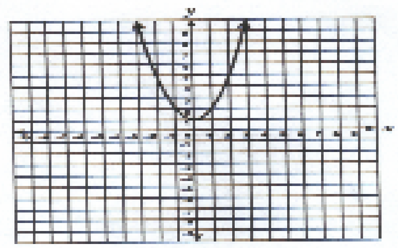
G $9s + 21 \leq 58$

H $30s < 58$

J $9s - 21 \leq 58$

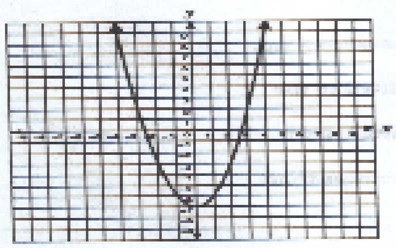
Pretest Questions for Objective 5 part a

The graph of a function is shown below.

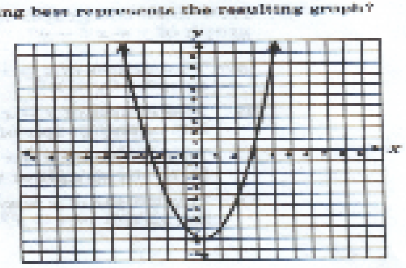


If the graph is translated 7 units down, which of the following best represents the resulting graph?

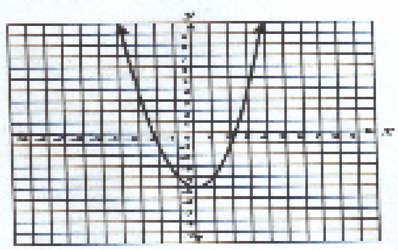
A



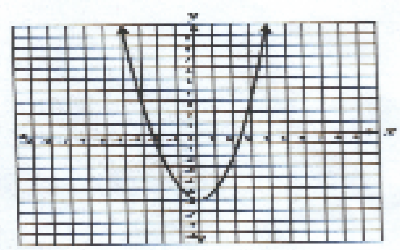
C



B



D



9. **How does the graph of $y = x^2$ differ from the graph of $y = x^2 - 4$?**

A **The graph of $y = x^2 - 4$ is wider than the graph of $y = x^2$.**

B **The graph of $y = x^2 - 4$ is shifted to the left of the graph of $y = x^2$.**

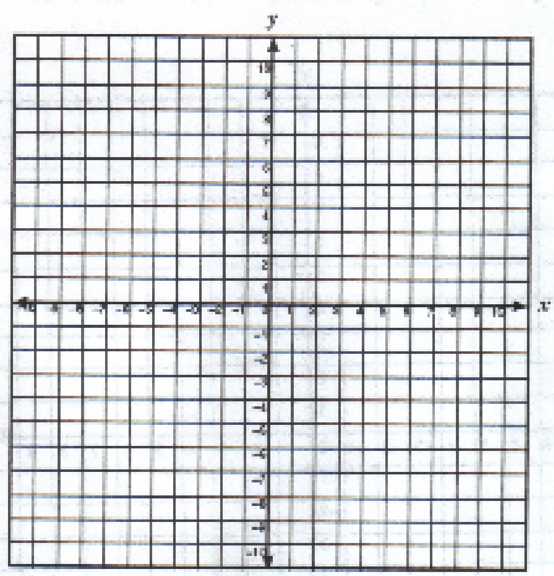
C **The graph of $y = x^2 - 4$ is shifted down from the graph of $y = x^2$.**

D **The graph of $y = x^2 - 4$ is narrower than the graph of $y = x^2$.**

4. Which of the following is the vertex of the graph of the equation $y = -x^2 + 2x + 3$?

A (0, 3)
B (−1, 0)
C (1, 4)
D (3, 0)

12. When graphed, which function would appear to be shifted 2 units up from the graph of $f(x) = x^2 + 1$?



F $g(x) = x^2 - 1$
G $g(x) = x^2 + 3$
H $g(x) = x^2 - 2$
J $g(x) = x^2 + 2$

Posttest Questions for Objective 5 part a

5. How would the graph of the function $y = x^2 + 4$ be affected if the function were changed to $y = x^2 + 1$?

F The graph would shift 3 units up.

G The graph would shift 3 units down.

H The graph would shift 3 units to the right.

J The graph would shift 3 units to the left.

10.

Which equation will produce the widest parabola when graphed?

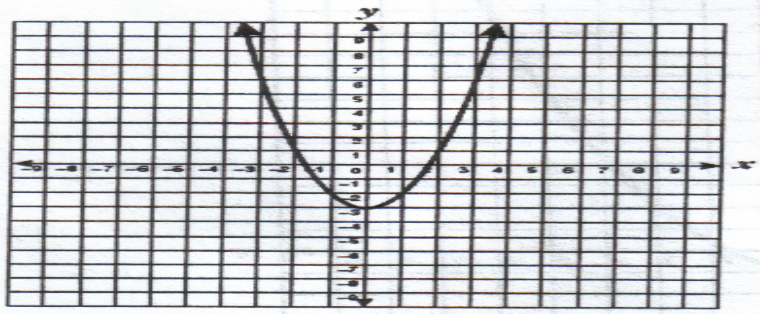
A $y = 2x^2$

B $y = -6x^2$

C $y = -0.6x^2$

D $y = 0.2x^2$

3. The graph of the function $y = x^2 - 3$ is shown below.



If the graph of the original function is shifted 5 units up, which of the following equations best represents the translation of each point on the curve?

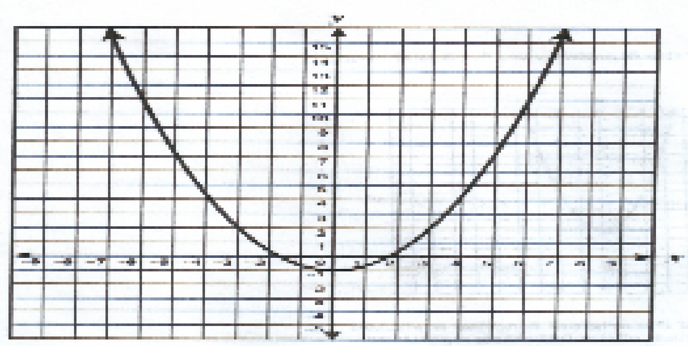
F $y = x^2 + 5$

G $y = x^2 + 2$

H $y = x^2 - 2$

J $y = x^2 - 8$

1. The graph of a function of the form $y = ax^2 + c$ is shown below.



If the graph is translated only up or down to include the ordered pair (6, 7), which of the following equations best represents the resulting graph?

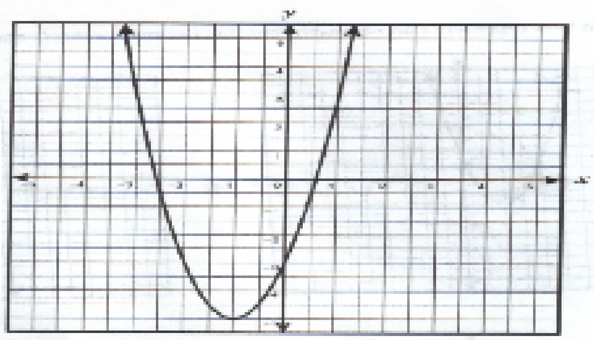
A $y = -\frac{1}{3}x^2 + 8$

B $y = \frac{1}{3}x^2 + 1$

C $y = -\frac{1}{3}x^2 - 10$

D $y = \frac{1}{3}x^2 - 5$

3 Which points best represent the roots of the graphed quadratic equation shown below?



A (0.6, 0) and (−1, −5)

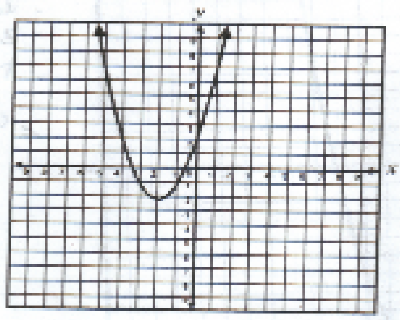
B (−1, −5) and (−2.6, 0)

C (0, −2.6) and (0, 0.6)

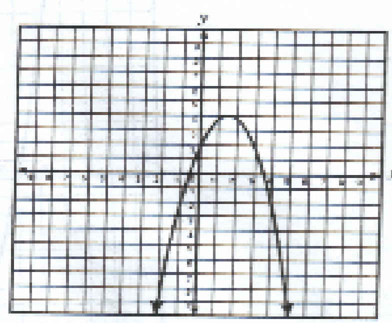
D (−2.6, 0) and (0.6, 0)

4. Which graph best represents an equation that has the roots $x = -\frac{3}{2}$ and $x = \frac{1}{2}$?

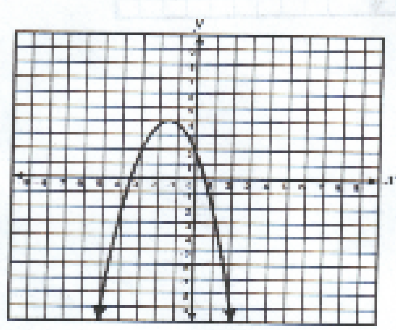
F



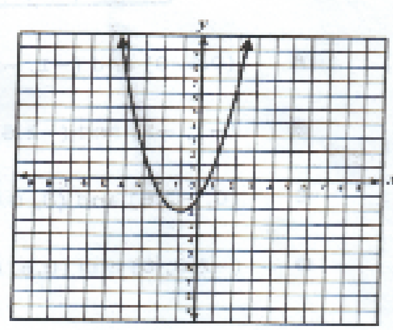
H



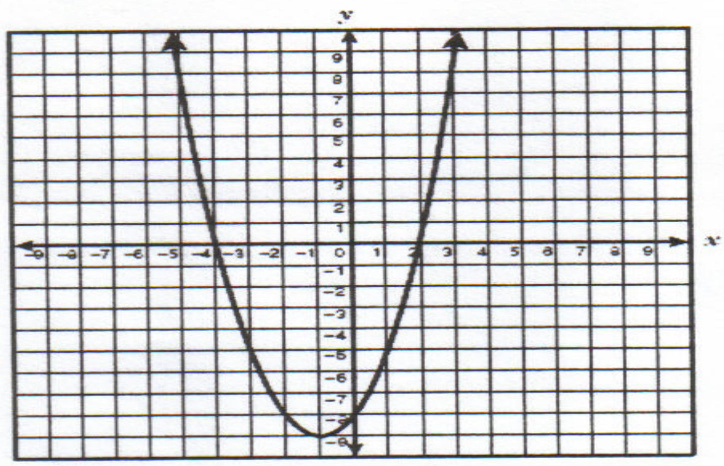
G



J



8. What are the roots of the function graphed below?



F (−1, −9) and (0, −8)

G (0, −4) and (2, 0)

H (−4, 0) and (2, 0)

J (0, 2) and (0, −4)

Posttest Questions for Objective 5 part b

12. What are the x-intercepts of the graph of the equation $y = x^2 + x - 12$?

A $x = 4, x = 3$

B $x = -4, x = 3$

C $x = -4, x = -3$

D $x = 4, x = -3$

10. Which equation will produce the widest parabola when graphed?

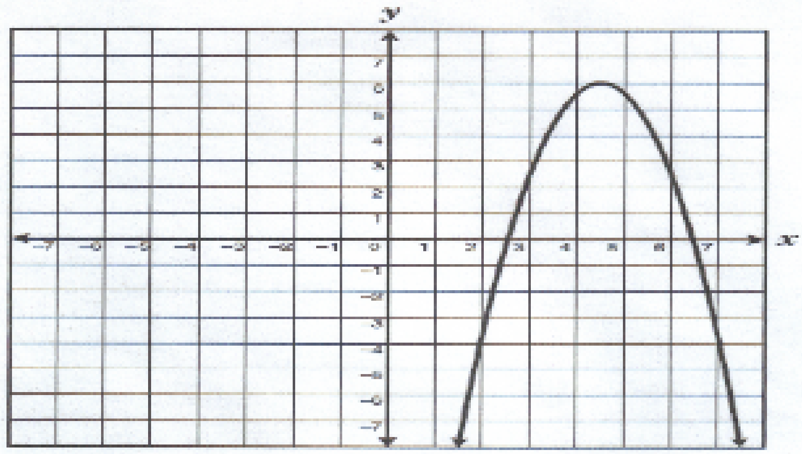
A $y = 2x^2$

B $y = -6x^2$

C $y = -0.6x^2$

D $y = 0.2x^2$

3. Which points best represent the roots of the graphed quadratic equation shown below?



F $(6\frac{1}{2}, 0)$ and $(4\frac{1}{2}, 6)$

G $(4\frac{1}{2}, 6)$ and $(2\frac{1}{2}, 0)$

H $(2\frac{1}{2}, 0)$ and $(6\frac{1}{2}, 0)$

J $(0, 2\frac{1}{2})$ and $(0, 6\frac{1}{2})$

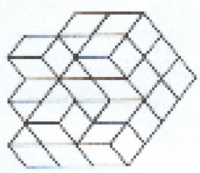
Pretest Questions for Objective 7 part a

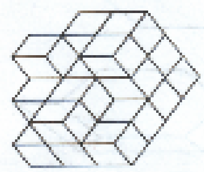
1. The drawing below shows both the top view of a solid structure built with identical cubes as well as the number of cubes in each column of the structure.

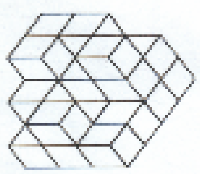
2	3	3
3	2	3
2	1	1
1	2	1

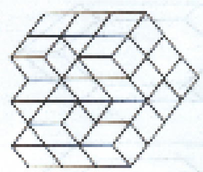
Front

Which 3-dimensional view best represents the same structure?

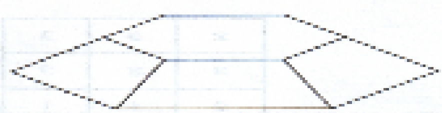
F 

H 

G 

J 

4. The drawing below shows a solid with hexagonal bases.

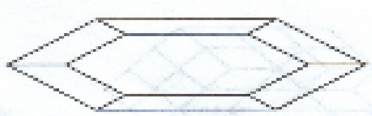


Front

Which drawing best represents the top view of this hexagonal solid?

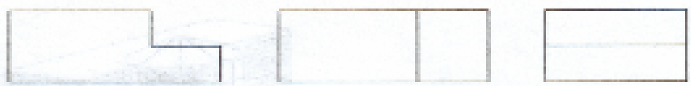
F 

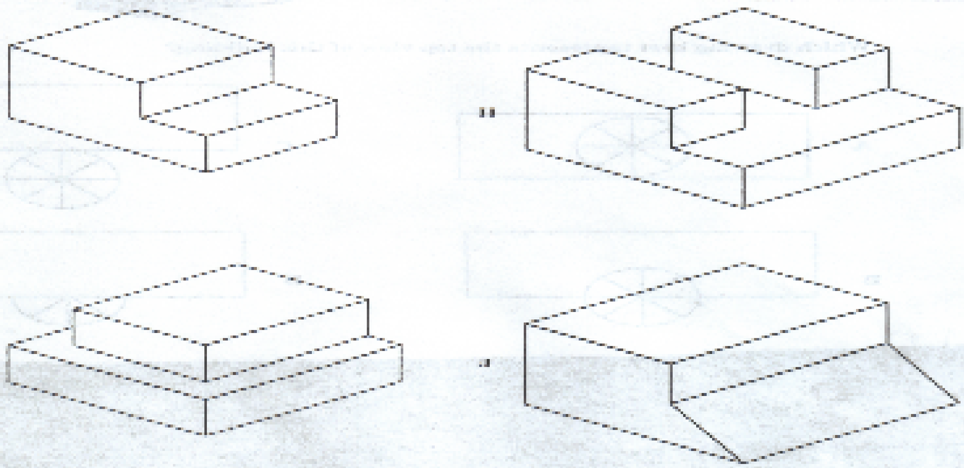
G 

H 

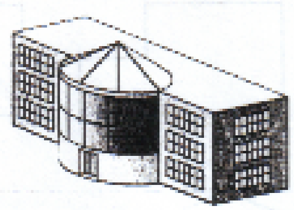
J 

9. Match the three views of this solid to its 3-dimensional sketch.



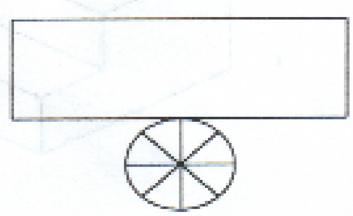


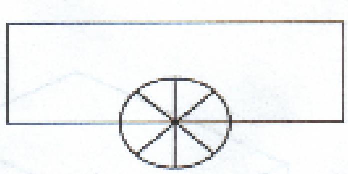
11. The drawing shows a view of a building.

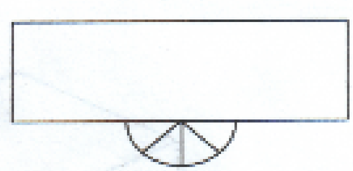


Which drawing best represents the top view of this building?

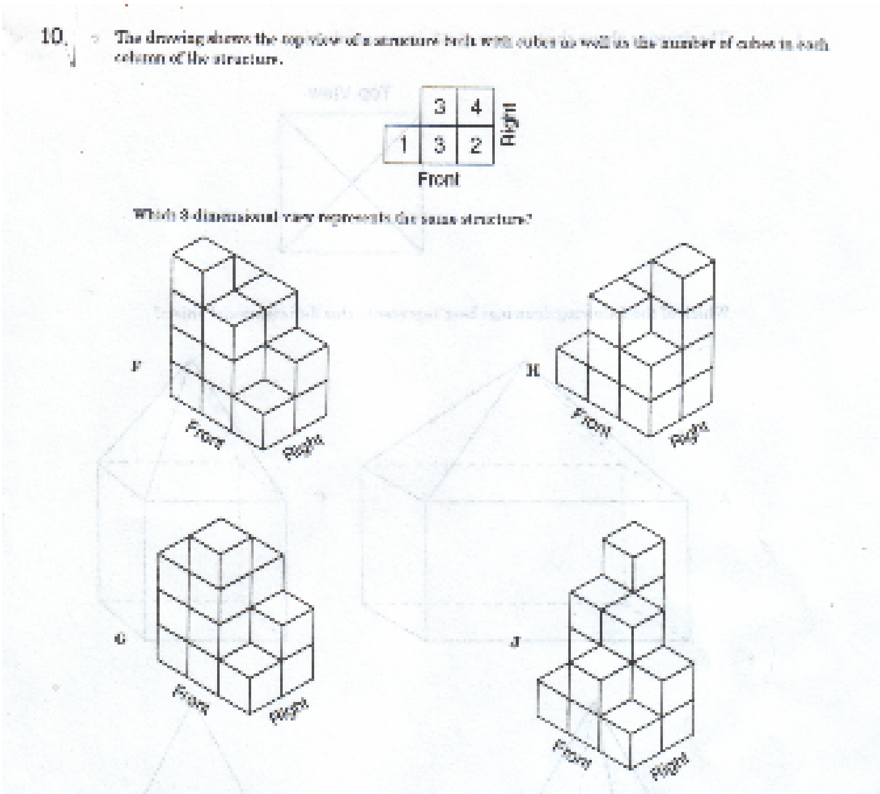
A 

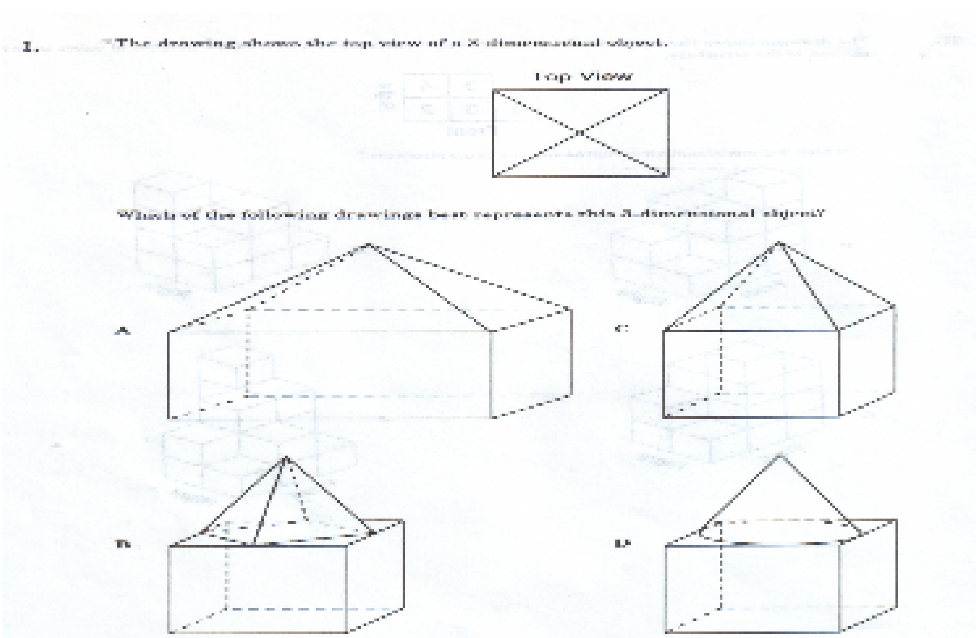
C 

B 

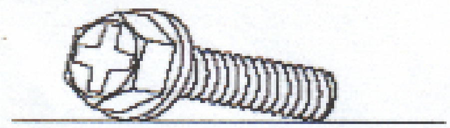
D 

Posttest Questions for Objective 7 part a

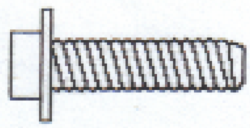




7. The illustration below shows a 3-dimensional view of a screw.



Which of the following best represents a front, a side, or a top view of this screw?

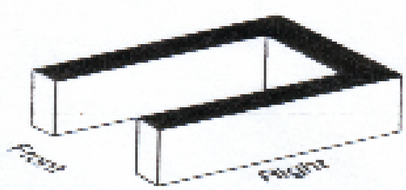
F 

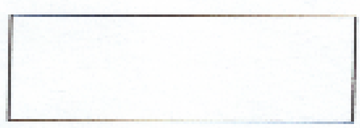
H 

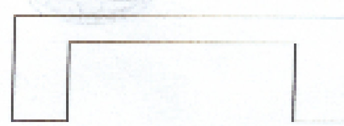
G 

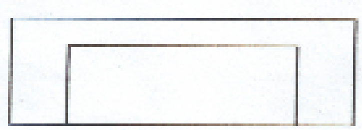
J 

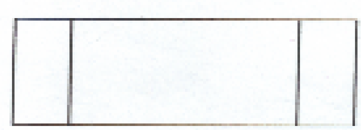
8. Which of the following best represents the front view of the solid shown below?



A 

C 

B 

D 

Curriculum Vitae

Felipe D. Guevara started his education in Cd. Juarez, Chih. Mex. up to high school graduating in the spring of 1989.He entered the University of Texas at El Paso in the fall of 1989. He perused a bachelor's degree in electrical and computer engineer (ECE) graduating in the fall of 1996.After graduating he performed different roles in the area of engineering.

In the spring of 2006 started the process of becoming a certificate teacher in special education achieving this in spring of 2007. Since then he has been teaching mathematics to students in special education at Thomas Jefferson high school. Also he has been working for the Upward Bound program (TRIO federal program) since 2006 teaching mathematics to students that match the criteria to be identified as "at risk" by the department of education. (Either low-income families or be potential first-generation college students). He obtained a second certification in the area of mathematics 8-12 in the spring of 2009. Currently he is perusing an engineering master's degree in information technology (MIT) and a certification as educational diagnostician.

He has participated as an expositor in the education cycle of conferences sponsored by the Department of Educational Psychology and Special Services at UTEP during the fall of 07.

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