Mathematics Instruction for Young Children

Abstract

Unfortunately, according to the United States of America Department of Education (2009), the mathematic achievement level for eighth grade students has continued to decline since the year of 1996. In an effort to improve achievement levels in the critical skill area of mathematics, researchers have suggested that immersion in mathematics at the Pre – K level is necessary, and that it is imperative that our school systems encourage students especially at a young age to embrace mathematics. The purpose of this study is to "plant the seed of interest" concerning mathematics, and to explore whether the use of discrete trial training (DTT) will improve the extent to which Pre – K students with disabilities learn basic mathematical concepts.

Statement of the Problem

Currently, an intense focus in the United States of America has been placed on Science, Technology, Engineering, and Mathematics (STEM) education. STEM education shapes each of our everyday experiences and is extremely vital not only to our future, but also to the future of our children. STEM affects every single experience that we have in our lives. Science can literally be defined as our natural world which includes the sun, moon, stars, oceans, land, weather, natural disasters, nature, animals, plants, and food. Technology consists of both computers and smart phones, and also goes back in the past to include the invention of television, radio, microscopes, the telegraph, telescopes, and even the very first wheel. When considering the effects of engineering in the daily lives of human beings, think of building designs, the infrastructure of both roads and bridges, and of the diminishment or elimination of today's transportation challenges like pollution and global warming. Mathematics, are also highly immersed into the activities of daily life.

Unfortunately, according to the United States of America Department of Education (2009), the mathematic achievement level for eighth grade students has continued to decline since the year of 1996. This indicates that American schools are not satisfactorily educating students regarding mathematics, and that schools are not producing the excellence required in the subject matter to maintain global economic leadership or homeland security in the 21st century (United State Department of Labor, 2009). In an effort to improve achievement levels in the critical skill area of mathematics, researchers have suggested that immersion in mathematics at the Pre – K level is necessary, and that it is imperative that our school systems encourage students especially at a young age to embrace mathematics. Encouraging students in the educational system at an early age regarding the merits of learning mathematics has been likened to the expression of planting seeds of interest.

Purpose and Research Question

The purpose of this study is to "plant the seed of interest" concerning mathematics, and to explore whether the use of discrete trial training (DTT) will improve the extent to which Pre – K students with disabilities learn basic mathematical concepts. (DTT) is a method of teaching in which the educator uses adult directed, massed trial instruction, reinforcements chosen for strengths, and clear contingencies and repetition to teach new skills. (DTT) can be described as presenting a stimulus, requesting a response, and rewarding (reinforcing) appropriate responses, starting with an approximation of a correct response, and withdrawing any prompts or support until the child provides the correct response. Additionally, the following researched based teaching strategies will be used to "plant the seed of interest" concerning mathematics: storytelling, mathematical modeling, creative lesson plans with engaging mathematics activities, use of the five main principles from *Teaching Math to Young Children*, number strip games, and the number tile game. Additionally, the following research question will be investigated: Does

providing interesting and stimulating materials to teach mathematics along with the use of discrete trial training (DTT) improve the extent to which Pre – K students with disabilities learn basic mathematical concepts?

Literature Review

Young children normally have a natural interest in mathematics and of the world around them. This time period is a window of opportunity for teachers. During this opportune period of time for teaching, teachers are able to capitalize on the natural interest of children and make their preschool experience both more beneficial and engaging. The *Teaching Math to Young Children* guide was developed by a panel of nationally recognized experts in early childhood education field and is based off of five main principles that encourage beneficial learning experiences in mathematics for young children. Those principles are to teach number and operations using a developmental progression, to teach geometry, patterns, measurement, and data analysis using a developmental progression, to use progress monitoring to ensure that math instruction builds upon what each child already knows, to teach children to view and describe their world mathematically, and to dedicate time each day to teaching math and to also integrate math instruction throughout the school day (Panaoura & Panaoura, 2014).

Another way to ensure that mathematics instruction for young children is beneficial is by the implementation of creativity into mathematical teaching and practice. Contemporary curricula emphasizes that the development of students' creative thinking throughout all aspects of learning is inherently important. Moreover, creativity is known as an integral part of mathematics and has long been proposed as one of the major components to be included in mathematics education oftentimes referred to as the essence of mathematics is creativity. Ultimately, creativity is a dynamic characteristic that can be developed during the educational

process of a student and one that should never be underestimated regarding its value to mathematics education (Panaoura & Panaoura, 2014).

An additional key element for young children in understanding mathematics knowledge on the early childhood level lies in active, creative, and intellectual engagement. Children are actively engaged and learn best as they explore their environment. The course of intellectual development for children or adults learning new material progresses through the following three stages: enactive (concrete actions on objects), iconic (pictorial of visual images), and symbolic meaning (abstractions like words or numbers). When thinking of how to best help young children think and learn, teachers need to engage them by providing them with numerous opportunities to act on objects (manipulatives). Providing young children with these ample opportunities for hands on, minds – on, relevant learning experiences in mathematics only fuels their learning at this level. However, it is also important to note that manipulatives by themselves do not teach children mathematics. Yet, the manipulatives must suit the developmental level of each child and close the gap between informal and formal school mathematics. Understanding the connection between informal and formal mathematics is critical. Teachers can help young students make these connections by carefully observing them while they work with manipulatives and other materials (Gallenstein, 2005).

At the pictorial level, also described as the second stage of knowledge representation, young children can express their understanding of concepts through either conversation or by creating a picture or mental image of their concrete understanding. Just allowing children to act on objects or manipulatives is not enough to facilitate appropriate learning. Young children must make deliberate connections between the manipulatives and underlying mathematic concepts. At the abstract or symbolic level of learning, children are introduced to symbols like numerals and

mathematic signs for number concepts. Before moving to the symbolic level of learning, both the concrete and pictorial stages of learning must be nurtured as beginning to work to soon at the symbolic stage by introducing numerals, letters, and other symbols can create confusion within children's minds. When young children are allowed to progress through all three stages of learning, engaging teachers provide children with opportunities to take ownership of their learning, knowledge, and understanding by recreating, reconstructing, and redefining concepts on their own (critical thinking) (Gallenstein, 2005). Once a teacher has successfully gained the interest, attention, and engaged a child in the subject area of mathematics, only additional responsibilities lie ahead.

The Role of the Teacher

Due to the fact of low levels of student achievement, the No Child Left Behind Act (NCLB, 2002) now holds schools and teachers accountable for the adequate achievement of all students, including those with disabilities in the areas of reading and language arts, and mathematics. To support this expectation even further, each state in America has defined adequate yearly progress (AYP) to measure achievement. Primarily the AYP results are based on state assessments, attendance records, and high school graduation rates. Additionally, the evaluations of AYP must include the progress of students with disabilities. Along with the requirements of the (NCLB, 2002), teachers serving students with disabilities must also adhere to the regulations set forth by the Individuals with Disabilities Education Improvement Act (IDEIA, 2004). This law ensures that students with disabilities have access to the general education curriculum and that they meet AYP standards (Burton, Curtis, Flores, & Hinton, 2015).

Even with mounting responsibilities and increasing mandates from legislation, the seeds of interest concerning mathematics education must be planted, watered, and tended to by knowledgeable education professionals or teachers. Yet, how can these actions occur if many

pre – service general education and special education teachers question their own ability to perform effectively at this task. A mixed method study was used to investigate pre – service general education and special education teachers' preparation for effectively teaching mathematics. The study occurred during the last semester of their program and yielded astonishing results. The teachers in the study completed elementary level mathematic computations, problem solving assessments, a survey about mathematics efficacy beliefs, and open – ended questions regarding their teaching methods. The analysis of the data revealed that the participants who felt that their instruction method was solely procedural in nature rated their teaching outcome expectancies lower and also achieved lower computation scores than other participants (Burton et al., 2015).

Although it is very difficult to identify a causal relationship between teachers' content knowledge, methodological training, and education, these are all certainly key factors in promoting overall student mathematic achievement. Studies have shown that teachers who exhibit low mathematical content knowledge are less likely to effectively teach mathematics. Additionally, Burton, Curtis, Flores, and Hinton (2009) found that the higher the teacher mathematical content knowledge, the higher the achievement of their students. Some of the core concepts related to teacher effectiveness in mathematics instruction include, but are not limited to the following: content knowledge, pre – service and early career teachers' preparedness, and mathematics efficacy beliefs (Burton et al., 2015).

Just as in any other subject, when teaching mathematics, the teacher must have a strong foundation in the content. The understanding of the content that a teacher possesses directly impacts the instruction that they provide in the classroom. This is extremely important when considering mathematics instruction for students who are diverse as a significant number of

special education teachers were unfamiliar with the goals of the National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics. This finding certainly conveys a lack of understanding of content knowledge, and is very alarming. Special education teachers are not only responsible for providing mathematics instruction using the general education standards so that students with disabilities make adequate progress according to NCLB of 2002 and IDEIA of 2004, but also for providing mathematic instruction within the response to intervention (RTI) model. This happens when special education teachers assist general education teachers in differentiating instruction and working directly with students who do not have disabilities (Burton et al., 2015). Further, teacher preparation programs lay the groundwork for future teachers. The teacher coursework and field experiences within the teacher preparation program are ways of improving both general education and special education pre – service teachers' content knowledge, pedagogical knowledge, and efficacy beliefs (Burton et al., 2015).

Self-efficacy can be described as the belief that one can achieve a certain outcome by accomplishing a specific behavior. More specifically, self-efficacy regarding teachers, examines the teachers' belief in his or her own personal ability to bring about student learning. Studies have shown that teacher mathematics efficacy beliefs have been directly correlated with mathematics anxiety and instructional practices. These findings show that teachers with low mathematic teaching self-efficacy are more likely to use less effective strategies like lecturing, worksheets, and reading from the textbook (Burton et al., 2015).

Strategies

Teaching is referenced in various studies of mathematics education. Many of these studies primarily examine the art of teaching in order to identify the repercussions of it for students, to isolate and capitalize on its effectiveness, and to harness its potential for promoting

learning. Most of these analyses of teaching fall into what is sometimes considered the "effective teaching" paradigm. The "effective teaching" paradigm aims to classify both "good" and "bad" teaching strategies and also seeks to improve teachers' practices. There is a full landscape of teaching actions, which are generally clustered within the following three broad categories when teaching mathematics: informing actions, orienting actions, and shepherding actions. Shepherding is seen as the optimal category for which teachers should aim when providing mathematic instruction (Proulx and Towers, 2013).

Even when educators use good teaching strategies, both students with and those without disabilities can find understanding many mathematical concepts a challenging task. This problem causes teachers to search for specific or evidenced based strategies to help all of their students to succeed in the subject area of mathematics. One such strategy is the use of storytelling to teach mathematical concepts. Storytelling appeals to both children's imaginations and emotions, and is a powerful shepherding tool that produces connections, and brings rich, vibrant, meaningful, and lasting images to children. After children listen to stories, they create mental images, and connect the content to something personally significant. At this point in their lives, children are in the age and stage of imaginative thinking and the most effective teaching strategy would allow content to be delivered through imagery. Using storytelling as an added support to manipulatives and also as a catalyst to mathematics instruction is oftentimes enjoyable and very versatile (Gnadinger & Goral, 2006).

Another strategy that can be used to improve students' ability to learn mathematical concepts is mathematical modeling. Mathematical modeling provides a chance for explaining thoughts in reality by making connections with both knowledge and skills. Ordinarily, a model is a simplified form of a complex object or process, and modeling is an intricate process that

includes several ongoing activities throughout many stages. Modeling is very meaningful and serves to interpret, configure and try different possibilities for achieving results, and also as a facilitation method of understanding deeper events or concepts (Bal & Doganay, 2014). Modeling is an effective teaching strategy, and is useful in mathematics education because of the significant relationship it presents between mathematics and reality. Generally, mathematical modeling is the demonstration of real life problems using mathematical terms, and also includes the process of changing these problems into solutions. The activities included within the mathematical modeling process make it easier to identify the components of and many of the problems faced in reality, then to associate these problems with mathematical information in order to classify and generalize these problems, and then to make an appropriate decision according to such information. Additionally, mathematical modeling enables students to learn mathematics through different methods, and affords young children with excellent opportunities to use their own ideas in different areas, to establish logical connections, and to develop the necessary mathematical skills for implementation with real life problems. When using the mathematical modeling strategy, teachers have the following three main purposes: to reveal the thought processes of each student, to share thoughts and viewpoints with others about the subject, and to learn how to apply these ways of thinking to several other subject areas (Bal & Doganay, 2014).

Successful mathematical modeling and modeling in general is most effective when educators "meet" students where their skills currently lie, and build upon their existing knowledge base. Many educators understand that in order to build upon where their students are, they must acknowledge and accept the fact that each child is an individual who may learn and retain information differently. Further, some students may have disabilities that can adversely

affect their ability to socialize, communicate, or process sensory information. Moreover, those with Autism spectrum disorder (ASD) may experience restricted interests and repetitive behaviors (Lai, Rivera, & Su, 2012). Yet, under the NCLB of 2002 and IDEIA of 2004, educators are held accountable for the adequate achievement of all students (Burton et al. 2015). Designing and implementing teaching strategies that support the development of young children with disabilities is a challenge to both teachers and administrators. Especially, when considering the development of mathematic concepts as research on strategies for teaching mathematics to students with disabilities is limited. However, the National Research Council noted that students benefited the most from mathematical instruction that included interventions which emphasized constant feedback and explicit instruction. One such program that included interventions which emphasized constant feedback and explicit instruction was created by Hui Fang Huang Su, called Project MIND (Math is not Difficult). Project MIND consisted of instructional designs to get all students and all teachers excited about mathematics through math related games, stories, poems, songs, art, puzzles, mental math activities, and competitions. Many of the students exposed to Project MIND, including those with disabilities and even those with ASD who were mainly at the early childhood and elementary levels obtained impressive test results showing growth in the subject area of mathematics. Two specific strategies that are used in Project MIND are the number strip game and the number tile game (Lai et al. 2012).

Another proven method of teaching children with (ASD) and other disabilities is Applied Behavior Analysis (ABA). (ABA) is based upon the foundation of human behavior, and is the ultimately the utilization of the basic principles of learning and motivation to address specific important problems. The founding principles of (ABA) are that all behavior is learned, all behavior serves a purpose, and that all behavior is contextual (Loiacono & Palumbo, 2011).

Today, a substantial number of schools are relying on "positive behavior support" which is rooted from (ABA) as a means of dealing with behavior problems, and as a way to effectively teach academics. One (ABA) teaching strategy proven successful in classrooms concerning both behavior and academics is discrete trial training (DTT) (Loiacono & Palumbo, 2011).

DTT is a very specific form of teaching involving clear, concise, and simple instructions with immediate feedback provided to students. DTT is made of multiple and repeated discrete trials. A discrete trial includes a three term contingency consisting of an antecedent, a behavior, and a consequence. The first step in DTT is the antecedent or discriminating stimulus. The antecedent can be adjusted accordingly to elicit interest from the student by adding other reinforcers if necessary (Ghezzi, 2007). During DTT the student is required to repeat the same skills over and over again, until the skill is completely mastered. Once the student is able to show proficiency with that same skill, then that skill is mixed with other skills in a random rotation. During the random rotation, students must then switch back and forth amongst different types of skills to ensure mastery (Pindiprolu, 2012). DTT enables all students to acquire preferred behaviors and complex skills including mathematic concepts through ample practice opportunities.

The literature review supports the proposed action research that will explore whether strategies that support planting the seed of interest along with the use of DTT improves the extent to which Pre – K students with disabilities learn basic mathematical concepts. Again, we know that STEM affects every single life experience, consider how STEM affects young children. STEM is their future. They live in a technological age where their best career options and many key to wise decisions are STEM based (United States Department of Labor, 2009). We are living in an era often referred to as the information age, and the challenges that we face

today may be extremely different from those that our children will face in their adulthood. As a result, educators must view mathematics as more than a body of knowledge, but as the cornerstone of STEM.

Research Methodology

The action research will take place in a Greene Lamp Head Start / Early Head Start Pre-K classroom. Five Pre-K students identified as having disabilities (i.e., varying exceptionalities) will participate in the study. The general education teacher will work one on one with each student to implement the (DTT) program, and will also be responsible for collecting data before, during, and after the implementation of the program. The general education teacher will also be responsible for following the Creative Curriculum and choosing goals to teach that align according to the prescribed standards. In this process students will first be surveyed to determine how interested they are in mathematics and in concepts related to mathematics. Next, students will be assessed using a Dial Test to determine their baseline knowledge in mathematics such as counting, adding, subtracting, number recognition, shape recognition, and concepts of quantity. After the assessments have been scored, the general education teacher will begin to implement the (DTT) program. During the second and final week of the (DTT) program being implemented, the students will be assessed with the Beery Developmental Test of Visual Motor Integration (VMI)**.** The Beery Developmental Test of Visual Motor Integration (VMI) will be used to collect data during and after the intervention, to determine the level of effectiveness of the program. The assessment will also be used to measure visual and spatial abilities and to determine the each participant's level of acquisition for mathematical concept knowledge by participants.

Results

Research findings will be available in time for the conference and will be presented.

Implications

Again, we know that STEM affects every single life experience, consider how STEM affects young children. STEM is their future. They live in a technological age where their best career options and many key to wise decisions are STEM based (United States Department of Labor, 2009). We are living in an era often referred to as the information age, and the challenges that we face today may be extremely different from those that our children will face in their adulthood. As a result, educators must view mathematics as more than a body of knowledge, but as the cornerstone of STEM.

References

Bal, A., & Doganay, A. (2014). Improving primary school prospective teachers' understanding of the mathematics modeling process. *Journal of Educational Sciences: Theory and Practice*, 14, 1375 – 1384.

Burton, M., Curtis, R., Flores, M., & Hinton, V. (2015). An investigation into pre - service special education teachers' mathematical skills, self - efficacy, and teaching methodology. *Issues in the Undergraduate Mathematics Preparation of School Teachers: The Journal, 1*, 1-13.

Gallenstein, N. (2005). Engaging young children in science and mathematics. *Journal of Elementary Science Education, 17*, 24 – 41.

Ghezzi, P. M. (2007). Discrete trials reaching. *Psychology in the Schools*, 44 (7), 667 -679.

Gnadinger, C., & Goral, M. (2005) Using storytelling to teach mathematics concepts. *The Australian Primary Mathematics Classroom*, 11, 4- 8.

Lai, L., Rivera, H., & Su, H. (2012). effective mathematics strategies for pre – school children with autism. *The Australian Primary Mathematics Classroom*, 17, 25 – 30.

Loiacono, V., & Palumbo, A. (2011). Principals who understand applied behavior analysis perceive they are better able to support educators who teach students with autism. *International Journal of Special Education*, 26, 17.

Panaoura, A., & Panaoura, G. (2014). Teachers' awareness of creativity in mathematical teaching and their practice. *Issues in the Undergraduate Mathematics Preparation of School Teachers: The Journal, 4,* 1 – 11.

Pindiprolu, S. (2012). A Review of Naturalistic Interventions with Young Children with Autism. *Journal of the International Association of Special Education*, 13, 69 – 78.

Proulx, J., & Towers, J. (2013) An enactivist perspective on teaching mathematics: reconceptualising and expanding teaching actions. *Journal of Mathematics Teacher Education and Development*, 15, 5 – 28.

United States Department of Education. (2009). T*he Facts About …… Math Achievement*. Retrieved from http://www.ed.gov/nclb/methods/math/math.html

United States Department of Labor. (2009). *Why STEM Education is Important for Everyone*. Retrieved from https://www.dol.gov/sciencepioneers/parents/why-stem-is- important-to-everyone