Effective Teaching Strategies for Students with Autism

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Abstract

This paper examines effective strategies for teaching autistic students in the mathematics classroom. As the number of children diagnosed with autism spectrum disorder grows every year, the public's attention on the subject has naturally increased as well. It is important to understand that autism is not as portrayed by popular culture or as depicted in some movies, especially in an autistic student's ability to do or not do higher order mathematics. However, there are some effective teaching strategies that allow autistic students to improve their critical thinking and problem solving skills needed to solve mathematical problems. Therefore, the purpose of this paper is to provide teachers with a better understanding of what autism is, and how autism can hinder students in learning mathematics.

Introduction

Autism is defined as a neural development disorder which impairs one's ability to socialize, communicate, and process sensory information (Su, 2012). For instance, many autistic students may have strong reactions to certain textures, smells, sights, sounds, or other stimuli. Unlike people who are blind or deaf, people with autism receive sensory information, but perceive the information in a strange way that causes distress, discomfort, and confusion. Apart from their senses, those with autism spectrum disorders (ASD) experience restricted interests and repetitive behaviors creating difficulty when making friends and communicating with others (Su, 2012). There are many subtypes of autism including high functioning autism and Asperger syndrome. Like the name suggests, high functioning autism identifies children on the spectrum who exhibit milder symptoms than other forms of autism and typically have average to above

average intelligence. Hence, students with high functioning autism or Asperger's are more likely to be placed in an integrated classroom at a mainstream school. There are many other aspects of autism that inhibit children from being placed in a conventional classroom, one being behavior, thus making autism a multifaceted topic. The purpose of this paper is to provide teachers with a better understanding of what autism is and how it hinders students from learning mathematics, while providing strategies that can be integrated into a teacher's academic instruction.

Unlike many disorders that have a medical test for diagnosis, autism is diagnosed through a doctor's analysis of a child's behavior and development (CDC, 2012). The developmental areas regularly monitored are gross and fine motor abilities. These motor skills, which are closely observed by a child's pediatrician and parents, consist of sitting, crawling, walking, eye contact, and the ability to manipulate small objects in a coordinated way. Along with their physical development doctors also monitor a child's cognitive abilities such as their speech and language acquisition, and indicators of intelligence (Benaron, 2009). Children as young as 18 months can be diagnosed with autism spectrum disorder or ASD. According to 2008 data from the Centers for Disease Control and Prevention (CDC), around 1 in every 88 children in the United States has an autism spectrum disorder. This is a 78% increase since 2000-2002, when the CDC first began tracking the disorder and estimated the rate at 1 in 150 children (CDC, 2012). There are a few reasons as to why the diagnosis of autism has increased over the past few years. One reason being the improvement of diagnosis and awareness. A second reason suggests that autism has increased due to the widening of the spectrum and the broadening of the definition of autism (Feinstein, 2010). For instance, in past years autism did not include Asperger's syndrome, a form of high functioning autism. Studies also show that autism is 4 to 5

times more common among boys than girls. An estimated 1 out of 54 boys and 1 in 252 girls are diagnosed with autism in the United States (CDC, 2012).

Perceptions of Autism

Since the number of people diagnosed with autism has risen, many recognizable movies have brought attention to the disorder and the difficulties they face. Pop culture often depicts people with high functioning autism or Asperger's syndrome as autistic savants; that is, people who demonstrate high levels of ability in music, visual skills, art, or math, yet still exhibit bizarre behavior that isolates them from the majority of society (Donaldson & Zager, 2010). For example, the leading characters in movies such as *Rain Man*, *A Beautiful Mind*, and *Sherlock Holmes* are considered autistic savants because they excel in one or more of these areas. However, "only 10 percent (or less) of individuals with autism spectrum disorders (ASD) have savant skills" (Benaron, 2009). In Temple Grandin's book *Thinking in Pictures*, Oliver Sacks (1995) states:

> These pictures are not wholly false, but they fail to indicate that there are forms of autism which (while they may indeed go with ways of thinking and perceiving very different from the "normal") do not incapacitate in the same way, but may (especially if there is high intelligence, and understanding, and education) allow lives that are full of event and achievement, and a special sort of insight and courage too. (p. 12)

In other words, autistic people that are not labeled savant still have the potential to live purposeful lives, specifically if they are given the chance to be understood.

While the movies can bring positive awareness to autism, they also leave people under the assumption that students with autism are great at math, when in reality this is not always the

case. Data shows that during middle school years, students with ASD perform on average 5 years below their neurotypical peers in mathematics (Wagner et al., 2003). This means while an autistic student's seventh grade classmates, who are not developmentally disabled, perform mathematics at the seventh grade level, the autistic student's achievement level in math could be at the second grade level. The reason for this gap between autistic students and their peers may be associated with the abstract nature of mathematics at the middle school level. For instance in middle school, math becomes more abstract and applied, which requires students to use higher level thinking, reasoning, and problem-solving skills in order to apply these abstract notions to the real-world (Whitby, 2012). On average, students with ASD have a hard time comprehending abstract concepts such as place value, organizing information, comprehending the language in instructions or word problems, and remembering operations throughout an equation (Minshew, Goldstein, Taylor & Siegel, 1994). They also may exhibit impaired visual spatial abilities; that is, understanding and conceptualizing visual representations and the ability to distinguish differences among similar objects or forms. This skill helps children in understanding relationships and recognizing underlying concepts. Visual spatial capability is closely related to the problem solving and conceptual skills required for higher level math. Therefore, the inability to perceive objects correctly can lead to difficulties in math skill achievement (Donaldson & Zager, 2010). Therefore with the many perception and organizational problems experienced by autistic children it can be very difficult for educators to teach students with autism mathematics; thus, teachers are forced to find effective strategies created specifically for helping students on the autistic spectrum.

Instructional Strategies

According to professor and autistic advocate, Temple Grandin, one size does not fit all when it comes to education. In other words different people have different types of thinking even within the autistic spectrum. The "really good" teachers, according to Grandin, are those who try different methods and use those that work for a particular child (Grandin, 2006). In Dr. Grandin's exploration of how high-functioning people on the spectrum think, she discovered three basic thinking types: visual thinkers, pattern thinkers, and word specialists. The visual thinkers consider abstract concepts in the form of pictures and are good at hand-on activities. The pattern thinkers excel in patterns and can easily see relationships between numbers. Lastly, the word specialists are great at memorizing facts (Grandin, 2006). Taking into account these three types of thinking, consider the following instructional strategies, which can help particular students with ASD succeed at math.

There are many approaches to support an autistic student who struggles with mathematics. The first step to connecting the right strategy with the appropriate student is understanding that each student has a unique learning style, as seen with Grandin's three thinking types. Finding an approach for learning should not focus on the deficits of a student, but rather developing their talents and strengths (Grandin, 2006). For example, when trying to understand trigonometric functions, Grandin— a visual thinker— would make model suspension bridges and calculate the strength of the bridge when placing the cables at different angles. By focusing on Temple Grandin's strength, hands-on experiments, she was able to work around the abstract concepts of trigonometry. Therefore, it is essential for educators to observe and interact with their students in order to notice these strengths and assess different methodologies for efficacy. Although these instructional approaches are recommended for autistic students, they

can also be beneficial for teaching their neurotypical peers. In fact many of the following strategies focus on building competence in mathematical word problem solving, which *all* students can benefit from, not just those with ASD.

A problem solving strategy entitled "*Solve It!* Problem Solving Routine," was first developed by Montague as an instructional approach for teaching mathematical word problems (Montague, 2003). The routine was later tested for its ability to utilize autistic students' strengths as visual thinkers with strong rote memories, while also providing support in the areas of attention, memory, sequencing, and organization (Whitby, 2012). Temple Grandin explains that word problems are particularly hard for students on the autistic spectrum because of the difficulty in manipulating the symbols for different types of problems (Grandin, 2006). Note effective learners adapt strategies to meet the demands of the learning task. Based on methods effective learners use to complete mathematical tasks, such as planning, memorizing, and checking, Montague designed cognitive and meta-cognitive strategies to teach students with learning disabilities how to strategize word problems. The seven cognitive strategies consist of the student reading the question for understanding, putting the question in their own words, creating a picture or diagram to illustrate the problem, constructing a plan to solve the problem, predicting the result, computing the answer, and checking their work. The three meta-cognitive strategies are statements or questions the student should ask themselves at every cognitive step. The first statement is "Say," which is to keep the student on-task and aware of what needs to be done. The second meta-cognitive question is "Ask," which causes the student to ask themselves if they have performed the task declared in "Say." The last statement is "Check," which reminds students to evaluate their work (Whitby, 2012). To get a better understanding, Montague (2003) describes these strategies further in the following table:

Cognitive process	Meta-cognitive strategies
Read (for understanding)	Say: Read the problem. If I don't understand, read it again. Ask: Have I read and understood the problem? Check: For understanding as I solve the problem.
Paraphrase (your own words)	Say: Underline the important information. Put the problem in your own words. Ask: Have I underlined the important information? What is the question? What am I looking for? Check: That the information goes with the question.
Visualize (a picture of a diagram)	Say: Make a drawing or a diagram. Ask: Does the picture fit the problem? Check: The picture against the problem information.
Hypothesize (a plan to solve the problem)	Say: Decide how many steps and operations are needed. Write the operation symbols (+, −, ×, and /) Ask: If I do ____, what will I get? If I do _____, then what do I need to do next? How many steps are needed? Check: That the plan makes sense.
Estimate (predict the answer)	Say: Round the numbers, do the problem in my head, and write the estimate. Ask: Did I round up or down? Did I write the estimate? Check: That I used the important information.
Compute (do the arithmetic)	Say: Do the operations in the right side. Ask: How does my answer compare with my estimate? Does my answer make sense? Are the decimals or money signs in the right places? Check: That all of the operations were done in the right order.
Check (make sure everything is right)	Say: Check the computation. Ask: Have I checked every step? Have I checked the computation? Is my answer right? Check: That everything is right. If not, go back. Then ask for help if I need it.

Solve It! Problem-Solving Routine Cognitive and Meta-Cognitive Processes (Montague, 2003)

Researchers tested these strategies on three adolescents with high functioning autism who were reported as having word problem difficulties. In the study, a certified educator taught the participants the problem solving routine, developed by Montague, using scripted lessons, pre-/post- assessments, strategy cue cards, and strategy posters. By the end of this intervention, students were expected to complete 10 problems in 60 minutes (Montague, 2003). The following are some general problems the three students had pertaining to some of the cognitive strategies. For the first strategy the students were taught to read the problem, ask themselves if they understood what they read, and if not reread it until they did understand. Many times the language used in the problem interfered with the participant's ability to complete the mathematical task. For example, one of the students stopped during a problem about purchasing supplies to build a pen for a dog and stated, "I know how to solve this problem but why would

anyone pay $46.99 for a dog pen?" He thought the pen was a writing pen with a dog displayed on it (Whitby, 2012). In this case the student was not able to pick up on the context clues given in the word problem, which happens with the majority of students with ASD.

In the second step students were asked to paraphrase the word problem. All three participants were able to define paraphrasing as the ability to put the question in their own words or to state the important parts of the question (Whitby, 2012). Next, students were able to identify the significant elements of the problem by underlining these elements in the question. However, the students were not able to put these elements in their own words; they simply reread what they had underlined. This example demonstrates the mental inflexibility and communication deficits often associated with students with autism spectrum disorders. According to Farrugia and Hudson (2006), autistic students with high verbal abilities give the illusion that they are effective communicators when that is not usually the case. However, Grandin (2006) believes mental flexibility can be taught.

Two out of the three participants were able to apply estimation to solving the question. One student who had difficulty with this task stated that "he did not understand why he needed to perform this step because he could simply solve the problem and get the correct answer" (Whitby, 2012). The inability for this student to comprehend why an estimation would help him find the exact answer is consistent with the difficulties autistic people have with abstract concepts and their desire for exactness (Donnelly, 2005; Griswold et al., 2002).

When computing the exact answer one student declared, "The largest number always had to be the dividend and the smallest number had to be the divisor because you cannot divide a number by a larger number" (Whitby, 2012). In this student's case, he demonstrates an adherence to a set of rules, dividing by smaller numbers, and could not modify the rule to meet

the demand of the new task. The inability to manipulate a mathematical rule is a common impediment for students with ASD (Barnhill, 2001).

After practicing the *Solve It!* routine with multiple word problems, data was collected and generalized. Results showed that all participants increased their percentage of correct responses on the given mathematical word problems immediately after the intervention was completed. However, 4.5 weeks after the intervention the students did not maintain use of the strategy at the same level they performed during the study. Therefore, teachers should provide the same support while in their classroom environment by implementing the *Solve It!* routine to enhance a student's problem solving skills (Whitby, 2012).

Miller, Butler, and Lee (1998) have identified several practices that have been proven effective for students with learning differences. One strategy that has been used in math instruction is self-regulation. The definition of self-regulation focuses on a student's control of their mind and body. For example, in order to be an active learner in a classroom a student must demonstrate the ability to control their behavior and emotions as well as control their attention. These self-management skills are important for adolescents to obtain so as to become responsible for their own learning. Miller, Butler, and Lee's (1998) use of self-regulation in a math environment involves students completing checklists, with reminders of each step, as they perform computations (Donaldson & Zager, 2010). The idea of having a checklist is similar to the *Solve It!* approach with its seven cognitive strategies and three meta-cognitive strategies. Once any instructional task is completed by the student, whether correct or incorrect, the teacher provides verbal feedback. Positive feedback enhances students' confidence when moving forward and will most likely cause the student to repeat their actions. If the student answers incorrectly the teacher responds by reminding them of the related mathematical concepts and

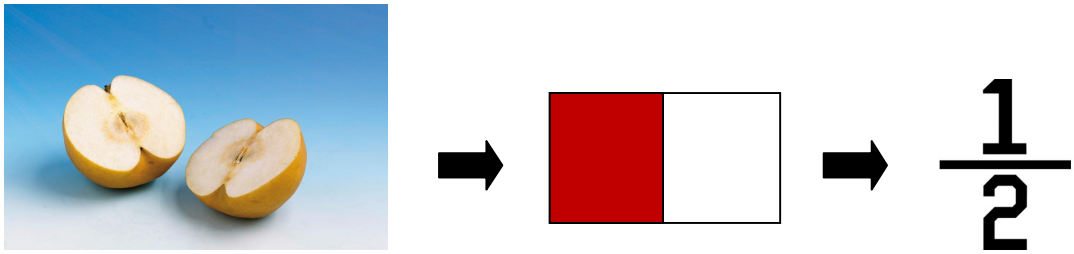
encouraging them to try again. In order for a teacher to provide feedback they must be involved with their students and the student's work; thus, ensuring each student comprehends each step of the checklist.

A second strategy is direct instruction, where the teacher demonstrates "how to perform a task, prompts and guides the learner, and reinforces correct responses" (Donaldson & Zager, 2010). Accurate responses are rewarded, while inaccurate responses are redirected (Donaldson & Zager, 2010). By redirecting a student, the teacher takes the student's answer and reminds them of the mathematical concepts that apply to the problem. Direct instruction is suggested for teaching computation or problem solving because it takes a cognitive skill and breaks it into smaller steps. An example of direct instruction is the traditional set up of a mathematics classroom. That is, where the teacher starts class at the board demonstrating a task by going over the steps and working through a few example problems. Then, the focus turns to the students as they complete practice problems on their own while the teacher walks around and provides reinforcement if needed.

The third strategy is goal structure which allows students to set goals for themselves with the promise that a reward lie waiting for strong performance and completion of the mathematical task. Recall that people with autism experience restricted interests. So consider a student whose interests involve baking. Therefore an example of a personal learning goal may be to learn how to half a recipe for chocolate chip cookies, which requires an understanding of division and fractions. The key to students setting goals is that they must be invested in reaching it; thus, they must see the connection the goal has to their daily lives. Establishing such a goal, whether long term or short term, has the ability to motivate a student to keep trying until they reach their target. To reinforce their success at meeting their goal, teachers should reward each student.

The reward does not have to be candy, but rather playing a fun game such as Sudoku's or playing card games that are rooted around math concepts.

Another strategy is concrete-representational-abstract, which can be used to teach fractions. Students utilizing concrete-representational-abstract are first shown concrete examples such as two halves of an apple. Then they are shown a pictorial representation like a picture of rectangle half shaded. Last they are shown the abstract depiction or symbol of the concept—the fraction $\frac{1}{2}$. For example, the teacher would display each of the following pictures respectively:



Progression of the Concrete-Representational-Abstract Strategy

The sequence of these images allows students, autistic or not, to first link math with something from their everyday lives, like in this example apples. Then slowly take them to a more abstract representation such as a rectangle half shaded. Then finally giving the mathematical symbol that represents the previous two images, $\frac{1}{2}$. This strategy has been found to be effective for teaching computation problems, such as unit conversions, problem solving, and algebra (Miller & Mercer, 1993a, 1993b; Witzel, 2005). The success of the concrete-representational-abstract sequence of instruction for students with high functioning autism and Asperger's is partially due to the fact that it addresses the challenge in processing abstract concepts by using multisensory models (Rourke & Strang, 1978).

Lastly, Integrated Behavioral Experiential Teaching (IBET) is a strategy often used to teach fundamental academics and social skills to children on the autistic spectrum. IBET uses elements from the direct instruction strategy such as its use of rewarding students for accurate responses. IBET also integrates ideas from the concrete-representational-abstract strategy. These ideas include showing students a sequence of images that all represent one thing. For example, a teacher using the Integrated Behavioral Experiential Teaching strategy will represent a concept in math using a real-life experience, then transition to a photographic representation, followed by the abstract symbol. Integrating these skills creates a vivid experience for the students (Donaldson & Zager, 2010). The goal of IBET is to utilize students' direct personal experiences to make learning applicable through the combination of photographs, experiential learning, errorless learning, and systematic reinforcement.

There is more than one way to support students with autism in a mathematics environment. Some of the strategies this paper discusses are *Solve It!*, self-regulation, direct instruction, goal structure, concrete-representational-abstract, and Integrated Behavioral Experiential Teaching (IBET). Each approach helps organize a mathematical task by providing step-by-step instructions for students to follow such as the cognitive and meta-cognitive steps in *Solve It!*. Other strategies offer a smooth transition from real life experiences to abstract concepts such as the concrete-representational-abstract strategy and IBET. These six educational strategies are slightly different from one another making it the teacher's responsibility to find which strategy works best for their students with autism spectrum disorders.

Observing at an All Autistic School

In May 2013, I had the unique opportunity to observe at a public autistic school in London, England. Before my first day of observations I was under the impression that being autistic was equivalent to being savant. I believed this fact to be true because of the movies and television shows I had seen, prior to my observations, which showcased autistic savants. However, my eyes were opened to the various forms of autism within the spectrum, none of which were autistic savant, although they do rarely occur. While not suggesting that this class is a typical representation of all autistic children, I did observe some interesting behaviors and strategies within this classroom of autistic students. In the class, there were 7 students, ages 7 to 8 years old, whose autism ranged from nonverbal to high functioning and five teachers, not including myself observing. I did not notice academic instruction as much as I did behavioral and social instruction. Some of the behaviors I observed included spitting, hitting, biting, throwing inanimate objects, and grabbing. Since the majority of class time was spent educating students on proper behavior, I realized that these 7 students would not be able to function in a mainstream classroom because of their behavior outburst and need for one on one direction.

Recall Whitby's (2012) statement that many students with autism spectrum disorders have strict adherence to rules and routines. An application of this behavioral tendency in the classroom is that each student had their own schedule, which was organized in such a way that worked best for the student. For example, one child had a chart that listed everything they were to do that day. After one activity was done the student had to mark through it and tell the teacher what was coming next. Another student had pictures with Velcro on the back so they could take off the completed activity and place a new one on the board. Through this process the teachers had to constantly remind the students of what they just finished, what they were doing, and what

they will do next. These constant reminders are similar to the three meta-cognitive strategies in the *Solve It!* approach, which prompts students to "say," "ask," and "check" as they move forward with each step. When transitioning from one activity to the next the teachers I observed would use the same sequence of techniques until the student responded correctly. This sequence of techniques began by giving the student a warning that this activity was almost over. Once time was up the teacher counted down "5-4-3-2-1 and finished" to reiterate that it was time to move to a different activity. If the students still did not respond, the teacher would ask them a series of questions or statements such as "Are you doing good thinking?" or "Today is Wednesday and on Wednesdays we go to P.E." to remind the students of their schedule for that day.

On our last day observing we met with the principal of the school to discuss our thoughts about what we had observed in our classrooms. The topic of bribing the students to do what was asked of them was brought up in the conversation. The head teacher clarified that bribery is a set of consequences and rewards which is the primary method to teaching students with autism. In other words, bribery is the tool used when getting a student to behave appropriately or getting the student to learn an academic skill. In order to bribe students the teacher must find every child's motivator and use it to persuade them into behaving or learning. As unorthodox as this sounds, recall that many of the strategies such as direct instruction, goal structure, and self-regulation use bribery in the form of verbal feedback from the teacher or rewarding students for accurate responses. However, instead of candy or math games, these students' motivators ranged from silly putty, which they may have called their "squishy" or "chewy," or taking off their shoes in order to get them to sit in their chair. An application of a motivator in a mainstream classroom for students with autism may be giving them something to chew on or hold while they are

working on a mathematical task so their mind can focus on that particular task. The administrator went on to explain that sometimes teachers have a hard time finding a student's motivator. For instance for one student, teachers tried everything from music to weighted blankets in order to figure out what motivated this student to behave or to learn. After multiple years of searching, they discovered that his motivator was to be left alone.

Keep in mind that every student sitting in a classroom learning, whether it is in an Advanced Placement classroom, an inclusion classroom, or a college classroom has a motivator for being there and being or not being attentive during the lesson. For some neurotypical students their motivator is the grades they make on assignments, for others it's the concept that education is important therefore they try their best on everything they do. Autistic students are no different from the rest in that they need a motivator to learn. Their motivator may look or sound different, but is the same none the less.

Conclusion

The placement of students with autism spectrum disorders (ASD) in general education classes has increased at a faster rate over the past 10 years than all other disability categories combined. Therefore as more children with autism are expected to meet the same academic standards as their neurotypical peers there is a demand for effective educational strategies in the general education classrooms (Whitby, 2012). The *Solve It!* routine, self-regulation, direct instruction, goal structure, concrete-representational-abstract, and Integrated Behavioral Experiential Teaching strategies can assist educators who teach students on the autistic spectrum, as well as their nuerotypical peers. In addition, many of the techniques implemented at the autistic school in London can be modified for a general education classroom. For example,

laying out the big mathematical concepts the class will cover at the beginning of class each day as well as making clear the consequences and rewards given to students in response to their actions. Ultimately the goal for teaching students with ASD is to understand that autism comes in many different forms, each of which have their own struggles and strengths. What constitutes an effective teacher is being able to differentiate a lesson using these strategies in order to accommodate to the learning differences of students with autism.

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