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An Analysis of Educational Strategies Suited for Students with ASD

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AN ANALYSIS OF EDUCATIONAL STRATEGIES SUITED FOR STUDENTS WITH ASD

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Contents

Introduction

Autism Spectrum Disorder (ASD) is a developmental disability that affects millions of people across the world. According to Haq and Le Couteur (2004), ASD is a disability that is characterized by difficulties with social interaction and communication, and often expresses itself with repeated behaviors, and persistent fixations. These behaviors may be more or less controllable depending on the environment, but are consistently present. These characteristics and behaviors have been known to cause problems for the ASD population in areas such as socialization and education. One 2004 study showed that between 6-13 in every 1000 students under six years old entering the school systems have been diagnosed with ASD (Haq & Le Couteur, 2004, p.61). With so many students presenting with the disability, it stands to reason that specific methods for ASD education should be followed to ensure that students with ASD get the individualized instruction needed to succeed in their schooling.

It is important to note that, as the name suggests, people with ASD exist on a spectrum. This means that from case to case, the intensity of behaviors or effects of the disorder will be more or less severe. Throughout this paper, not every behavior that is detailed will apply to every student with ASD, and similarly, every method outlined will need to be adapted to individual needs. Moreover, students with ASD are individuals with their own interests, strengths, and weaknesses, and some of these weaknesses are most apparent when instruction is not tailored to their particular needs. Standard mathematical instruction is designed for typically developing students, and fails to recognize areas where students with ASD need additional support. A crucial subject area where the ASD population encounters many barriers to educational success is mathematics. Developing mathematical skills in school is vitally important for students of all abilities, but especially for students with ASD, because these skills can allow them to live

independently as adults. There are many skills that are necessary to survive independently, but due to the nature of ASD, these skills may not be accessible with general education. An example of one of these skills would be applying mathematical operations to everyday situations, such as measuring out ingredients for cooking or filing taxes.

This paper will analyze several reasons why traditional educational practices are not well suited for students with ASD, and will explore multiple promising areas of research on mathematical education for these students. The project has several goals, which will be described in more detail throughout the rest of this paper. One such goal is to create a web resource for teachers that is designed to be suited towards students with ASD. The website will contain an overview of my research and analysis, as well as access to sample lesson plans. The purpose of the website is to bridge a gap between research and implementation by making the dense and long research papers accessible to a wider audience and to help educators access and feel able and inspired to actually implement these concepts in their classrooms.

Barriers to Education

ASD makes mathematical education difficult for a variety of reasons. Students with ASD generally have a lapse in their executive functioning, ability to communicate and participate, and in their general processing. All of these abilities are crucial when learning new mathematical skills, as well as interpreting mathematical problems in context. Further analysis into each of these deficit areas will reveal the barriers that need to be overcome when educating students with ASD in math. Through uncovering these barriers, the keys to effective teaching strategies will be revealed.

Issues With Executive Functioning

Executive functioning consists of the abilities relating to "organization and planning, working memory, inhibition control, impulse control, time management, prioritizing, and using new strategies" (Constable, Grossi, Moniz, & Ryan, 2013, p.8). Executive functioning is a valuable asset to mathematics students for several different reasons. However, in order to understand why executive functioning is important when learning mathematics, it is important to acknowledge the skill deficits that are common amongst students with ASD. According to that same article,

> Students with ASD who have executive functioning issues struggle with organization and planning, working memory, inhibition control, impulse control, time management, prioritizing, and using new strategies. Students with ASD exhibit these issues with difficulty initiating their work, staying on task, and being able to organize themselves. (Constable, et al., 2013, p.8)

Each of these skill deficits impact learning in very important ways. The ability to organize and plan can ensure that students do not get lost in their work, and can allow observers to see their process. Also, working memory allows students to keep the numbers and processes that they are working on in their heads as they move through a problem. Inhibition and impulse control allows a student to stay on task and persevere, even when focusing on their tasks becomes difficult for them. Time management and prioritizing is useful for staying on track and allocating appropriate time to each problem. The skills that are associated with executive functioning are heavily relied on in typical mathematics education, because skills like organizing and prioritizing important aspects of a problem are useful when solving it. As a result of the reliance on these skills, students with ASD who have deficits related to executive functioning are at a disadvantage in the classroom.

In fact, executive functioning skills have been identified as a predictor of success in mathematics amongst students with ASD. A report that compared the executive functioning skills of students aged six and nine who had ASD found that not only did higher executive functioning skills predict a higher mathematical performance, but it was a more important factor than IQ (St. John, Dawson, & Estes, 2018, p. 280). It is clear that executive functioning skills are vital for success in mathematics. Clearly, if executive functioning is necessary in order to learn mathematics, and if students with ASD are likely to struggle with these skills, then educational methods that are designed for students with ASD need to address this skill set in order to adjust for the deficit.

Issues With Communication and Participation

The ability to communicate, participate, and collaborate are necessary for success in both school and in life. Also, mathematics success is largely dependent on these abilities. Whether it be asking for help when a problem is too challenging, or sharing a response with a classmate to understand the concepts more clearly, collaboration takes many forms within the mathematics classroom. Deficits in communication and social skills are extremely common amongst people with ASD, which makes this particular aspect of mathematical education more challenging.

Students with ASD are more likely than their typically developing peers to lack communication skills and even be nonverbal. One particular case study conducted by the researchers Lambert et al. (2020) follows a young boy called Oscar who was diagnosed with ASD. They wrote about his participation in class,

> According to Ms. Rey, Oscar had a history of being reserved at school, reportedly taking 4 months before speaking to his fourth-grade teacher. He was described on his IEP as 'nonverbal,' although both Oscar and Ms. Rey used the word "shy" in separate

> interviews. While Oscar chose most often to communicate nonverbally, he did have access to verbal communication. (p. 503)

Although Oscar is a single case study, his behavior is not unique. Being non-verbal is often associated with ASD, and presents a unique challenge for educators who work with these students. In Oscar's case, he did not speak directly to his teacher for four months, which makes it extremely difficult to know what he needs at any given moment, as well as gauge his understanding of a given mathematical concept. A lack of communication is a large obstacle in ASD education, and needs to be addressed when discussing best practices.

Further, one possible explanation given by Constable et al. (2013) for a lack of communication in the mathematics classroom has to do with the theory of mind. Theory of mind is the ability to understand that other people think differently and may possess knowledge about things that you do not. In students with ASD, this is often a skill deficit, and may contribute to students with ASD asking less clarifying questions. If a student does not know that other students are grasping new content, they may not know or be able to express a need for additional support so that they can also understand that same content (Constable et al., 2013, p.9). Although the link between improving communication skills and success in mathematics may not seem immediately clear, the ability to share ideas and ask meaningful questions does play a significant role in mathematics education. Teaching students to be more aware of the general feeling of the class can ensure that they are engaged in the lesson and can allow them to ask questions when they feel stuck.

Issues With Processing

Processing has to do with intaking and understanding information. Processing deficits can come in multiple forms, such as visual or auditory, each of which can lead to issues in the

classroom. In mathematics, processing is vital in many ways, from reading and interpreting a word problem to analyzing graphs and charts to find key details. When there are issues in processing, typical mathematics problems are nearly impossible to complete. Research examining the processing abilities of students with ASD compared to typically developing peers showed that students with ASD are eight percent more likely to make errors on problems that assess their processing skills (Kim et al., 2018). Similarly, another study done by Bullen and colleagues (2020) found that having ASD resulted in significant delays when it comes to both problem solving in and calculating abilities. Due to the increased likelihood of making processing errors, it is clear that deficits in processing ability need to be addressed in specialized education.

Sensory processing allows people to take in information from their environment and make sense of it and use that information in practical ways. Furthermore, sensory processing has been shown to be different in students with ASD, and can explain some behaviors that are common amongst them. One study found,

> Regarding atypical [sensory processing], our study reveals that is extremely common in children with ASD, especially sensation avoiding and sensation seeking. Gender, age, IQ, and autistic severity did not influence these processes. Atypical SP was strongly associated with maladaptive behaviors and explained a large proportion of them (Dellapiazza et al., 2019, p. 2148).

Due to the nature of sensory processing that is oftentimes present in ASD, maladaptive behaviors can be present within classrooms. An example of this issue would be a student who struggles to be around loud noises or background chatter. If that student is present in a classroom where other students are talking or all working in groups, it can make it very difficult for the student to

remain engaged and focused on their work, and the student may even try to leave the room. Without addressing these processing issues, it will be very difficult for students with ASD to engage in a mathematics lesson. Not only should processing skills be taught and practiced amongst students with ASD, but information should be presented in a way that makes processing less of an obstacle, or at least in a way that eliminates the necessity for effective sensory processing.

There is research to suggest that the way in which numbers are represented to students could contribute to the processing issues that are common amongst students with ASD. Some forms of representing quantities tend to be more easily understood by students than others. For example, nonsymbolic representations, such as arrays of dots or images that represent a quantity of an object, have been shown to result in more errors for the ASD population when working through problems compared to typically developed peers. Contrary to the common belief that students with ASD have particularly high abilities to assess symbolic representations of numbers, the research supports the opposite. Hinker and colleagues write, “we hypothesized that non-symbolic number sense might be enhanced in individuals with ASD. Instead, we found that children with ASD were significantly impaired on a non-symbolic comparison task relative to their TD peers” (2015, p. 1277). Educators need to be cognisant about how they choose to represent a problem to students with ASD, so that certain processing issues do not interfere with the actual mathematical concepts that are being assessed. Another area of mathematics where processing difficulties present particular challenges is word problems. Students with ASD have been shown to perform worse when solving word problems than typically developed peers (Bae et al., 2015, p. 2205). There are many different issues that word problems present, such as word

decoding and sentence comprehension that are added obstacles that need to be specifically addressed due to the processing issues that are common with ASD.

Due to the challenges with executive functioning, communication and participation, and processing skills, students with ASD require educational methods that not only make up for these deficits, but also address them and teach skills to help students in each area. The truth is, mathematics education for students with ASD is not simply about teaching mathematical concepts and skills. The education that these students receive should address their weaknesses, and help them to improve so that they can tackle new problems in an effective manner. If a student is taught one particular skill in a mathematics class, they may have proficiency in that one area, but not be able to understand new skills in the future. However, if a set of skills that are applicable to any problem that may be encountered are fostered, and the transfer of those skills is practiced, students can use their skills to overcome any obstacle.

Working Through Challenging Behaviors

Educators cannot simply attempt to address these issues of processing, executive functioning, and communication in order to aid students with ASD, though. Even when these behaviors are being accommodated, there are still strategies that need to take place in order to maximize learning. The typical behaviors associated with ASD can often make learning difficult, as well. Behaviors that are commonly seen in students with ASD include obsessive interests in a specific topic, repeated behaviors, and even meltdowns or tantrums when their needs are not being met. Each student with ASD will likely have an Individualized Education Plan (IEP) that expresses their typical behaviors, and even effective ways of managing said behaviors. In order for their educational opportunities to be optimized and maintained, behavior management and intervention plans should be considered.

However, there are general strategies that address these types of behaviors that can be implemented in classrooms that can make learning easier to accomplish. Sarah Helm, who writes for the *MayInstitute* publication, offers a particular tip for keeping students with ASD engaged and diverts away from challenging behaviors. Helm writes,

> Build in reinforcement from the start: offer your child something she really wants at the end of a trip or activity if she will refrain from engaging in a behavior you don't like. This will help motivate her to 'let it go' when something else catches her eye (2020, p.1).

It may not seem natural to offer a student a prize for doing the work that they are expected to do, but when working with students with ASD, the reward can serve as additional extrinsic motivation that could help them remain focused. Whether the student needs a piece of candy at the end of a task, or a small break to do something that they love can make a world of difference for that student. Managing disruptive behaviors is beneficial not only to the students with ASD, as it allows them to focus more of their effort on the desired task, but it is also beneficial to other students in the class as it limits distractions for them, as well. Methods that not only address the developmental deficits of students with ASD, but the behavioral challenges as well are the best practices for increasing the likelihood of success for students with ASD.

Promising Strategies

For the educational approaches outlined in this section, it is important to remember that ASD exists as a spectrum. Students that are high functioning generally will need less intervention and less individualized instruction as opposed to students with lower functioning skills. According to the Individuals with Disabilities Education Act, students should be placed in their least restrictive environment throughout the school day (Adcock & Cuvo, 2009, p. 319). Keeping students with ASD in the general education classroom is seen as the goal for special

education, with students being removed for specialized instruction as little as possible, depending on their needs. The details for how each student should receive their education are determined by a student's Individualized Education Program (IEP). The following strategies are outlined for methods of ASD education, but are not universally applicable to every student with ASD. Although these methods have been shown to be promising overall, a student's support team would ultimately decide which of these methods, if any, would be best suited for that student.

Schema Approach

The schema approach was researched by Kasap and Ergenekon (2017) and refers to the knowledge and ability to create an outline and methodology for solving verbal mathematics problems. Verbal mathematics questions refer to prompts that are given auditorily to students. There is a deficit, due to a lack of communication skills, in interpreting verbal problems when administered to students with ASD. According to Kasap and Ergenekon, "Schemas used in the solution of verbal mathematics problems are achieved through the direct instruction method (Rockwell, 2012), which involves four steps: (a) creating a need, (b) setting an example, (c) guided applications, and (d) independent application steps" (p.1790). The purpose of this approach is to teach the skills, as well as the mathematical content that makes solving verbal problems possible. In the first part, the researchers would explain why it is important to solve the problem, and then they would go on to solve a problem as an example. Next, they would allow the students to try to solve a problem with support, and finally, they would have students answer the problems without support. Another study looked into the effectiveness of using schema based approaches, and arrived at a similar conclusion. The study involved students with ASD using visual supports, organizers, direct instruction, and other techniques that involve accessing the students' schemas. Through the use of this strategy, the students were all able to determine the

skill that was being assessed in the word problem, and were able to accurately solve these problems (Root & Boccumini, 2018, p. 335). The effectiveness of this method shows that it is a strategy that should be considered for ASD education.

The schema approach benefits students in a variety of ways. First of all, it establishes a motivation for the students, and explains why they should value the ability to solve the problem. Also, it clearly teaches processing and executive functioning skills that are necessary to solve word problems by doing an example, instead of simply teaching the mathematics skills. The schema approach proved to be effective in teaching students with ASD how to solve the comparison type verbal mathematics problems, and retain that ability, even after five weeks. Comparison type verbal problems include a comparison set and a difference set and ask students to find an unknown value(Kasap & Ergenekon, 2017, p.1803). For example, 'If Jordan has five dollars, and Sam has two less, how many dollars does Sam have?' The schema approach addresses several of the cognitive deficits that are common amongst students with ASD, as well as a behavioral challenge. Mathematical concepts are a focus of the approach, but not the main skill being taught. By providing an outline and guided practice, the skills that are being developed can translate to multiple areas of mathematics. Further, getting the student to understand why they are learning the skills, and getting them invested in the process will keep them engaged during the lesson and hence reduce behavioral challenges.

Cover, Copy, Compare Method

The Cover, Copy, Compare Method (CCC) is another approach to ASD mathematics education that seems to be promising. The CCC method involves giving students an equation and the answer, and having them copy both of them down. Then, they would cover them on the page so they could not see them, and write the equation and answer from memory, and then compare

what they wrote to the original equation and answer. This method is designed to improve fact fluency and accuracy for operations in typically developing students(Morton & Gadke, 2017, p. 81). According to Codding and colleagues, they found that the cover, copy, compare method improved computational fluency compared to students in the control group (2009, p.181). The efficacy for average students has shown to be promising, but that does not mean that it directly translates into an effective method for students with ASD. However, working memory is an area that is typically lacking in students with ASD, so the idea of working to improve memory at the same time as increasing mathematical fluency makes this method intriguing. Although the study conducted by Morton and Gadke from the *Behavior analysis in practice* publication showed some improvement from students with ASD, the study lacked foundational evidence to support the generalized conclusion that the CCC method aided students with ASD. Two of the three students studied did improve their performance on standardized mathematics tests after using the CCC strategy. Additional research into this method would be useful to see if it should be a practice that is commonly used in schools.

Systematic Instruction

One study conducted by Cox and Jimenez (2020) looked into effective strategies on educating students with extensive support needs (ESN). Autism Spectrum Disorder is included in this category, and it was found that using forms of systematic instruction can be useful in mathematics education for these populations. Some of these forms include systems of least prompts and time delay. The systems of least prompts method is when the teacher asks the most simple aspect of the problem first and then builds on that to continue the problem. Time delay strategy is where teachers provide the question and increase delay before the answer is prompted. Cox and Jimenez write,

> Systematic instructional strategies (i.e., systems of least prompts, time delay, simultaneous prompting, and task analysis) have been used to effectively teach a variety of mathematical skills to students with ESN. Prompting strategies such as a system of least prompts or simultaneous prompting can be used to help students gain independence and mathematical fluency (2020, p. 3).

Some particular mathematical skills that this strategy can be used for include learning new procedures, understanding orders of operations, and other areas that are related to mathematical fluency. Although systematic instruction is not as specific of an approach compared to the Schema approach or the CCC method, the findings point to a set of promising strategies that should be considered when designing lessons for students with ASD.

Another study researched the effectiveness of similar educational strategies. Practices such as representing tasks in altered manners that were easier to comprehend, use of positive reinforcement (rewarding students to increase a desired behavior), implementing error correction procedures (such as explicitly stating a correct answer when an incorrect one is given), and the use of tangible stimuli and manipulatives (such as base ten blocks) were all present within the study. Overall, areas such as operation accuracy, comprehension of the problem, and the ability to follow directions consistently rose throughout the entire study. These practices are all important to examine to see what aspects of different strategies work and why they work. These general strategies should be commonly considered when educators are creating IEPs for students with ASD to maximize their learning.

Technology Centered Approaches

A common approach that can be implemented in a variety of ways is the use of technology to support ASD mathematical education. Whether it be through a series of video

lessons or interactive applications, there have been multiple promising strategies that depend on the use of technology for student success. Technology is prevalent in all sectors of education nowadays, and should be explored for its usefulness when educating students with ASD in mathematics. The article, "Design approach of mathematics learning activities in a digital environment for children with autism spectrum disorders" explores the benefits of online learning environments for children with ASD. It concluded that online learning methods allow for education to be tailored to a student's particular needs, and students respond well to the variety of ways that information can be displayed (Santos et al., 2017, p.1308). Classroom instruction is inherently limited to what the teacher is able to show with the tools at their disposal. However, online instruction can allow students the opportunity to view a given topic in a multitude of ways.

The same article talked about a particular Learning Environment on Mathematics for Autistic Children (LEMA) in an online format. The program that they wrote about provided feedback and tutorials that were aimed at improving problem-solving skills and accuracy so that students with ASD could perform work more independently. It did this by providing multiple forms and representations through images, symbols, and other icons that made text-based problems more easily manageable. The program helped to facilitate user problem-solving and even increased mathematical vocabulary (Santos et al., 2017, p.1320). Oftentimes, interpreting and solving word problems is challenging for students with ASD, so an online program that can break apart these types of problems and make them more easily accessible can improve the students' abilities to complete the problems at a high rate of accuracy. Providing tutorials and feedback would aid any student who is struggling with performing a new mathematical ability, but for students with ASD in particular, creating an environment where many different forms of

the same problem are expressed can expand understanding overall. There is one particular website called ALEKs.com that follows this criteria to create a personalized learning environment. The website tracks the progress of the students to provide adequate learning experiences for each student, and because of the individualized nature of the site, as well as the tutorials that it provides, it could be a beneficial website for students with ASD.

Another pair of researchers, Cox and Jimenez (2020), studied the use of augmented reality videos to benefit students with ASD. They hypothesized that this technology would help to allow students to gain more independence with their mathematics education. Their model included an app that students would use that would prompt certain videos for the students to watch that were specifically designed to suit their educational needs. This approach is beneficial because it allows students to move at their own pace, and rewatch videos as needed, and it also allows teachers to monitor progress in an effective manner (Cox & Jimenez, 2020, p. 5). Since independence is one of the primary goals of ASD mathematics education, it makes sense that programs and apps that encourage students to learn skills associated with independence should be promoted. Not only are students learning mathematical strategies with the augmented reality videos, but they are learning the skills of rewatching videos when they need further clarification, and moving on when they feel that they are able to. The practice of rewatching videos also enhances the students' abilities to understand their theory of mind, because they need to be aware of what they do not fully understand. Also, these types of videos and applications can be used across all content areas of mathematics, which makes them valuable tools for any ASD mathematics educational program. In fact, it is not just those two researchers that have concluded the benefits of using video modeling for mathematics instruction. Yakubova, Hughes, and Hornberger (2015) also wrote about the benefits of video based instruction. A study they

conducted on videos that aimed to teach fraction skills to students with ASD concluded that video instruction can be an equalizer for students with ASD because of the ability for these students to use the videos as needed (p. 2867). It seems clear that including a technology based aspect of mathematics instruction for students with ASD can be a strong asset. Whether it be the freedom and independence that it grants to students, or the ability to tailor instruction to a student's particular needs, online and technology centered intervention should be considered a promising strategy.

Technology utilization does not need to happen only through interactive websites or programs, however. There are other technological tools that have been shown to increase results for students with ASD. One such example is the use of sound amplification technologies, like microphones, in class. The use of sound amplification is proving to be an effective means to keep student engagement high for both students with ASD and without, and could be a factor in improving academic outcomes for students with ASD. A study conducted by Wilson and colleagues on the effects of using sound amplification devices in classrooms with students with ASD and without, found that the impact was positive for the students with ASD. Not only were students with ASD able to remain more engaged throughout the lesson, but improvements in phonological processing were observed (Wilson et al., 2021, p.11). A different and unrelated study done by Schafer and colleagues supports the idea that sound amplification tools are beneficial for students with ASD. The study found that sound amplification resulted in increased auditory processing abilities, as well as speech recognition and ability to accept background noise (2019, p. 431). The fact that the ability to process auditory information is increased, as well as the distraction caused by background noise is diminished results in a higher ability to perform in the math classroom. This is still preliminary research, but should be a tool that should be

considered, as it does not seem to negatively impact any students while also providing a positive impact for the students with ASD. Technology covers a wide scope of educational tools, and can be a very integral part of ASD mathematics education.

Importance

First of all, due to the nature of mathematics a basic understanding of simple mathematical concepts is necessary in order to move on to more complex ones. For instance, a student must understand the basics of working with fractions and decimals before moving on to learn the basic principles of algebra and beyond (Yakubova et al., 2015, p. 2866). For students with ASD who aspire to take and succeed in higher mathematics courses, a solid foundation for mathematical principles must be established.

Perhaps more importantly, however, students with ASD generally have a specific need for altered instruction, not because the content is particularly challenging to them, but because mathematics instruction involves so much more than performing operations. Many students with ASD can perform simple operations as well as, or even better than their typically developing peers. However, understanding how and when to use these skills in the context of everyday life can often be lost on them (Santos et al., 2017, p.1307). For instance, a student with ASD may be able to tell you that 1.00 plus 0.25 is 1.25, but not be able to answer the question, “If you have a dollar, and I give you a quarter, how much money will you have in total?” So much of what is learned in mathematics classes is connected to everyday life, so that students can see the value of what they are learning. However, as beneficial as that may be to typically developing students, it can often become an obstacle for students with ASD.

Despite this deficit, one of the biggest goals of ASD education is gaining independence in their lives. Understanding how and when to apply basic mathematical principles is a key to

independence, and without it, independence is nearly impossible (Kasap & Ergenekon, 2017, p.1788). The truth is, ASD affects everyone differently, and symptoms range drastically from one end of the spectrum to another. For some people with ASD, after acquiring basic life and mathematical skills, independent life is not much harder than a typically developed person. Other people, despite any level of mathematics intervention, will not fully possess the skills necessary to live autonomously. However, even in these cases, understanding basic mathematical principles can increase the freedom and responsibility that someone with ASD can take on in their living environment. From cooking their own dinner, to managing their own money or working part time in the community, applications of mathematics will reach every part of their lives. In order for anyone with ASD to achieve their desired level of independence, mathematical skills, as well as executive functioning and processing skills overall, need to be fostered throughout their years in formal education settings.

Purpose

The purpose of my research is to create an index of educational practices that have been proven to be effective for teaching mathematics to students with ASD. There are promising strategies that are being researched by top institutions across the country, but that information can be difficult to access for educators in the field, and may seem daunting to implement. My goal was to collect a substantial list of practices, and explain how to implement them and why they have been proven to be effective. In order to display this information clearly, I have created four sample lesson plans on how one could implement these strategies in higher level math courses. Similarly, by creating a website to share my findings, I aim to present an easily accessible tool for educators who are seeking to implement research based teaching practices to

aid their students who have ASD in their mathematical journeys. Below are the sample lesson plans that can be used as a model for implementing the strategies in practice.

Schema Approach Lesson Plan

Topic and Grade:

Topic: Solving word problems involving functions in context
Grade: Algebra 1

Rationale:

Being able to understand and contextualize word problems will be extremely useful in daily life for students. There will be a lot of times throughout their lives where they are presented with a situation where mathematical skills are needed, but without the ability to parse through these situations to find out which skills to apply, it could lead to a non favorable outcome. These situations could be as simple as figuring out how much they need to pay when going out to eat or to the grocery store, or in more serious situations like how much of a certain medication they need to take or budgeting concerns.

MA Common Core Frameworks

A1.F-IF A. Understand the concept of a function and use function notation

1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output (range) of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

http://www.doe.mass.edu/frameworks/current.html

The Desired End Results:

Understandings/Big Ideas	**Essential Questions**
- Word problems can have information in them that we can use to solve math problems. - We can use our skills in solving functions to solve a word problem by looking for clues in the problem.	- How can we know what information is important in a word problem?
Knowledge	**Measurable Objectives**
Prior Knowledge: - Students will be familiar with the basic functions and solving	After instruction and practice, students will then be able to complete word problems that involve creating a linear equation, evaluating the equation at a given value,, and

for a variable. New Knowledge: - After the lesson, students will be able to apply their addition skills to word problems and be able to contextualize their answers.	contextualizing the answers 80% of the time or more.
(We are going to assume that this student or small group of students are not ELLs, but proper language objectives can be used here in the case that ELLs are present).	

Assessment Measures:

Observation and Questioning	**Other Assessment (formal or informal)**
There will be a lot of back and forth in this lesson, it will be a guided practice instead of lecture. That being the case means that there will be plenty of questioning and asking for clarification that is being done throughout the entire lesson. Also, it is important to check the student's worksheet to make sure that they are on the right track.	*The worksheet that students will be working on will be collected and reviewed after the lesson to see how they have progressed.* Students will complete an exit ticket to demonstrate their learning.
Evaluation	**Next Steps**
Gauging the student's responses from the observation and questioning, as well as their worksheet will give me a good idea of how well they understood the concepts in the lesson. Judging this will help determine the next steps.	*More practice will likely be needed, and the next step would be to introduce subtraction into these problems, and then they would need to know how to differentiate between addition and subtraction by finding key words in the problem.*

- Copies of all assessments, answer keys, and rubrics should be included in the Attachments.

Figures 1.1 and 1.2 at the bottom are associated with this lesson.

Materials:

I would use a white board and expo markers to display the guided examples, but work sheets would also be needed. The information could be presented in a variety of ways as long as it is clear and easy to follow for the students.

Procedure:

The procedure of the lesson will be starting with the initiation for 5 minutes, and then the development period which will be 20 minutes, and then the closure which will be 5 more minutes. See the boxes below for more details.

Initiation/Before: (5 min.)

- I will start by presenting a broad concept to introduce the topic for today. I will use this time to start creating a need. I will say that there are many times in our life when we have to create a function to model a situation or solve for an unknown variable, and give the example "If I make $10 per hour, and I start with $100, create an equation that shows how much money that I will have depending on how many hours I work?" I will just use that as an example, and then see if they can think of an example where you need to use functions in their daily life.
- Then, I will explain that it is someone's birthday coming up, and we want to bake them some goodies! I will spend a little time asking what the students' favorite dessert is, and then explain that for the person's birthday, we will be making cookies and brownies.
- I will then hand them a worksheet, the first problem of which will be related to the baking problem that I presented to them. The problem will read, "If I start with 25 cookies, and I can make 10 brownies per batch, create an equation that shows how many desserts I will have after X batches." I will go over the basics of identifying key information in a word problem by referencing the anchor chart (included below). I will walk through each step on the anchor chart for this problem in the next section. Now that our need has been established, and an example has been set, we can transition into guided practice.

Development/During: (20 min)

- I will use an overhead projector to project the problem onto the board, and I will then ask the student for help with underlining the key information. I will ask things like, "Ok, let's look at our problem and see what information we should pull out. If I want to look for my constant, what number is that?" This will be followed by underlining the 25 cookies, and I will repeat this process to create the mx term for brownies. Once the key info is underlined, we can move on to the actual addition.
- I will make it a point to say that showing work is a good way to make sure that the teacher can follow the work, so it is important. We will use our key

information to formulate our equation, and I will make sure to clearly show where each part comes from in our word problem.

- Once we have our equation, I will model how we can understand this formula in practice. For example, we will be left with the equation 25 cookies + 10X brownies = Y, where Y is the total number of desserts. I will ask something like, "If I make 3 batches of brownies, how many total desserts will we have?" And then I will show how you plug in 3 for x, leaving 25 + 30 = 55 desserts. To directly instruct the process, I will work through the problem out loud in the following manner; "Ok, so we know that we have three batches of brownies, I am going to underline that information because we know that it is important, but what can I do with this information? Well, I have two variables, and y is the number of desserts we have in total, which means that x is the number of batches of brownies that I bake. And if x is the number of batches of brownies, and I know that I have 3 batches of brownies, then that means that x is equal to 3. What does that do to our equation? It means that I substitute the x with a 3, and I am going to draw an arrow from the 3 in our question to the x in the equation to remind myself that I am plugging in 3 for x, and now I see that I am left with 25 + 10(3) = y. Now, I can multiply 10 and 3 together to get 30, and add 30 and 25 together to find out that y = 55. But wait, I am not done yet, I have to specify what y = 55 means. I have 25 cookies and 30 brownies, so we have 55 total desserts."
- I will work through another problem on the board, that is also on their worksheet. The student should be following along on their paper as I work on the board, and I can check on their progress by checking their paper. The next problem will be "If I make $10 per hour, and I start with $100, create an equation that shows how much money that I will have depending on how many hours I work?" I will ask the student if they remember that was the example that I used earlier in the lesson.
- We will work through this problem in the same way as the last one, where we first underline our key information, and then add our two quantities together. Again, make sure that students clearly see that we are not just doing 10X + 100, but instead it means that we are making 10 dollars per hour and we are adding an additional 100 dollars to it to make sure we keep in mind the context of this problem..
- After these two examples, I will ask students to try the next problem on their own, which will be "If you and your friend are making toys, and your friend already has made 15, and you can make 2 toys per minute, create an equation to show how many toys you have after X minutes." Allow the student time to work and process at their own pace, but stand by to answer questions or clarify things that may need clarification. When they have an answer, make sure that they acknowledge that they are measuring the number of toys. For a student who seems to be handling the concepts well, it can help them practice more with applying the context to another situation, but simply labeling and understanding what is happening is the priority.

Closure/After: (5 min.)

- I will give the student one more problem and an open ended question to end class. This will be an informal exit ticket that will not be graded but help me to see where the student is after the lesson in terms of understanding. The word problem will be "Create an equation to model the following situation: You are making $15 per hour, somebody gave you an additional 50 dollars. How long will it take to reach $110?" Also, the open ended question will read, "Please list at least one thing that you should do when you solve a word problem." Possible answers could be to underline key information, make sure to label the correct units, or other relevant information. This is to get the student to think more about the process that is being done.
- I will collect the exit ticket from students and reinforce the skills that we learned using the schema approach by reminding students to underline and pull out and keep track of key information, as well as keep in mind the context of the problems.

Meeting the Needs of Diverse Learners:

- The schema approach is being used here, which is beneficial in ASD math education. Other tools or skills are present, though. For example, writing in big and clear words on the board helps the student to follow the work, and scaffolding on independent work where needed is also beneficial.

Extension and Backup Plan:

- More problems of this style can be generated quite easily. If a student is finishing faster than expected, I recommend giving them more practice problems, and a fun way to do this is to incorporate their interests into the problem. Say for example that your student loves baseball, then ask them a question where the unit is baseballs or even runs scored in a game.

How to solve word problems!

Step 1: Read your problem once all the way through.	**Example:** If you have two apples, and you are given one more apple for each minute that passes, how many apples do you have after 10 minutes?
Step 2: Underline or highlight the key information you need to create an equation.	**Example:** If you have two apples, and you are given one more apple for each minute that passes, how many apples do you have after 10 minutes?
Step 3: Create your equation, and label your variables!	**Example:** 2 apples + 1 apple per minute (x minutes) = y apples. Where x = apples per minute, and y = total number of apples.
Step 4: Plug in your known variable to solve for your unknown variable.	**Example:** We know that 10 minutes have passed, so we substitute 10 in for x. 2 apples + 10 apples = y apples.
Step 5: Solve your equation, and make sure to include units in your final answer!	**Example:** 2 apples + 10 apples = 12 apples. After 10 minutes, I will be left with 12 apples.

Anchor chart.

Figure 1.1

Name:_____ Date:_____

Directions: Follow along with the teacher for problems 1 and 2, and show your work. Then, try problem 3 on your own when the teacher says that it is time. Show all of your work and ask questions if you need help.

1. If I start with 25 cookies, and I can make 10 brownies per batch, create an equation that shows how many desserts I will have after X minutes.

2. If I make $10 per hour, and I start with $100, create an equation that shows how much money that I will have depending on how many hours I work?

3. If you and your friend are making toys, and your friend already has made 15, and you can make 2 toys per minute, create an equation to show how many toys you have after X minutes.

Figure 1.2
Exit Ticket
Name:_____ Date:_____
Directions: Answer both questions to the best of your ability. For problem 1, show all of your steps, and for problem 2, use complete sentences. When you are done, turn your paper over and wait quietly for the teacher to collect it.

1. Create an equation to model the following situation: You are making $15 per hour, and someone gave you an additional $50. How long will it take to reach $110?

2. Please list at least one thing that you should do when you solve a word problem.

Cover, Copy, Compare Lesson Plan

Topic and Grade

Topic: Multiplication Facts Grade: Middle to High School (Refresher in basic skills)

Rationale:

The skill of multiplication has countless real world applications, and without the understanding of how to multiply, students can be at a real disadvantage in their daily lives. Some students may need refreshers on multiplication facts in order to learn new skills, so this practice will be beneficial to them.

MA Common Core Frameworks

3.OA.C. Multiply and divide within 100. 7. Fluently multiply and divide within 100, using strategies such as the relationship between multiplication http://www.doe.mass.edu/frameworks/current.html

The Desired End Results:

Understandings/Big Ideas	**Essential Questions**
- We can use the Cover, Copy, Compare method to practice and become more comfortable with multiplication facts.	- How can we practice our multiplication facts?
Knowledge	**Measurable Objectives**
- Students will be familiar with the concept of multiplication before the lesson. - Students will be more comfortable and can list off multiplication facts involving a factor of two. Key vocabulary that students will understand include multiplication, and multiplication families.	After being shown examples of the cover copy compare method, students will be able to complete the CCC method for multiplication facts involving a factor of 2, getting correct answers 80% of the time.
(We are going to assume that this student or small group of students are not ELLs, but proper language objectives can be used here in the case that ELLs are present).	

Assessment Measures:

Observation and Questioning	Other Assessment (formal or informal)
When we are going through the two example problems, I will be looking for participation on the steps, this will allow me to see if they are following along. Also, I will be able to observe their work when they work independently.	*I will have two worksheets that I will be able to collect, one being the CCC worksheet and the other being the same problems with the answer left off that students will have to fill in.*
Evaluation	**Next Steps**
Based on the performance in class and the success of the worksheets, it will allow me to see how much more practice is needed.	We will use this method for the basic multiplication facts, from 0-12. If the student seems like they are ready to move on after this lesson, then another value will be done next time. If the student needs more time and practice on the number 2, then that will be done. Students can implement this strategy at home for continued practice in building fact fluency.

- Figures 2.1 and 2.2 refer to this lesson.

Materials:

We will need the two worksheets, as well as a foldable construct that allows the students to cover the given answers. An overhead projector may be needed to show the examples if there is a larger class size.

Procedure:

The procedure of the lesson will be starting with the initiation for 5 minutes, and then the development period which will be 10 minutes, and then the closure which will be 5 more minutes. See the boxes below for more details.

Initiation/Before: (5 min.)

- I want to give a detailed example to start the lesson so students have a good model for what to do on their own. I will work through the equation '3 x 5 = 15' using the cover, copy, compare method. Then, I will work through '4 x 6 = 24' but I will ask for input from the student. I will ask them what I should do in each step by asking things like, "Where should I start?" and "Now what do I do next?"
- We are going to construct foldable templates that will be used throughout the lesson, so we will do this before we start on the independent practice. The step by step guide will be listed at the bottom.

Development/During: (10 min)

- I will then give the students the worksheet that has the foldable parts that allows students to easily cover sections that need to be covered. The worksheet will have 10 problems, of which students should work through at their own pace, with my observation and scaffolding when needed. The equations will be the multiplication facts for 2; (2 x 0 = 0, 2 x 1 = 2, etc.)
- Students will use the CCC method independently, but I will be sure to be available when needed to help students.

Closure/After: (5 min.)

- Now that the practice has been done, I will give students the equations that they had previously worked on, without the answers present. Then, students will answer the multiplication facts in the typical way.
- I want to explain that this method of practice is very useful, not just for practicing operations, but for any type of math studying, especially when memorizing definitions.

Meeting the Needs of Diverse Learners:

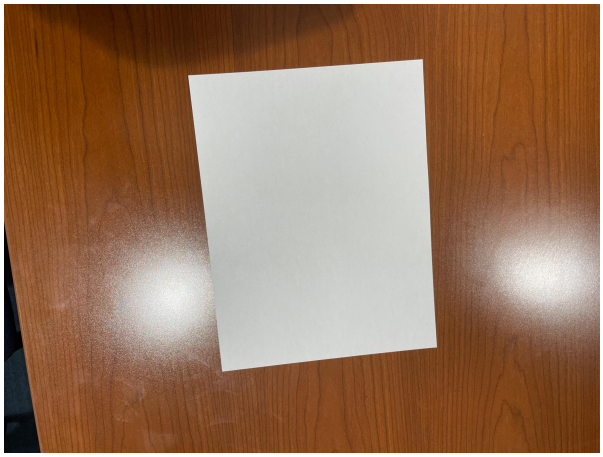
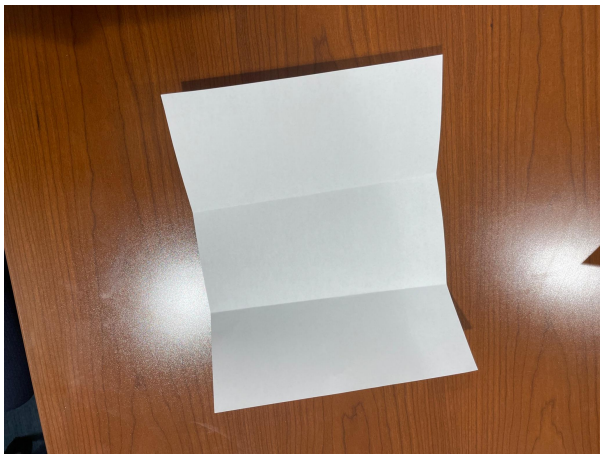
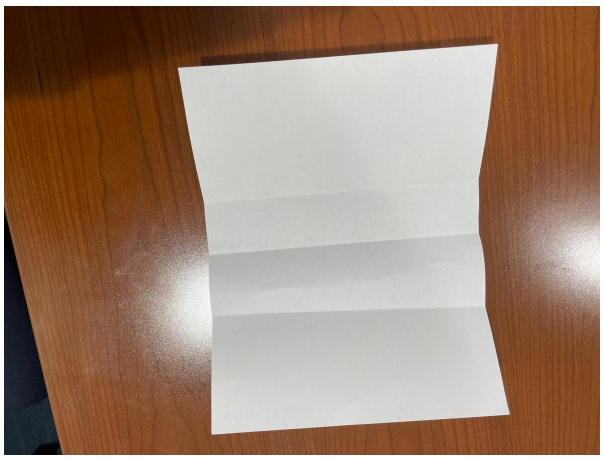
- The cover, copy, compare method is being used here to help students with ASD become more familiar with multiplication facts, but using a clear and slow speaking voice for directions, and big legible handwriting will make it easier to follow.

Extension and Backup Plan:

- After we are finished with the multiplication facts involving 2, you can repeat the process for math facts involving 3, and so on.

Sources:

(Listed in the essay).

We will start with a blank piece of paper.	
Fold the paper into thirds, the easiest way to do this is to create a cylinder of sorts by folding one side into the other, and when the two sides are about equidistant, fold down on both sides leaving something like the image presented.	
Next, fold your paper in half.	

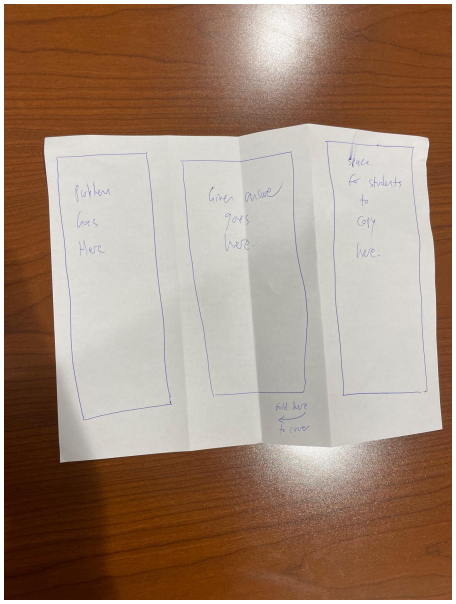
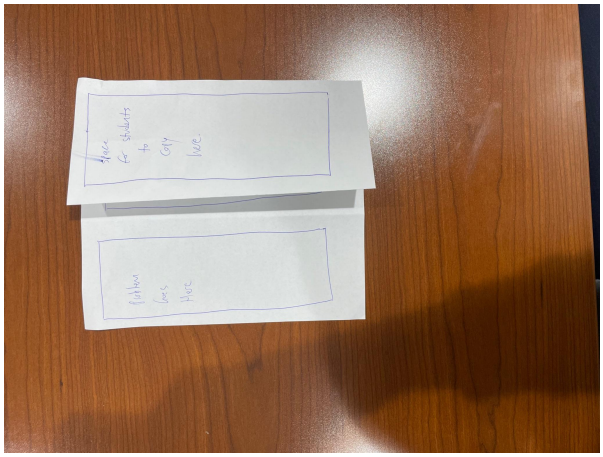
This is a sample of what goes where on this foldable. On the left hand side, we would have the problem or equation. In the middle, we would have our given answer, and the last part would be a blank space where students are going to write their answers.	
When it is time, students will fold their paper so they cannot see the given answer and write their answer on the right hand side. After this, they can unfold the paper and compare their answer to the original.	

Figure 2.1
Name:_____ Date:_____
Directions: *Use the foldable format to use the cover copy compare method for these multiplication facts.*

1. 2 x 0 =	*0*	
2. 2 x 1 =	*2*	
3. 2 x 2 =	*4*	
4. 2 x 3 =	*6*	
5. 2 x 4 =	*8*	
6. 2 x 5 =	*10*	
7. 2 x 6 =	*12*	
8. 2 x 7 =	*14*	
9. 2 x 8 =	*16*	
10. 2 x 9 =	*18*	
11. 2 x 10 =	*20*	

Figure 2.2

Name:_____ Date:_____

Directions: Please complete these equations based on what you learned from the earlier exercise.

1. 2 x 0 =
2. 2 x 1 =
3. 2 x 2 =
4. 2 x 3 =
5. 2 x 4 =
6. 2 x 5 =
7. 2 x 6 =
8. 2 x 7 =
9. 2 x 8 =
10. 2 x 9 =
11. 2 x 10 =

Systematic Instruction Lesson Plan
Topic and Grade

Topic: Order of Operations Grade: 6th Grade

Rationale:

Following the proper order or operations allows us to arrive at the correct answer to a given problem. Without a clear approach to following orders of operations, people can misuse the math operations or end up with an incorrect value.

MA Common Core Frameworks

6.EE.A. Apply and extend previous understandings of arithmetic to algebraic expressions. 1. Write and evaluate numerical expressions involving whole-number exponents. 3. Apply the properties of operations to generate equivalent expressions. http://www.doe.mass.edu/frameworks/current.html

The Desired End Results:

Understandings/Big Ideas	**Essential Questions**
- We must follow the correct order of operations because it guarantees that we will arrive at the same answer as someone else.	- Why is following the order of operations important?
Knowledge	**Measurable Objectives**
Prior Knowledge: - Students will be familiar with the operations of math, like addition/subtraction, multiplication/addition, and exponents. New Knowledge: - After the lesson, students will be familiar with the order of	After the time delay method is used for order of operations problems, students will be able to evaluate expressions by applying the correct order of operations 80% of the time.

operations to the point where they can be presented with a problem and arrive at the correct solution.	
(We are going to assume that this student or small group of students are not ELLs, but proper language objectives can be used here in the case that ELLs are present).	

Assessment Measures:

Observation and Questioning	**Other Assessment (formal or informal)**
There will be a lot of back and forth in this lesson, it will be a guided practice instead of lecture. That being the case means that there will be plenty of questioning and asking for clarification that is being done throughout the entire lesson. Also, it is important to check the student's worksheet to make sure that they are on the right track.	*The worksheet that students will be working on will be collected and reviewed after the lesson to see how they have progressed.*
Evaluation	**Next Steps**
Gauging the student's responses from the observation and questioning, as well as their worksheet will give me a good idea of how well they understood the concepts in the lesson. Judging this will help determine the next steps.	*More practice will likely be needed, but when a solid base of orders of operations is established, word problems involving these operations will be explored to see the importance of using these skills.*

- Figures 3.1 and 3.2 refer to this lesson.

Materials:

I would use a white board and expo markers to display the equations and answers, and students will need their worksheets to work out their thoughts. An anchor chart will be provided (see below).

Procedure:

The procedure of the lesson will be starting with the initiation for 5 minutes, and then the development period which will be 20 minutes, and then the closure which will be 5 more minutes. See the boxes below for more details.

Initiation/Before: (10 min.)

- This lesson will start with a hook that will hopefully demonstrate the importance of using the correct order of operations. I will write on the board the expression $6(5 - 2) - 3^2$. I will give students a minute or two to solve on their own, and hopefully there will be different answers given because students will not be using the correct order. The correct answer is 9, but expected answers would include 19, 225, or any other plausible answer that is arrived at without using PEMDAS. I will then explain that the reason why people have different answers is because in math we have to follow a consistent order when we solve problems so that everyone can agree on the correct answer.
- I will start with introducing the PEMDAS acronym, and explaining what it means and how we use it (parenthesis, exponents, multiplication/division, addition/subtraction) . Then, I will give an anchor chart (included below) that has the example of a memory device of Please Excuse My Dear Aunt Sally. Then, I want to give students a chance to be creative as well as practice memorizing the acronym, so I will give time to create their own memory device, and we will share our devices. Students will get to write their own example on the anchor chart that they receive. This chart can be available for them to reference throughout the lesson.

Development/During: (20 min)

- I will then start by introducing the order of operations in a problem in a Think Aloud. I would do a Think Aloud, and it would go something like this: “Ok, so I am given the expression, 4(5+5), how do I know where to start? Well if I think of my memory device, Please Excuse My Dear Aunt Sally, I know that I will start with my parenthesis, ok good. What is inside my parenthesis? I see that I have 5 + 5 inside my parenthesis, so I am now left with 4(10). Are there any exponents here? No, so I know that I can move onto Multiplication or division, which means that I can do 4 (10) to get our answer of 40.”
- The time delay method will be introduced then to the student or students with ASD preferably by an aid in the classroom that can give them the necessary support. If there is no aid available, it is possible to do this method yourself, but you have to dedicate a portion of time to just help the student or students with ASD while the rest of the class population works independently. To start this method, I would introduce the problem $3+ ((4-2)^2)$, and whoever is using the time delay method for the students with ASD will do the following. They will ask a clarifying question about the steps necessary to solve the problem, and simultaneously prompt the correct answer with a nonverbal cue, usually a point to the correct part of the expression. For example, if the aide were to ask “in PEMDAS, which step comes first?” They would immediately point to the parenthesis of (4-2). Then, as more practice is done with these types of

problems, the aid would wait a few seconds after asking a clarifying question to prompt the correct answer. An example of this would be after the student has done (4-2), asking "what operation is next in the order?" and waiting for five seconds before pointing to the exponent in the expression. This method will be used for the guided practice throughout the lesson, and as needed in the future.

- We will share our thoughts when students are done, and then the next problem will be introduced. "2 + 3(5-2) " I will circulate around the room the same as before to check for understanding and provide support where needed. The same time delay method will be used again for the student or students with ASD.
- We will do one more practice problem with necessary scaffolding before the exit ticket. Repeat the same practice of circulating the room and providing guidance as needed, and repeat the time delay for the students with ASD, provided that they still require that level of intervention possibly increasing the delay between the question and the non-verbal prompt. If the student is consistently answering the questions before the prompt is given, then allow them to practice this problem all the way through, and provide prompting when it is needed. The new practice equation is "(5+1)(4-3) + 6 "

Closure/After: (5 min.)

- I would end this class with a brief summary of what was learned. Today, we learned … Then I would give an exit ticket. There would be two questions. 1. "Please write the order of operations in order" and 2. "Solve this equation: 2((3-1)^2) = ?" I will collect these when they are done.

Meeting the Needs of Diverse Learners:

- The time delay system will be used, but so will strategies such as speaking clearly and slowly, as well as clear modeling will be useful.

Extension and Backup Plan:

- More problems can be generated if necessary, make sure to make the numbers easy to work with though. If time is left over, just provide more practice because the more comfortable students are the better.

Anchor Chart:

Order of Operations!

(Create your own Memory Device in the boxes!)

Operation being performed:	Letter:	Memory Device:
Parenthesis (a + b) or ((a)(b))	P	Please
Exponents a^b	E	Excuse
Multiplication and Division (a)(b) or a/b	M and D	My Dear
Addition and Subtraction a + b or a - b	A and S	Aunt Sally!

Sources:

(Listed in the essay).

Figure 3.1
Name:_____ Date:_____
Directions: Copy the problem that is given by the teacher in the space provided, and then show work as to how you know that the two sides of the equation are equal to each other.

1.

2.

3.

Figure 3.2
Exit Ticket
Name:_____ Date:_____
Directions: Please answer each question to the best of your ability. For problem 1, you do not need to use complete sentences as long as it is easy to understand your answer. For problem 2, please show all of your steps.

1. Please list the order of operations in order.

2. Solve this equation: $2((3-1)^2) = ?$

Technology Use Lesson Plan
Topic and Grade

Topic: Algebra 1 Grade: 9th Grade

Rationale:

The scope of topics that are covered in ALEKS are wide and are meant to be done over a long period of time, so the rationale for why they should learn a particular topic will change depending on the topic being taught. However, take isolating a variable for example. Not only will this skill be built upon in future mathematics instruction, but there are real world situations where students will need to know how to apply this skill. For example, when trying to figure out how much a subscription service costs that they may want to enroll in, or how much they will be making at a certain job depending on how many hours they work, understanding how to solve for a given variable is an important skill.

MA Common Core Frameworks

(This is an example of a framework that will be addressed in the Algebra 1 lessons of ALEKS, but many more frameworks are addressed, as well!) A1.A-SSE.A. Interpret the structure of linear, quadratic, exponential, polynomial, and rational expressions. 1. Interpret expressions that represent a quantity in terms of its context. ● Interpret parts of an expression, such as terms, factors, and coefficients. ● Interpret complicated expressions by viewing one or more of their parts as a single entity. http://www.doe.mass.edu/frameworks/current.html

The Desired End Results:

Understandings/Big Ideas	**Essential Questions**
- When I don't understand how to do something, I will be able to look at a detailed breakdown of steps for a particular type of problem. Also, I can always give myself more practice in areas where I need it so I am more comfortable solving those types of problems in the future.	- How can I use the tools that I have access to to maximize my learning?
Knowledge	**Measurable Objectives**

Prior Knowledge: - Students will be familiar with the basic workings of a computer, (i.e. how to type and scroll and so on). Students will also have some experience in the math concepts being covered, but the purpose of the lesson is to find out what they know by having them complete the pretest. New Knowledge: - After the lesson, students will be familiar with the ALEKS website, including how to navigate the interface, how to submit answers in the correct way, and also have a personalized program that is ready for them to use throughout the year.	After an introduction to the ALEKS website and examples of how to complete the tools tutorial, students will be able to correctly navigate the site and complete the pretest.
(We are going to assume that this student or small group of students are not ELLs, but proper language objectives can be used here in the case that ELLs are present).	

Assessment Measures:

Observation and Questioning	**Other Assessment (formal or informal)**
The majority of this class will involve students working independently on their computers, so there will not be too much opportunity for questioning, so observation will be very important. Walking around and checking the progress of the students will be beneficial.	*The pretest that is taken will be the assessment that is used throughout the lesson.*
Evaluation	**Next Steps**
Obviously, the breakdown of the pretest will be a good measure of understanding,	*After the pretest is completed, the website will create a curriculum that is tailored to*

but the lesson will also give a good understanding of how the students engage with the website. If they remain engaged and work well with the website, then it can be a good tool that is used more frequently. However, if you find that they get distracted by their computers or just find it difficult to remain engaged, it may not be a great option for those particular students.	*the student's particular skills, so they can work on their content areas as the website presents them.*

- Copies of all assessments, answer keys, and rubrics should be included in the Attachments.

Materials:

Each student needs access to a computer, which makes this lesson particularly cost prohibitive. If you are in a district that provides laptops/ipads to students, or if there is a laptop cart of some sort, then those will be used in this lesson.

Procedure:

The procedure of the lesson will be starting with the initiation for 10 minutes, and then the development period which will be 35 minutes, and then the closure which will be 5 more minutes. See the boxes below for more details.

Initiation/Before: (10 min.)

- I will start by explaining to the students the purpose of today's lesson, which is to get them familiar with ALEKS and get their individualized plan ready for them. I will explain that they are going to take a pretest to determine what areas they are comfortable with and what ones they need more work on, so it is important to try their best on it so that the website has an accurate understanding of what needs to be done.
- I will then share my screen with the class and show them how to log in, and how to complete the tool tutorial. I want this part of the lesson to be interactive, meaning that I will go step by step, and students will be completing these steps alongside me. I will make sure to go slowly and wait for a consensus before moving to the next step. Luckily, the website provides clear bubbles that explain what to do in order to take the tool tutorial, meaning that I will have to read those bubbles out loud and also provide a visual on how to do these things.
- After all of the students are done with the tool tutorial, I will show them how to start the pretest, and explain that they should take their time with it and use a scrap piece of paper to work out their thinking.

Development/During: (35 min)

- This is an odd lesson to plan for, because these 35 minutes there are not a whole lot of steps to complete from the teacher's perspective. However, there are a lot of things that should be done while students are working independently. You should . . .
    - Circulate the room the entire time, checking screens to monitor how engaged students are, as well as answer questions that students have. Since this is a pretest, don't give too many hints about how to solve particular problems, because if a student is struggling then that means that they probably need additional practice with those types of problems. Instead, give hints about general practices, like writing steps on scrap paper, highlighting key information from the questions, and also answering any questions about how to use the website itself.
    - The pretest is fairly long, and will likely take most students the entire time to complete, but if any students finish early, then you should check their score report, and then show them how to continue on the website and complete additional lessons. This will be done on an individual basis because students will finish at their own pace.

Closure/After: (5 min.)

- One thing that must be done before the class period ends is to make sure students know that the pretest must be completed before they can start their individualized lessons. That means that if any students cannot finish during the class period, then they must do so for homework. Luckily, the website saves progress so they will be able to continue where they left off if need be.
- I will also explain that students will be using this website as instructed, so they should not just go through as many lessons as they can on their own time. I will end class by explaining that there will be times throughout the year that I assign topics on ALEKs as homework, and that it will be beneficial for us as a class because it'll allow extra practice, as well as help us introduce new topics at certain times.

Meeting the Needs of Diverse Learners:

- The website itself is the tool that meets the needs of diverse learners, because it is tailored to their specific needs.

Extension and Backup Plan:

- If students finish the pretest early, then they will just use the remainder of the class time to complete more lessons on ALEKS.

Sources:

(Listed in the essay).

References

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