Strategies for Supporting Students Diagnosed with Autism Spectrum Disorders in STEM Education

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Abstract

Educators and employers are working together to promote students diagnosed with autism by developing skills related to the STEM fields. Students diagnosed with autism spectrum disorders (ASD) are showing high levels of interest in STEM fields. This paper will review STEM and ASD literature and offer methods for improving student access to education through transition services and using a Universal Design for Learning (UDL) framework in efforts to encourage a blend of evidence-based instructional methods and supports for STEM educators working to include students diagnosed with ASD in their classrooms.

Keywords: Autism Spectrum Disorders, STEM education, transition, UDL

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It is critical that educators consider ways to enhance Science, Technology, Engineering and Mathematics (STEM) education for individuals diagnosed with Autism Spectrum Disorders (ASD) who show preference for the field. The publication, Rising Above the Gathering Storm (Committee on Prospering in the Global Economy of the 21st Century (U.S.), & Committee on Science, Engineering, and Public Policy (U.S.), 2007), details an initiative by federal policymakers to develop concrete steps, recommendations and strategies to strengthen efforts in the United States to develop talent to serve the growing science and technology initiatives. The committee developing the report asserted that the United States is falling short in international evaluations and specifically recommended improving STEM education in compulsory K-12 schooling and higher education. Recent efforts to promote research and practice in STEM education have increased. The White House alone has devoted substantial financial resources (2.9 billion dollars) to research based STEM education efforts leading to effective practice (Office of Science and Technology Policy, 2014). STEM education approaches seek to break down the traditional silos that separate the four disciplines and thereby emphasizing the intersection of disciplines leading to interdisciplinary solutions to existing real-world problems (Breiner, Johnson, Harkness, & Koehler, 2012). Broad educational reform efforts include the development of a comprehensive national curriculum for science that reflected the need for an integrated STEM education approach (National Research Council, 2012). This document clearly argues the need for an inclusive curriculum that accentuates the need to reach all student populations.

Occupational fields that benefit from knowledge and practice in STEM education are undergoing rapid growth, and STEM-infused companies around the world are seeking ways to fill essential positions to meet the demands for scientific and technological knowledge (National Research Council, 2011; National Science Board, 2014). Educators are working steadily to prepare their students for enrollment in college programs across the STEM fields (National Research Council, 2012). However, for people with disabilities this career path often ends before program completion due to lack of consistency and predictability in higher education environments (Wei, Yu, Shattuck, McCracken, & Blackorby, 2013). Are we leaving behind a population of students capable of becoming the next Sal Kahn or Steve Jobs? Researchers are asking critical questions about how to educate community members diagnosed with disabilities in the area of STEM in the hope that all students can access employment and realize their full potential. This is specifically true of individuals with Autism Spectrum Disorders (ASDs) due to their unique abilities in STEM disciplines including a need for structure, predictability, and operating systems (Scientific American, 2013).

Literature Review

Why are so many individuals with ASD motivated and engaged with STEM education and integration efforts? Researchers are discovering that individuals diagnosed with ASD enjoy STEM activities because of systematic processing and logic skills (Baron-Cohen, Wheelwright, Burtenshaw, & Hobson, 2007). A recent study examining college enrollment rates indicates that individuals with ASD are increasingly choosing STEM majors when compared to their typically developing peers (Wei, Yu, Shattuck, McCracken, & Blackorby, 2013). As research is still emerging, the explanations as to why students with ASD are drawn to STEM education, currently focuses on how their unique abilities align with the external structure of the scientific inquiry and engineering design process. It is critical to understand both strengths and deficits related to the disorder so educational programs can be developed to support them as many STEM pre-service and in-service educators are woefully underprepared to address the unique needs of the population of students with ASD's in the content area classrooms.

One theory suggests that STEM preferences are related to strengths and weaknesses of the disability (Baron-Cohen, 2009). Social, behavioral, and communication impairments are identified characteristics of students diagnosed with autism. These deficits link to poor social and academic outcomes (e.g., Gest, Sesma, Masten, & Tellegen, 2006). Students have difficulties, engaging and collaborating, staying organized, completing tasks, yet demonstrate specific interests and focus on specific details. Hedges et al. (2014) asserts three themes of challenges that students with ASD experience in high school settings. There are intrinsic inconsistencies inherent to the secondary schooling environment, challenges for students in their interpersonal connections, and knowledge/process breakdowns. Baron-Cohen's (2009) cognitive theories apply to individuals diagnosed with ASD due to their immense behavioral features. The Empathizing–Systemizing (E-S) theory (Baron-Cohen, 2009), expanded from the Theory of Mind (ToM) (Baron-Cohen, 1995), indicates that individuals with ASD have greater abilities to approach tasks that require thinking and information analysis when compared to social-emotional interactions which may make them viable candidates for the STEM field (Baron-Cohen, 2009). It notes specific deficits in empathy and social skills but also highlights strengths including following rules, questioning, exploring, and structuring systems. Baron-Cohen (2009) notes that some types of systems like collectible, mechanical, numerical, natural, social, and motoric are definite strengths for this population. STEM fields require a broad understanding of mathematical concepts, engineering principles, and scientific processes that directly parallel those desired skills (NGSS, 2013).

While student motivation to pursue STEM content knowledge is high, issues surround completion at the post-secondary level and college enrollment. Wei et al. (2013) completed a longitudinal study examining students with ASD and found they were one of the highest populations choosing STEM degrees, although their enrollment rates (31.95%) were the third lowest when compared to students in other disability categories (*average* = 55.55%). Very few individuals with disabilities are entering college prep programs. They are twice as likely to drop out of school that their typically developing peers and only 35% of people with disabilities maintain full or part time employment (Wagner, Newman, Cameto, Levine, & Garza, 2006). Data on employment rates of people with ASD are even lower, estimating students with ASD enrolled in college were between 0.7% to 1.9% with an 80% incompletion rate (VanBergeijk, Klin, & Volkmar, 2008).

Poor organizational, social, behavioral, and communication skills may serve as barriers to entering and sustaining employment in the work force since these are characteristics associated with the disorder. College and university educators are seeking answers about how to best prepare this population to reach their goals so they can be successful in STEM careers. Specifically, how can we enhance the success of individuals diagnosed with ASD who have above average skills in STEM? In order to answer this question, is important to consider the requirements of STEM programs, autism characteristics, critical skills, transition supports, and evidence-based strategies.

Science, Technology, Engineering, and Mathematics (STEM) Programs

STEM literacy is "the knowledge and understanding of scientific and mathematical concepts and processes required of personal decision making, participation in civic and cultural affairs and economic productivity" (National Research Council, 2011, p. 5). A scientifically literate population would be able to read, understand and value scientific research and mathematical modeling that speaks to, for instance, global climate change or whether or not it is a viable strategy to build harden structures (i.e. jetty's and terminal groins) to reduce erosion on the US coastline. In addition to scientific understanding, problem solving real world solutions require people to think holistically about the problem so they can address complex relationships (Paige, Lloyd, & Chartres, 2008).

As articulated in a student's Individualized Education Plans (IEP), regular education teachers make efforts to provide accommodations and modifications to the discipline specific curriculum for children with special needs. Yet when general education students are compared with students with special needs, persistent achievement gaps in end of grade/course (EOG/C) test scores remain (Albus, Lazarus, & Thurlow, 2015). There clearly needs to be more of an effort made to prepare our future (and current) educators with strategies and resources to be successful with children in the classroom.

This is specifically true for educators who are serving students with ASD who prefer STEM over other disability categories, as incidence rates climb. It suggests that educators pay specific attention to this population; evidence based instructional supports, and transition supports can allow students to seek and sustain educational opportunities. The U. S. Autism and Asperger Association (2013) reported that a lack of self-identification paired with social, learning, and organizational challenges often affect college success rates. Gobbo and Shmulsky (2014) identified specific areas of deficit for individuals with ASD in the classroom including poor critical thinking skills, anxiety issues, and social skill difficulties. These studies indicate that educators can address barriers to successful college experiences in the K-12 classrooms.

For those students with ASD's that do graduate college, Baron-Cohen (2009) suggest that due to their abilities to think logically and systematically, there is a high propensity of adults with ASD working in STEM related fields. When researchers examine individuals with ASD in STEM and other fields, findings indicate higher levels of autism characteristics (measured using Autism Quotients), than those in other fields (Ruzik, Allison, Chakrabarti, Smith, Musto, Henry, et al., 2015).

Autism Characteristics and Skills Needed for STEM Careers

Hedges et al. (2014) conducted focus group research with 41 participants with ASD, across multiple community colleges. They assert three themes that highlight the challenges of the high school setting for students with ASD. These include: 1) Intrinsic inconsistencies inherent to the secondary schooling environment; 2) Challenges for students in their interpersonal connections; and 3) Knowledge/process breakdowns. We will examine each below.

Intrinsic Inconsistencies in Environment

As students enter secondary and post-secondary environments schedules become more complex, expectations can vary and this can cause discomfort in students with ASD. Hedges et al. (2014) found that differing teacher personalities, expectations, and schedules caused discomfort in individuals seeking consistency. Researchers have found that cognitive flexibility, the ability to switch rapidly between different tasks can be challenging for individuals with ASD (Monsell, 2003). Clear and consistent expectations across collaboration and settings may assist this population in succeeding in the STEM environment.

Furthermore, secondary educational settings are highly dynamic and require planning and organizational skills that are often demanding on students diagnosed with ASD

(Rosenthal et al., 2013). Simple changes to the environment can cause anxiety levels to rise in students who seek sameness.

Interpersonal Connections

Students diagnosed with ASDs often have difficulties engaging in classrooms (Keen, 2009). This may be due to deficits in social, communication, and behavioral skills (Wright & Wright, 2014). STEM programs often have fieldwork or collaborative components, which may increase social anxieties. Strategies to support collaboration and social interactions are one area of need for this population of students.

Knowledge/Process Breakdowns

Researchers describe issues related to deciphering between relevant and irrelevant content (Wainwright-Sharp & Bryson, 1996), attention difficulties (Goldstein, Johnson, & Mineshew, 2001), and challenges with gleaning concepts that are not explicitly taught (Klin, 2000). STEM processes require building on prior knowledge from multiple disciplines, working in collaborative teams to construct meaning, exploring the applications of new knowledge, employing innovative and creative approaches to solving complex challenges and effectively communicating those results to others. This may prove difficult for students with ASDs. Researchers examining memory in individuals with ASD indicate that the completion of intricate tasks is a deficit and suggest the use of explicit strategies as supports (Bowler, Gaigg, & Gardiner, 2010; Cheung, Chan, Sze, Leung, & To, 2010). Students diagnosed with ASD may also experience difficulties completing tasks that require attention to more than one concept (Koegel, Singh, & Koegel, 2010; Ozonoff & Strayer, 2001) and effective communication about the results of those trials. When confronted with these challenges, students will struggle in their efforts to design and conduct experiments, participate in discussions, troubleshoot and redesign a solution and share coherent solutions with their peers.

Shifts in thinking and development of new operations may also prove overwhelming for this population of students since structure, schedules, and repetition can be important (Goldstein et al., 2001). Teachers employing STEM educational strategies often require students to develop a plurality of understandings across multiple disciplines. This can prove challenging to mediate for classroom practitioners. Finally, student behaviors can interfere with learning and involvement in collaborative activities. Ozonoff and Strayer (2001) found that breaking down tasks into smaller steps and ensuring task each one is completed is often problematic. Teachers often employ constructivist and inquiry-based strategies where students are responsible for creating their own meaning from experiential pedagogies in STEM fields and educators need to consider how best to pair evidence-based reform minded strategies with supports so students can engage with the curriculum.

Transition Supports for Students with ASD Entering the STEM Field

Given the overwhelming need to prepare students with ASD for careers in STEM, educators should attend to the ways in which secondary schools are preparing them to pursue majors related to STEM in post-secondary education. Therefore, it is imperative that the proper transition planning is available to successfully transition from high school to post-secondary education, employment, and independent living. According to the Individuals with Disabilities Education Act of 2004, transition is a requirement for all students with disabilities who turn 16, or younger if deemed appropriate by the Individualized Education Plan (IEP) team. Transition planning is an essential component to the educational programming for students with disabilities because it systematically uses activities and instruction to help students reach their annual goals that are aligned with their strengths, interests, preferences, and needs related to their post-secondary goals in post-secondary education, employment, and independent living. According to the National Technical Assistance Center on Transition, there are 20 identified predictors for post school employment and education, and independent living success (e.g., career awareness, inclusion in the general setting, interagency collaboration, occupational courses, work experience, parental expectations, parental involvement, and program of study, self–advocacy, self-care, social skills, student supports, transition programs, vocational education, and work-study) (National Technical Assistance Center on Transition, n.d.) Incorporating these skills in a high school curriculum can help ensure students' post school success in the STEM field. For example, STEM teachers can dedicate a portion of their curriculum to STEM careers to help strengthen students' career awareness as well as help them understand how their interests and strengths align with a particular career. In addition, teachers can include work study opportunities in the STEM field during high school so that students can have hands on experience with a particular job which will help them determine if the job within their chosen STEM field is right for them.

Deficits of individuals with ASD correlate with some of these indicators which may be a part of the reason that effective transition planning can be difficult to achieve at the secondary level to prepare students with ASD for post-secondary education and employment. For example, poor social skills, and lack of self-advocacy skills can be barriers because they require emphasis on social, communication, and behavioral skills that are discrepancies in this population; however, needed to be successful in post-secondary education and employment settings (Wright, Wright, Diener, & Eaton 2014). Therefore, it is critical that the needs of students with ASD are clearly identified prior to their transition to the employment setting so that they can receive the appropriate support to help them be successful.

Evidence-based Strategies to Support STEM Education

Students with ASDs benefit from several universally designed supports when preparing for STEM related college programs. Universal Design for Learning (UDL) highlights a set of principles that give all individuals equal opportunities to learn through multiple means of representation, expression, and engagement (National Center on UDL, 2014). Concurrently, a Framework for K-12 Education (National Research Council, 2012) asserts, "equity in science education requires that all students are provided with equitable opportunities to learn science and become engaged in science and engineering practices (p.28)."

Educators employing UDL supports in educational and employment settings can increase preparedness, productivity, social, engagement, communication, and behavioral skills in conjunction with evidence-based interventions for students with ASDs. The goal of UDL is to ensure that educators provide students with strategies that can improve learning within a setting versus individualizing education for only a few students. Therefore, educators can apply the UDL framework to STEM education by offering alternate methods for how the material is presented, how understanding is demonstrated, and how motivation is achieved, which can facilitate learning. Moreover, all students can benefit from UDL principles and strategies. For example, visual PowerPoints, speech–to-text software, asynchronous online discussion forums, in real time online interactions, web-based simulations, and video themed resources can help with productivity, understanding, and distance. Students diagnosed with ASDs benefit from hands-on learning opportunities, coaching, modeling, practice, and feedback (Swiezy, Stuart, & Korzekwa, 2008). STEM programs serve as a universal mechanism for engaging and maintaining student attention (NSTA position statement: Students with disabilities, 2004). It has been demonstrated that when engaged in hands-on activities, individual student knowledge (Markowitz, 2004) and motivation (Thompson & Windschitl, 2002) increase. Educators utilizing UDL supports can open connections for students to STEM programs but educators must also consider what individualization is required for students with ASD to be successful.

Research indicates that specific evidence-based strategies can help students, but are often absent in inclusive college classrooms. For example, a typical college student would likely not require conversational prompts for discussions or extended time for task completion. These deficits may be a result of executive functioning deficits in children with ASD (Ozonoff & Strayer, 2001). Executive functioning relates to the ability for individuals to coordinate goal-directed behaviors like shifting attention, planning, and self- monitoring (Ozonoff & Strayer, 2001). Schedules and task lists can improve understanding of expectations and offer structure (Mesibov, Shea, & Shopler, 2005).

Individuals with ASDs benefit from procedures and predictable routines in the classroom by prompting students (Wong & Wong, 2009), offering explicit procedures, and providing consistency (McIntosh, Herman, Sanford, McGraw, & Florence, 2004). For instance, an effective STEM infused classroom should structurally present itself the same way from day-to-day and week-to-week. The first 15 minutes of a 90-minute daily block class could be video infused (i.e. YouTube) and relational to accomplishing the day’s objective. Educators should write each day’s learning objectives on the board, in the same place, every day offering the learner consistency and predictability. Providing students with conversational prompts can assist them in discussing the main ideas, and allowing all students to respond to the prompts by first journaling their ideas in a notebook. Students can then orally share their responses as requested. Educators can build the next 60 minutes around disciplinary core idea delivery (i.e. PowerPoint or guided notetaking) and scientific and engineering practices (hands-on activities or experiential learning). The final 15 minutes of class should reinforce the concepts through a social skill activity. By easily embedding these supports into each classroom lesson, you encourage understanding and enhance learning.

Priming is another strategy that researchers indicate enhances content knowledge in individuals with ASD. Priming is a way to offer access to materials and procedures before carrying them out (Koegel, Koegel, Frea, & Green-Hopkins, 2003). For example, STEM educators could 'flip the classroom' and offer videos of experiments and materials to students prior to class so they can gain familiarity and improve understanding. It may be advantageous for educators to present a finished product to the students so they can visualize, touch and feel. Students can have input into identifying the science and engineering practices that may present some challenges. Simply drawing attention to items that are most important can assist to clarify relevant details (O'Connor & Klein, 2004).

Special interests are another way to ensure that students with ASDs are engaged in learning and motivated to complete work (Koegel et al., 2010; Mancil & Pearl, 2008; Winter-Messiers, Herr, Wood, Brooks-Gates, Houston, & Tingstad, 2007). STEM educators can use special interests as motivators. For example, if a student enjoys programming a Lego Mindstorm Robot but the assignment does not reflect its inclusion, he/she can have 15 minutes at the end of class upon completion of their work. It is imperative that STEM educators solicit from their students innovative and unique ideas related to their curricular goals and objectives. The value of STEM education is that all ill-structured problems require disciplinary, crosscutting concepts and therefore, present the learner with a multitude of solutions and outcomes. Problem based learning, typical of successful STEM programs, require students to generate unique solutions.

The explicit and transparent efforts to link learning across the STEM disciplines while providing relevant opportunities for students with autism to solve real world problems in generalized contexts does harbor hope for student learning moving forward. Missing from past reform efforts at the K-12 level has been opportunities for children to demonstrate their 'creativity' and their 'innovations' within a relevant context (NGSS Lead States, 2013). Engineering approaches to learning hold possibilities to change the dynamics for children who have traditionally not connected with a curriculum relevant to their situations. But, while engagement in engineering education strategies at the pre-collegiate levels have been rare, there is an increased emphasis among STEM educators to include those principals across grade levels (Katehi, Pearson, & Feder, 2009). Special attention to proven supports and strategies during course development and implementation aligned with emerging best practices in STEM may be the key to later success for these students.

Table 1 outlines to embed into STEM programs to support this growing population of students.

Table 1
Evidence based strategies and supports

Skills	Evidence-Based Strategy	Supports
Preparedness	Priming	Video modeling Demonstrating a tangible finished product/solution, Intentional instructional design
Productivity	Task lists Focused tasks	Continually monitor progress Daily and unit checklists
Social Skills/ Communication supports	Visuals	Social stories/Scripts Students acting out the content Multimedia tools and applications
Engagement	Special interests	Contextually relevant activities Place-based resources Citizen science
Organizational Skills	Visual maps	Graphic organizers Semantic maps Web-based tools
Task Completion	Reminders and deadlines	Deadline or reminder applications Classroom exit tickets Diverse assessment strategies

Evidence-based supports have been rigorously researched and shown to be effective for enhancing learning. Using the UDL framework to design and implement effective instruction for students with ASD's can align to a STEM learning environment (Basham & Marino, 2013). Supports in STEM education are outlined in the next section.

Supports to Promote Preparedness

The imperative for STEM infused learning experiences requires that students engage with ill structured problems crossing a multitude of academic disciplines where active learning takes place. All students are expected to move beyond passive learning and generalized lower order cognitive tasks to contextually relevant problem solving and critical thinking. Organization, understanding, and planning can be challenging for individuals with ASD. The following are evidence based supports that can enhance readiness.

Video Modeling. Research supports the use of video modeling to demonstrate specific behaviors that can be repeated later (Bellini & Akullian, 2007; Delano, 2007; Gelbar, Anderson, McCarthy, & Buggey, 2012). This intervention is implemented in STEM environments by modeling procedures via a video to increase the likelihood that an experiment, equation, or project is accomplished successfully.

Supports for Increasing Productivity. STEM education provides all students with opportunities to explore mathematics and science content in a problem based, inquiry educational environment using technology as a tool for learning. Engineering design draws upon a student's ability to think critically about solutions while generating approaches to solve a problem. To inquire effectively, students with ASD may need supports to increase their productivity on the task. The following are evidence based supports that can enhance productivity.

Task lists/ Focused Tasks. An educator's explicit explanation of tasks can offer students information about what work needs to be done, how many steps are involved, and what order to complete tasks. Task lists break large multi-step activities into small, meaningful and manageable steps. Research on memory, in individuals with ASD, suggests fewer prompts and "free recall" can uncover deficits and complicated, multistep tasks (Bowler, Gaigg, & Gardiner, 2010; Cheung, Chan, Sze, Leung, & To, 2010). Dermot, Gaigg, & Gardiner (2015) found that individuals with ASD perform better on tests that offer explicit tasks. By providing a breakdown of explicit steps, within a task, students with ASD may perform more effectively in STEM environments. STEM teaching and student learning benefit from a curriculum designed around problem based learning that incorporate inquiry based activities allowing there to be variability in student decision making. This may prove troublesome for students with ASD's engaged in an activity where the general directions simply ask student to design Lego Mindstorm robots to move from one location to another and then tap a ball. STEM educators should consider offering activity task lists with specific steps for students to follow when engaging in such an engineering assignment.

Checklists/ Schedules. Checklists can assist students diagnosed with ASD in production by offering them a way to self-regulate. Invariably, when students learn through individual or group inquiry, it can take students different periods of time to complete a designed task and the learning environment should allow for this differentiation. These STEM infused learning environments encourage students to use trial and error strategies (with many learned failures) requiring a multitude of different approaches to solve the problem. Students with ASD may require a simple checklist that can remind them what task to complete and a schedule can assist in time management (*see* Figure 1.)

Expected time to spend on the task	Activity	Completed (mark with a ✓)
5 minutes	Read the assigned problem and brainstorm possible solutions.	
5 minutes	Design a diagram with written procedures to demonstrate a possible solution.	
10 Minutes	Build a Model or Prototype	
5 minutes	Test the model/prototype, collect data and evaluate results that either verify or refute the original design.	
10 minutes	Redesign the diagram and manipulate any variables used to generate another solution	
5 minutes	Re-test the model/prototype, collect data and evaluate results that either verify or refute the revised design.	
5 minutes	Record and report on a desired solution when reached.	
5 minutes	Demonstrate/share the finished product with your teacher and peers.	
Total: 50 minutes		

Figure 1. Example Schedule and Checklist for Solving an Engineering Problem

Communication/ Social supports

Students diagnosed with ASD often demonstrate deficits in social and communication domains. Let us say the activity in question asks a group of students to design a bottle rocket that when launched will stay aloft for as long as possible. Engineering solutions to problems like this employ STEM infused disciplines that require some debate, some critique and some analysis of ideas. This creative learning process, while iterative and systematic, requires the evidence based argumentation to both defend their ideas as well as highlight any limitations to a design (NGSS Lead States, 2013). Below are effective strategies for supporting student social and communication needs in STEM settings.

Social Stories/scripts. Social stories use visual and auditory input to provide a specific set of guidelines addressing social situations, skills, events, or concepts so individuals with autism understand the who, what, when, where, and why of specific situations (Gray & Garand, 1993). Research suggests that social stories are effective because they help individuals adjust to schedule changes, understand thoughts and feelings, learn problem-solving behaviors, and increase appropriate behaviors (Kuoch & Mirenda, 2003, & Charlop-Christy & Kelso, 2003). Scripts offer directions and rules for conversations (Gray, 2000; Kamps et al., 2002). When engineering a solution to the rocket design, a social story or script might include how to share information about what worked or possible future approaches to programming a rocket (see figure 2). Explicit instructions can provide what and how to state a hypothesis when conducting a scientific experiment but can be adapted for other fields.

Today, I am excited to work on building bottle rockets with my peers. We will design the bottle rockets, do a test run, and then discuss what changes we need to make with when re-designing. I will look at my peers when I talk because they will understand that I am interested in the project. I will:

1. Name one issue I noted in the trial run (e.g., "The rocket did not _______ successfully")
2. Provide one statement about why I think there was an issue (e.g., "I think that the rocket did __________ because of a design flaw").
3. Offer one suggestion for improving the design (e.g., "I think we can _______ ").

If I speak clearly and stay on topic, my friends will understand me more easily. Group experiments can be fun!

Figure 2. Social story for Sharing Information with Peers

Multimedia tools. Multimedia tools offer visual and textual information in multiple formats. Videos and visual supports are used and paired with assistive technology supports such as text-to-speech, where text are read aloud, dictionary functions, so words and definitions can be looked up, and can be tailored for the individual needs of the student. For example, on student may require more visual examples, while others can focus on more text. Integrating technology, whether its assistive technology or technology as a tool for learning content, into STEM infused environments is natural for the design process. Technology should serve as a tool for teaching and learning both content and process.

Promoting Multiple Means of Engagement

Students diagnosed with ASD are often motivated to participate when provided with multiple means of engagement. For instance, it is important to select items of interest when students employ Global Positioning Systems (GPS) receivers to 'hide' and 'seek' interesting objects. Students can choose the navigational clues that best suits their interests in the activity. Below are effective strategies for supporting engagement in students with ASD's.

Special interests. Incorporating a student's special interest can increase motivation to improve academic, social, and behavioral outcomes for students diagnosed with ASD (Koegel et al., 2010; Mancil & Pearl, 2008; Winter-Messiers, Herr, Wood, Brooks-Gates, Houston, & Tingstad, 2007). For example, some individuals with ASD are drawn to technology tools because it includes vivid auditory and visual information (Leham, 1998). Thus, completion of an educational program related to Geocaching on the computer may be preferred over a worksheet, which is not multimodal.

Choice. Choice is an effective way to motivate students with ASD to complete tasks (Koegel, et al., 2010). Allowing for choice can increase engagement and motivation by building on individual strengths (Greenspan, Wieder, & Simons, 1998). One way to encourage choice in assignments is using Tic-Tac-Toe lessons on GPS systems. Special interests can be incorporated through the differentiation of content, process, and product (Bishag, 2011).

Task Completion

Reminders and deadlines can increase representations for students. App-based tools and web-based tools can offer a list of tasks to complete; digital reminders and track time per item (e.g., remember the Milk, etc.). These can also be made using basic pencil and paper methods. List items; build in time to work on tasks, and deadlines.

Summary

As the field of STEM education develops, it is important to understand the strengths and deficits of individuals with ASD. Evidence-based interventions are often utilized in school and employment settings to improve success rates. Consider these interventions and supports early and focus on them during the transition process so student skills develop over time. Using socialization, behavioral, and educational supports early in schooling is important. Students can hone in on tools and strategies that are specifically helpful to their individual skills so they become more rote for those entering college programs. A thoughtful and purposeful approach to designing Science, Technology, Engineering and Mathematics (STEM) experiences in the UDL context hold special promise for students with ASD's. If individuals diagnosed with ASD are already naturally drawn to STEM activities (Baron-Cohen, Wheelwright, Burtenshaw, & Hobson, 2007) and STEM preferences are linked to strengths and weaknesses related to the disability (Baron-Cohen, 2009), then educators can design, employ and evaluate effective strategies that provide relevant pedagogical opportunities for all their students. By employing research-based strategies in UDL lesson plans, STEM education efforts for all students can be realized. It is important to consider what professional skills students with ASD need to be successful in STEM educational environments to promote their academic achievements. UDL supports can be integral for STEM educators to learn with support from the professionals in special education.

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