Learning to Teach

Volume 6 | Issue 1 Article 8

Making Scientific Inquiry Activities Accessible to Students with Autism

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Abstract: In light of the major trend within science education of focusing on inquiry-based activities, students with autism may face difficulties in the classroom due to barriers such as problems with communication, social situations, and desire for routine (Hedges et al., 2014). Though research regarding inquiry-based science education for students with autism is scarce, explicit instruction appears to be a promising option for elementary students (Knight et al., 2012). Additionally, Applied Behavior Analysis and Self-Regulated Strategy Development have proven useful in other content areas (Casey et al., 2014; Ryan et al., 2011; Szapacs, 2006). Extrapolating from this data, the author discusses how these strategies could be applied in inquiry-focused science classrooms and suggests that researchers use these strategies as starting points for future research.

Introduction

> *Mrs. Baker notices early on in her first year of teaching that Dawson, who has autism, is an extremely bright student. He studies, stays on task, and if he is asked a question, his answers clearly demonstrate his knowledge of chemistry. Still, he is relatively quiet, a little uncomfortable during group work, and it sometimes seems like he needs time to put his answers together. He also appears to struggle with short-answer questions and writing laboratory reports. It seems to Mrs. Baker that Dawson has trouble transferring his ideas to paper, which could be a problem given that in this class, students often design their own laboratory procedures or draw conclusions based on their data. Mrs. Baker does her best to help, talking with Dawson about long written responses before he is asked to write them down and making sure to always group him with students with whom he is comfortable, both of which seem to help. Mrs. Baker worries, however, that the strategies she is using may not necessarily be based in research and may not work for every student. Furthermore, she is frustrated because she knows that not much research exists on helping students with autism access an inquiry- based science curriculum.*

Mrs. Baker's use of scientific inquiry activities in the classroom represents a scenario familiar to many science educators, as the use of inquiry represents a major goal in the field of science education centered on helping students to develop their scientific literacy skills (AAAS, 1989). In general, inquiry involves generating questions that students can attempt to answer through experimentation, data analysis, and communication of results (Knight et al., 2012). Although inquiry has been deemed useful for students with exceptionalities, implementing inquiry-centered learning environments can be challenging for teachers working with this population of students (Knight et al., 2012; NSTA, 2017). While some students with autism demonstrate high levels of performance in the general education classroom, their communication styles, along with various other types of barriers, may not allow them to adequately demonstrate what they know without intervention (NSTA, 2017). Furthermore, in light of the accepted understanding that curriculum materials need to be appropriate and accessible for students of all learning styles, the need to provide research-based interventions for students with autism becomes abundantly clear (NSTA, 2017).

Despite this pressing need, few, if any, studies specifically address interventions for students with autism in an inquiry-based science classroom. A similar scarcity of research was noted by Knight and colleagues (2012) regarding science and students with developmental disabilities, in general. Given this lack of research, this author has sought to develop her own model. She hypothesizes that teaching strategies developed for a range of other content areas may be effective when applied to the scientific inquiry environment, as well. Following a description of barriers faced by students with autism in the classroom, the literature on research-based teaching strategies to aid these students will be examined in terms of how such techniques could be adapted for scientific inquiry. Overall, the aim of this paper is to provide researchers with a starting point to develop content-specific teaching strategies for students with autism within the inquiry-focused learning environment.

Autism and Barriers to Student Learning

What is autism? Usually diagnosed by age three, autism spectrum disorder (ASD) can cause difficulties with social skill development, interests, and ability to communicate; however, a range of disorders with variable severity fall within the ASD classification. This means that different students can present with different symptoms of the disorder. In terms of prevalence and etiology, by age eight, one in 150 children have been diagnosed. No known cause for the disorder has been identified (Ryan et al., 2011).

Barriers in the classroom. In terms of the effects of autism on the classroom experience, trouble with communication of information has been noted by several researchers (Hedges et al., 2014; Ryan et al., 2011). Such struggles can manifest in the science classroom, as scientific inquiry involves communication of results (Knight et al., 2012). For example, students

might have difficulty writing laboratory reports or participating in a class discussion. In addition to communication, navigating the social environment may be an additional barrier faced by students with autism (Casey et al., 2014; Friedlander et al., 2009; Hedges et al., 2014; Ryan et al., 2011). As noted in a focus group conducted by Hedges and colleagues, secondary students may face social anxiety as their difficulty in social situations becomes clearer to them (Hedges et al., 2014). In turn, it makes sense that difficulty interacting with peers can cause students to become uncomfortable in group work situations (Hedges et al., 2014). Students with autism may also crave routine and consistency, which can lead to difficulty adjusting to several different teachers and changes in the bell schedule (Friedlander et al., 2009; Hedges et al., 2014; Ryan et al. 2011). This could be a potential source of stress for students participating in scientific inquiry activities, as no two experimental procedures are exactly alike (Hedges et al., 2014). Focus on small details and trouble generalizing concepts also may present barriers in the classroom (Casey et al., 2014; Knight et al. 2012). Because scientific inquiry involves data analysis, students must be able to organize and make sense of how what they observed can be placed into the bigger picture (AAAS 1989; Knight et al., 2012). Other issues may include sensory issues or repetitive behaviors (Friedlander et al., 2009; Hedges et al., 2014; Ryan et al., 2011).

Teaching Strategies for Students with Autism

Strategies for Inquiry Learning. Given the challenges outlined above, it makes sense that research-based teaching strategies should be developed in an effort to overcome them. Knight et al. (2012) studied the use of explicit instruction with three elementary school students with ASD in order to test its efficacy for teaching students how to describe objects in general and in an inquiry laboratory setting. Using a strategy called model-lead-test, researchers followed three steps: show students an adjective and the objects it applies to, guide students in identifying objects, and ask students to identify objects on their own. Finally, students attempted to use these adjectives in an inquiry-lab setting with typically developing peers. While the instruction was effective for teaching the words, the results did not transfer as well to the inquiry setting. Knight et al. speculate that teaching the words during the actual inquiry lesson by giving examples prior to lab or using a response board during lab could yield greater improvements.

Applying this research to high school students, the results suggest that explicit instruction could be effective in science classrooms (Knight et al., 2012). In the context of inquiry, students would be carrying out experiments that require them to note observations. Using these techniques to make sure that students are familiar with the vocabulary that will be used, then, may be a way to help them communicate with other peers and their instructors.

Strategies from Other Content Areas. Looking at the research conducted with students with ASD in other content areas points educators to Applied Behavior Analysis (ABA) ABA has been recommended in general and for physical education (Ryan et al., 2011; Szapacs, 2006). In the physical education setting, ABA breaks down behaviors into what caused the behavior, what the behavior was, and what type of reinforcement resulted from the behavior (Szapacs, 2006). In terms of a gym class, a larger goal, such as correctly kicking a soccer ball, can be broken down into individual steps using visual cues. A pre-test is given first to help develop the steps, and then the cues can be slowly reduced or removed over time until they are no longer needed. Ryan and colleagues (2011), too, found that providing reinforcement helped to promote positive behavior.

For the sciences, ABA could be used in order to help students explain what their data mean. If a student struggles to write a laboratory report or describe a procedure, for example, the teacher could break the process into smaller steps and allow the student to gradually reach independence with the task. In addition to helping students complete and write about a laboratory experience, the development of steps could help address the lack of routine that some authors have noted may be stressful (Friedlander et al., 2009; Hedges et al., 2014; Ryan et al., 2011).

A research-based strategy called Self-Regulated Strategy Development (SSRD) has been proven useful for students with autism who struggle with writing (Casey et al., 2014). SSRD is a 6-stage technique that uses acronyms to help students through the writing process. Acronyms and tools such as "POW" (pick ideas, organize notes, write more), and "WWW," which guides students through 7 smaller questions, have proven helpful for students with ASD. Although the "WWW" strategy seems to work better for creative writing, it seems plausible that a similar approach could be used for writing laboratory reports. For example, students could answer "What was my question?", "How did I figure it out?", "What did I see?", "What does it mean?" Similarly, a process could be developed for thinking about how to write a laboratory procedure. Again, the presence of a strategy to follow could improve communication, as well as addressing the desire for routine (Friedlander et al., 2009; Hedges et al., 2014; Ryan et al., 2011).

General Recommendations. Apart from studies for specific content areas, general strategies have been developed that work for multiple areas. Among these, the use of social stories can help to alleviate social issues by providing a depiction of how to navigate social situations (Friedlander et al., 2009; Ryan et al., 2011). Such stories could be used for expectations such as laboratory safety or working with others. A system called Treatment and Education of Autistic and Communication Handicapped Children (TEACCH) also recommends keeping an area organized, providing a schedule, and giving visual prompts on the task and how to navigate the work area. This organization helps students to be clear about expectations

and gives them a sense of routine (Friedlander et al., 2009; Hedges et al., 2014; Ryan et al., 2011). Friedlander and colleagues (2009) also suggest providing some sort of outlet for sensory problems. For writing, Casey and colleagues (2014) suggest explaining both verbally and visually, allowing extra time and individual attention, and shortening tasks. Finally, Hedges and colleagues (2014) say that care should be taken to help students form relationships with other students and that the use visual cues and good communication among staff may be helpful (Hedges et al., 2014).

Limitations and Recommendations

Although some of the strategies listed above have been proven effective, the current research is limited. First and foremost, only one of the above strategies specifically discusses implementation in an inquiry-based science environment (Knight et al., 2012). Additionally, the study by Knight and colleagues, as well as the study by Scapacz (2006), only assessed teaching strategies at the elementary level. Further he study by Knight and colleagues only had three participants, all from the same school district, so results may not generalize to other students. Most importantly, despite success in other content areas or with other age groups, it cannot be guaranteed that the strategies discussed above will work well in the specific setting of inquiry-based science education until further research is implemented. That being said, this publication has reviewed strategies that have been successful over several different content areas and given a few general recommendations; however, the assertions described above represent hypotheses about what *may* work. Further research is desperately needed in order to determine how we can best serve students with autism in this type of environment. It is the hope of this author that the hypotheses outlined above will serve as starting points to spark future research.

Conclusion

While inquiry activities are essential to the teaching and learning of science, students with autism may face barriers in the classroom which make it difficult to access and communicate the information learned. Among these barriers are communication and social skill difficulties, a need for a routine, a tendency to focus on small details, and the prevalence of sensory issues, generalization issues, and repetitive behaviors (Casey et al, 2014; Friedlander et al., 2009; Hedges et al., 2014; Knight et al., 2012; Ryan et al., 2011). Although strategies such as ABA, TEACCH, explicit instruction, and SSRD have been successful in other settings, only explicit instruction has been examined during a scientific inquiry lesson, and most strategies have only been attempted with elementary, rather than secondary students (Casey et. al. 2014; Knight et al., 2012; Ryan et al., 2011; Szapacs, 2006). Yet given their success in other content areas, it is reasonable to believe that such strategies, as well as the general recommendations noted above would be viable in the high school, inquiry-based science classroom; however, such claims cannot be substantiated without empirical evidence. The lack of research on autism and science inquiry specifically presents a major hole in what is known and points to a need to study this topic in a more in-depth way to gain more answers. Studies should be conducted that follow students with autism through science classes in order to test whether similar interventions will work for inquiry activities. If this research proves fruitful, very positive changes in the classroom could result.

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