GROUNDWORK
Furthering the Influence of Earth Science

Harnessing an Effective Geoscience Curriculum for Students with Autism Spectrum Disorder

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INTRODUCTION

There is a growing awareness of the need to help individuals with autism survive the rigors of the classroom. On average, one in 68 students is diagnosed with autism spectrum disorder (ASD) annually (Autism Speaks: "Facts about Autism," n.d.). ASD is a large spectrum, ranging from nonverbal individuals who respond minimally to intervention to individuals who "lose their diagnosis" (Sarris, 2016). A loss of diagnosis occurs when individuals are nearly indistinguishable from their peers; some individuals even use their savant-like qualities to compensate for their challenges (Winter-Messiers and Herr, 2007; Wisconsin Medical Society, 2016). ASD causes challenges with communication, knowledge of socially appropriate behaviors, and sensory regulation (Autism Speaks: "DSM-5 Diagnostic Criteria," n.d.). Individuals with autism are said to attempt to cope by engaging in self-stimulatory behaviors. These are behaviors that provide sensory input, which include rocking, flapping hands, and rubbing hands. These challenges can be mitigated when building on the strengths of individuals with ASD, which can include science (Education Insider, 2015). One area of difficulty for students with autism is the *hidden curriculum*—the accepted attitudes and behaviors not part of the formal curriculum but necessary for social interactions (Myles and Simpson, 2001). Teachers can build on areas of strength while utilizing science to teach the hidden curriculum.

METHODOLOGIES

Effective teaching methodologies first must be in place before building beyond the geoscience curriculum. The first step is to interest students in the natural world. Students with autism are often withdrawn and avoid new and unfamiliar experiences. However, we have found that a camera can be used to motivate students to voluntarily look for new experiences and become more involved and social. This can be incorporated into the curriculum by having them take photographs both on field trips and in man-made environments, such as at school and students' homes. More challenged students can compare indoor and outdoor environments. If motivation is effective, a good geoscience curriculum will bring science to life; motivation may become self-generating. Many teachers disregard the essence of a well-rounded geoscience curriculum and design static lessons bound to PowerPoint presentations, worksheets, and online video curricula. However, students' natural curiosity itself can be an effective motivator (Chalufour, 2010). Because science is about exploring, collecting, and organizing the rules that govern the natural and/or social world (Science Made Simple Inc., 2006), geoscience should be applied to students' lives using hands-on activities and field trips (Chalufour, 2010; Berer, 2015). The science curriculum should be used to deepen students' understanding of natural processes and to discover the beauty and symmetry around them (Teacher Vision, n.d.). Providing autistic students with an understanding and opportunity to interact with natural phenomena may decrease anxiety, as well as provide a sanctuary for when they become overwhelmed (Mind, 2013, p. 38).

When the geoscience curriculum becomes more abstract, teaching from the *bottom-up* by beginning with basic details before moving to the more complicated, overarching concepts and skills is essential. Temple Grandin, a well-known autistic writer and lecturer, advocates the use of bottom-up teaching with many examples to provide context and generalization (Grandin, 2011). Bottom-up teaching could include beginning the year by defining the study of geoscience and its purpose in the classroom as a base for the other science units. It is also important to explain the concept of time to include thousands of years (Flammer, 2011). Flammer suggests using one dollar to represent one year and then having students imagine that some of the fossils' years in dollar thickness would add up to the size of a football field. Students with autism will benefit from this visual method of explaining what would otherwise be esoteric concepts. Flammer also describes a possible class activity whereby students guess how long ago selected fossils lived, after which they place the fossils in chronological order (Flammer, 2011).

To reach all students, vary the mode of instruction to encompass visual, tactile, kinesthetic, musical, and artistic strengths (Virginia Dept. of Education, 2011, p. 11). Varying learning experiences can address sensory issues, motivate students, and improve application of the material (Virginia Dept. of Education, 2011, p. 94). Building on students' strong curiosities, fixations, and strengths can be accomplished by providing choices in the topics covered, as well as letting students choose the modes of input and output of information. Student choice enables better learning, motivation, engagement, and classroom management to aid in developing

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flexibility and problem-solving (National Science Teachers Association, n.d.). However, three choices should be the maximum provided to decrease the chance of being overwhelmed (Education Insider, 2015).

Cooperative learning should be used to build social skills (Virginia Dept. of Education, 2011, p. 19, 115). Because individual strengths are integral to the group, cooperative learning enables students with autism to utilize advanced skill sets. Emphasizing individual strengths within the group may help students carve a niche in the classroom hierarchy, and improve self-esteem and peer acceptance (Chalufour, 2010).

APPLICATIONS

Teachers could teach a scientific concept alongside an application into the hidden curriculum—that is, concepts not normally intended to be taught in lessons. Examples include social skills such as deceit, life skills, and flexibility to changes. To organize these concepts, students can use a double-entry journal to log the scientific area of study alongside its application.

Typically, children develop their understanding and application of concepts, such as determining sarcasm, innately, but many students with autism require specific instruction in this regard (National Science Teachers Association, n.d.). To help students understand deceit, they could research causes of falsified fossil records. Fossils have been falsified for attention, money, fame, religion, medicinal quackery, and to embarrass others (Monteith, 2012). Discussing the concepts of sarcasm, lies, and deception with examples may help students apply them to their own lives.

The fossil record can be used to explore the concept of change. The fossil record contains patterns of extreme and sudden change followed by long periods of stasis (punctuated equilibrium). Learning and exploring the concept of change, being able to name types of change, and seeing that there are times of stability can help prepare students with autism for life changes such as moving to middle or high school, or into adulthood. The teacher can point out that these periods of change are followed by periods of calm and equilibrium. Moreover, this lesson can be used as a springboard for calming strategies during periods of change. Students will then be better equipped to deal with expected changes because they can expect periods of stasis as well. Even in an inclusive classroom, special-needs students may have difficulty relating to their peers and vice versa. However, learning about the differences between brachiopods and bivalves, for example, could demonstrate that differences do not preclude similarities. The class could be grouped and assigned questions to discover common interests.

One field trip technique that helps students with autism overcome defensive behaviors, such as repetitive self-stimulation, is a fossil-collecting trip. In the Hudson Valley, New York, USA, there are several shale outcrops from which it is easy to collect specimens of brachiopods, solitary corals, and bivalves. Students are given a handout and plastic bags and told to scour the outcrop to locate the fossils and place them in the bags. They work in pairs and become very enthusiastic and more curious and energetic as their collection grows. Ritual with the same pattern reduces fear of change; it is a task with order and routine. Finding the fossils and identifying the specimens could act as a distraction that makes some of them temporarily forget their defensive behaviors. It should be noted that in addition to collecting opportunities such as that mentioned in the Hudson Valley, numerous opportunities exist elsewhere and should be sought out.

CONCLUSIONS

The Common Core curriculum emphasizes reading, writing, and math more than science and history. However, this does not diminish the importance of science to every student, and especially to students with autism. Although most of these methodologies benefit students at the higher end of the ASD spectrum, geoscience can be utilized to encourage long-term growth socially and emotionally. Teachers can build on effective teaching methodologies to strengthen socio-emotional skills, develop self-confidence, and mitigate anxiety in students with autism.

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