Science Education for the Developmentally Disabled

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SCI398
Thursday April 6, 2006
Developmental disabilities are chronic disabilities attributed to mental or physical impairments that result in below average functional limitations within areas such as self-care, language, and learning. Down syndrome, attention deficit/hyperactivity disorder, dyslexia, and autistic spectrum disorders are all classified as developmental disabilities. Individuals with these disabilities have learning needs that differ from those of the general student population (Specht, 2004). Prior to the introduction of the Education Amendment Act in 1980, guidelines regulating special education in Ontario did not exist (Ministry of Education, 2006) and the learning needs of the developmentally disabled were ignored. The current school curriculum requires that all students with disabilities be placed in an inclusive environment that does not restrict development and allows, whenever possible, interaction with their general education peers (Cawley et al, 2002; Steele, 2004). Inclusion is considered the best practice for schools, and is placed on a continuum to accommodate for the wide variety of abilities portrayed between and within various developmental disabilities (Brownell and Walther-Thomas, 2001).

The learning needs and placement requirements for each individual with a developmental disorder are determined through extensive diagnostic procedures, the results of which are then used to create an Individual Education Plan (IEP). The primary function of the IEP is to describe the student’s academic abilities, needs, goals, and more importantly how the school will address and meet these needs and goals (Ministry of Education, 2006; Specht, 2004). Once an IEP has been created, students with developmental disabilities can be placed in a variety of classroom settings (Ministry of Education, 2006).

The largest amount of inclusion occurs when students with developmental disabilities are placed in a general education classroom for the entire school day, with or
Students with developmental disabilities may also be placed in a general education classroom during pre-selected subject blocks, while being pulled out of the classroom for subjects in which they require additional one-on-one instruction. The least amount of inclusion occurs when a student with a developmental disability is completely separated from their general education peers. This type of separation can occur by placing a student with a developmental disability in a special education classroom within a general education school, or in a fully segregated school that is designed for individuals with developmental disabilities. The option of placing the student in a special education class within a general education school is generally preferred as it still allows the student to benefit from social interaction during occasions such as physical education class and recess.

Researchers have established that parents of individuals with developmental disabilities have shown preferences in the type of inclusionary setting their child is placed within depending on the type of developmental disability the child is diagnosed with. It has been shown that parents of individuals with autism prefer their child to be placed within a general education class on a consistent part-time basis, while parents of children with Down syndrome had a significant preference for full-time placement in a general education classroom for their child (Kasari et al, 1999). Unfortunately, the whole team that completed the IEP, which includes not only the child’s parents, but also, the child’s teachers, principal and many other professionals, determines placement decisions. This means that the parental preferences do not always determine the placement for their child.

The Education Act clearly states that a student must be placed in the least restrictive environment and that exclusion from the classroom can only occur if it is absolutely necessary (Ministry of Education, 2006). This requirement under the Act has
resulted in an increased amount of students with developmental disabilities receiving their educational instruction in a general education classroom. This increase in inclusion creates a dilemma for instructors, as they need to amend their teaching materials and assessment tools to accommodate for students with developmental disabilities (Grumbine, and Brigham Alden, 2006; Brownell and Walther-Thomas, 2001;).

Unfortunately, many of the instructors have very little training and experience with individuals with developmental disabilities and they require addition help or training to be able to adapt their teaching methods (Cawley et al, 2003; Norman, Caseau, and Stefanich, 1998). The materials used to teach science, in particular, need to be modified to reduce the barriers that exist due to slower reading ability, an inability to focus, and/or poor organizational skills (Sullivan Palincsar et al, 2001; Stefanich, 1998; Ormsbee and Finson, 2000). Unfortunately, additional help or training is not always available and the instructor must try to adapt as best as they can with the limited resources on hand.

The exclusion of student with a developmental disability from the classroom environment is determined via diagnosis of the severity of the developmental disability. Generally, the more severe the diagnosis, the greater the extent of the exclusion. This method of determining exclusion is the educational systems most unbiased means to ensure that no child is ignored or ‘left behind’ in their education, while not jeopardizing the educational advancement of students within the general education classroom by including a student with a developmental disability that will not benefit from it.

Students who are placed in a segregated special education classroom usually do not receive any formal science instruction, rather, they are taught basic life skills, some of which require an appreciation of scientific concepts, that will enable them to be as independent as possible as adults (Schneider, 2002). This appreciation of scientific
concepts is taught through basic explanations, for example, that a hot stove shouldn’t be touched or else a burn will result, and not explicit instruction as to how and why these scientific concepts occur.

An exception to the general relationship between the severity of an individual’s disability and the level of educational exclusion occurs in the very rare cases of savants (Schoen, 2003). Savants are generally autistic individuals that are placed on the severe end of their disability (Schoen, 2003) and possess an exceptional talent in one particular area. A savant case for science has not yet been documented, yet savants in mathematics have been widely noted (Pring, 2005). Pring and Hermelin (2002) found that the savant they were studying made no errors when given a new mathematical problem and concluded that this demonstrated the savant’s “fast and spontaneous recognition of new rules and of new relationships between them”. Through this study, Pring and Hermelin (2002) were able to support the notion that savants do not require strict formal instruction in their area of excellence as their skill in that area comes naturally and without any additional instruction or practice.

Although individuals with developmental disabilities may require curriculum modifications in order to be able to participate and benefit from their school environment, they can excel in their academic endeavours with proper modifications (Brownell and Walther-Thomas, 2001).

Individuals diagnosed with mild or moderate developmental disabilities are included in regular classroom activities as often as possible. General adjustments to the curriculum are made using input from the student’s individual education plan and accepted recommendations from research studies (Cawley et al, 2002). Individuals within the mild to moderate range require a highly structured routine (Cooper Swanson,
2005) due to deficits in organizational ability (Kirk et al, 2003). They need to know what
tasks or activities they will be completing, when they will be completing them, and how
they will be completing them.

Many general environmental modifications can be made to assist students with
developmental disabilities to achieve academically while in an inclusive setting.
Auditory and visual distractions need to be reduced, clear physical and visual boundaries
need to be established, and space needs to be organized (Cooper Swanson, 2005).

Auditory and visual distractions disturb the concentration of individuals with
disabilities due to the fact that these individuals have difficulty filtering out secondary
distractions in order to concentrate at the task at hand (Cooper Swanson, 2005; Ormsbee
and Finson, 2000). These distractions can be reduced by having simple and very few
decorations around the workspace, being aware of and controlling for noises that may
distract the student from focusing on their task, and by having children work in a quiet
area when possible.

Clear physical and visual boundaries are required for students with developmental
disabilities due to the fact that they learn more effectively when there is a specific context
to a room or table (Cooper Swanson, 2005). Individuals with developmental disabilities
have improved concentration and transitions between tasks if they can pair the context of
a room or table with the subject they will be working on (Cooper Swanson, 2005).
Science and math are subjects often taught in the same classroom as history, geography,
and art. This makes it difficult for the student to link the setting to the subject. The
instructor can assist the student in transitioning and concentrating on science by having
them wear a lab coat and pretending they are scientists. Mathematics can be shown by
placing numbers on the desk or by having the student take out their calculator. These
simple environmental modifications create clear physical and visual boundaries for students with developmental disabilities.

As mentioned previously, students with developmental disabilities require very structured atmospheres and routines. Ensuring the work environment is a very organized space for the child will facilitate this requirement (Steele, 2004) and allow the child to focus their concentration. Spatial organization is achieved when all classroom items and materials have definite locations where the student is familiar and comfortable retrieving and replacing them. Organization is also achieved when clutter is kept to a minimum. Minimal clutter promotes concentration and reduces visual distractions.

Aside from the environmental modifications noted above, many other general, educational modifications can be made to assist students with developmental disabilities achieve success in their inclusive classroom. Many of these students may benefit from having schedules, transition cues, highly organized activities, clear rules and routines, and choices (Grumbine and Brigham Alden, 2006; Cooper Swanson, 2005).

Schedules created for the student may take many forms. Monthly schedules prepare a student for what will occur over a longer time frame and provide a sense of where the classroom instruction will progress (Grumbine and Brigham Alden, 2006; Cooper Swanson, 2005). These schedules can be used to assist a student in counting down to an event and preparing them in the long-term for a change in routine that may be approaching. Weekly schedules are used as a shorter-term preparation for changes in routine (Cooper Swanson, 2005) and show the student what changes they can expect within the week. For example, the weekly schedule may prepare the student for a long weekend, a trip to the observatory, or an in-class laboratory. Activity schedules are useful in assisting the student to complete a task (Grumbine and Brigham Alden, 2006;
Cooper Swanson, 2005). These schedules outline the steps in a task and are in the form of a checklist. When the student completes a step, he/she checks it off and moves on to the next step, progressing through the activity with each step. For example, the natural progression of a student through a mathematics period would be to start by reviewing their previous homework assignments, followed by instruction of a math lesson, after which they will start their assignment, and when time is up they will receive the homework from the teacher (Cooper Swanson, 2005).

Transition cues are also beneficial for individuals with developmental disabilities as they assist the student in determining the completion of one task and the commencement of the next. There are several different means of presenting transitional cues. Pictures that show the student what subject will be occurring next, such as a picture of a microscope to demonstrate science, are the most basic. Activity schedules provide a guideline for task completion. The use of clocks is also useful to help the student align activities with the time of day. All of these transition cues have been shown to be advantageous for students with developmental disabilities (Cooper Swanson, 2005; Cawley et al, 2003).

Another beneficial modification occurs when activities are highly organized, structured and visually stimulating. Individuals with developmental disabilities profit greatly when an instructor videotapes an activity, such as the science experiment that will be performed, and then shows this videotape to the student before the experiment is begun (Cawley et al, 2003; Steele, 2004). This is beneficial due to the fact that if the student can observe what is expected of them prior to attempting their experiment, they will feel more prepared, and less overwhelmed by all the procedures.
Clearly explained rules and guidelines facilitate learning for individuals with developmental disabilities by providing the structure and feedback required to maintain an activity and classroom routine (Grumbine and Brigham Alden, 2006; Cooper Swanson, 2005). Also, presenting students with an option as to which worksheet they will complete, especially in mathematics, allows the student to feel as if they have some control over their education, motivating them to focus on the task at hand (Cooper Swanson, 2005).

In addition to the general modifications listed above, science classrooms, science instruction, and science teaching materials need to be altered in a variety of ways to accommodate for students with developmental disabilities (Sullivan Palincsar et al, 2001; Grumbine and Alden, 2006; Cawley et al, 2002; Steele, 2004; Cawley and Miller, 2003; Ormsbee and Finson, 2000).

Many students with developmental disabilities have deficiencies in basic academic skills such as reading, science, and mathematics, when compared with their age-matched peers (Olson and Platt, 2004). As a result, science and mathematics textbooks are currently written two to three years above the reading level of students with disabilities (Steele, 2004). To properly incorporate students with developmental disabilities, these textbooks either need to be rewritten or additional teaching materials, such as Coles notes, need to be used. The most effective adjustment to accommodate developmental disabilities occurs when science material used to teach the students is rewritten or restructured in a way that adjusts for the literary deficiencies students with developmental disabilities possess (Ormsbee and Finson, 2000). Modified teaching tools and materials offer a more realistic alternative than expecting authors and publishers to re-write textbooks.
Researchers recommend that, when teaching science, instructors use a multisensory approach that accommodates diverse learning styles and strengths (Alexakos, 2001; Grumbine and Brigham Alden, 2006). When material is presented in a variety of arrangements, multiple senses such as auditory, visual, oral, and/or kinaesthetic and tactile, are used (Steele, 2004). This multisensory environment does not focus on one sense alone and allows a student with a developmental disability to effectively learn science by compensating for a lack in one sensory area by using other sensory areas. Hands-on science experiments are also an ideal way of implementing this multisensory approach because the student must listen to receive information and instructions while physically participating in the observation, recording and discussion of experimental results. These hands-on experiments have been validated and supported through a number of research studies (Cawley et al, 2002).

Students with developmental disabilities also benefit when science material is taught explicitly (Grumbine and Brigham Alden, 2006), in themes (Steele, 2004), and is broken down into sub-units (Alexakos, 2001). Theme and content breakdown help a student with a developmental disability focus without overwhelming them with new and complex material (Steele, 2004). Explicit instruction teaches the student how to plan and complete their task, as well as manage their time effectively (Grumbine and Brigham Alden, 2006). The ability to manage time properly is essential in the science curriculum as new concepts are built upon previous concepts, and thinking and organizational skills are a necessity for successful task completion and academic achievement (Grumbine and Brigham Alden, 2006).
Although, most students with developmental disabilities may benefit from the modifications mentioned above, certain developmental disabilities may require additional modifications in their science curriculum.

Students with dyslexia generally do not have concentration impairments similar to students with autistic spectrum disorders, attention deficit hyperactivity disorder, or learning disabilities. The symptoms of dyslexia are characterized by delayed ability to learn how to read (Shaywitz and Shaywitz, 2004). However, when the student learns how to read, he/she is able to comprehend the science and mathematics material presented to them. Unfortunately, once the ability to read proficiently is attained, students with dyslexia remain reluctant to write (Straits, 2005). These students need to be inspired to write via methods that motivate them to practice their analytical and organizational thought skills (Straits, 2005). Straits (2005) noted that science was the ideal subject to achieve these skills due to the fact that each experiment requires a written hypothesis, documentation and collection of information, and demonstration of results. Researchers have found that modifications created to alleviate the problems that students with dyslexia face surrounding practical and written work, benefit the students in the general education science classroom as well (Rowcliffe, 2002).

Successful integration into the science curriculum can occur if special education teachers, general education teachers, parents, and professional workers collaborate in assessing the needs of individuals with developmental disabilities (Steele, 2004). Achievement in the science classroom is accomplished when the needs and abilities of the individual with developmental disabilities are considered, and when properly designed modifications of the environment and curriculum are made.
References


