**What are the Best Methods for Teaching STEM Concepts in Environmental Education to Students with High Spectrum ASD and ADHD?**

## Abstract

Currently, in the United States, Autism Spectrum Disorder (ASD) is the fastest-growing developmental disability, affecting 1 in 68 children and costing $11.5 billion - $60.9 billion a year (2011 US dollars) – 29-83% of people with autism also Attention Deficit Hyperactivity Disorder (ADHD) (Data & Statistics: Autism Spectrum Disorder (ASD), 2015). In a report to President Obama from the Committee on STEM Education National Science and Technology Council, Holdren details the, "importance of STEM education to American scientific discovery and innovation, the need to better prepare students for today's jobs and those of the future, and the importance of a STEM-literate society." (Holdren, 2013, p. 14) However, students with disabilities have, for the most part, been left out of the conversation. Traditionally, the number of individuals with disabilities in STEM careers lags behind underrepresented minority students or women. (Green, 2014, dedication page) In a comprehensive review, Spooner et al. (2010) found 17 studies related to science." As of December 2015, only ten resources that touch on using Direct Instruction (DI) or Explicit Instruction (EI) methods in teaching students with ASD or ADHD could be located. The only textbook published specifically on the topic, *S.T.E.M. education: Strategies for teaching learners with special needs* by Green (2014) does not specifically discuss the use of DI or EI as beneficial teaching methods in this realm. However, the tenants of DI and EI, present information in a systematic manner, paired with model-lead-test correction procedures are congruent with recommendations from research findings of the Center for Assistive Technology and Environmental Access (CATEA, 2012). The authors found that students on the spectrum benefit from: Graphic organizers with which to visualize connections and relationships; Time management techniques for breaking down complex tasks into manageable tasks; Charts and graphics to illustrate concepts; Vocabulary lists; Clear concise instructions; Study guides; Discussions and directions for completing research techniques; Distraction-free environments (Moon, Todd, Morton, & Ivey, 2012, p. 94). Green's textbook also introduces notable autistic professor Temple Grandin theory of three different types of brains of individuals on the Autism spectrum: (I) visual thinkers; (2) music and higher math brains; and (3) verbal lists and translator

brains (Green, 2014, p. 88; Grandin & Duffy, 2008).This paper explores how an existing general education science lesson can be redesigned using EI principals. In the discussion section, specific adaptations and why they meet recommendations by CATEA (2012) and Grandin & Duffy (2008) will be highlighted.

## Introduction

As a parent of a child with ASD and ADHD I have spent years seeking equally effective education for twice exceptional students like my daughter who is exceptionally intelligent and exceptionally challenged. In this paper inspired by the journey to advocate for my daughter, I begin with an "Overview of ASD and ADHD" to insure that readers understand the different challenges these students face in life. I explain why the need for properly educating these students has far reaching implications for many populations. Next, I address how challenges effect students and teachers in the classroom. Exploring the foundations of DI and EI provides the framework for my decision to redesign a current general education Science lesson using EI teaching methodology. During that research I discovered recommendations by CATEA and Dr. Temple Grandin which also influenced my redesign of the Science lesson. I include my redesign in the "Implementation" section and then cover data-based reasons for specific areas of the redesign in the "Discussion" section. Finally, I conclude why further research and studies are important in this area.

## Overview of ASD and ADHD

### What is Autism Spectrum Disorder (ASD)?

According to the National Institutes of Health Autism Spectrum Disorder (ASD): Condition Information (2013), ASD is a complex neurological and developmental disorder that begins early in life and affects how a person acts and interacts with others, communicates, and learns. ASD affects the structure and function of the brain and nervous system. Because it affects development, ASD is called a developmental disorder**.** ASD can last throughout a person's life.

The *Diagnostic and Statistical Manual of Mental Disorders* (2013) states that people with this disorder have problems with: Communication and interaction with other people and restricted interests and repetitive behaviors. Different people with autism can have different symptoms. For this reason, autism is known as a spectrum disorder—which means that there is a range of similar features in different people with the disorder.

Naturally, spectrums have two endpoints. Asperger Syndrome and High-Functioning Autism (HFA) are terms applied to the high- functioning end of what is known as the spectrum of pervasive developmental disorders, or the autism spectrum. Asperger Syndrome is a relatively new category, as it was officially recognized in the Diagnostic and Statistical Manual of Mental Disorders (DSM IV) for the first time in 1994. In the future, it is possible that the DSM may combine AS and HFA into one category, as they are very similar and the treatment approaches for each are the same. Since AS/HFA shows a range or spectrum of symptom severity, many individuals who might meet criteria for that diagnosis are viewed as "unusual" or “awkward," or are misdiagnosed with other conditions such as Attention Deficit Disorder. (Diagnostic Overview: Asperger Syndrome and HFA, n.d.)

**What is Attention Deficit Hyperactivity Disorder (ADHD)?**

According to the National Institutes of Health, ADHD is one of the most common childhood disorders and can continue through adolescence and adulthood. Symptoms include difficulty staying focused and paying attention, difficulty controlling behavior, and hyperactivity (over-activity).

ADHD has three subtypes. 1) Predominantly hyperactive-impulsive: Most symptoms (six or more) are in the hyperactivity-impulsivity categories. 2) Predominantly inattentive: The majority of symptoms (six or more) are in the inattention category and fewer than six symptoms of hyperactivity-impulsivity are present, although hyperactivity-impulsivity may still be present to some degree. Children with this subtype are less likely to act out or have difficulties getting along with other children. They may sit quietly, but they are not paying attention to what they are doing.

Therefore, the child may be overlooked, and parents and teachers may not notice that he or she has ADHD. 3) Combined hyperactive-impulsive and inattentive: Six or more symptoms of inattention and six or more symptoms of hyperactivity-impulsivity are present. Most children have the combined type of ADHD. (National Institutes of Health, n.d)

## Needs Assessment: How do ASD and ADHD affect students and why should we all care?

Currently, K-5 curricula are not designed to accommodate students with High Spectrum ASD and ADHD. Most typically developing classrooms do not have a track for students who are extremely advanced in vocabulary, spelling and math with very strong interest in science. High Spectrum ASD and ADHD students tend to excel at and have a greater interest in STEM. These students are falling through the cracks because they are bored in age appropriate classes, quickly become disengaged then develop behavioral issues to keep themselves occupied.

A study involving half a million people in the UK published October 2015,"conclude(d) that autistic traits are consistently higher in males than females, and in those working in STEM than in non-STEM fields." (Ruzich et al., 2015) One of the study's authors, Professor Baron-Cohen added: "Previous studies have found the number of autistic traits a person has is influenced by both genetic factors and prenatal testosterone levels. These may shed light on why we find males in the population on average have slightly more autistic traits than females do, and why fathers and grandfathers of children with autism are over- represented in STEM fields." (Ruzich et al., 2015) This supports the notion that High Spectrum ASD students have a higher probability of succeeding in physics and mathematics at high levels. We cannot afford to lose these students who could be so valuable to America's ability to compete in the global work force.

### How do ASD and ADHD affect students?

Centers for Disease Control and Prevention (CDC) Data & Statistics on ASD states that some of the main difficulties (for ASD students) can include: Communicating with teachers, support staff

or other students, following instructions, following classroom rules, knowing how to behave, concentrating on a task – 29-83% of people with autism also ADHD.

**Why should we all care?**

The Individuals with Disabilities Education Act (IDEA) of 2004 insure that students with disabilities (including ASD and ADHD) are provided with Free Appropriate Public Education (FAPE), but the population with these diagnoses continues to increase.

According to the CDC (2015) Data & Statistics:

- Autism is the fastest-growing developmental disability.
- It affects 1 in 68 children in the U.S.
- It affects over 3 million individuals in the U.S. and tens of millions worldwide.
- The total costs per year for children with ASD in the United States were estimated to be between $11.5 billion - $60.9 billion (2011 US dollars).
- It costs a family $60,000 a year on average.
- Statistics suggest an increase of 10 to 17 annually in recent years.
- There is no medical detection or cure for autism or ADHD.

ASD and ADHD diagnoses are not only increasing and expensive, all of these students bring unique perspective and offerings to our body of knowledge. Like my daughter, they are loved by friends, family and community members. They deserve to have an education that best serves their individual needs so they have a chance to live their lives as productively as anyone else in our country.

## History of Direct Instruction (DI) and Explicit Instruction (EI)

### Direct Instruction (DI)

According to the The National Institute of Direct Instruction (NIFDI), the term direct instruction was first used in 1968, when Science Research Associates published a beginning reading program called DISTAR, authored by Sigfried Engelmann and his colleagues. Since 1968, the use

of the term direct instruction has evolved in two main directions: DI and di. (NIFDI, 2015)

*Direct Instruction (DI)*

In the 1960's, Zig Engelmann created this explicit, carefully sequenced and scripted model of instruction. Published Direct Instruction programs are based on a landmark empirical research study and numerous follow-up studies over the last thirty years about how children actually learn. *Project Follow Through* (1967), the largest educational experiment ever conducted, evaluated nine major approaches to educating at-risk students. Only students taught with the Direct Instruction approach consistently outperformed control students on basic, cognitive, and affective measures. Direct Instruction is sometimes referred to as "capital DI". (NIFDI, 2015) DI from the NIFDI, Zig Engelmann's legacy, offers a very specific curriculum which addresses all Common Core Standards and is based on a model of group choral responses to the teacher's verbal and visual scripts provided in NIFDI course materials. NIFDI does not provide curriculum specifically directed towards students with ASD and ADHD.

*direct instruction (di)*

In his 1976 teacher effectiveness research, Barak Rosenshine gave this term to a set of variables found to be significantly related to student achievement. This set of variables included engaged time, small group instruction, and specific and immediate feedback. This approach is often referred to as "small di". (NIFDI, 2015)

**Explicit Instruction (EI)**

EI is based on Engleman & Carnine's 1991 work which created a teacher-lead instruction model that used examples and "non-examples" in teaching students. In 2011, Archer & Hughes (2011) expanded on Engleman & Carnine's (1991) work by creating their own instructional foundation in their book about EI that provides clear guidelines for identifying key concepts, strategies, skills, and routines to teach; designing and delivering effective lessons; and giving students opportunities to practice and master new material. Archer & Hughes (2011) also provide

sample lesson plans, lively examples, and reproducible checklists and teacher worksheets so that rather than providing an all-inclusive, off the shelf curriculum as NIFDI does, they provide examples for instructors to develop their own curriculum. Being open-ended, EI provides the basis I need for developing new curriculum for underserved students with ASD and ADHD.

## Exploration of current methodologies using EI to teach STEM curriculum to students with ASD and ADHD

There are very few publications addressing STEM education for students with developmental disabilities – no matter what teaching method is employed. In a 2012 study by Knight et. al. *Using Explicit Instruction to Teach Science Descriptors to Students with Autism Spectrum Disorder*, the authors state, "Although science learning is important for all students, there are few studies addressing this content for students with developmental disabilities. In a comprehensive review, Spooner et al. (2010) found 17 studies related to science. While these studies provide some evidence that students with developmental disabilities can learn science content, much more research is needed to develop effective interventions." (Knight, Smith, Spooner & Browder, 2012, p 378).

To date, my literature review only found eight resources that touch on using EI methods in teaching STEM curriculum to students with ASD or ADHD. The only textbook published specifically on the topic, "S.T.E.M. education: Strategies for teaching learners with special needs" by Green (2014) does not specifically discuss the use of DI or EI as beneficial teaching methods in this realm. Instead the author defers to a well-recognized person on the Autism spectrum in current academia, Temple Grandin, an author, advocate and professor at Colorado State University. "Grandin contends that there are three different types of brains of individuals on the Autism spectrum: (I) visual thinkers; (2) music and higher math brains; and (3) verbal lists and translator brains." (Green, 2014, p. 88; Grandin & Duffy, 2008) Green also acknowledges the link between ASD and ADHD: A survey of the Online Asperger Syndrome Information and Support Website (OASIS) found that" ... 65% [of parents] indicated that their child had been initially described as one or another type of ADHD, while 44% stated that their child had a dual diagnosis of AS and a form of

ADHD" (Romanowski-Bashe & Kirby, 2001, p. 69).

Based on this theory, Green (2014) writes, "Along with a very clear understanding of a student with Autism's educational needs there are many ways to incorporate customized instruction. According to the research findings conducted by the Center for Assistive Technology and Environmental Access (CATEA), students on the spectrum will benefit from: Graphic organizers with which to visualize connections and relationships; Time management techniques for breaking down complex tasks into manageable tasks; Charts and graphics to illustrate concepts; Vocabulary lists; Clear concise instructions; Study guides; Discussions and directions for completing research techniques; Distraction-free environments; Access to technology for creating notes, drawings storing and accessing information; Course management through web-based instructional software; Online bulletin boards and Social media." (Moon, Todd, Morton, & Ivey, 2012)

## How could EI be used to enhance teaching STEM concepts in Environmental Education to students with high spectrum ASD and ADHD?

The principles of effective instruction that are introduced by Archer & Hughes (2011) in their book *Explicit instruction: Effective and efficient teaching* can be matched with many of the suggestions based on research findings conducted by the Center for Assistive Technology and Environmental Access.

I drew links between the two theories summarized in table #1 and added my comments about specific ways that EI supports CATEA findings.

**Table #1: Principals of Explicit instruction and CATEA Findings**

**What are the Best Methods for Teaching STEM Concepts in Environmental Education to Students with High Spectrum ASD and ADHD?**

| **Principals of Explicit instruction: Effective and efficient teaching** | **Research findings conducted by CATEA** |
|---|---|
| **1. Optimize engaged time/time on task.**<br><br>The more time students are actively participating in instructional activities, the more they learn. | EI focuses on "active participation" by all students as a group for a majority of the instruction time (Discussions and directions for completing research techniques)<br><br>Since all of the students are actively discussing the same topic and answering teacher's questions at an accelerated pace, there is little time and space for distractions (distraction-free |
| **2. Promote high levels of success.**<br><br>The more successful (i.e., correct/accurate) students are when they engage in an academic task, the more they achieve. | EI focuses on student success and the teacher does not move on to new material until all students perform current material correctly. The material is repeated with clear instructions until all students succeed (Clear concise instructions). |
| **2. Increase content coverage.**<br><br>The more academic content covered effectively and efficiently, the greater potential for student learning. | EI uses vocabulary lists, charts, graphics and illustrations to help students focus on the content that is most important and has the greatest potential for reuse in the future (Charts and graphics to illustrate concepts; Vocabulary lists; Study guides). |
| **3. Have students spend more time in instructional groups.**<br><br>The more time students participate in teacher-led, skill-level groups versus one-to-one teaching or seatwork activities, the more instruction they receive, and the more they learn. | This area was not addressed by the research findings, but as discussed in the Overview of ASD and ADHD, students with these disorders have difficulty in communication and interaction with other people. Constant group work and partnering can teach these students valuable social skills. |

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| **4. Scaffold instruction.**<br><br>Providing support, structure, and guidance during instruction promotes academic success, and systematic fading of this support encourages students to become more independent learners. | EI uses a repetitive scaffolding approach where new skills are only introduced when previous skills are mastered. New skills always build on previous skills (Time management techniques for breaking down complex tasks into manageable tasks). |
| **6. Address different forms of knowledge.** The ability to strategically use academic skills and knowledge often requires students to know different sorts of information at differing levels: the declarative level *(what* something is, factual information), the procedural level *(how* something is done or performed), and the conditional level *(when and where* to use the skill). | The structure of an EI lesson begins with the What (goal of the lesson), How (a review of critical necessary skills) and Why (the relevance of the skills to be learned in the lesson). Reinforcement of concept connections through multiple formats is an integral part of EI (Graphic organizers with which to visualize connections and relationships). |

## Implementation

A sample lesson will be used explore ways to adapt a published general education science lesson plan be adapted for students with ASD and ADHD using EI. I chose *Nocturnal Animals* (2012) from ShareMyLesson.com because it was revised in 2014, has a 5 star rating based on 4 reviewers and is aligned with Common Core State Standards. The full lesson plan, specific Common Core State Standards that are addressed and support materials (except for audio files) are available in Appendix A for reference. Although the sample lesson has been adapted to better serve students with ASD and ADHD, it is meant to be taught to the entire class of typically developing and special education students.

Archer & Hughes (2011) recommend the following design for all EI lessons and provide table #2 as a reproducible in their book.

**Table #2: Designing EI Lessons**

**What are the Best Methods for Teaching STEM Concepts in Environmental Education to Students with High Spectrum ASD and ADHD?**

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| **1. Opening of the** | **Gain students' attention.** | **Review:** Review critical prerequisite skills. | **Preview:** State the goal of the lesson. |
| **2. Body of the lesson** | Skill or strategy | Vocabulary of concept | Academic rule |
| **3. I do it.** | **Modeling:**<br>Show and tell.<br>Involve<br>students | • Introduce the word.<br>• Introduce the meaning of the word.<br>• Illustrate with examples<br>• and non-examples | • Introduce the rule.<br>• Use If-then construction for the rule.<br>• Illustrate the rule with examples and non-examples. |
| **4. We do it.** | **Prompted or guided practice:**<br>• Guide students in performing the skill or strategy.<br>• Provide physical, verbal or visual prompts.<br>• Gradually fade scaffolding.<br>• Guide students in analyzing examples and non-examples using the critical attributes. | • Guide students in analyzing examples and non-examples, using the critical attributes. | |
| **5. You do it.** | **Unprompted practice:**<br>**Review:** Review critical content.<br>• Check students' understanding.<br>• Have students perform the skill/strategy without prompts. | • Check students' understanding.<br>• Have students distinguish between examples and non-examples.<br>• Have students generate examples and non-examples.<br>• Ask questions that<br>• require deep processing | • Check students understanding, using examples and non-examples. |
| **6. Closing of the lesson** | | **Preview:** Preview the content of the next lesson. | **Assign independent homework** |

**Table #3: Nocturnal Animals lesson adapted for EI**

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| **1. Opening of the lesson** | **Gain students' attention:** Show students the first PPT slide and play one of the nocturnal animal sounds. Ask if they recognize any of the animals or sounds. | **Review:** For today's lesson you will need to use 3 of your 5 senses. We discussed our 5 senses yesterday. Let's all say them out loud together as I point to my body. The only sense we will not use today is taste. What sense do humans rely on most strongly? Yes, it is the sense of sight. | **Preview:** We learned about how we use our 5 senses, now we can learn about how some animals use their senses in different ways and more or less than we do. |
| **2. Body of the lesson** | Skill: Students will learn about how nocturnal animals use their senses to find their way around their habitat in the dark. | Vocabulary:<br>**Nocturnal** – active at night.<br>**Echolocation** – using sound to "see"<br>**Elongated** – Longer than tall. **Lateral** – horizontal lines **Aye-Aye** - the world's largest nocturnal primate and can be found in the forests of Madagascar.<br>**Bandicoot** - pointy-nosed marsupial from Australia and New Guinea.<br>**Great Spotted Kiwi** – a flightless bird from New Zealand.<br>**Jerboa** - a small, long-tailed rodent that jumps long distances using its long hind legs.<br>**Okapi** - giraffe-like mammal found in rainforests of central Africa<br>**Philippine Tarsier** – tiny nocturnal primate that lives in forests. | Academic rule: Nocturnal animals have genetic adaptations that help them adapt to their environments. |

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| **3. I do it.** | **Modeling:**<br>Show and tell.<br>Involve students | • Introduce the animal.<br>• Introduce facts about the animal.<br>• Illustrate with examples and non-examples | • Introduce the rule: Nocturnal animals have genetic adaptations that help them adapt to their environments.<br>• Use If-then construction for the rule.<br>• Illustrate the rule with examples and non- examples. |
| **4. We do it.** | **Prompted or guided practice:**<br>• Guide students in performing the skill or strategy.<br>• Provide physical, verbal or visual prompts.<br>• Gradually fade scaffolding.<br>• Guide students in analyzing examples and non-examples using the critical attributes. | • Guide students in analyzing examples and non- examples, using the critical attributes.<br>• Guide students in identifying similar genetic adaptations for sight, hearing, touch, smell, taste and unique adaptations | |
| **5. You do it.** | **Unprompted practice:**<br>**Review:** Review critical content.<br>• Check students' understanding.<br>• Have students perform the skill/strategy without prompts. | • Check students' understanding.<br>• Have students distinguish between examples and non-examples.<br>• Have students generate examples and non-examples.<br>• Ask questions that require deep processing | • Check students understanding, using examples and non-examples. |

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| **6. Closing of the lesson** | | **Preview:** Preview the content of the next lesson. | **Assign independent homework** |

**Redesign of the "Nocturnal Animals" lesson using EI methods and principals**

I have included the teacher's notes in the main section of this paper so that it can be located and easily referred to when reading the discussion section. The remaining redesigned materials (all except audio files) are in Appendix B.

## EI Revision of NOCTURNAL ANIMALS Teachers' Notes

**Who is it for?** 5-7 year olds
**How long will it take?** The activity is ideal as a 1 hour session.
**Learning outcomes:** Students will learn about how nocturnal animals use their senses to find their way around their habitat in the dark.

**What do you need?**

- Interactive whiteboard or projector
- Computer to connect to whiteboard or projector, with speakers
- Revised Nocturnal Animals classroom presentation (PowerPoint)
- Set of 6 sounds for hearing activity
- 1 bag of 6 textures per group of 6 students
- Nocturnal Animals homework sheets

**Summary:**

This hands-on activity is designed to teach 5-7 year olds about nocturnal animals and the senses they employ to navigate life in the dark. As humans we rely heavily upon our sense of sight, so in this module we explore the ways other animals have become adapted to life where light is less readily available.

First the teacher will capture students' attention by turning on the PPT and playing the sound of an owl. Then the teacher will briefly review information from last lesson to scaffold the learning for this lesson and set learning expectations.

Next will be a group vocabulary review.

For the first group activity, students listen to sound recordings of different animals and have to match the sounds to the images of animals on the PPT slide. The students have their eyes shut while listening to the sounds and then open their eyes when the teacher prompts.

The second group activity uses one drawstring bags per group of 6 students. Students are encouraged to engage their sense of touch in order to describe and identify each mystery object without looking inside the bags. Students then discuss which items they feel could be each of the animals on the PPT slide.

## Preparation guidelines:

1. Read through the instructions to make sure you understand the activity.

2. Download the El Adapted Nocturnal Animals PowerPoint presentation.

3. Download the audio file with sounds of the Philippine Tarsier, Great Horned Owl, Greater Horseshoe Bat, Rattlesnake, Bat-eared Fox & Rabbit.

4. Collect 6 animal textures to place inside the bags. Suggested textures are items that can be found at the dollar store and cut into pieces to save on cost: smooth plastic slimy toy for the squid, toy with fish texture for the Mexican Tetra, cat toy with feathers for the Great Spotted Kiwi, mouse cat toy for the Jerboa, fake plastic bat for the bat, fake plastic alligator for the American Alligator.

5. Download and print out the El Adapted Nocturnal Animals homework sheets for the class (these can be printed double sided to save paper)

## How to run the session:

1. First PPT slide: Begin by capture students' attention by turning on the PPT and playing the sound of an owl. Ask students to think of what animal it could be, then share it with their partners. The teacher will then ask students to raise their hands with guesses. Teacher will use correct guesses as examples and incorrect guesses as non-examples. Students will be able to guess a correct sound for the non-examples. (from tables 2 & 3 above, Step 1. Opening the lesson)

2. Second PPT slide: The teacher will briefly review information from last lesson to scaffold the learning for this lesson and set learning expectations for today's class. (Step 1. Opening the lesson)

3. Third PPT slide: Vocabulary word review. Teacher says the word, class says the word as a group then teacher says the definition and class says the definition as a group. (Step 2. Body of the lesson)

4. Fourth PPT slide: Teacher introduces information about animal sight. See slide notes on the PowerPoint presentation for further guidance and information. (Step 3. I do it.) Teacher asks what each of these animals seem to have in common, asks students to tell their neighbor. The teacher will then ask students to raise their hands with guesses. Teacher will use correct guesses as examples and incorrect guesses as non-examples. Teacher will discuss each animal's specific adaptation with the class, then review what the different animals have in common with their adaptations for nocturnal life in a series of back and forth choral responses. (Step 4. We do it.)

5. The teacher will do the same for PPT slides 6-1 0 - see slide notes for additional information about the animals. (alternating between Step 3 & Step 4)

6. Eleventh PPT slide: Review the information on the slide so students know what to expect. (Step 3. I do it.)

7. Twelfth PPT slide: Teacher will play the first animal sound, signal students to whisper their guesses to their partners. (Step 3. I do it.) Teacher will call on students for guesses. The class will all say the correct answer together when prompted by the teacher. When the whole class correctly identifies the animal, the teacher will move through the remaining sounds in the same manner. (Step 4. We do it.) At the end, the teacher will point to each animal and ask the entire class to

approximate the animal sound together. (Step 5. You do it.) When all students make an appropriate sound, the teacher will move on to the next slide.

8. Thirteenth PPT slide: Review the information on the slide so students know what to expect. (Step 3. I do it.)

9. Fourteenth PPT slide: Arrange the class into groups of 6 students each. Give each group a bag and tell them all not to touch it until instructed to Point to the 1st photo and chose one student from each group to go first Ask the chosen students to close their eyes and reach into the bag to locate a texture in the bag that could be what the animal feels like. Ask them to hold onto the texture until prompted to remove it from the bag. Once all students seem ready, tell the students to remove the texture from the bag and open their eyes. Teacher will use correct guesses as examples and incorrect guesses as non-examples. Students will be able to guess a correct animal for the non-examples. After all examples and non-examples are discussed, return the textures to the bags and repeat with different students chosen for each of the remaining animals. (Step 4. We do it.)

10. Fifteenth PPT slide: Ask the questions (which are based on the materials in the notes for each PPT slide). Have students take guesses, whisper to their partners and then call on students to give answers. Teacher will use correct guesses as examples and incorrect guesses as non-examples. Students will be able to discuss the correct answers for the non-examples. After all examples and non-examples are discussed, the teacher will read the question again and say the correct answers and the class will repeat the question and correct answers. (Step 5. You do it.)

11. Sixteenth PPT slide: The words will be initially shown without their definitions The teacher will point to the first vocabulary word and the class will pronounce the word in unison without a verbal prompt until all students correctly pronounce the word. (Step 5. You do it.) Once the word has been correctly pronounced, the teacher will ask students to raise their hands to guess the definition. Once the definition has been stated correctly, the teacher prompts the student with the correct answer to lead the class in saying it in unison. The students will repeat the word and definition until all students say it correctly. The teacher will continue through the remaining words in the same fashion. (Step 5. You do it.)

12. Seventeenth PPT slide: Pass out homework. Ask if anyone has questions about how to complete the homework. Preview the topic and learning expectations for next class. (Step 6. Closing the lesson)

**Suggestions for extension activities:**

Direction of sound activity. Get the students to stand in a circle in the room with their eyes closed. Stand on the outside of the circle and clap twice, and then get them to point in the direction that they think the sound came from. Repeat the activity by moving to different positions around the room. You can also try repeating the activity but getting the students to cover one of their ears with one hand and see if it alters their perception of the direction of sound. This links to how owls hear (e.g. the barn owl), as their ears are in slightly different positions on each side of their head, which helps them carefully locate the direction of sounds made by prey. (Step 5. You do it.)

## Discussion

Overall, the original *Nocturnal Animals* (2012) lesson was very strong because it engaged learning through multiple senses. The weakness in the original lesson for ASD

and ADHD leaners were in the breadth of information covered, number of animals introduced, lack of scaffolding on previous knowledge and lack of insuring that material was learned by all before moving on.

The redesigned lesson addresses the principals of EI and many of the CATEA research findings for ways to teach students with ASD and ADHD. The specific design of the EI lesson plan has the following benefits for our target learners.

1. **Opening the lesson: Gaining students' attention, reviewing learning & setting expectations**

Setting the expectation in each lesson that all students will need to settle down and concentrate incorporates CATEA's recommendation for "distraction-free environments". Reviewing critical information from the previous lesson and specifically addressing the goals for the day's lesson meets CATEA's criteria of "Discussions and directions for completing research techniques." Using a PPT slide to review prior learning while connecting it to the day's lesson and learning expectations provide CATEA's recommendation of using "Graphic organizers with which to visualize connections and relationships." (Moon, Todd, Morton, & Ivey, 2012).

2. **Body of the lesson: Vocabulary review**

The first words in the vocabulary review are critical words that have a high probability of being used in future lessons and in life. The remaining words are lesson specific words that students probably would not already know. CATEA recommends vocabulary lists since they connect with Grandin's third type of autistic brain: "verbal lists and translator brains." (Green, 2014, p. 88; Grandin & Duffy, 2008) Using EI techniques that involve the entire class in fast-paced back and forth interaction keeps the class focused on the present task. Traditional methods of asking students to write down the words or definitions on their own could lead to distractions if one student finishes before others, becomes bored and has time to act out.

### 3. I do it: Modeling

For the EI version of the lesson, the number of animals used to teach the lesson were reduced from 26 to 17. Instead of briefly discussing diurnal and crepuscular animals when the name of the lesson is "Nocturnal Animals," diurnal animals will be discussed in the next lesson to scaffold the difference between daytime hunters on previous learning about nighttime hunters. Instead of introducing a random sensory exercise that focus on local household items such as a sponge, key, clothes peg, tin foil, golf ball, etc.; animal textures are used to reinforce the discussion of six of the nocturnal animals in the lesson. These changes coincide and model CATEA's recommendation for teaching "Time management techniques for breaking down complex tasks into manageable tasks." CATEA recommends the use of "Charts and graphics to illustrate concepts." This connects with individuals on the Autism spectrum who Grandin identifies as "visual thinkers." [24] The PPT uses verbal language with visual support while a teacher briefly models the lessons students are expected to learn. Additionally, EI's basic tenants of "I do it, We do it, You do it"[3] reinforces the act of supplying CATEA's recommendation of "Clear concise instructions" before asking students to complete tasks.

### 4. We do it: Prompted or guided practice

Providing explicit instruction in small doses then requiring students to participate keeps students in the moment and on task. The original lesson had students working alone to identify sounds and textures then record answers on their individual papers. Again, this traditional way of teaching allows for lag time due to varying writing and self-expression skills of individual learners. In the EI redesign, students are always reinforced verbally and visually while they work in teams to actively participate in group learning. Initially, working in groups may be difficult for ASD students because of hindered ability for appropriate social interaction as part of the diagnosis criteria. However, modeling of typically developing peers is a crucial skill that ASD students need to develop for classroom and community success. Embedding group interaction and peer modeling

into lessons will help ASD students achieve success through practice.

Using examples and "non-examples" of correct answers allows for immediate correction of mistakes during the learning process. Traditional methods having students writing down a wrong answer to a question on a paper and then receiving the graded paper the next class allows for possible reinforcement of wrong answers if a student discusses the day's learning with others. Having the group recite the correct answer immediately after being prompted then having time to explore why non-answers are incorrect reinforces correct content in real-time.

**5. You do it: Unprompted practice to review critical content**

Ending the lesson by requiring students to pronounce each vocabulary word in unison without a verbal prompt until all students correctly pronounce the word; then asking students to raise their hands to guess the definition reinforces areas of critical learning. Prompts are excellent tools for initial learning. However, teachers need to check in to confirm that students are learning concepts individually and not "coat tailing" other students by waiting a second to respond directly after the class without actually knowing the correct answer. Homework pages which cover all of the vocabulary words, definitions and facts learned about each graphic or chart covered in the day's lesson helps to insure that all students are actually learning every topic.

**6. Closing of the lesson: Prepare for next class**

Asking for questions about the homework and introducing the topic and learning expectations for the next class continues to build on EI's principal of scaffolding instruction and CATEA's recommendations of teaching, "Time management techniques for breaking down complex tasks into manageable tasks."

## Implications for Further Research

It would be interesting to develop a study where the original *Nocturnal Animals* (2012) curriculum and EI redesigned version could be taught to evaluate which curriculum was more effective for general education students and those with ASD and ADHD. Success of either program

would not be solely based on acquisition of knowledge for ASD and ADHD students. Time focused on task, ability to interact with classmates in groups, ability to verbalize thoughts and amount of time spent distracting the rest of the class by acting out would also be important measures. As mentioned in the overview of ASD and ADHD, these are often critical barriers to learning progress in school for students with these diagnoses.

## Conclusion

Based on my research of ASD and ADHD issues for classroom behavior and barriers to learning and a review of DI, di and EI methodology; I believe that it is possible to develop general education lessons that, in theory, better assist special education classmates. It appears that with training in EI methods, teachers could relatively easily change existing lessons into EI format. What remains unconfirmed is how beneficial these adaptations would be for ASD and ADHD students. I believe I have proposed an interesting question that, in light of Autism Spectrum Disorder (ASD) being the fastest-growing developmental disability, affecting 1 in 68 children and costing $11.5 billion - $60.9 billion a year (2011 US dollars) – 29-83% of people with autism also Attention Deficit Hyperactivity Disorder (ADHD),[14] deserves further study to empower these students.

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## Appendix A & B PowerPoint Photo References

PPT Slide 4:

Philippine Tasier: http://listverse.com/2010/12/12/10-animals-with-incredible-eyes
Leaf Tailed Gecko: http://listverse.com/2010/12/12/10-animals-with-incredible-eyes
Great Horned Owl: http://georgiainfo.galileo.usg.edu/images/uploads/gallery/greathornedowl1.jpg
Colossal Squid: http://listverse.com/2010/12/12/10-animals-with-incredible-eyes

PPT Slide 5:

Okapi: http://dingo.care2.com/pictures/causes/3059/3058499.large.jpg
Bandicoot: http://www.acuteaday.com/blog/wp-content/uploads/2011/05/big-eared-bandicoot.jpg

PPT Slide 6:

Jerboa: http://www.visiontimes.com/uploads/2015/04/Minijerboa.jpeg

PPT Slide 10:

Aye-Aye: http://www.wired.com/images_blogs/wiredscience/2013/09/aye1.jpg