Transforming a Student's Persistence, Resilience, and Motivation

Improving Executive Skills through Mathematics

By Cynthia Z. Hansen, M.Ed., ET/P

As an educational therapist, I specialize in working with children with gifted profiles or who have high, but as-yet unrealized, potential due to poor production and self-regulation skills. Many of my private clients have dual exceptionalities, combining superior intellectual ability with diagnosed ADHD, mild to moderate dyslexia, or executive dysfunction. Some are challenged by the asynchronous divide between their highly developed intellectual abilities and slower developing self-regulation. A challenge for these students is learning to cope with the social and emotional consequences of these seeming contradictions.

My clients often come to me because they experience difficulty with work production. Often, they have a very narrow threshold between "too easy" and "too difficult." While persistence for some of them means anticipation of success, for others the *necessity* to persist is unsettling. Struggle is uncomfortable for these students and accompanied by a fear that mental exertion may reveal that they are "posers," not truly gifted. Their inner fears of not being "smart enough" may linger and affect their interactions with peers and learning. To avoid this discomfort, these students often remain *happily unchallenged.*

The Happily Unchallenged

We can make some generalizations about gifted students. They process information in a more complex manner, examining multiple perspectives. Those with strong executive skills can benefit from traditional differentiation, compacting, and independent study because they have the self-regulation to persist through challenge. They tend to be confident, autonomous learners who actively seek outside resources, requesting coaching or instruction as needed.

Then there are the happily unchallenged. These may be gifted students who process information more slowly. These are the kids who seem lethargic during a lesson that uses rote skills, but who become alert when given more inviting problems that involve plausible situations or more complex reasoning, especially when they can process the problems in their head.

Or they may be gifted students who are unable to work well independently. Difficulties with focus, self-monitoring, initiation, or sustained attention can make it hard for them to complete homework or worksheets. They may make errors on tests or leave questions blank because they lack the persistence to process multiple steps.

Because of these students' poor production, schools can have a hard time identifying their true abilities. The schools may fail to provide the students with appropriate differentiation or delay accelerating them. In cases like these, where bright children are producing work at levels far below what they are capable of, parents can become concerned and seek the help of someone like me, an educational therapist. Let's look at a typical situation.

Meet Geoffrey

During the year before he came to see me, Geoffrey's misunderstood difficulties of inattention and poor persistence had severely lowered his motivation in math. His creativity and natural mathematical abilities were stifled by basic arithmetic coupled with his poor executive skills.

At the beginning of sixth grade, with encouragement from his former teachers, Geoffrey attempted the comprehensive exam to skip into seventh-grade pre-algebra. However, he had difficulty sustaining attention during testing and only passed 78 percent of the course material, not enough to skip the grade without further intervention from his parents. What scared Geoffrey off from pursuing the skip was a comment made in his presence by the mathematics coordinator. Geoffrey heard that he could fail the state high school exam if he skipped a critical lesson at the end of the year. Geoffrey's stress and fear of missing that lesson prevented his parents from advocating for him further, and he remained in a sixth-grade math class for gifted students.

Geoffrey was happily unchallenged in that class, learning few new concepts, and spending the majority of his time reading novels hidden beneath his desk. Because his executive dysfunction continued to affect his production, self-monitoring, and persistence, Geoffrey was considered to be an average student — one who consistently made careless mistakes and had difficulty completing the repetitive nightly homework.

Finding What Works for Students Like Geoffrey

My goal is to encourage students like Geoffrey to expand their executive functions, face frustration and failure safely, and discover the thrill of effort that produces meaningful results. In order to improve the self-regulation and production habits of these

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students, I use mathematics to frame my intervention program. This highly structured discipline has a concrete vocabulary and rules that require logic and creativity to progress onto higher concepts. Math is a subject that enables students to experience tangible progress as they work to achieve goals.

In order to turn things around for Geoffrey, I collaborated with a local professor. We hit upon using ALEKS®, a web-based math tutoring and assessment program, as a way to introduce him to algebra while enabling him to review pre-algebra skills as needed. I have found that ALEKS provides a foundation for students challenged by executive functioning delays and dysfunctions in the following ways.

ALEKS catches skills that may have slipped by our gifted learners. When advancing students in math, teachers and parents are often concerned that the children will miss critical information as they leap forward and that gaps in these fundamental concepts, if not mastered, will create problems later on. Yet gifted learners often learn math by instinct, seeming to skip over concepts to reach a deeper understanding. Topics may just make sense to these learners, and they don't want instruction to solve a particular problem. These students may habitually zone out during repetitive instruction, missing new information in the process. As a result, they come to answers in unconventional, and not necessarily efficient, ways. ALEKS catches the missed steps through a variable assessment process and gives short, limited practice in these skills to be sure that higher concepts are supported.

ALEKS is not repetitive. Math strands are broken down into topics (guided by the National Council of Teachers of Mathematics standards) and sub-topics. In general, each sub-topic requires a student to answer three problems correctly in order to prove mastery. The exception is when a child is reviewing information for practice; then usually just a problem or two are presented.

Let's say that a student has diligently worked to understand a topic and gets one wrong, then two correct, then one wrong over a series of problems. The program will take the mean results and move the child forward, even though mastery is still in question. In the same manner, if a child is clearly not getting a concept, the program reinforces my suggestions to the child to take a break or return later after exploring other topics. Review for any topic is always available.

While ALEKS has a sub-program called QuickTables, which assists students in building automaticity of basic arithmetic facts, I direct my students to other online tools that are more child-friendly. I prefer to teach fluency by engaging directly with my students through math games, manipulatives, puzzles, and discussing the process of mental math.

ALEKS demands complete understanding. Students are presented with multiple viewpoints of a similar task. Scientific and real-world application, reciprocal thinking, and logic are used to ensure that students understand the full context and application of the topic. Sometimes the problems seem unrelated, and it is at these times that a student may benefit from my coaching to investigate the connection. Providing the student with multiple

What Is ALEKS?

ALEKS (www.aleks.com), short for Assessment and LEarning in Knowledge Spaces, is a subscription-based online assessment and learning system. It uses artificial intelligence and adaptive questioning to precisely assess a student's knowledge in mathematics and to provide personalized instruction on the exact topics the student is most ready to learn. This system was originally developed by a team of cognitive scientists and software engineers at the University of California, Irvine, with major funding from the National Science Foundation.

ALEKS Math levels have a breadth and complexity that most math texts are unable to provide during a school year. Each level adjusts to the child's current knowledge, filling in the gaps, offering review, and allowing advancement without excessive repetition. The initial assessment allows students to advance past areas of strength in order to focus on the areas they need to learn. Each level is aligned with national Common Core Standards and can be modified to fit textbooks or specific state requirements. Each level includes a broad range of skills that may be below or above the chronological grade equivalent.

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viewpoints strengthens mental flexibility, persistence, and critical thinking.

When a student skips a problem or makes an error during assessments, the program will push the child to revisit the idea, providing more focus on a difficult concept and additional opportunities to learn from failures in a profoundly powerful way. Precious are the *Ah Ha!* moments of discovery when a child realizes that s/he understands a concept better the second or third time it's reviewed. This process builds resilience and the intrinsic rewards of persistence that students would not likely encounter if they simply reworked a problem from a test or moved on after a test in a traditional class.

ALEKS pushes students to reflect upon their ignorance. One of the most difficult tasks in ALEKS is the assessment procedure. There are no answers, no teaching, no hints. Learners have two choices for each problem: enter an answer or click a button labeled, "I haven't learned this yet." For my gifted students who are used to already knowing the answers, choosing the latter can be painful. I often sit with my students during this process to help them through their discomfort of not knowing.

Sitting with a child who is struggling through an assessment offers opportunities to discuss executive functioning, study skills, and the value of note-taking. I explicitly teach my students how to create a personal math notebook to hold the ideas, terms, and formulas that become individualized shortcuts and foundational information for deeper concepts. Students benefit as they learn to use their notes to relate learned concepts to the newest problem or task. Note-taking easily transfers to other subjects as students realize the value of the skill.

Self-monitoring comes into play as students practice reading and interpreting the instructions, and accurately tracking and typing the answer onto the computer screen. For students who struggle with writing, being able to use a keyboard for math becomes an assistive technology. For those with poor tracking or copying skills, I scaffold their production difficulties by discussing the process of the problem and format, and by typing in the answers for these students as needed. For students who have difficulty moving away from mental math, I offer white boards for their initial computations, gradually moving them to math notebooks as they become more aware of the need to record their data.

Considerations for Implementing an ALEKS Program

- Assign a level within reach of the child's capabilities. ALEKS levels are comprehensive when the teacher or administrator selects the broadest topic range.
- Be available to coach children though the process of becoming familiar with the program. This may simply involve teaching them the key strokes needed to accomplish the program's tasks.
- Help the child understand that the program learns about their abilities and offers tasks within their ability range.
- Preview the course to ensure that the child is not repeating content that s/he already knows and to help the child accept the discomfort of the unknown.
- Provide encouragement to ensure that students do their best and do not skip problems that take too much effort, even if they know the material. A child who avoids a test item will have to face it at some point during the course.
- Give students time to explore math puzzles and topics related to their learning in ALEKS. Geometry explorations may include building a bridge or creating an origami figure; probability may include locating the best geology to hunt for gems in Minecraft or more traditional games of chance. Or students may create their own inquiry problems to solve.
- Use the "Student View" to explore an assessment, demonstrate a concept, or work with small groups on practice problems.
- Inform students that they may move from one level to another with teacher and parent guidance when a course is completed or if a course seems too advanced.
- When possible, offer a participatory introduction for parents, caregivers, and students before the program starts to encourage a partnership among parent, child, and school and to ameliorate any fears.

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Building a Community of Mathematicians

When using ALEKS, I set up groups of two to ten students to converse and share strategies as they work through their assignments. They may be working in different courses, or within the same course, but with various strengths. While some students are initially competitive and protective of their advanced math skills, their need to compare themselves to others tends to diminish as they become more focused on their personal progress. One of my greatest joys is listening to the creativity, enthusiasm, and noise of students conversing about mathematics during my ALEKS workshops.

ALEKS has become a core tool in a broader, multidimensional math program, offering frequent opportunities to interact with real-life situations using inductive and deductive reasoning. Projects, manipulatives, and visual constructs help to develop core concepts. Students also engage in original creative thinking and the application of mathematical concepts. Ensuring that students have encountered and conquered all of the concepts in their course level, my colleagues and I closely monitor the progress of their mastery using the learning logs and records embedded in ALEKS.

Whether in workshops with colleagues or individually within my educational therapy practice, I introduce math sessions with explicit introductions or explorations of core skills within a math strand. Hands-on investigations may include setting up a store, paper folding using geometric vocabulary, inventing original problem-solving interactions, or investigating a problem from *Harkness Math* (See the resource list that accompanies this article for more information.). These are all fundamental tools and enticing opportunities for students to connect enthusiastically with mathematics and with their like-minded peers.

One of the truest gifts of ALEKS is the freedom that comes with being able to move on immediately when a concept is understood instead of waiting for classmates or the teacher to finish the chapter. The workshop setting creates opportunities to discuss planning, prediction, persistence, the relevance of mistakes, self-awareness, and strategy development. This process offers me and my students frequent opportunities to discuss their math frustrations, feelings of distress, and how they are applying their new functioning skills to other areas of their lives. The result of these open discussions is executive functioning growth that permeates to students' overall learning and social environments.

What Happened to Geoffrey?

ALEKS allowed Geoffrey to work to his potential without the stress of unnecessary repetition. The process not only re-engaged him in mathematics, but offered the excitement of reaching a difficult goal, persisting through frustration, and nurturing the ability to ask for assistance without shame, all while introducing the importance of taking notes and recording his problem-solving process. Geoffrey continued to develop these skills after completing the ALEKS algebra course. His public middle school was willing to make the accommodation for Geoffrey to take honors geometry at the local high school, and he remained an advanced-track student.

Over the next few years, Geoffrey's executive skills grew tremendously, helping him to manage

Common Characteristics of Students Who Benefit from Executive Function Coaching Using Mathematics

These children:

- Love science and mathematical thinking
- Started hating math around third grade, learning to equate the subject with the repetitive arithmetic typically needed for concept development
- Often lack fluency in math facts, although they have known the concepts intuitively since before they began formal schooling
- Are ahead of their chronological or course peers and often have no access to math classes at their level
- Hate redundancy and repetition
- May miss new fundamental skills because they lost focus during an earlier rote exercise
- Freeze during speed tests and are difficult to assess accurately
- Often understand new concepts after being exposed to one to three examples
- Like to instantly know the answers to any problem and may shut down within the first few minutes when confronted with something they don't understand
- Love to solve the puzzle and theoretical components of math, chemistry, and physics
- Are not independent workers.

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his coursework in other subjects. Though production continues to be a struggle, he now has tools to help him complete his work in a timely manner. Most importantly, he rediscovered his passion for mathematics, finished AP calculus by the 11th grade, and aspires to be an aerospace engineer.

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Please see the table on the next page that lists common definitions of executive functions and how they may appear in gifted and twice-exceptional students.

Additional Online Resources

- Cool Math for Kids (a fun, game-based website for practicing fundamental skills), www.coolmath4kids.com
- Davidson Institute (a cost and services comparison of several online programs), www.davidsongifted.org/db/Articles_print_id_10642.aspx
- Destination Math (an online math curriculum for grades k-12 used by many schools, home schoolers, and independent learners), www.hmhco.com/shop/education-curriculum/intervention/math/destination-math
- Fun Brain (a fun, game-based website for practicing fundamental skills), www.funbrain.com/brain/MathBrain/MathBrain.html
- Harkness Math, www.exeter.edu/academics/72_6540.aspx and www.nais.org/Magazines-Newsletters/ITMagazine/Pages/Harkness-Math.aspx
- Ian Byrd's ByrdSeed (teacher, parent, and student resources plus engaging demonstrations of math concepts), www.byrdseed.tv and www.byrdseed.com/tag/math
- Johns Hopkins Center for Talented Youth, http://cty.jhu.edu/ctyonline/index.html
- Khan Academy (videos and practice in a wide range of mathematics, including fundamental concepts), www.khanacademy.org
- MIT OpenCourseWare, http://ocw.mit.edu/courses/mathematics
- Mr. Nussbaum.Com (curriculum enrichment designed for both teachers and students), http://mrnussbaum.com/
- Northwestern University Center for Talent Development, www.ctd.northwestern.edu/gll
- Open Education Database (lectures in various advanced mathematic disciplines from a variety of sources), http://oedb.org/open/subjects/math
- Stanford EPGY Challenge Zone (games for skill practice for grades K-7), http://giftedandtalented.com/challenge-zone
- Stanford University Education Program for Gifted Youth, http://epgy.stanford.edu
- Vi Hart, www.khanacademy.org/math/recreational-math/vi-hart and www.youtube.com/user/Vihart (Note: These videos should be previewed before using them with students.)

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Executive Functions with a Gifted Perspective

Executive functioning skills are qualitatively different for gifted students. The following table gives common definitions of executive functions and how they may appear in gifted and twice-exceptional students.

Executive Function	Description	In Gifted and 2e Individuals
Attending & Sustaining Attention	Choosing to focus even when a task is non-preferred, and maintaining that focus through task completion	• To maintain focus on routine tasks, gifted students often require novelty, which may take the form of increased sensory input. • Exhaustion comes quickly with the stress of attending to routine tasks, increasing the likelihood of gaps in attention.
Working Memory	Holding onto information in short-term memory while manipulating it to complete a task or organizing it for long-term storage	• Gifted students with poor working memory have difficulty holding onto information bites, directions, or sequenced tasks that have little connection to their interests. • They rely on multisensory input to hold and manipulate new information.
Time Management	Using time in service of a goal and internally conceptualizing the passage of time	• Time seems flexible for students when working on passionate topics, leaving their judgment of task complexity blurred. • Procrastinating interferes with their ability to produce products that reflect true capabilities.
Planning & Task Initiation	Being able to begin a task in a timely manner after setting goals, creating a plan of action, and organizing materials	• Many high-ability students have extravagant plans that could be attainable because of their abilities; however, their lack of understanding that planning is a step-by-step process hinders their success. • Initiation is stalled when students have a poor concept of the time it actually takes to complete tasks.
Flexibility	Mental and emotional flexibility, including the ability to shift from one task to the next and to see connections among novel tasks, situations, and learning	• Mental flexibility includes being open to multiple ways to confront a problem, willingness to confront the unknown, openness to admitting to mistakes, and the ability to re-calibrate conclusions based on new evidence. • Emotional flexibility includes being adaptive to social, emotional, and environmental shifts.
Metacognition	Thinking about thinking that leads to self-awareness and self-monitoring of executive functions	For highly gifted and 2e students, empathy and social awareness may be strong, but relating those strengths to learning, self-correction, and the need for self-advocacy may be underdeveloped.
Emotional Control & Inhibition	Utilizing self-monitoring and awareness to modulate intensities, emotions, and actions	A high-ability child's intensities may make it difficult to: • Move beyond the desire to give up • Overcome frustration • Regulate impulsivity • Find hope.