A Teacher's Guide to Developing Expertise through Ascending Intellectual Demand

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Abstract

How can teachers adapt the curriculum to help advanced learners attain expertise? An abundance of research exists on the topic of expertise, exploring the traits students exhibit as they progress from the initial stages of novice-like uncertainty to the more confident stages of expertise. However, fewer researchers have demonstrated how teachers can use the curriculum to propel students along this continuum toward expertise. The purpose of the present article is to integrate conclusions of prior publications with an existing and effective model of curriculum, the Parallel Curriculum Model (Tomlinson et al., 2009). The resulting guide is intended to accompany the Ascending Intellectual Demand (AID) component of PCM and provide a proposal for a systematic way to consider and assess expertise, as well as guidance for using curriculum to help challenge advanced learners to perform at expert levels.

Keywords: Ascending Intellectual Demand, Parallel Curriculum Model, expertise

Why Expertise?

Before exploring what it means to be an expert, it is first important to establish why expertise is relevant within the classroom environment. First of all, teachers are often encouraged to set high expectations for their students, so helping students progress toward expertise is a natural extension of this recommendation. Second, establishing expertise as a goal lends itself to continual productivity on the part of the student, as well as the teacher. Expertise is not easy to attain, nor can the process be abbreviated. Therefore, when students and teachers recognize that progressing toward expertise is the goal, there can be no point at which students feel “finished” or at which teachers feel they have done all they can. Rather, there is always a next step that students can take in order to extend their knowledge and skills in the development of expertise. Finally, when teachers help their students make progress toward expertise, they recognize that they are not, in fact, merely preparing students to demonstrate proficiency on end-of-year assessments. Instead, they acknowledge their role in preparing students for a future that is yet to be known, for discoveries that have yet to be made, and for problems that have yet to be solved, all of which require progression toward expertise in order to be effectively met.

Traits of Expertise

What, then, is expertise? Although different fields may hold different criteria for what it means to be an expert, several overarching aspects help illustrate an interdisciplinary portrayal of expertise. To understand what is meant by expertise, then, it will be useful to consider experts in terms of the knowledge, skills, attitudes, and habits of mind they possess. Experts possess both a breadth and depth of knowledge in a particular domain (Ackerman, 2003; Alexander, 2003b; Sternberg, 1998). They know how to create and evaluate such knowledge, as well as how to solve new problems in their field (Weinstock, 2009). Experts’ knowledge extends beyond facts, however, and encompasses skills, such as problem-solving abilities and strategies, which they are able to deftly manipulate and handle in order to solve the problems they are facing (Alexander, 2003a). Their ability to develop complex representations of problems (Sternberg, 1998) and their reliance on deeper-processing strategies (Alexander, 2003b) both aid in their efficient and reliably superior performance (Mieg, 2009).

In addition to knowledge and skills, attitudes of experts tend to be distinct. Their individual interest in a subject or topic helps motivate them beyond merely situational interest (Alexander, 2003b). Finally, students require proper habits of mind in order to grow into experts. Primarily, they need to be aware that becoming an expert requires time, perhaps up to ten years (Alexander, 2003b; Bransford, Brown, & Cocking, 2000; Mieg, 2009), depending on the domain. They need to be metacognitive (Bransford et al., 2000; Sternberg, 1998), self-reflective (Sternberg, 2001), and capable of self-monitoring and regulating the feedback they receive from themselves or others (Lajoie, 2003; Sternberg, 1998; Thompson, Licklider, & Jungst, 2003).

Expertise and Gifted Learners

The development of expertise and eminence has become an increasingly emphasized goal for gifted students (Subotnik, Olszewski-Kubilius, & Worrell, 2011), who often seem perfectly positioned to develop the type of expertise that can help shape the world. Sternberg (2001) has supported the view that giftedness may lead to expertise and has suggested that giftedness itself could be viewed as a form of developing expertise in a specific domain. The path for gifted students to develop true expertise, however, is complicated by school systems where students learn about numerous domains in great breadth but limited depth, as well as by the general lack of significant contexts surrounding learning in schools (Hatano & Oura, 2003). Fortunately, the forces surrounding gifted children can influence either the making or breaking of their giftedness

(Dai & Renzulli, 2008). Therefore, an appropriate curriculum can help gifted students advance by providing an effective match between the student and the curriculum, leading to greater student expertise (Ackerman, 2003) and encouraging teachers to incorporate individual student strengths into learning activities (Kay, 2001).

Expertise and Ascending Intellectual Demand

Bearing in mind the importance of the environment and the curriculum in helping gifted students develop expertise, Tomlinson et al. (2009) presented the Parallel Curriculum Model (PCM) as a curriculum design intended to fully develop students' potential. By presenting four potential curriculum parallels – The Core Curriculum, The Curriculum of Connections, The Curriculum of Practice, and The Curriculum of Identity – the PCM is designed with the goals of ensuring that student thinking is extended. In addition to the four parallels, the PCM includes Ascending Intellectual Demand (AID), a guide for developing expertise in students. Presented as a continuum starting with the stage of novice and progressing through apprentice and then practitioner before reaching expertise, AID provides descriptions of students at each level along the continuum to help teachers identify where their students are and how to help them progress to the next level.

Rubric for Progression Toward Expertise

The purpose of this guide is to use the results of research on expertise to further elaborate on the AID model, making it as practical as possible for teachers to use with gifted students in their classroom. This begins with a recommendation to reformulate the Novice to Expert Continuum (Tomlinson et al., 2009, p. 238) into the form of a rubric to be used to assess students, presented in Figure 1. This presents a new contribution to the previous Novice to Expert Continuum with the aim of improving ease of application by simplifying the process of developing expertise into a series of concrete steps. The traits of expertise are categorized into knowledge, skills, attitudes, and habits of mind. Knowledge refers to the acquisition of content (Tomlinson et al., 2009), while skills refers to the application of such content or the skills necessary to be successful in a given domain. The category of attitudes represents a student's fluctuating need for intrinsic and/or extrinsic motivation in the learning process, while habits of mind characterize a student's academic independence, resilience, and metacognition. These four categories serve as the criteria of the rubric, while the varying degrees of expertise (novice, apprentice, practitioner, and expert) serve as the continuum against which teachers may assess each criteria. As a result, teachers can use this rubric to identify where their advanced learners are on the continuum from novice to expert in each category of expertise.

Figure 1. Rubric to assess students on the progression toward expertise.

	Novice	Apprentice	Practitioner	Expert
Knowledge	• Experiences content at a concrete level • Manipulates microconcepts one at a time • Struggles to distinguish between relevant/irrelevant or accurate/inaccurate information	• Understand the connections among microconcepts within a discipline • Connects information within a microconcept • Begins to interpret generalizations and themes that connect concepts • Retrieves relevant knowledge with effort	• Manipulates two or more microconcepts simultaneously • Creates generalizations that explain connections among concepts • Develops knowledge base in breadth and depth • Retrieves relevant knowledge fluently	• Utilizes concepts within and among disciplines in order to organize knowledge and derive theories and principles • Creates innovation within a field by asking questions and conducting investigations • Recognizes patterns in domain • Retrieves relevant knowledge and strategies automatically
Skills	• Needs skill instruction and guided practice • Uses surface-level strategies to solve tasks	• Applies skills with limited supervision • Applies surface-level and deep-processing strategies	• Selects and utilizes skills in order to complete a task • Begins to rely more on deep-processing strategies to solve tasks	• Practices skill development independently and for the purpose of improvement • Uses only deep-processing strategies to solve tasks • Uses "chunking" to improve memory's capacity
Attitudes	• Requires support, encouragement, and guidance • Relies on situational interest to remain engaged and motivated	• Seeks confirmation at the end of a task • Develops increased individual interest in the domain	• Seeks input from others as needed • Establishes individual interest in domain as a source of motivation	• Seeks input from other experts in a field for a specific purpose • Works to achieve flow and derives pleasure from the experience of high challenge and advanced skill/knowledge
Habits of Mind	• Seeks affirmation of competency in order to complete a task • Views problem-solving as involving memorization and recall	• Reflects upon content and skills when prompted • Begins to develop problem-solving strategies	• Exhibits task commitment and persistence when challenges are moderate • Reflects upon both content and skills in order to improve understanding/performance	• Is independent and self-directed as a learner • Maintains flexibility and high engagement over time • Seeks experiences that cause a return to previous levels in varying degrees • Self-monitors problem-solving strategies

Criteria for each level in each category reflect the content of the original continuum developed by Tomlinson et al. (2009), as well as various scholarly sources (Alexander, 2003b; Bransford et al., 2000; Sternberg, 1998). Note that the arrow in the background of the rubric extends beyond expert. This serves as a reminder that expertise is not an end goal in and of itself (Alexander, 2003b; Sternberg, 1998). Just as there are perpetually more knowledge, skills, attitudes, and habits of mind to develop, teachers should encourage students to continue pushing themselves further, even if they reach expert levels of performance.

Finally, in an effort to combine simplicity and effectiveness, the rubric itself is sufficiently generic to allow for an interdisciplinary application. For instance, a novice in attitudes is likely to require encouragement and guidance from the teacher, no matter the subject being considered. However, for more in-depth and subject-specific examples of characteristics of students at novice, apprentice, practitioner, and expert levels, refer to Tomlinson et al. (2009) for such descriptions and continuums in science, math, history, and English and language arts.

It is important to note here that the purpose of the rubric presented in this article is not necessarily to produce experts upon high school graduation. Rather, the purpose of the rubric is to set students on the path toward achieving expertise. The development of expertise may not be observable prior to entering high school, college, or even graduate school. To expect otherwise would be to overlook the simple fact that it takes time to become an expert (Alexander, 2003b).

Additionally, it is worth noting that high levels of expertise, as presented in the rubric, correlate conceptually with the idea of creative-productive giftedness (Renzulli, 2011). According to Renzulli (2011), giftedness is the intersection of above-average ability, task commitment, and creativity. In the rubric presented in the present article, above-average ability and task commitment are incorporated throughout the entire progression toward expertise. The aspect of creativity, however, begins to emerge more in the higher levels of Practitioner and Expert. In this way, the result of above-average ability and task commitment can be thought to lead, with time and deliberate practice, to the ability to create innovation within a given field of study, which in turn, would lead to the fulfillment of the three components in Renzulli’s (2011) conception of giftedness.

Benefits of using a rubric. Using the rubric as opposed to the original continuum helps clearly specify and distinguish between the various categories encompassed in the progression to expertise. Such clarity and transparency aid with efficiency in assessing and promoting expertise (Francis, 2018). Rubrics also provide guideposts that mark points for student growth. For instance, if a student is a novice in skills, the teacher can look at the next level along the continuum to envision where the student should be performing next. In this way, rubrics provide a systematic way to think about the process of expertise development that is both efficient and effective, as evidenced by researchers who have found the benefits of using a rubric to aid in student skill development, particularly when students have access to the rubric and the rubric was discussed beforehand (e.g., Bradford, Newland, Rule, & Montgomery, 2016). The use of rubrics also aligns well with Vygotsky’s concept of zone of proximal development: by providing recommendations that are slightly above what a child is able to do independently, an appropriate level of challenge is targeted to promote growth toward expertise with adult scaffolding (Daneshfar & Moharami, 2018).

The use of rubrics also encourages the teacher to focus on the quality of the behavior observed, rather than simply the presence or absence of it (Hale, 2018), which makes for more meaningful evaluation of student performance. It is worth noting that reliability in assessing student performance using a rubric tends to increase when training on using the rubric is provided to teachers beforehand (Lovorn & Rezaei, 2011). Finally, as with any rubric, a student is not likely to perform at a single level (e.g., practitioner) across all categories. Therefore, a student might be a practitioner in knowledge, but a novice in attitude. Such distinctions help determine with specificity where the student is currently situated along the continuum with respect to each category, which aids in the development of appropriate curricula for them. In so doing, the rubric allows for greater customization of a teacher’s understanding of students’ progress toward expertise.

Recommendations for using the rubric. When using the rubric, the following recommendations will be useful for teachers to keep in mind. First and foremost, student performance changes from day-to-day. Therefore, it is useful for teachers to keep their eyes open for any opportunities for students to show growth in knowledge, skills, attitudes, or habits of mind. Students may reflect growth when coming to the front of the board to demonstrate something new, when raising their hand to excitedly make a connection to something they learned in another class, or even when expressing more interest in relearning how to do something right than they showed in the grade they earned on an assignment.

Second, teachers may find it easier to apply the rubric if they keep a copy of it where they typically create lesson plans. Then, when creating activities or tasks for your students, the rubric serves as a reminder to think ahead to how the activity may serve as a formative assessment to determine student placement along the rubric. For instance, a teacher may develop a math activity for students in the twelfth grade that may require students to make the leap from simply taking the derivative of an equation to using calculus to solve a physics problem. Individual student performance on this task may help prove if the student has moved from being a practitioner in knowledge to being an expert in knowledge. It is not necessary to create separate tasks with the sole purpose of gauging student performance along the expertise rubric. Rather, it is often sufficient to keep mental notes of how each activity can serve multiple purposes.

A third recommended practice is to make four charts (one for knowledge, one for skills, one for attitudes, and one for habits of mind), similar to attendance charts, with student names for each subject taught. When grading student work, it is useful to keep these charts nearby. Then, bearing in mind the purposes of the activity, a teacher may quickly jot down how a student is performing by writing, for example, “N” for novice. A quick glance, then, across the row would hopefully yield a steady progression along the expertise continuum from “N” to “E.” For instance, Figure 2 reflects how part of a knowledge chart may appear. The teacher has identified several activities that will help gauge student development of knowledge. While grading or reviewing student work on each of these activities, the teacher takes note of whether each student is demonstrating novice, apprentice, practitioner, or expert levels of knowledge. The chart can then be used to guide the development of future differentiated or individualized tasks for students to complete in order to help their progression along the continuum. For categories such as habits of mind, however, planned activities may not provide as much information as observable behaviors in the classroom, but such notes may still be maintained in a similarly formatted chart.

Figure 2. Sample chart assessing students' progression of knowledge based on class assignments.

Student Name	Quiz #1 on factoring	Graphic Organizer for Quadratic Functions	Journal entry	Homework #2
Student 1	N	N	A	N
Student 2	N	A	A	A
Student 3	N	N	A	A
Student 4	A	A	P	A

The fourth recommendation for teachers is to involve students in self-assessment. For instance, when students settle into the habit of journaling, they practice reflecting on their own understanding of their knowledge, skills, attitudes, and habits of mind. They do not need to know about the expertise rubric to accomplish this. Instead, as a warm-up or wind-down activity, students can journal either in a notebook or on an index card about how comfortable they feel with what they are learning. In reviewing their journals, statements such as, "I understand this math problem when you solve it on the board, but I struggle to do it on my own," can point, for instance, to a novice in skills. Involving students in the process of metacognition may help provide further insight into where they are performing on the rubric.

Finally, it would be unrealistic to expect to immediately develop a spreadsheet with student performance in each category of expertise for each subject or subtopic taught. It may be easiest to begin with assessing one student per day. There may be moments when students unexpectedly do something that helps identify their place along the rubric. Most importantly, however, recording student progress should always be secondary to pursuing and pushing for greater progress. That is why the rubric alone is insufficient without the proper chart of recommendations, described below.

Recommendations for Progression

By filling out the rubric in Figure 1, the teacher has effectively identified the current levels of student performance. If the rubric in Figure 1 is diagnostic, then the chart in Figure 3 is prescriptive. In other words, based on the results of the rubric in Figure 1, the teacher may use the suggestions and recommendations in Figure 3 to determine how to adapt the curriculum to help students progress to the next level in each category. These recommendations are derived from the suggestions presented in numerous publications on expertise (e.g., Alexander, 2003b; Bransford et al., 2000; Feldhusen, 2005; Lajoie, 2003).

Figure 3. Chart of recommendations to move toward expertise based on assessment of students using the rubric.

	Novice	Apprentice	Practitioner	Expert
Knowledge	• Present students with new concepts that require connections from prior work • Prompt students explicitly to consider how their prior knowledge is related to the present situation	• Provide students with deliberate practice to help them become more fluent with skill and knowledge retrieval • Prompt students to create a categorization grid (Thompson et al., 2003) to organize their knowledge	• Expose students to concepts from other disciplines that can be approached using familiar strategies • Prompt students to consider their own strengths and weaknesses • Encourage students to consider why certain knowledge is useful in certain situations	• Encourage students to ask and find unanswered questions in the field and approach them • Encourage students to discuss topics with other experts and learn tacit knowledge from them
Skills	• Provide students with guided practice to ensure they establish accuracy in foundational skills • Have students practice surface-level strategies (e.g., used to understand text) until they become fluent with them	• Introduce students to some deeper-processing strategies (e.g., judging credibility) and encourage them to begin using them • Provide students with independent deliberate practice to improve their skills	• Immerse students in tasks involving deeper-processing strategies • Teach students how to "chunk" information to expand their capacity for memorization	• Ask students to identify and perform tasks that use their knowledge to help others or their communities • Create tasks for students within the actual domain (or authentic simulations)
Attitudes	• Encourage students and provide intellectual and emotional guidance as they learn new information • Balance emphasis on domain knowledge and student interest to maintain motivation	• Allow students to pursue interest-based topics to begin moving past merely situational interest and toward individual interest • Encourage students to remain motivated in the face of challenges	• Demonstrate relevance of knowledge to further student interest in domain • Help students identify short-term and long-term goals based on their talents and interests	• Connect students to experts in the field who can provide them with more specific topics to consider • Encourage students to pursue their interests beyond the boundaries of a given domain
Habits of Mind	• Explicitly teach students strategies to be more effective and efficient • Provide examples of what expertise looks like in a given domain to help students visualize it more concretely	• Provide students with immediate feedback within the context of an activity • Provide opportunities and guidance for self-monitoring and self-questioning strategies	• Teach students to self-regulate attention and evaluate feedback while working on a task • Prompt students to become independent learners by asking them to identify topics or problems of interest	• Encourage students to remain flexible in how they apply their knowledge • Pair experts with apprentices or practitioners to develop their ability to articulate their ideas for others

To use the chart in Figure 3, mark the cells whose positions match the cells circled in the rubric in Figure 1 (see Figure 4 for an example of how this would appear). These marked cells contain suggestions to help each student progress to the next level on the continuum for each category. For instance, in Figure 4, a teacher has sufficient evidence that a student is an apprentice in skills in science. After following the recommendations in the corresponding cell in Figure 3, the teacher introduces the student to deeper-processing strategies to use when solving problems. In this way, the chart in Figure 3 is meant to take the results of Figure 1 a step further, moving the teacher from considering where the student is currently performing to what the next step should be.

Figure 4. Example application of rubric assessment and corresponding recommendations.

A student performing at these levels on the rubric:

	Novice	Apprentice
Knowledge	• Experiences content at a concrete level (Tomlinson et al., 2009) • Manipulates microconcepts one at a time (Tomlinson et al., 2009) • Struggles to distinguish between relevant/irrelevant or accurate/inaccurate information (Alexander, 2003b; Sternberg, 1998)	• Understand the connections among microconcepts within a discipline (Tomlinson et al., 2009) • Connects information within a microconcept (Tomlinson et al., 2009) • Begins to interpret generalizations and themes that connect concepts (Tomlinson et al., 2009) • Retrieves relevant knowledge with effort (Bransford et al., 2000)
Skills	• Needs skill instruction and guided practice (Tomlinson et al., 2009) • Uses surface-level strategies to solve tasks (Alexander, 2003b)	• Applies skills with limited supervision (Tomlinson et al., 2009) • Applies surface-level and deep-processing strategies (Alexander, 2003b)
Attitudes	• Requires support, encouragement, and guidance (Tomlinson et al., 2009) • Relies on situational interest to remain engaged and motivated (Alexander, 2003b)	• Seeks confirmation at the end of a task (Tomlinson et al., 2009) • Develops increased individual interest in the domain (Alexander, 2003b)
Habits of Mind	• Seeks affirmation of competency in order to complete a task (Tomlinson et al., 2009) • Views problem-solving as involving memorization and recall (Bransford et al., 2000)	• Reflects upon content and skills when prompted (Tomlinson et al., 2009) • Begins to develop problem-solving strategies (Alexander, 2003b)

Would benefit from the corresponding recommendations:

	Novice	Apprentice
Knowledge	• Present students with new concepts that require connections from prior work • Prompt students explicitly to consider how their prior knowledge is related to the present situation	• Provide students with deliberate practice to help them become more fluent with skill and knowledge retrieval • Prompt students to create a categorization grid (Thompson et al., 2003) to organize their knowledge
Skills	• Provide students with guided practice to ensure they establish accuracy in foundational skills • Have students practice surface-level strategies (e.g., used to understand text) until they become fluent with them	• Introduce students to some deeper-processing strategies (e.g., judging credibility) and encourage them to begin using them • Provide students with independent deliberate practice to improve their skills
Attitudes	• Encourage students and provide intellectual and emotional guidance as they learn new information • Balance emphasis on domain knowledge and student interest to maintain motivation	• Allow students to pursue interest-based topics to begin moving past merely situational interest and toward individual interest • Encourage students to remain motivated in the face of challenges
Habits of Mind	• Explicitly teach students strategies to be more effective and efficient • Provide examples of what expertise looks like in a given domain to help students visualize it more concretely	• Provide students with immediate feedback within the context of an activity • Provide opportunities and guidance for self-monitoring and self-questioning strategies

Because expertise is not the end goal of education (Alexander, 2003b; Sternberg, 1998), suggestions are also available for students who have been identified as experts in any of the four categories. These are meant to encourage students to continue moving further and expanding the boundaries of what they know, as well as the boundaries of the domain itself, either through scholarly contributions or through artistic productions (Subotnik & Jarvin, 2005).

Guidelines for using the chart of recommendations. As with the rubric, there are certain guidelines and suggestions that teachers may find useful when applying the chart of recommendations. First, it is useful for teachers to know their resources before they begin. At the beginning of the school year, a teacher may ask students, perhaps on an interest survey, to describe their parents' occupation or hobbies. This provides information about potential experts to bring to class or whom students may contact as they progress along the rubric.

A second recommended practice is to teach thinking strategies explicitly. Although teachers often expect students to know how to think, they do not always *teach* them how to think. Making these implicit expectations explicit will be useful when prompting students to use deep-processing strategies. For instance, explaining to students how to reteach something they know and why this strategy is effective will make it easier when students are trying to progress from being a novice in skills to being an apprentice. Teachers may use warm-up time each morning or once a week to introduce students to and have them practice a new strategy.

The third guideline also serves as a useful recommendation when using differentiation: students should be prepared for the fact that they will not all be working on the same task all of the time. A student who is an expert in attitudes may be talking to outside experts in the field, while other students who are between apprentice and practitioner attitudes pursue an interest-based project they designed with the teacher's approval. Such discrepancies within the classroom are normal and to be expected, but it is important that students are adequately prepared – both cognitively and emotionally – for this reality.

Finally, perhaps one of the most important recommendations is to be prepared. If a teacher administers an interest survey to students at the beginning of the year, he may note common themes and find as many reliable, age-appropriate resources as he can, both print and electronic. Then, when the occasion arises during the year, he will be prepared to connect students to the necessary resources. Furthermore, it would be beneficial to save these resources each year in a document. Each year, as the file expands, so will the options for the incoming class of students to explore.

Examples: Rubric and Recommendations

Often, specific examples of student performance are useful in developing a visual understanding of how each level of performance might appear in the classroom. Toward this end, Figure 5 provides narrative examples of students at varying levels of the continuum in each category. These are intended to provide further guidance in identifying students' positioning along the continuum when using the rubric in Figure 1, as well as demonstrations of the application of Figure 3.

Figure 5. Examples of students performing at varying levels on the rubric, as well as recommendations for progression toward expertise.

Exemplar A:
In Algebra class, Mark is learning about solving systems of equations through several different methods. Although he doesn't understand how solving systems of equations is related to solving a single equation, he is able to solve problems by following the steps used in similar class examples or if his teacher provides him step-by-step guidance on a specific problem. His class has learned several different methods, but Mark isn't able to tell when each one would be most appropriate. When he's working independently, he also isn't sure if he's using the right information to solve the system of equations. He usually tries to use all the information he's given because he thinks if the information is included, it must be important. Although Mark can sometimes follow the steps independently, he isn't sure what the answer means or why these particular methods actually work. However, his teacher has shown them why such problems are useful in real life, which has caught Mark's attention because he wants to be an engineer. This has motivated him to continue working and asking his teacher if he's solving the problem correctly. Occasionally, he can use the context of the problem to determine if his answer is reasonable or not. However, he still struggles to find where he made a mistake, although his teacher has shown him how to label his work clearly to avoid making careless errors.

Based on this description of Mark, he can be described using the rubric in Figure 1 as a novice in knowledge and skills and an apprentice in attitudes and habits of mind. Using Figure 2, then, there are several actions his teacher can take to move him along the continuum toward expertise. He would benefit from his teacher explicitly prompting him to consider the similarities between solving a single equation and solving a system of equations. By using a T-chart to outline the steps used to solve two such problems, Mark might be able to make more connections between his prior knowledge and the current lesson. He should continue practicing the different methods they have learned to become more fluent at identifying relevant and irrelevant information. His interest in engineering can be used to develop context-driven problems that help promote his individual interest in the lesson and motivate him to continue working hard to succeed. Mark's teacher can also model problem-solving using a think-aloud to help promote self-reflection and self-monitoring, which would guide Mark in identifying potential errors in his problem-solving strategy.

Exemplar B:
Elizabeth is also learning about systems of equations in Algebra. She immediately noticed how solving systems of equations is related to solving a single equation, and she also noticed how the two were different. She can identify relevant and irrelevant information when solving a problem, although she does need to focus more on the problem to make this determination. She makes occasional mistakes when working, but she is able to solve problems independently, checking in with the teacher occasionally to make sure her answers are correct. She is able to look at the system of equations and eliminate one of the three methods she could use to solve it because she knows it would make the problem more difficult. Elizabeth understands that the solution would represent the intersection of two functions on a graph, but she's not sure why this is important or useful in real life. Although her teacher attempted to explain why systems of equations are relevant, Elizabeth isn't totally convinced. She doesn't see them as being relevant to her own interests. This has limited her motivation to solve problems and remain engaged in the lesson. Her main motivation to do well is to earn good grades on the test. To study for her test, she usually works on memorizing the different methods she could use to solve systems of equations.

Using the rubric in Figure 1, it's clear that although Elizabeth has developed apprentice knowledge and skills, she tends to hold novice attitudes and habits of mind. Based on the suggestions in Figure 2, Elizabeth's teacher can provide her with additional deliberate practice to improve her skills and fluency and move her toward expertise. This can be paired with developing problems based on Elizabeth's interests to help increase her motivation. It would be useful to also teach her strategies to be a more effective learner – such as having her explain the concepts she's learning to others – in order to move her away from memorization and toward deeper understanding.

Exemplar C:
In her Algebra class, Simone is quickly grasping the concept of solving systems of equations. She is able to draw from her skills in solving a single equation to effectively solve a system of equations. Just as she knows that "solving for x" is identifying an unknown quantity, she knows that solving a system of equations is solving for an unknown point of intersection, which represents the solution to many practical, real-life problems. She is able to represent the solution as a graph, as a point, and as a variable. Simone can do basic calculations and manipulations quickly, effectively saving time when solving a problem. By looking at the system of equations, she knows which method of the three they've learned would be the most efficient for solving the system, depending on the position and coefficients of the variables. She can even solve some of the more basic systems mentally and use her knowledge about the functions to determine if her answer is well-aligned with her estimate. She loves the feeling of being able to use what she knows to solve a real-life problem, and she enjoys spending her free time finding other domains where systems of equations can be useful. She has even begun solving systems of equations involving more than two equations by watching tutorials online. When systems of equations can't be solved by hand, she has learned how to use a computer software to accurately determine the solution.

Simone's teacher can use Figure 1 to conclude that Simone is a practitioner in the domains of knowledge and skills, and an expert in attitudes and habits of mind. To help develop Simone's knowledge and skills, her teacher can ask her to see how systems of equations can be applied in physics. She may connect her with a high school or college mentor who can guide her in applying systems of equations to solve for physics problems involving velocity and acceleration. She may also give Simone the task of finding other practical applications of systems of equations that she can learn about to see the lesson's practicality. It would also be useful to encourage Simone to connect her interests to systems of equations in the form of an independent project. Finally, to encourage Simone to remain flexible, her teacher might prompt her to consider more unique topics, such as how an artist might represent systems of equations or to develop metaphors for solutions of systems of equations in various domains.

Exemplar D:
James is excelling in his Algebra class's lesson on solving systems of equations. Before the lesson even began, he had looked ahead in his book and began teaching himself how to solve systems of equations using what he knew about solving single equations. He's contacted his older sister – a math major in college – to ask her about solving more complex systems of equations, the relationship between the number of variables and the number of equations in a system for the system to be solvable, and how they can be applied in real life. Before the teacher pointed it out, James began to notice patterns of when to apply which method to solve for a system, depending on the types of equations presented. Furthermore, he was able to develop his own system of equations that could be used to solve a real-life problem he identified. His ability to tap into his prior knowledge and make connections across various lessons is automatic. In his free time, he continues to practice solving systems of equations, often asking his younger brother for random numbers to use as coefficients. He refuses to rely on a calculator, preferring to solve each system by hand. When necessary, he uses an advanced computer program he downloaded and taught himself to use. His interest in the topic is driven primarily from his belief that this will help him in his pursuit of becoming a physics major in college. He pushes himself to try more challenging problems, but is hesitant when the problems come from a domain with which he is unfamiliar.

Using Figure 1, James can be described as an expert in knowledge and skills, and a practitioner in attitudes and habits of mind. To show James that knowledge has no limit, his teacher can encourage James to contact professors at the local university to find as many relevant uses for systems of equations in as many domains as possible. She can encourage him to be more inquisitive in seeking problems beyond his domains of comfort, and to consider how his knowledge might be used to improve the community in which he lives (for example, he might create a system of equations to maximize the living area of a developing home without exceeding a set budget). It would also be useful to encourage James to pursue more challenges and remain motivated when facing them.

It will be useful here to remember that a student will not likely be an expert in all subjects. Even when expertise is successfully developed, it is more likely an individual will be an expert primarily in one subject (Lajoie, 2003), or even in one facet of a subject. This is similar to what is known about famous examples of experts today: Einstein is renowned for his scientific contributions, while Shakespeare is still remembered, centuries after his passing, for his inimitable writings. Therefore, in order to provide a consistent domain in which these levels of distinction (and the progression between them) may be easily observed, the student examples are positioned along a continuum that measures the progression of expertise specific to one subject, Algebra. More particularly, the examples focus on the topic of solving systems of linear equations, a process that can be executed with numerous approaches, three of which teachers typically introduce at the secondary level.

Two more points about the examples should be noted. The first is that the examples are designed to reinforce the notion that a student may develop expertise asynchronously (Tomlinson et al., 2009). The students in the examples are not at the same level across all categories. For instance, in Example A, Mark is a novice in knowledge and skills, but an apprentice in attitudes and habits of mind. Although each student presented in Figure 5 spans across a maximum of two levels, it is possible to have students who manifest a different level in each category. Finally, in Example D, even when a student is deemed to have demonstrated expertise in a certain category, there is no boundary to the realm of expertise. Rather, great effort should be taken to provide continual recommendations to students to help further stretch and develop their potential and, consequently, the expertise they have to offer.

Summary

Curricula employed by teachers provide a potentially powerful means of challenging students at personally appropriate levels to help them achieve growth. The model of Ascending Intellectual Demand, presented by Tomlinson et al. (2009), was designed to assist teachers in thinking about and planning for progressions of challenge that can consistently extend the learning horizons of advanced learners. This guide builds on research and scholarly writing on expertise to expand on the AID model by providing practical and efficient ways to measure and encourage student progress along the continuum. The environment surrounding advanced learners, including the curriculum they study, is of critical importance when considering how students' potential can be maximized (Dai & Renzulli, 2008). This article represents an attempt to share a few of the ideas from the Parallel Curriculum Model and Ascending Intellectual Demand in a format that encourages teachers to use them in instructional planning so that teachers themselves become catalysts for developing emergent expertise in all of their students, including those who are academically advanced.

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