

# Technology Tools for Students with Autism

## Innovations that Enhance Independence and Learning

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## About the Editors

**Katharina I. Boser, Ph.D.**, received her B.A., M.A., and Ph.D. from Cornell University in developmental psychology and cognitive science and wrote her dissertation about the early development of child language. She completed postdoctoral work at the University of Maryland studying language rehabilitation using computing technologies for patients with aphasia. In 2000, she joined the research faculty at Johns Hopkins University School of Medicine in Cognitive Neurology, where until 2005 she studied language training with low-verbal subjects and cognition (number representation, memory, and visual attention) in children with autism. She has conducted research on social robots and is involved in usability research with technology companies developing computer software for use with children with autism and other cognitive and/or learning issues. She was a board member and later cochair of the Innovative Technologies for Autism initiative for Autism Speaks until 2011. Dr. Boser is president of Individual Differences in Learning, an educational nonprofit in Maryland that provides professional development to teachers and parents regarding brain-based teaching techniques and innovative technologies for students with a range of cognitive impairments, including autism and twice exceptionality. She presents at many national and international conferences on autism technology research and cognition and advocates for universal design for learning and 21st-century learning and teaching at state and national levels. Since the fall of 2011, she has been a technology coordinator for the Glenelg Country School in Ellicott City, Maryland.

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Active in the local disability community, she has helped organize numerous conferences designed to help parents and professionals learn more about ways to help their children with disabilities. She is on the executive committee of the Individual Differences in Learning Association and has been a board member of the Special Education Citizens' Advisory Committee of Prince George's County, Maryland, since 2007. She comoderates GT-Special, an international Listserv for parents of twice-exceptional children (children who are both gifted and learning disabled), and is a member of the Gifted and Talented with Learning Disabilities (GT/LD) Network. She is also a Parents' Place of Maryland PEP (Parents Encouraging Parents) leader of Prince George's County, Maryland.

Dr. Wayland lives with her wonderful husband and their two fabulous boys in Riverdale Park, Maryland.



# Universal Design for Learning

## *Meeting the Needs of Learners with Autism Spectrum Disorders*



Yvonne Domings, Yvel Cornel Crevecoeur, and Patricia Kelly Ralabate

These are exciting times. New digital technologies are developing in ways that were impossible to envision in the 1990s. These developments have had a huge impact on peoples' lives—on the availability of information and our ability to connect with each other. Digital technologies have also had a huge impact on the learning sciences and the way teaching and learning are viewed. Simultaneously, digital technologies have made developing flexible, high-quality learning experiences much quicker and easier. At CAST, we believe these new developments have the potential to change the way educators are able to help a larger number of learners, including those with autism spectrum disorders (ASDs),<sup>1</sup> reach their full potential. This chapter explains how universal design for learning (UDL)—an innovative framework for curriculum and instructional design—addresses the needs of learners with ASDs in classrooms. We share two instructional examples that apply UDL to the development of literacy skills and social and emotion understanding, areas that can be particularly challenging for learners with ASD. In addition, we present a different approach to developing learning experiences, one that views the learning environment as “disabling” rather than viewing the learner as disabled. Finally,

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<sup>1</sup>We acknowledge the current debate in the autism community regarding the accepted practice of using person-first language. Although we agree with the point made by autism self-advocates that autism is part of their individuality and therefore should not be separated in language like a disorder or disability, we also feel that universal design for learning (UDL) focuses on barriers in the curriculum and how these barriers “disable” learners. In this regard, we prefer to focus first on individual learners and avoid labels. When it is necessary to refer to a group, we use person-first language to maintain the focus on individual learners and their interactions within learning environments.

tools are recommended that benefit learners with ASD by reducing barriers in the environment.

## **CURRENT VIEWS OF LEARNING**

The modern learning sciences leverage such digital technologies as fMRIs and PET scans, which enable researchers to view the brain while an individual is learning and performing tasks. Digital imaging has revealed two very consistent findings: 1) that learners are highly variable and 2) that learning is highly dependent on the context (Fischer & Bidell, 2006; Rose & Fischer, 2009; Siegler, 1994; van Geert & Fischer, 2009). As a result of these new understandings, the learning sciences have undergone a dramatic shift from traditional linear perspectives of the way learning occurs (i.e., that all individuals progress through the same series of stages during learning) toward a much more dynamic view of learners and the learning process (i.e., that learning happens in the interaction of the individual and the learning context).

### **Learners Are Highly Variable**

Modern learning sciences have consistently found that learners are highly variable. Some of this variability is individual. Every person is unique based on his or her individual genes (nature) and on his or her experiences over time (nurture). In other words, the combination of the two (nature and nurture) means that there are inherent differences among learners in how they think and act as well as fluctuations in performance within individuals as they interact in different environments. Variability in how people learn is a result of the interaction of genetic makeup and experiences (Fischer & Bidell, 2006; Grigorenko & Sternberg, 1997). The bottom line is that the way an individual interacts with and processes experiences will vary and will have a tremendous influence on the way he or she learns.

### **Learning Is Highly Dependent on the Context**

Another consistent finding from the learning sciences is that learning is highly dependent on the learning context (e.g., Fischer & Bidell, 2006; Grigorenko & Sternberg, 1997; van Geert & Fischer, 2009). A person may be very talented when learning in one context, yet be challenged to learn in another. A person's ability is a function of the interaction between the person's skills or knowledge (his or her internal resources) and the requirements in the environment (demands).

Enabling learning means offering appropriate challenges by ensuring demands are high enough to require the learner to push himself or herself beyond his or her current repertoire of skills and understanding. However, demands cannot be so high that they overwhelm the learner's ability to achieve the instructional goal. It is also important to reduce or eliminate those demands in the environment that are unnecessary. If a learner does not immediately possess the internal resources required to perform well in the learning environment, an educator should provide supports and scaffolds to reduce excessive demands without reducing expectations. Supports include but are not limited to glasses, braille, or communication boards that the learner may always need; whereas such scaffolds as concrete prompts, cuing, hand-over-hand assistance,



coaching, or modeling can be progressively reduced or removed as the learner begins to demonstrate proficiency.

Consider a basic example to contextualize possible scaffolds before we delve deeper into the needs of learners with ASD: A learner who does not understand Spanish will not learn well in a classroom where the teacher is speaking only Spanish. That learner does not have the internal resources (understanding of Spanish) or the external resources (translation) to meet the demands of the learning environment. If the goal is to master Spanish, the learner may come to understand Spanish over time from being exposed to the language in the classroom. However, it is also almost certain that he or she will fall behind the rest of the learners in other content areas if language translation is not available while the student develops an understanding of Spanish. In other words, if the external resources or scaffolds (e.g., translation of content, vocabulary support) are not provided while the student is developing an ability to understand Spanish (i.e., the student's internal resources), he or she will fail to learn other content areas and may even appear disabled.

Understanding learner variability, minimizing unnecessary demands within the context, and providing options are ways to positively affect not only a learner's perceived ability but also, over the long run, a learner's potential to learn and succeed in life (Luria, 1976). If educators do not do these things, some learners will certainly fall behind.

### **Variability in Learning Is Systematic**

Although learner variability in an environment of high expectations can seem to be a formidable planning challenge, a good deal of variability is actually predictable or systematic and, therefore, can be planned for in advance. For example, it is reasonable to expect that young children know and are able to do less than adults. This type of variability, developmental variability, is systematic; thus it can be expected and planned for in advance. In fact, such advance planning is regularly done by creating curricula that vary to meet the needs of different developmental or age levels.

Individuals also vary as they learn and develop skills, knowledge, and expertise. A novice (e.g., an individual learning something new) in any subject or skill area will learn differently than a person who has developed some understanding, skill, or expertise in that area. For instance, a novice musician will differ in what and how he or she learns a new musical piece from how an expert musician will learn the exact same piece (Bloom, 1985; Dreyfus & Dreyfus, 1980; Karmiloff-Smith, 1992). This is another type of systematic variability that can be expected and planned for in advance.

The main point is if educators know where to expect variability in learners, it is possible to create learning experiences that address the wide range of learner variability without having to retrofit curricula and reduce expectations.

## **AUTISM AND LEARNING**

Where does autism fit into this? The label ASD is used to identify individuals whose interests and communication, social, and executive functioning skills differ broadly

from those of learners who are typically developing (National Autism Center [NAC], 2009; National Research Council [NRC], 2001; Quill, 1995). Although differences in these areas are characteristic for anyone with an ASD label, it is important to recall that learners with ASDs also vary considerably from each other, just as all learners do (Grigorenko & Sternberg, 1997).

Not so long ago, learners with ASD were educated primarily in self-contained classes or schools, with modified—and often-reduced—expectations (Rose, Meyer, & Hitchcock, 2005). Today, most learners with ASD are educated in general education classrooms and expected to progress in the general education curriculum (U.S. Department of Education, 2011).

Indeed, learners with ASD can and do learn quite well. There are numerous examples of individuals with ASD who became famous for skills, knowledge, and expertise in very specific areas (Heaton, Williams, Cummins, & Happé, 2008). There are many others, not famous at all, who have amazing skill repertoires in particular areas called *splinter skills*, which often developed outside traditional learning environments (Motttron, 2011).

### Traditional Learning Environments

Why is there such a discrepancy between what some individuals with ASD learn on their own and what they learn in a traditional learning environment? Take a step back to think about traditional learning environments. Relying heavily on verbal language, printed materials, and paper-and-pencil assessments, traditional learning environments are designed with

- One means of representing information (text, lecture, etc.)
- One means of acting and expressing what learners know (by listening, reading, and writing)
- One means of engaging with learning (one topic that may or may not be interesting to all)

Traditional classrooms are designed to be responsive to the “illusory average student” and assume a baseline degree of competence in communication, social understanding, and self-regulation. Learners with ASD may not have accrued the knowledge and skills in these areas that other learners have developed. Given that the abilities of learners are a function of the intersections of the skills or knowledge they have (internal resources) and the demands in the environment, learners with ASD may be unprepared for a traditional classroom.

### Options to Traditional Learning Environments

There are now many options for teaching materials and methods other than those that a traditional classroom offers. Unlike older fixed technologies, such as print, digital technology makes manipulating the learning context for a wide range of learners faster and easier (Rose, Gravel, & Domingos, 2010). This is good news for learners who are perceived as having a disability when using traditional curricula or in traditional contexts. Educators can reduce contextual barriers in the learning environment and offer learners with ASD the flexibility and support they need to be successful by applying the principles of UDL.

## UNIVERSAL DESIGN FOR LEARNING

The UDL approach is “a set of principles for curriculum development that give all individuals equal opportunities to learn—not a single, one-size-fits-all solution but rather flexible approaches that can be customized and adjusted based on individual learner needs” (CAST, 2012). UDL views learner variability as a strength to be leveraged, not a challenge to be overcome. Instead of focusing on intrinsic deficits or challenges that are perceived to be present in learners, UDL requires instructional designers and educators to be mindful of areas where they can expect learners to vary naturally, allowing them to plan for this variability in advance. The UDL principles help educators design learning experiences that provide opportunities for all learners, including those with ASD, to have access to, participate in, and progress in the general education curriculum by reducing barriers to learning.

The ultimate purpose of UDL is to help all learners develop into *expert learners*, that is, learners who set their own learning goals and monitor their progress toward those goals. Expert learners also understand the resources they need to engage with and persist with learning tasks in the service of the learning goals they set (CAST, 2011). It is important to note that UDL can help many learners with ASD not only learn, but learn at a rate that would enable them to progress through the general education curriculum alongside or even beyond that of their peers. In the past, academic expectations were low for these learners; but when educators use UDL in their classrooms, all learners have increased opportunities to go beyond rote learning. Learners with ASD and their peers can fully engage with content while simultaneously moving toward the same learning goals.

### Universal Design for Learning Principles

The UDL framework addresses three neural networks (recognition, strategic, and affective) that are involved in learning and provides educators with guidance about how to plan for expected or systematic variability. The UDL principles focus on learner needs, highlighting how each area of the curriculum should provide flexible options. Hence, the UDL principles require educators to provide

- Multiple means of representation
- Multiple means of action and expression
- Multiple means of engagement

Associated with each principle are a series of guidelines and checkpoints to help educators design instruction to meet the needs of a broad range of learner variability<sup>2</sup> (CAST, 2011; Table 2.1).

### Universal Design for Learning and Learners with Autism Spectrum Disorder

As mentioned, the UDL framework provides educators with guidance about where to expect the most variability in learning. It also offers educators suggestions on how to provide options that will accommodate a wide range of learning needs.

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<sup>2</sup>See the National Center on UDL (2010a, 2010b) for more detailed information on planning lessons and curricula using the UDL guidelines (<http://www.udlcenter.org/aboutudl/udlguidelines>).

**Table 2.1.** The universal design for learning principles**Multiple means of representation**

- Perception
- Language, expressions, and symbols
- Comprehension

**Multiple means of action and expression**

- Physical action
- Expression and communication
- Executive function

**Multiple means of engagement**

- Recruiting interest
- Sustaining effort and persistence
- Self-regulation

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Applying UDL starts with three initial steps:

1. Understanding or defining the instructional goal
2. Evaluating the demands in the current curriculum or approach
3. Addressing learner variability using the UDL guidelines

In classroom situations, educators formally and informally assess the success of instruction and redesign instructional approaches based on outcome evidence to continuously improve instruction through an iterative process.

In the following two sections, we offer instructional examples contrasting traditional approaches with strategies that address variability in learners with ASD by applying the UDL framework. In particular, we highlight specific, applicable UDL guidelines (represented by numbers in parentheses). These examples offer curriculum designers and educators suggestions for how to use the UDL framework to design instruction that is less disabling and has fewer barriers for learners with ASD and can actually benefit all learners.

### EXAMPLE 1: USING APPROPRIATE VOICE VOLUME

No child comes into the world with an understanding of how to regulate his or her voice or to use discretion to match voice volume with a context or situation. These are rules that are learned over time, though often implicitly. In addition, there is a wide range of expectations, even among adults, about what is an appropriate voice volume in any given situation. For example, one teacher or parent may require soft voices or silence whereas another hears collaborative discussion and raucous play as “music to the ears.” Appropriate voice volume is a fluid, implicit, contextually dependent concept, and as such it is a concept that needs to be explicitly taught to learners with ASDs.

Let’s compare a traditional approach to the UDL approach to teach learners how to use appropriate voice volume.

#### Traditional Approach

Traditionally, the concept of what is appropriate voice volume is implicitly taught across communities, in classrooms, but also in libraries, churches, homes, and

elsewhere. Learners who do not experience difficulties regulating voice volume internalize rules over time through social interactions with such elders as parents, teachers, and community members. Typically, the following strategies are used to teach the voice volume concept:

- Adults use verbal prompts, for example, “lower your voice” or “use your library voice” or “use a quiet talking voice.”
- Verbal language is often paired with nonverbal cues: holding finger to lips or “zipping” the lips.
- Adults assess when learners are out of appropriate range and then verbally and nonverbally remind them to adjust their voices.
- Learners are exposed to varied contexts (e.g., church, hospital, or silent reading versus center time, recess, or outdoor play) in which various voice volumes may be appropriate.
- Learners are expected to compare their behavior with that of others (models) in order to develop discretion for adjusting their voice volume.

Some learners will pick up these strategies without much effort, but many learners with and without disabilities will, in fact, continue to rely on adult cuing rather than developing the ability to independently regulate their voice volume. For example, learners with ASD are often challenged by the demands of the social domain and tend to require a great deal of scaffolding and supports to help them develop needed skills. With a UDL approach, all learners are encouraged and given opportunities to develop independence and expertise in appropriate voice volume as well as other areas.

### Universal Design for Learning Approach

Given that all learners are variable, the UDL approach starts by identifying the goal and then looking at the contextual barriers that are inherent in the traditional approach by asking the following questions: What demands does learning this concept make of learners, and are these demands necessary for learning this concept or are they irrelevant? How high are the irrelevant demands in relation to the learners’ resources? How does the UDL framework help reveal where learners are likely to vary? What options can be made available in order to address variability, minimize irrelevant demands, and ensure an appropriate level of challenge? After asking these types of questions, the educator is better able to understand how to utilize the UDL approach to teach learners how to use appropriate voice volume. This is accomplished through a three-step process: 1) articulate the instructional goal, 2) evaluate the demands in the curriculum, and 3) address learner variability.

**Step 1: Understand or Identify the Instructional Goal** In utilizing a UDL approach, the first step in instructional planning is to clearly identify and understand the goal. In this example, the goal is that learners will be able to use discretion in regulating their voices depending on the context, but the real task is to make an implicit concept (i.e., appropriate voice volume) explicit for the learner.

**Step 2: Evaluate the Demands in the Current Curriculum or Approach** Next, analyze the task by evaluating the demands in the traditional approach:

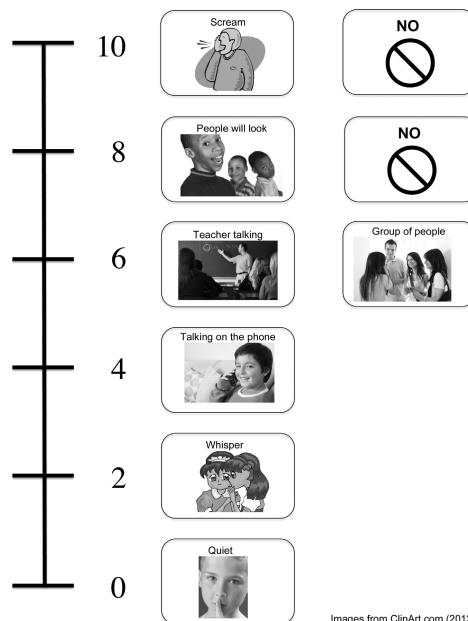
1. Verbal language must be understood.
2. Nonverbal language must be understood.
3. Role models must be noticed and followed.
4. Appropriate volume that matches the context needs to be produced, remembered, and internalized as a skill that can be applied in various settings.

Figure 2.1 shows a visual support that might be used to help learners practice this skill.

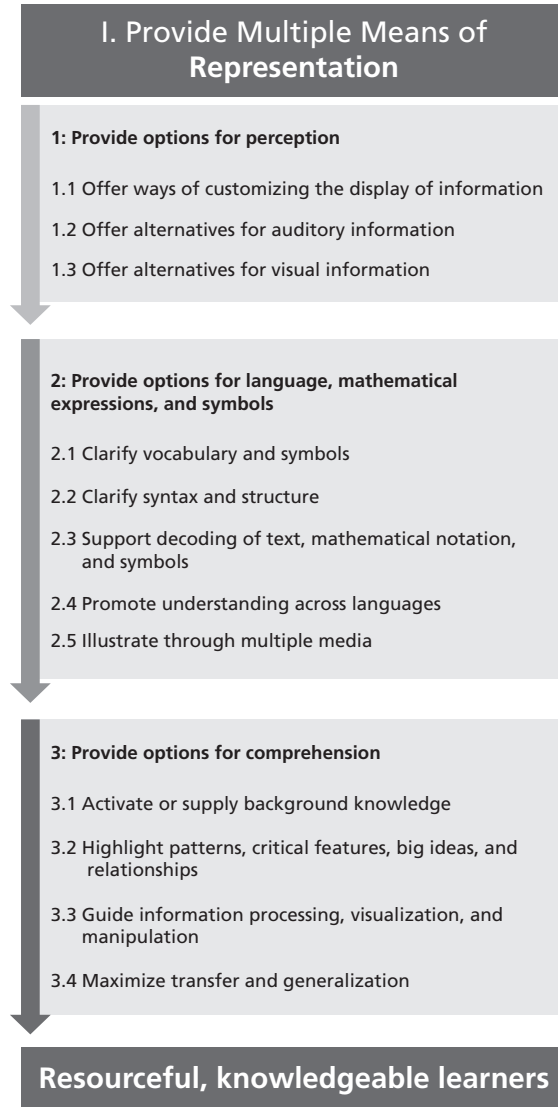
**Step 3: Address Learner Variability**

**Multiple Means of Representation** The UDL framework encourages educators to provide multiple means of representation (Figure 2.2). To do this, educators must consider the way information is presented and whether learners will ultimately understand and be able to use what is presented. Finally, educators need to determine how much access to a lesson’s content is necessary versus that which is irrelevant to achieve the goal.

Educators commonly pair verbal language or printed words with visual supports to offer accessible information while helping a wide range of learners develop language. In accordance with this strategy, the UDL guidelines suggest the use of options for language, expressions, and symbols, thereby clarifying vocabulary and promoting understanding across languages (2.4 in Figure 2.2). In this example, this



**Figure 2.1.** Zero to ten visual support scale to develop appropriate voice volume. (From D. Milewski; adapted by permission.)



**Figure 2.2.** Principle 1: Multiple means of representation. ©2011 by CAST. All rights reserved.

abstract concept is made more concrete by creating a visual representation using a chart or graphic organizer, like the one shown in Figure 2.1.

However, simply providing multiple means of representation is not sufficient because doing so provides access only to information, not to deeper understanding. Good learning experiences push beyond access to help learners develop the ability not only to gain information but also to decipher it, apply it to what they already know, and transform it into usable knowledge that can be used in the service of their own learning. The UDL guidelines also advise educators to aid comprehension by providing options for activating or supplying background knowledge (3.1). To this end, educators can help learners develop a deeper, shared understanding of



voice volume by modeling examples and nonexamples of various volume levels and helping the learners agree on what each level means. This strategy explicitly provides a model rather than expecting the learner to implicitly understand the need to pay attention to a peer model in an otherwise distracting social environment.

*Multiple Means of Action and Expression* The UDL framework encourages educators to provide multiple means of action and expression (Figure 2.3). To do this, educators must provide options in the way learners express their understanding of the concepts being presented. This prevents the means of expression from being a barrier to achieve the goal.



**Figure 2.3.** Principle 2: Multiple means of action and expression. ©2011 by CAST. All rights reserved.



Learners express their understanding by pairing the model (above) with options of concrete symbols (e.g., icons, pictures, numbers). Doing this provides them with multiple means of expression and gives them access to learning through something that they personally understand. By connecting a symbol with the concept of each volume, educators highlight critical features, big ideas, and relationships (3.2 in Figure 2.2) between the concrete (i.e., icon, picture, number) and the abstract idea of the appropriate volume. This is done both verbally and nonverbally.

In addition, a chart (as in Figure 2.1) incorporating all the representations above is cocreated by the educator and the learners and posted in the classroom environment. Learners participate in creating the representations in order to promote their understanding of the different levels and to enhance relevance for each of them. To guide appropriate goal setting (6.1), a volume goal is set ahead of time for each activity and a magnet, clothespin, or other pointer shows the appropriate volume to the learners. Over time, such a chart can be faded or left in the environment as a support.

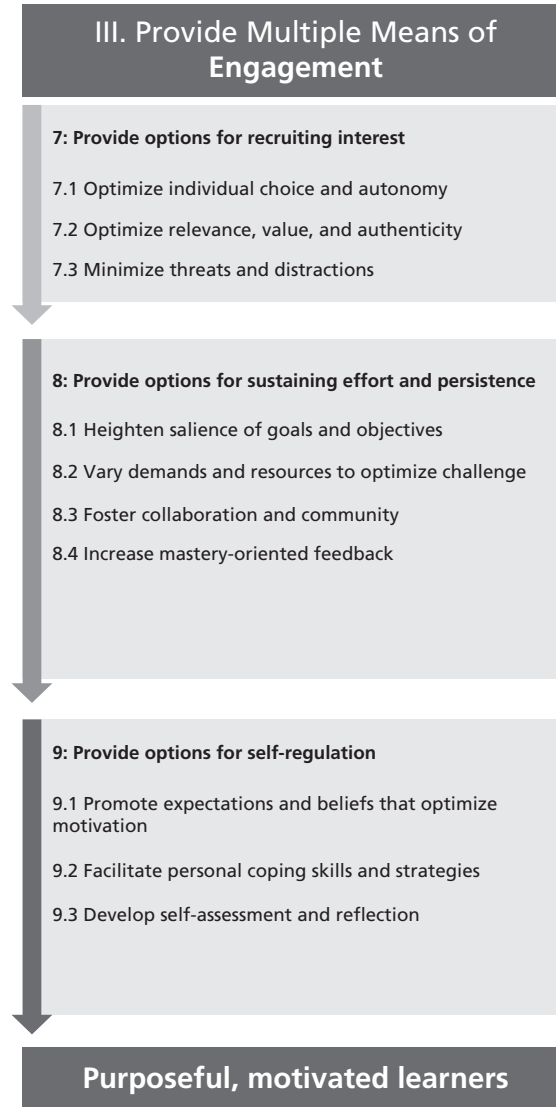
**Multiple Means of Engagement** The UDL framework encourages educators to provide multiple means of engagement (Figure 2.4). A vital role for educators is to ensure that all learners are engaged in their work by ensuring learners are “hooked,” engagement is persistent, and they can effectively self-regulate their own learning. In this particular example, the educator provides other means of engagement for learners who are not motivated to comply with social norms. Having learners participate in choosing and assigning meaning helps optimize relevance, value, and authenticity (7.2 in Figure 2.4) for each individual. In the volume chart, numbers in the range correspond to various volume levels and are paired with images. For some learners, numbers enhance authenticity; for others, the visual representations do the same. In both cases, they add relevance to the expectations.

Educators refer to the volume chart periodically to point out appropriate and inappropriate examples, thereby helping to sustain effort and persistence (8). The permanence of the chart in the environment serves to heighten the salience of the goal (8.1) and helps to enhance learners’ capacities for monitoring their own progress (6.4 in Figure 2.3). Learners are guided to develop the ability to self-assess and reflect (9.3)—both key to developing independent self-regulation skills and expertise.

By adding options for representation, expression, and engagement, the educator is able not only to make the lesson much more accessible to a wider range of learners but also to build expertise and independence in all learners.

**Additional Examples** To provide multiple means of representation, educators can employ several strategies:

- Use digital examples offered in blogs or such teacher support web sites as Hands in Autism (<http://www.handsinautism.org/pdf/Voice%20Chart.pdf>), Geneva Centre for Autism (<http://www.elearning.autism.net>), and KinderKraziness (<http://www.kinderkraziness.blogspot.com>)
- Create a customized version of the chart in the example using pictorial representations such as those available from Picture It (<http://www.slatersoftware.com/pit.html>) or ToonDoo (<http://www.toondoo.com>)



**Figure 2.4.** Principle 3: Multiple means of engagement. ©2011 by CAST. All rights reserved.

- Provide alternatives for auditory information (1.2) using digital tools and assistive technologies, for example, using a portable voice volume monitor (available from <http://www.ibridgenetwork.org>) to model and compare various volume levels
- Illustrate through multiple media (2.5) using digital technologies, for example, Softpedia BOT 1.0 (<http://www.mac.softpedia.com/get/Utilities/BOT.shtml>)

To provide multiple means of action and expression, educators can use these strategies:

- Support planning and strategy development (6.2) and enhance learners' capacity for monitoring their own progress (6.4) using stories to build deeper understanding

- Use story models, for example, prepared social story and success story examples related to modulating voice volume, available online from such publishers as Carol Gray's Center (<http://www.thegraycenter.org/social-stories>) and Sandbox Learning (<http://www.sandbox-learning.com>) or from autism resource centers

To provide multiple means of engagement, educators can apply these approaches:

- Facilitate personal coping skills and strategies (9.2) and develop self-assessment and reflection (9.3) using video applications, for example, Camtasia (<http://www.techsmith.com/camtasia.html>), or using animation applications, for example, Animoto (<http://www.animoto.com/education>)
- Increase relevance and authenticity (7.2) with Blabberize (<http://www.blabberize.com>), which allows educators to upload a picture of the student, add an audio recording of the student's voice, and produce an animated photo with a mouth that moves in sync with the student's voice

## EXAMPLE 2: DEVELOPING READING COMPREHENSION AND INFERENCE-MAKING STRATEGIES

Reading is “the most critical academic skill a child can learn,” according to the President’s Commission on Excellence in Special Education (U.S. Department of Education, 2002, p. 60), because weak literacy skills compromise success across the curriculum. According to the report of the National Reading Panel (National Institute of Child Health and Human Development, 2000), reading comprehension, or making meaning from text, is an essential component of reading. It affects a person’s ability not only to read for enjoyment but also to learn and obtain information. Reading comprehension is tied to success in school after third grade, when reading to learn becomes the primary mode of delivering information in traditional classrooms (Annie E. Casey Foundation, 2010). Reading comprehension relies upon vocabulary and background knowledge to make connections with the text and to make inferences or predictions. Good comprehension strategies are also strategies used by good listeners, so there is a great deal to be gained by teaching the strategies explicitly. See also Chapter 8 for more on reading comprehension and strategies for students with ASDs.

Some learners, particularly those with ASD, are precocious decoders of text and fluent oral readers, seeming to learn to read without being taught (Grigorenko, Klin, & Volkmar, 2003). This skill set is often coupled with poor reading comprehension, particularly of narrative text (Grigorenko et al., 2002). This combination of strengths and challenges is often referred to as hyperlexia. The ease with which hyperlexic learners acquire reading skills and improve fluency often masks their poor comprehension until they are much older (Gately, 2008).

Reading comprehension in typical children has been correlated with fluency (Pinnell et al., 1995); hyperlexic learners, however, do not make the predictions or inferences required nor do they comprehend text well despite reading fluently. As a result, their difficulties with comprehension may be affected by their inability to make inferences or predictions as a result of a lack of background knowledge in social and emotion understanding (for more information on the connection with social and emotion understanding, also see Steps 1 and 3 below under the heading “UDL Approach”).

To explore this connection, CAST conducted a demonstration project in 2011 called Building Comprehension Through Social Understanding (BCSU), which focused on the goal of developing social understanding or theory of mind<sup>3</sup> skills through the reading comprehension strategies mentioned (i.e., making predictions, making connections, inferencing).

In this intervention, CAST's work in UDL-based solutions was extended to improve the reading comprehension and social understanding of learners with ASD. Preliminary results on this implementation of UDL-related strategies for learners with ASD showed that addressing learners' development of theory of mind and imaginative skills as part of literacy instruction can result in improvements in theory of mind and reading skills (Domingos, 2012).

To examine how the UDL framework was applied to this study, let us unpack how reading comprehension skills are traditionally taught and compare that approach with the UDL approach designed by researchers at CAST.

### Traditional Approach

According to the NRP, reading comprehension is “an active process that requires an intentional and thoughtful interaction between the reader and the text” (2000, p. 13). The traditional approach to teaching reading comprehension (Harvey & Goudvis, 2000) involves instructing readers in specific strategies, including

- Making predictions about what is (or may be) coming next
- Making connections between self and the text
- Making connections between the text and other texts

Some of the traditional methods for helping readers develop these strategies include questioning the reader, having the reader develop and ask questions, and asking the reader to summarize what he or she has read.

### Universal Design for Learning Approach

As noted before, after a teaching goal is determined, it is important to begin by looking at the elements that may pose barriers to learning by asking the following questions: What demands does learning this concept make of learners, and are these demands relevant to learning this concept or are they irrelevant? How high are the irrelevant demands in relation to the learners' resources? How does the UDL framework help to reveal where learners are likely to vary? What options can be made available in order to address variability, minimize irrelevant demands, and ensure an appropriate level of challenge? After asking these types of questions, the educator is better able to understand how to utilize the UDL approach to teach his or her learners the skills required to improve their reading comprehension. The BCSU study used the following three-step process: 1) articulate the

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<sup>3</sup>Theory of mind is part of a larger group of skills referred to as emotion understanding. To have a theory of mind, one must be aware that others have differing beliefs, desires, and knowledge from our own and that these beliefs will affect their thoughts, behavior, and emotions. A person uses this knowledge to understand, explain, and predict the other person's knowledge, behavior, or emotion (Premack & Woodruff, 1978).

instructional goal, 2) evaluate the demands in the curriculum, and 3) address learner variability.

**Step 1: Understand or Identify the Goal** The first step in any good instructional planning and teaching is to clearly identify and understand the goal. In the BCSU study mentioned above, CAST researchers determined that the goal was to help learners develop inferencing and prediction skills in order to comprehend text. In order to do so, learners need to have adequate skills for strategic comprehension of text and background knowledge in social understanding (i.e., theory of mind; more detail is provided in Step 3).

**Step 2: Evaluate the Demands in the Curriculum or Current Approach** Once the goal was determined, the demands in the traditional approach for teaching reading comprehension were evaluated and found to include six key demands:

1. Text must be decoded.
2. The topic of the text must be comprehensible to the reader. In other words, both the language and concepts need to be understood. This level of comprehension involves several requirements:
  - a. The reader must understand the language of instruction.
  - b. Vocabulary must be sufficient.
  - c. Background knowledge of the topic must be sufficient. Note: Narrative text requires background knowledge in social and emotion understanding to allow the reader to understand the beliefs, desires, and motives of the characters and in order to make inferences or predictions about their thoughts, behaviors, or emotions (this is often referred to as theory of mind understanding).
3. The reader needs to be actively engaged with the text by making and testing predictions, making connections between the reader and the text and between the text and other texts.
4. Information from the text needs to be encoded into memory that can later be recalled.
5. Reading comprehension requires the reader to be able to make predictions (or inferences), which rely on the ability to imagine an outcome based on this background knowledge.
6. Making connections requires the ability to remember and hold one idea in mind while seeing connections or commonalities with the reader's life and with other texts that have been read.

In the case of social and emotion understanding, background knowledge typically develops through social interaction and imaginative play. In most learners, this ability develops through social interaction between 3 and 5 years of age, developing first as a child comes to understand his or her own emotions and then later when he or she comes to understand the emotions of others. A large body of research has focused on the way these skills develop in children who are typically developing

and those elements that are correlated with higher scores on theory of mind assessments (e.g., Cutting & Dunn, 2003; Dunn, Brown, & Beardsall, 1991; Harris, 1989; Pons, Harris, & de Rosnay, 2004; Pons, Lawson, Harris, & de De Rosnay, 2003; Wimmer & Perner, 1983).

Variability in theory of mind development has been documented in learners with ASD (Baron-Cohen, Leslie, & Frith, 1985). Factors related to the way autism develops tend to limit the experiences in socioemotional and imaginative play that build these foundational skills and background knowledge. Given that traditional reading curricula assume a baseline of socioemotional and imaginative understanding and skills, reading curricula contain barriers to comprehension for learners who do not have these skills and understanding.

**Step 3: Address Learner Variability** The following section describes how the BCSU study addressed the UDL guidelines.

**Multiple Means of Representation** Using multiple means of representing information (see Figure 2.2) is one way that educators can address variability in classrooms. The stories used in the BCSU study were created in a digital authoring environment, CAST Book Builder.<sup>4</sup> These stories included alternatives to auditory and visual information (1.2 and 1.3) through the inclusion of multiple media (e.g., audio clips, images). By offering multiple means of representation, BCSU increased external resources, scaffolded the language, and allowed learners to focus on meaning.

The guidelines suggest aiding comprehension by providing options for activating or supplying background knowledge (3.1). This was the major focus of the BCSU study: to explore the teaching of reading comprehension to learners who do not have a high degree of socioemotional understanding. One way to supply the background knowledge the researchers suspected was missing in this population was to create stories that make explicit the way that nonverbal cues are connected to characters' emotions. Stories were authored to specifically target concepts that represent the stages of emotion understanding as they typically develop (from recognition of emotion to theory of mind). Digital coaches on each page highlighted the critical features and relationships (3.2) between the nonverbal cues or events and pointed out which character emotions learners needed to notice when trying to make a prediction or connection. Digital coaches are animated avatars or buttons that allow the learner to access prompts, hints, or models just in time, allowing her to be provided with the right kind of support as needed.

The guidelines suggest options for language, expressions, and symbols, clarifying the vocabulary (2.1) of emotion (e.g., happy, sad). To do this, the BCSU study included "thought bubbles." To make the abstract more concrete, sticky notes were used to make the implicit thoughts of the characters explicit through a visual representation in the form of "thought bubbles." This also helped to guide information processing and manipulation (3.3) to help learners follow and remember the events on the page. The thought bubbles are permanent reminders that help to minimize the unnecessary demand of having to remember what the character is thinking as the learners develop expertise in theory of mind.

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<sup>4</sup>Freely available on the CAST web site (<http://www.bookbuilder.cast.org>).



**Multiple Means of Action and Expression** Traditional methods for teaching reading comprehension frequently use verbal language both as a means for instruction and as a means for assessment. The guidelines suggest that options for action and expression be provided to meet the range of variability (see Figure 2.3). As learners progress in their understanding, they can be asked to make a prediction or connection and fill in the thought bubbles. Learners can either write words or draw in the thought bubbles as a way to reduce expressive language demands. They can also work with a scribe to reduce unnecessary fine motor demands, all the while being supported as they build fluency (5.3) in the different methods of expression. Making the implicit thoughts of the character explicit helps support planning and strategy development (6.2), a skill that can transfer to other texts and situations.

CAST Book Builder allowed the inclusion of three digital coaches on each page, allowing leveling from an open-ended prompt to a model response. This hierarchical prompt model—going from an open-ended question to a model response—matches learners' development, providing graduated levels of support (5.3) as they progress in their understanding, all the while promoting independence and their ability to monitor their own progress (6.4). It is important to note that digital technology makes it simple to embed these coaches into each page, allowing the learner to practice independently, but an educator or parent can also provide similar support in person.

**Multiple Means of Engagement** Providing topic choices and both digital and paper stories, the BCSU project offered multiple means of engagement (see Figure 2.4). Research shows that even providing small choices enhances motivation (Patall, Cooper, & Robinson, 2008). Allowing learners to personalize the reading experience helps them optimize relevance, value, and authenticity (7.2) and helps sustain effort and persistence (8). The addition of role-playing activities and video self-analysis of the role playing not only aids in developing skills in prediction but also enhances the capacity for monitoring one's own progress (6.4 in Figure 2.3) and aid in transfer and generalization (3.4 in Figure 2.2) providing practice in taking on the role of others through pretend play. In addition, the video self-analysis helps learners to develop the ability to self-assess and reflect (9.3)—both skills key to developing independent self-regulation and expertise.

By adding options for representation, expression, and engagement, the BCSU project reduced irrelevant demands and also provided access by enriching learning experiences that helped learners build expertise in this foundational domain.

**Additional Examples** To provide multiple means of representation, educators can use several strategies:

- Clarify vocabulary (2.1) in subject matter content, such as science and social studies materials and preteach new vocabulary and concepts
- Illustrate through multiple media (2.5) by
  - Presenting graphic organizers, for example, Education Oasis ([http://www.educationoasis.com/curriculum/graphic\\_organizers.htm](http://www.educationoasis.com/curriculum/graphic_organizers.htm))
  - Creating voice avatars (i.e., a vocal character representing a real person) for digital text presentation, for example, Voki (<http://www.voki.com>)

- Using computer software to teach early reading skills, for example, Starfall (<http://www.starfall.com>)
- Provide options for perception (1) by offering vocal directions matched with printed and visual or image representations, for example, pictured directions in learning centers
- Reference online applications to clarify syntax and sentence structure (2.2), for example, Grammar Girl (<http://www.grammar.quickanddirtytips.com>)
- Provide links to support background knowledge (3.1) through digital media available on such content web sites as Teacher Tube (<http://www.teachertube.com>) and Kids National Geographic (<http://www.kids.nationalgeographic.com/kids>)
- Highlight critical features (3.2) by including color shading used for emphasis, for example, Visuwords (<http://www.visuwords.com>) and Interactives: Elements of a Story (<http://www.learner.org/interactives/story>) to teach narrative structures

To provide multiple means of action and expression, educators can use these strategies:

- Offer multiple tools for construction and composition (5.2), including, for example,
  - Slide show demonstrations using:
    - PowerPoint (Microsoft Office) or Prezi (<http://www.prezi.com>)
    - Word bubbles, using Wordle (<http://www.wordle.net>)
  - Add use of Writing Fun by Jenny Eather to develop expressive writing skills (<http://www.writingfun.com>)
  - Build fluencies with graduated levels of support (5.3) by providing outlines of subject matter content created from PowerPoint presentations using the outline feature

To provide multiple means of engagement, educators can apply these approaches:

- Provide choices (7.1) of topics for projects
- Provide simple self-monitoring (6.4) checklists in learning centers for learners to self-assess completion and accuracy
- Use consistent attention-getting techniques (7) that use visual as well as auditory cues
- Foster collaboration (8.3) by pairing with peers to share small-group activities

Additional examples can be found on the National Center on UDL (2011b) web site (<http://www.udlcenter.org/implementation/examples>). Under each principle are checkpoints that provide a series of concrete examples under the “Tell Me More” link and the “Examples and Resources” link.

## DEVELOPING EXPERT LEARNERS

The fundamental goal of the UDL framework is to develop *expert learners*, that is, learners who understand the way they learn and can independently use internal and external resources and manage irrelevant demands on their own learning (CAST,



2011). Research in the learning sciences has shown that learners change as they develop expertise (Bloom, 1985; Dreyfus & Dreyfus, 1980). Novices tend to treat and attend to all elements of a situation equally. Their attention may appear to be scattered. They are concrete in their understanding of a topic or domain, and they strictly adhere to rules in making decisions regardless of the context. As learners develop expertise in a subject area, they become better able to regulate their attention to focus only on the critical features. Their understanding becomes holistic and fluid; they employ rules in a flexible, discretionary way that accounts for the context. They are also able to manipulate elements in the abstract in order to achieve their goals.

The UDL guidelines (Version 2.0) help educators design learning experiences that enable all learners to become experts in their own learning (CAST, 2011). The guidelines provide explanations for curriculum options and offer scaffolds for learning by 1) allowing access to content, 2) providing guided practice with the content, and 3) helping learners understand information. By supporting learner variability in comprehending, planning, and self-regulation, educators help all learners become expert learners, that is, learners who know how they learn best, who leverage those strategies, and who do so as independently as possible.

### Meeting All Learners' Needs

It is important to remember that as educators, we should always have the highest expectations possible for *all* learners. The UDL guidelines help educators to move beyond just providing access to content, enabling us to instead move toward providing access to quality learning experiences—those that help all learners achieve their full potential. When the curriculum is designed in a way that removes barriers and minimizes irrelevant demands, learners with ASD can and do learn and progress in the general education curriculum. Furthermore, as shown in the foregoing examples, from the simplest behavior modification to an academic goal, learners with ASD can and do develop into expert learners.

The UDL framework offers a way to create a flexible, responsive curriculum that reduces or eliminates barriers to learning. Using a UDL approach, educators proactively offer curriculum options that present information and content in varied ways (multiple means of representation), options in the manner in which learners can express what they know (multiple means of action and expression), and options to engage learners in meaningful, authentic learning (multiple means of engagement).

Finally, UDL allows educators to teach effectively in diverse classrooms and spend more time on instruction, facilitating learning rather than accommodating a one-size-fits-all curriculum. The bottom line is that UDL helps educators meet the needs of learners with ASD. In fact, UDL helps educators address the needs of all learners.

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