Introduction

This is a challenging time to be a teacher. New policies and changing demographics are making schools more diverse than ever. An increasing number of students with disabilities and learning differences are being educated in regular classrooms, and new policies are holding schools accountable for the progress of all learners. State and federal standards, together with a shift in how literacy is defined, are compelling teachers not only to cover large amounts of material but also to instill a deep understanding of this material. These days, we are demanding more of students than the acquisition of facts: We want them to ask questions, find information, and use that information effectively. We want them to learn how to learn.

In this chapter, we share our vision for a new approach to pedagogy that responds to the challenges of education today. CAST has drawn on the neuroscience of learning and the study of media to develop the concept of Universal Design for Learning. The central practical premise of UDL is that a curriculum should include alternatives to make it accessible and appropriate for individuals with different backgrounds, learning styles, abilities, and disabilities in widely varied learning contexts. The "universal" in universal design does not imply one optimal solution for everyone. Rather it reflects an awareness of the unique nature of each learner and the need to accommodate differences, creating learning experiences that suit the learner and maximize his or her ability to progress. UDL provides a framework that helps teachers differentiate their instruction through carefully articulated goals and individualized materials, methods, and assessments.

We begin this chapter by tracing the origins and development of UDL and addressing the important difference between access to information and access to learning. Next, we introduce the three basic principles of UDL and illustrate how—by applying insights into the brain and the strengths of new media—teachers can use these principles to inject flexibility into their classrooms.

The Origins of UDL

Universal Design for Learning is an extension of an architectural movement called universal design. Originally formulated by Ron Mace at North Carolina State University, the idea behind universal design in architecture is to create structures that are conceived, designed, and constructed to accommodate the widest spectrum of users, including those with disabilities, without the need for subsequent adaptation or specialized design.
Universal Design: Access for All

Before the universal design movement, architects rarely addressed the mobility and communication needs of people with disabilities. The results were buildings that were inaccessible to many. Legislation mandating universal access led to extensive retrofitting with ramps, elevators, talking signs, and other access devices. But retrofitting is expensive, often aesthetically disastrous (as illustrated in Figure 4.1), and usually inadequate in many ways.

Universal design provided a new and better approach. Architects realized that by considering the needs of their buildings' potential users at the outset, they could subtly integrate universal accessibility into the fabric of the building's design. Universal design challenges architects to innovate, often improving aesthetics and functionality. For example, the universally designed pyramid-shaped entrance to The Louvre, shown in Figure 4.2, embeds a sleek modern elevator within its spiral staircase.

As universal design's concept of access for all spread to areas such civic engineering and commercial product design, an unanticipated benefit became apparent: *Addressing the divergent needs of special populations increases usability for everyone.* The classic example is the curb cut. Originally designed to enable those in wheelchairs to negotiate curbs, curb cuts also ease travel for people pushing strollers or riding skateboards, pedestrians with canes, and even the average walker. Television captioning provides another example. When captioning first became available, it was intended just for hearing-impaired people, who had to retrofit their televisions by purchasing expensive decoder boxes to access the captions. Later, decoder chips were built into every television, making captioning standard and available to all viewers. This universal design feature now benefits not only the deaf, but also exercisers in health clubs, diners in noisy restaurants, individuals working on their language skills, and couples who go to sleep at different times. Further, as a built-in feature, access to television captioning costs a few cents rather than several hundred dollars.

**Background Knowledge:** The Center for Universal Design advocates principles that result in environments and products for all people.

Extending Universal Design to Learning

Universal Design for Learning extends universal design in two key ways. First, it applies the idea of built-in flexibility to the educational *curriculum*. Second, it pushes universal design one step further...
by supporting not only improved access to information within classrooms, but also improved access to learning.

**Universal Design in the curriculum.** In the early 1990s, the staff at CAST was working with collaborating schools to adapt print-based curricula so these materials would be accessible to students with disabilities. The barriers inherent in printed textbooks had long excluded students with physical disabilities, students with visual impairments, and students with learning disabilities, among many others.

It seemed ironic to us that legislators and architects were working very hard to ensure that educational buildings were universally accessible, but no such movement pursued universal accessibility for the curriculum methods and materials used inside the buildings—the curriculum. From our work with individual teachers and learners, we realized that the concept of universal design could be applied to curriculum materials and approaches. We experimented with multimedia tools and created some learning materials with built-in options that made them more flexible than printed books.

Out of that work came the prototype for a new and flexible kind of electronic book that we later co-developed (with Scholastic Inc.) into the language arts curriculum called WiggleWorks. The books in the WiggleWorks curriculum, all available on CD-ROM, have one distinguishing characteristic: They were developed from the start with features that allow them to be used by all kinds of students, including those with disabilities. Students with physical disabilities can turn pages and access controls with the touch of a key or a switch attached to the computer. Students with visual impairments can select large text with high contrast or opt to hear the text read aloud, navigating the program through buttons that "speak" their functions. This feature is also helpful to students who have difficulty decoding printed text.

Most important, the program's management system allows teachers and parents to "set up" the books to suit each learner's needs and preferences. Varied presentations of content and differing sets of supports are available for each student who signs in to the program. WiggleWorks is not a special education product, but a literacy program for all learners. The built-in flexibility improves access and usability for all, making the program the first example of universally designed curriculum.

**Example:** Scholastic's WiggleWorks, the first literacy program to incorporate UDL principles, was co-developed by CAST. Find out how young children benefit from this learning tool.

**Access to information vs. access to learning.** Non-educators often make the mistake of equating access to information with access to learning. In reality, these are two separate goals. In fact, increasing access to information can actually undermine learning, because it sometimes requires reducing or eliminating the challenge or resistance that is essential to learning.

The distinction between access to information and access to learning is analogous to the kind of heavy lifting done by a professional mover versus that done by a body builder. The professional mover is interested in getting the sofa from point A to point B as quickly as possible and with the least wear and tear on his muscles. Therefore, he uses tools such as a dolly, a hydraulic lift, and a truck to help him do the job. These tools reduce the challenge of the work—a goal that suits the mover very well. The body builder has a different goal: increasing muscle. He seeks opportunities to
lift weights, undertaking long workouts and increasing the weight as his strength improves. He uses tools that selectively support the muscles not being trained and increase resistance for those that are.

The **goals** of learners more closely resemble those of the athlete-in-training than those of the mover. UDL is predicated on that difference. As educators, our aim is not simply to make information accessible to students, but to make learning accessible. This requires resistance and challenge. Much as the body builder needs to know which muscle group requires strengthening before he can structure his training, the teacher needs to know the instructional goal in order to appropriately structure teaching. For example, if Kamla's teacher, Ms. Abrams, sets the goal of helping Kamla learn to **decode** text more fluently, allowing Kamla to use the computer's text-to-speech function on a reading assignment would undermine that **goal** rather than support it. However, if the **goal** were to help Kamla master the content within the text and build her enthusiasm for that content, then computer-supported reading would be an appropriate **support**.

Similarly, when Ms. Chen wants to work on Charlie's research skills, providing full access to the World Wide Web (and its endless diversions) could undercut this "distractible" student's learning rather than enhance it. To help Charlie focus on learning research skills, Ms. Chen might restrict his access to a particular set of articles and Web sites relevant to the task. By aligning Charlie's focus with his learning challenge, Ms. Chen increases his chances of success.

Thus, although access to content and activities is often essential for learning, access to information is neither sufficient for nor synonymous with learning. Knowing the instructional goal is essential for determining when to provide **support** and when to provide resistance and challenge. With this balance aligned appropriately, students gain access to learning. The UDL framework provides guidance for using technology to support that balance.

**The Framework for UDL: Three Principles**

Because all three brain **networks** are involved in learning, teachers cannot literally "teach to" students' **recognition**, **strategic**, and **affective networks** as separate entities. However, thinking about these **networks** individually helps us remember that learning is multifaceted and that barriers in the **curriculum** can arise in a number of places. Broadly speaking, we teach our students to

- Recognize essential cues and patterns.
- Master skillful strategies for action.
- Engage with learning.

A successful learning environment supports and challenges students in each of these arenas while minimizing barriers. And because no two students show the same patterns of strength, weakness, and preference within these domains, minimizing barriers requires highly flexible teaching strategies and **materials**. Accordingly, the UDL framework consists of three overarching operative principles, each formed to minimize barriers and maximize learning through **flexibility**. Each of the principles, listed in Figure 4.3, advocates a particular teaching approach for supporting learner differences in recognition, strategy, or **affect**.

- **Figure 4.3**
  - Principles of the UDL Framework

http://www.cast.org/teachingeverystudent/ideas/tes/chapter4_1.cfm
Principle 1:
To support recognition learning, provide multiple, flexible methods of presentation

Principle 2:
To support strategic learning, provide multiple, flexible methods of expression and apprenticeship.

Principle 3:
To support affective learning, provide multiple, flexible options for engagement.

Background Knowledge: Additional material about Universal Design or Learning.

The three UDL principles share one common recommendation: to provide students with a wider variety of options. To accommodate a broad spectrum of learners, universally designed curricula require a range of options for accessing, using, and engaging with learning materials. Like universal design in architecture, with its stairs, ramps, and elevators, these alternatives reduce barriers for individuals with disabilities but also enhance opportunities for every student.

Consider an example. Suppose Mr. Costa is teaching a civics unit on national elections and wants to convey the fundamental importance of voter participation. He chooses to use a chart—an ideal means of representation for some kinds of information and for some students, but a medium that presents learning barriers for other students. Obviously, a student who is blind cannot learn from a visual chart, nor can students who have difficulty discerning colors, interpreting keys and symbols, or deciphering the significance of spatial relationships between elements. For these students, charts actually present a barrier.

What could Mr. Costa do about that barrier? In this case, both his teaching goal and the barriers in the medium he has chosen (images) relate to recognition, the learning networks addressed by UDL Principle 1. Principle 1 recommends that the teacher provide multiple representations of the same information. A verbal description of the chart, a tactile graphic representation, or an e-text version read by the computer would all make the key concepts accessible to students who are blind or otherwise visually impaired. The verbal description would have the additional advantage of helping other students in the class by providing complementary information not contained within the chart and offering a different context and emphasis. This option would also help students who have difficulty interpreting graphically displayed data. These are just a few of the ways that providing two representations of the data instead of one allows Mr. Costa to create a richer cognitive learning environment for all his students.

UDL Implementation

The framework of UDL consists of instructional approaches that provide students with choices and alternatives in the materials, content, tools, contexts, and supports they use. But in addition to challenging teachers to be more flexible, UDL provides guidelines for creating flexibility that is both systematic and effective. These guidelines are derived from research on the learning brain and knowledge of the qualities of digital media. How do we use these fields of knowledge to develop systematic methods for increasing classroom flexibility?

http://www.cast.org/teachingeverystudent/ideas/tes/chapter4_1.cfm
The Role of Applied Neuroscience

Brain research provides a basis for determining the kinds of teaching and learning alternatives most useful for a particular student in a given circumstance. Insights about how the three neural networks function help us understand corresponding kinds of teaching and corresponding ways to individualize instruction for different learners.

Recall that the three networks—recognition, strategy, and affect—share several organizational features. Each processes information via distributed modules operating in parallel, using both top-down (contextual information from high in the hierarchy) and bottom-up (detailed information from low in the hierarchy) pathways. When we understand these features, we can identify several parameters that will help structure and simplify the selection of teaching and learning alternatives.

Building on the bottom-up nature of the learning networks (their reliance on detailed sensory information), we know we should provide students with sensory alternatives to ensure that those who have difficulty with one sensory modality (such as speech or sight) will not be excluded from learning opportunities. The verbal description of Mr. Costa's voter participation chart is a good example of a bottom-up sensory alternative. Similarly, bottom-up motor alternatives, such as special keyboards or voice recognition software, can ensure that students with physical disabilities will not be excluded from a particular learning task. This kind of alternative crosses modalities, offering students a completely different way to obtain or express ideas.

A second kind of alternative preserves the sensory or physical modality but provides enhancement to highlight certain information. Through these additions, we can scaffold students who have weaknesses that interfere with learning a task or who are novices in a particular domain. Returning to the chart example, Mr. Costa might provide an alternative version with the critical information circled or illustrated in a different color. This is an ideal scaffold for students who might have difficulty identifying key information in the larger context.

Recognition, strategic, and affective networks also use top-down processing to do their jobs. Therefore, a representation that provides additional context or background knowledge to help students constrain their search or action based on prior knowledge and expectation can be an equally powerful tool. Mr. Costa might build an electronic version of the voter participation chart, with hyperlinks to related information or to guiding questions that would direct students' interpretation. This kind of representation would be particularly useful to students with cognitive challenges that make it hard for them to remember information, students who lack the necessary background knowledge or have little experience interpreting charts, or students who can interpret the chart easily but desire more in-depth knowledge.

This short illustration shows that teachers' choices of media alternatives for particular tasks and students can be guided by an understanding of how the brain learns. Because UDL accounts for the organizational features and specialized learning in the three types of brain networks, it can guide flexible, individualized teaching.

The Role of Digital Media

In an ideal world, teachers might present information in a dozen different ways and offer students an equal number of options for expressing knowledge. But realistically, even the most creative teacher can only present one option at a time. And even if we did manage to use a variety of approaches and

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media to present concepts, our students would still need to practice those concepts and apply them on their own. The impracticality of using fixed materials such as printed textbooks to create a flexible learning environment is obvious. New digital media offer a much more feasible foundation for the UDL framework.

As we noted in chapter 3, the qualities of digital media most germane to education are their versatility (the ability to present information in any one of several media); their transformability (the capacity for content to be transformed from one medium to another); their capacity for being marked; and their capacity to be networked. Teachers and students using networked digital materials can select the most suitable medium or use multiple media simultaneously. They can also convert material from one medium to another on the fly, modify the appearance of information within one medium, delve more deeply or connect laterally to other concepts through links, and communicate with many different people through networked computers. Let's revisit one of our example classrooms for an illustration.

**Digital Media Applied**

Ms. Chen’s 6th grade class is studying Mark Twain’s *The Adventures of Tom Sawyer*. The book is available both in a traditional print format and online at Project Gutenberg (http://promo.net/pg/). Ms. Chen has downloaded the digital version to the class computers. The content in the print and digital versions is identical, and students can choose the version they prefer.

**Resource:** Electronic text repositories store and index public domain materials. CAST's eText Spider can help you locate particular works.

The print version of *Tom Sawyer* offers many familiar advantages. Students can carry it around, mark it up to highlight important passages, make notes in the margins, and flip through the pages to look for particular sections. While reading, they know exactly where they are in the story and how many pages they have to go. Many students choose the printed version, finding it easy to use.

Many, but not all. Ms. Chen’s class includes one student who is blind, another who is physically disabled, and another who has been diagnosed with dyslexia. Several students speak limited English. For these learners, the printed version is not easy to use; in fact it may be totally inaccessible. Other students in Ms. Chen’s class whose reading is not fluent, who bring limited vocabulary and background knowledge to the story, or who are struggling with the literary concepts she is teaching find that although they can use the printed version, it provides little support for their learning. For them, the print version is a hurdle, not a ramp.

How is the digital version different? It offers multiple ways of presenting the same content—effectively supporting the different recognition, strategic, and affective networks of different learners and providing them both access to information and access to learning.

**Recognition support.** The digital version allows Ms. Chen and her students to customize the text according to their needs and preferences. Web browsers and word processors make it easy for them to change the size or color of text in order to make it more visible. Screen reading software is available to read the text aloud or display the digital text through a refreshable Braille device that provides a tactile representation of the story. The digital version can go beyond providing access, to also offer support for students with various recognition-based learning difficulties. There are a
number of software programs (including TextHELP Systems Ltd.’s TextHELP, Kurzweil Education Systems’s Kurzweil 3000, and CAST’s own eReader, shown in Figure 4.4) that can present digital stories with supports for reading.

The eReader is a special Web browser that reads and highlights words, emphasizing the link between written and spoken language. Students can click on any word to hear its pronunciation or set up the program to read and highlight text sequentially—a word, a sentence, a paragraph, or a chapter at a time. Students can decide how fast the program reads and choose from a wide selection of voices.

When Ms. Chen plans how she will use the digital version in class, she considers her instructional goals. She wants her students to enjoy and appreciate the humor in Tom Sawyer and to study some of the literary techniques Twain uses. Reading mechanics is not her objective; Therefore, she encourages struggling readers to use the eReader to get at the story’s meaning and keep up with their classmates.

**Strategic support.** Students with physical disabilities that prevent them from holding the book or turning its pages can navigate through the digital version, take notes, and generate their own text using alternative keyboards or programs that allow alternate means of navigating the digital text (examples include IntelliTools’ Intelliekeys-brand keyboard and overlays). Students with handwriting and spelling difficulties also find support for writing in the digital version of Tom Sawyer. For example, eReader offers a digital notebook next to the text itself, enabling students to copy passages and take notes while they read. Using programs that support embedded hyperlinks (such as Inspiration and HyperStudio), students can digitally record their own voices, draw, or write text comments. These digital tools provide media options for supported student expression.

http://www.cast.org/teachingeverystudent/ideas/tes/chapter4_1.cfm
Affective support. Finally, the digital version of *Tom Sawyer* offers multiple, flexible options for engaging students in the story. Because the story is in digital form, Ms. Chen can select from a menu of supports so that the level of challenge is appropriate for every reader. Links to background knowledge, vocabulary, and reading support can help students who struggle with the text in printed form—and keep their frustration levels low. Interested students who want to know more can follow embedded links to other stories by Twain, related information about the time and setting of the story, and other material relating to Twain’s writing technique. And Ms. Chen can also offer students varied choices of media for responding to the novel and creating their own compositions to demonstrate their knowledge. Students can create multimedia presentations using HyperStudio, design a Web page with links to related sites, devise a concept map, or write a paper.

As this example shows, digital media’s versatility, transformability, and capacity for being marked and networked not only enhance the supportive power of learning media but also transform the learning enterprise itself. Flexible materials do not replace teachers, but they do extend our reach and make it easier for us to provide individualized learning supports and challenges for our students.

The New Role of Assistive Technology

Assistive technologies include tools such as video enlargers (tools that magnify printed text on a video monitor), single ability switches (tools that enable users to activate a mouse-click via different muscles such as an eyebrow or an elbow), and alternative keyboards (tools that offer alternative surfaces and “key sizes” for people who cannot use a standard keyboard). Although both UDL and assistive technology rely on new media to improve learning access, each assumes a very different role for curriculum.

The assistive technology model assumes that a printed curriculum is a given and provides tools to support individual access to it. Tools such as the video enlarger are not integral to the curriculum, but rather, are associated with the individual students who need them; they are simply means to helping these students overcome barriers in the curriculum. The assumption that students must obtain individual tools in order to overcome barriers in an inflexible curriculum is inherently antithetical to UDL.

To solve the same problems, UDL looks not to the student but to the curriculum itself. The underlying assumption is that by using flexible media, we can embed options within the curriculum so that it can be adjusted to meet the needs and preferences of each learner. This built-in flexibility reduces, but does not eliminate, the need for assistive technologies. Students with motor difficulties who access the computer via alternative keyboards or single ability switches will still need their tools. However, we believe the role of assistive technologies and the way people view them will shift as UDL curricula become more available.

As the concept of UDL gains acceptance, people will understand that assistive technologies are tools like eyeglasses and personal digital assistants that enhance personal effectiveness; they do not relegate their users to a separate category such as "disabled." Already, some of these devices, once solely linked to disability, are working their way into the mainstream community. For example, speech recognition technology is applied in voice-activated telephone directories, airline reservation systems, and banking systems.

As you can see, UDL has the potential to minimize the need for assistive technology and to maximize learning opportunities for all. We use the word "potential" deliberately, because the

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inherent flexibility of digital media does not guarantee that UDL will become real. Multimedia and the World Wide Web can be as inaccessible as print is. For example, image-based computer learning games are inaccessible to students who are blind; games that rely upon aural prompts and feedback without text equivalents are inaccessible to students who are deaf; and games that are text-based are inaccessible to students with dyslexia. To overcome these barriers, technology developers need to consciously apply UDL principles as they develop learning materials, and teachers need to select tools that have inherent flexibility.

**UDL Application: Rethinking Our Practice**

The UDL framework shifts educators' understanding of learner differences. It challenges us to rethink the nature of curriculum materials and endow them with the inherent flexibility necessary to serve diverse learning needs. UDL also opens the door for rethinking how we teach. With the option to individualize learning supports and focus the challenge differently and appropriately for each learner, teachers must be very clear about the learning goals they set for any given assignment or unit. Only when goals are clear can we select and apply flexible materials to support and challenge each learner. Similarly, clear goals help us focus our assessment of student progress in an accurate and useful way. The UDL framework can guide these three pedagogical steps, helping teachers to set clear goals, individualize instruction, and assess progress.

### Setting Clear Goals

The first step, setting clear goals, seems on first glance to require little thought. After all, learning standards spell out what students need to learn, and curricula include summaries of the material to be covered. But looking through the UDL lens, we see that goals are often inadvertently embedded in the means for achieving them. Consider this goal:

*Every student will be able to write an essay in cursive.*

Though this degree of specificity would be quite unusual, the point is clear; as stated, the goal is so embedded in the method necessary to achieve it that many students could not possibly succeed. Those with physical disabilities, spelling and handwriting difficulties, and problems with organization could not even participate.

We can use the UDL framework to rethink this goal and analyze its true intent. Do we really care whether the essay is produced in cursive? Isn't organizing and composing the essay the real purpose? Once we clarify the overarching goal, we can reword it broadly enough to include all students, knowing that supports and scaffolds will be needed to help some students participate, and extra challenges will be needed to move other students to new levels. By simply removing express reference to the medium and stating the goal this way—“*Students will write an essay*”—we open the door for more students' participation and success. The clear goal helps teachers determine how to choose and apply the flexibility inherent in UDL learning materials. Chapter 5 provides a more detailed discussion of this topic.

### Individualizing Instruction

The next step in paving every student's path to high proficiency is to provide instruction that helps each achieve classroom goals. Diverse digital tools and materials, with UDL flexibility built in, allow teachers to provide a degree of individualization impossible with traditional instructional materials. The instructional strategies articulated in UDL's three principles can help us make...
educated and scientifically grounded choices from the many alternatives available. We discuss this in depth in chapter 6.

**Assessing Progress**

Good pedagogy also includes effective and ongoing assessment, not only to measure a student's progress, but also to adjust instruction and to evaluate the effectiveness of methods and materials. Ongoing assessment enables teachers to ensure that the goals they have set and the methods and materials they are using continue to support students' progress. As you will read in chapter 7, UDL provides teachers with the tools they need to align assessment with each student's instructional goals, materials, and methods.

**The Value of Universal Design for Learning**

Universal Design for Learning provides a framework for individualizing learning in a standards-based environment through flexible pedagogy and tools. It challenges teachers to incorporate flexibility into instructional methods and materials as a way to accommodate every student in the classroom.

Within the framework of UDL, Sophia, who needs supports to overcome her visual deficits, and Paula, who has trouble with reading comprehension, could successfully read the same story using a software program that offers text-to-speech, images, and links to vocabulary and background knowledge. Charlie, who needs sequenced, structured support when working on a research project, and Jamal, who can manage the sequential steps in research but needs support for his fine motor disability, could conduct online research using the same program, but different supports. Kamla, whose interests lie primarily in sports, and Jamal, who is an expert on tanks and submarines, could pursue the same reading or math project in the content area of their choosing, thus adjusting for their individual affective networks.

In a traditional classroom, with traditional perspectives, methods, and tools, this type of pedagogical flexibility seems totally implausible. With the perspectives gained from brain research and the possibilities afforded by new media, UDL offers teachers a practical framework for injecting flexibility into the classroom. UDL does more than insist on flexibility; it provides teachers with the information and resources they need to achieve it.

**Example: Watch a video of a teacher describing the positive effects of applying UDL principles: A Teacher Talks About UDL**

The practices we recommend should be familiar to you, because these are the very same practices good teachers use when they can. The difference is that UDL, drawing on the versatility of digital media and its capacity to be transformed and networked, enables teachers to adjust instruction for the whole class, and not just for individual students. In this manner, it empowers us to teach every student, not just some.

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