

Technology and Learning

Meeting Special Student's Needs

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Table of Contents

Universal Design and Universal Design for Learning	2
Part One: UDL – The Basic Framework	2
Part Two: The UDL Guidelines and Their Research Base	4
Part Three: Future Directions and Research.	10
Bibliography.	12
Further Reading.	12
Relevant Websites	13

Glossary

Elementary and Secondary Education Act

The Elementary and Secondary Education Act (ESEA) is the main federal law affecting education from kindergarten through high school (from 2001 to 2009 known as No Child Left Behind) (US Department of Education).

The Higher Education Opportunity Act of 2008

The Higher Education Opportunity Act (Public Law 110-315) (HEOA) was enacted on 14 August 2008, and reauthorizes the Higher Education Act of 1965, as amended (HEA). This latest reauthorization now includes language around Universal Design for Learning (US Department of Education, www.ed.gov).

Universal design

Universal design is an architectural concept that focuses on the design of products, buildings, or environments so they can be used readily by the widest possible range of users.

Universal design for learning (UDL)

UDL is a framework for teaching and learning that often capitalizes on the power and flexibility of modern technologies to address the needs of the broadest possible range of students

Universal design, although well established in architecture and other domains, is relatively new to education. However, there are signs that the newness is waning. In the recent higher education bill passed by the US Congress (The Higher Education Opportunity Act of 2008), the application of universal design to education – called ‘universal design for learning’ (UDL) – is prominently defined and recommended for colleges and universities. Furthermore, a task force composed of nearly 30 major national educational organizations has been formed to advocate for the inclusion of UDL in upcoming revisions of ESEA.

In spite of this recent increase in exposure and advocacy, most educators do not really know what UDL means, and still others have heard of it but do not know whether or how it differs from the architectural meaning of universal design. In this article, we hope to clarify what is meant by UDL and especially to provide the evidentiary basis for its principles and a review of its guidelines.

Universal Design and Universal Design for Learning

Universal design focuses on the design of products, buildings, or environments so they can be used readily by the widest possible range of users. Virtually all architects in the US now create buildings that are designed from the outset to reduce or eliminate architectural barriers through designs that consider the needs of diverse people. This practice is now recognized as more cost-effective and equitable than trying to retrofit buildings later or providing customized accommodations to individuals who are unable to navigate poorly designed structures. Universally designed environments are engineered for flexibility and designed to anticipate the need for alternatives, options, and adaptations to meet the challenge of diversity. While originally conceived to meet the needs of individuals with disabilities, universal designs actually make buildings that are more accessible and functional for everyone.

A good example of universal design in action comes from the history of television captioning. When captioning first became available, it was an expensive add-on purchase intended for people with hearing impairments. Building captioning into every television, rather than retrofitting it later, turned out to be a better, and more universal, design. It now benefits not only those with hearing impairments, but also exercisers in health clubs, travelers in airports, individuals working on their language skills, and couples who go to sleep at different times. The key to universal design is building options into initial designs, making better choices available for everyone.

UDL is one part of the overall movement toward universal design. The term UDL emphasizes the special purpose of learning environments – they are not created to provide access to information (that is the role for libraries and the Internet) but instead to foster the changes in knowledge and skills that we call learning. While providing access to information is often essential to learning, it is not sufficient. Success also requires that the means for learning – the pedagogical goals, methods, materials and assessments of instruction – are also accessible. UDL is the process by which we attempt to ensure that the means for learning, and their results, are equally accessible to all students.

Part One: UDL – The Basic Framework

The framework and guidelines for UDL are not derived from the principles for architecture. Instead, they are based on research and practice from multiple domains within the learning sciences – education, developmental psychology, cognitive science, and cognitive neuroscience. The research in those fields guides both the scope of the pedagogy that UDL addresses (i.e., the critical elements of teaching and learning) and the range of the individuals that UDL addresses (i.e., the critical elements of individual differences).

At its simplest, the scope of UDL is based entirely on three principles:

1. providing multiple means of representation;
2. providing multiple means of action and expression; and
3. providing multiple means of engagement.

These three principles have been chosen because they address three critical features of any teaching and learning environment: the means by which information is presented to the learner, the means by which the learner is required to express what they know, and the means by which students are engaged in learning.

While there are many ways to articulate the fundamentals of teaching and learning, the choice of these three foundational principles stems from their commonality across many aspects of theory and research in the learning sciences. Consider the field of cognitive neuroscience where it is common to think of three broad divisions of the learning brain: (1) the pattern recognition capabilities in the posterior regions of the cortex, (2) the motor and executive capabilities in the frontal regions of the cortex, and (3) the affective or emotional capabilities in the medial regions of the nervous system. While even this division is an oversimplification, it is an articulation that is common and draws historically on Luria's classic work and has been elaborated and modified by many others. It is by design that the three principles of UDL match up well with this framework from neuroscience – addressing in turn the perceptual learning of the posterior cortex, the strategic and motor learning of the anterior cortex, and the affective or emotional learning of the medial and orbital frontal cortex – in order to be systematic in considering learning differences.

Beyond cognitive neuroscience, however, researchers and theorists in other learning sciences have adopted very similar frameworks to consider the scope of teaching and learning. Among the most prominent, Lev Vygotsky, the preeminent Russian psychologist, and Benjamin Bloom, the American educational theorist, both adopted a similar three-part framework for their foundations.

From the three principles, nine guidelines have been developed that form the primary foundation of UDL. Those guidelines articulate the principles but their main purpose is to guide educators and curriculum developers in using evidence-based means of addressing the wide range of individual differences that any classroom typically experiences. To those guidelines we now turn.

Part Two: The UDL Guidelines and Their Research Base

A critical foundation of the UDL approach is to identify those evidence-based practices which should be included within an overall universal design. Typically, these practices have already proven effective for individual students in the margins, but they are generally not integrated within the one-size-fits-all curriculum of regular education. By taking advantage of the power and flexibility of modern technology, UDL provides a vehicle for delivering these practices to the individual students for whom they are likely to be most effective. But which practices, and for whom?

The UDL Guidelines help in making informed decisions about what practices are optimal. They articulate the specific practices that have been shown to be effective for one or specific types of learning or learners and that should be considered as important options to ensure that students with a full range of abilities and disabilities can access and progress in the general curriculum. The Guidelines assist curriculum developers (these may include teachers, publishers, and others) in designing flexible curricula that reduce barriers to learning and provide robust learning supports to all learners.

Each of the Guidelines, along with the three to four checkpoints associated with each Guideline, are based on the work of hundreds of researchers in many different institutions. A description of the Guidelines (CAST, 2008) and the associated checkpoints is described in the following. For a more detailed description of the UDL Guidelines and for a listing of the full references, the reader is referred to the National Center on UDL website.

Guidelines for Providing Multiple Means of Representation

Guideline 1: Provide options for perception

To be effective in diverse classrooms, curricula must present information in ways that are perceptible to all students. It is impossible to learn information that is imperceptible to the learner, and difficult when information is presented in formats that require extraordinary effort or assistance. To reduce barriers to learning, therefore, it is important to ensure that key information is equally perceptible to all students by: (1) providing the same information through different sensory modalities (e.g., through vision, or hearing, or touch); (2) providing information in a format that will allow for adjustability by the user (e.g., text that can be enlarged, sounds that can be amplified). Such multiple representations ensure that information is not only accessible to students with particular sensory and perceptual disabilities, but also easier to access for many others. When the same information, for example, is presented in both speech and

text, the complementary representations enhance comprehensibility for most students. Checkpoints suggesting specific strategies for providing options for perception are listed as follows:

- options that customize the display of information;
- options that provide alternatives for auditory information; and
- options that provide alternatives for visual information.

Guideline 2: Provide options for language and symbols

Students vary in their facility with different forms of representation – both linguistic and nonlinguistic. Vocabulary that may sharpen and clarify concepts for one student may be opaque and foreign to another. A graph that illustrates the relationship between two variables may be informative to one student and inaccessible or puzzling to another. A picture or image that carries meaning for some students may carry very different meanings for students from differing cultural or familial backgrounds. As a result, inequalities arise when information is presented to all students through a single form of representation. An important instructional strategy is to ensure that alternative representations are provided not only for accessibility, but for clarity and comprehensibility across all students as well. Checkpoints suggesting specific strategies for providing options for language and symbols are listed as follows:

- options that define vocabulary and symbols;
- options that clarify syntax and structure;
- options for decoding text or mathematical notation;
- options that promote cross-linguistic understanding; and
- options that illustrate key concepts nonlinguistically.

Guideline 3: Provide options for comprehension

The purpose of education is not to make information accessible, but to teach students how to transform accessible information into useable knowledge. Decades of cognitive science research have demonstrated that the capability to transform accessible information into useable knowledge is not a passive process but an active one. Constructing useable knowledge, knowledge that is accessible for future decision making, depends not upon merely perceiving information but upon active information processing skills like selective attending, integrating new information with prior knowledge, strategic categorization, and active memorization. Individuals differ

greatly in their skills in information processing and in their access to prior knowledge through which they can assimilate new information. Proper design and presentation of information – the responsibility of any curriculum or instructional methodology – can provide the cognitive ramps that are necessary to ensure that all students have access to knowledge. Checkpoints suggesting specific strategies for providing options for comprehension are listed as follows:

- options that provide or activate background knowledge;
- options that highlight critical features, big ideas, and relationships;
- options that guide information processing; and
- options that support memory and transfer.

Guidelines for Providing Multiple Means of Action and Expression

Guideline 4: Provide options for physical action

A textbook or workbook in a print format provides limited means of navigation or physical interaction (e.g., by turning pages with fingers, handwriting in spaces provided). Many interactive pieces of educational software similarly provide only limited means of navigation or interaction (e.g., via dexterously manipulating a joystick or keyboard). Navigation and interaction in those limited ways will raise barriers for some students – those who are physically disabled, blind, dysgraphic, or who have various kinds of executive function disorders. It is important to provide materials with which all students can interact. Properly designed curricular materials provide a seamless interface with common assistive technologies through which individuals with motor disabilities can navigate and express what they know – to allow navigation or interaction with a single switch, through voice-activated switches, expanded keyboards, and others. Checkpoints suggesting specific strategies for providing options for physical action are listed as follows:

- options in the mode of physical response;
- options in the means of navigation; and
- options for accessing tools and assistive technologies.

Guideline 5: Provide options for expressive skills and fluency

There is no medium of expression that is equally suited for all students or for all kinds of communication. On the contrary, there are media which seem poorly suited for some kinds of expression, and for some kinds of students. While a student with dyslexia may excel at story telling in conversation, he may falter drastically when telling that same story in writing. Alternative modalities for expression should be provided both to level the playing field among students, and to introduce all students to the full range of media that are important for communication and literacy in our multimedia culture. Additionally, students vary widely in their familiarity and fluency with the conventions of any one medium. Within media, therefore, alternative supports should be available to scaffold and guide students who are at different levels of their apprenticeships in learning to express themselves competently. Checkpoints suggesting specific strategies for providing options for expressive skills and fluency are listed as follows:

- options in the media for communication;
- options in the tools for composition and problem solving; and
- options in the scaffolds for practice and performance.

Guideline 6: Provide options for executive functions

At the highest level of the human capacity to act skillfully are the so-called executive functions. Associated with the prefrontal cortex in the brain, these capabilities allow humans to overcome impulsive, short-term reactions to their environment and instead to set long-term goals, plan effective strategies for reaching those goals, monitor their progress, and modify strategies as needed. Of critical importance to educators is the fact that executive functions have very limited capacity and are especially vulnerable to disability. This is true because executive capacity is sharply reduced when: (1) executive functioning capacity must be devoted to managing lower-level skills and responses which are not automatic or fluent (due to either disability or inexperience) and thus the capacity for higher-level functions is taken and (2) executive capacity itself is reduced due to some sort of higher-level disability or to lack of fluency with executive strategies. The UDL approach typically involves efforts to expand executive capacity in two ways: (1) by scaffolding lower-level skills so that they require less executive processing and (2) by scaffolding higherlevel executive skills and strategies so that they are more effective and developed. Previous guidelines have addressed lower-level scaffolding, this guideline addresses ways to provide scaffolding for executive functions themselves. Checkpoints suggesting specific strategies for providing options for executive functions are listed as follows:

- options that guide effective goal-setting;
- options that support planning and strategy development;
- options that facilitate managing information and resources; and
- options that enhance capacity for monitoring progress.

Guidelines for Providing Multiple Means of Engagement

Guideline 7: Provide options for recruiting interest

Information that is not attended to, that does not engage students' cognition, is in fact inaccessible. It is inaccessible both in the moment – relevant information goes unnoticed and unprocessed – and in the future: relevant information is unlikely to be remembered. As a result, teachers devote considerable effort to recruiting student attention and engagement. However, students differ significantly in what attracts their attention and engages their interest. Even the same student will differ over time and circumstance: their interests change as they develop and gain new knowledge and skills, as their biological environments change, and as they differentiate into self-determined adolescents and adults. It is, therefore, important to have alternative ways to recruit student interest; ways that reflect the important inter- and intra-individual differences among those students. Checkpoints suggesting specific strategies for providing options for recruiting interest are listed as follows:

- options that increase individual choice and autonomy;
- options that enhance relevance, value, and authenticity; and
- options that reduce threats and distractions.

Guideline 8: Provide options for sustaining effort and persistence

Many kinds of learning, particularly the learning of skills and strategies, require sustained attention and effort. When motivated to do so, many students can regulate their attention and affect in order to sustain the effort and concentration that such learning will require. However, students differ considerably in their ability to selfregulate in this way. Their differences reflect disparities in their initial motivation, their capacity and skills for selfregulation, their susceptibility to contextual interference, and so forth. A key instructional goal is to build the individual skills in self-regulation and self-determination that will equalize such learning opportunities (see Guideline 9). In the meantime, however, the external environment must provide options that can equalize accessibility

by supporting students who differ in initial motivation, self-regulation skills, etc. Checkpoints suggesting specific strategies for providing options for sustaining effort and persistence are listed as follows:

- options that heighten salience of goals and objectives;
- options that vary levels of challenge and support;
- options that foster collaboration and communication; and
- options that increase mastery-oriented feedback.

Guideline 9: Provide options for self-regulation

While it is important to design the extrinsic environment so that it can support motivation and engagement (see Guidelines 7 and 8), it is also important to develop students' intrinsic abilities to regulate their own emotions and motivations. The ability to self-regulate – to strategically modulate one's emotional reactions or states in order to be more effective at coping and engaging with the environment – is a critical aspect of human development. While many individuals develop self-regulatory skills on their own, either by trial and error or by observing successful adults, many others have significant difficulties in developing these skills. Unfortunately, most classrooms do not address these skills explicitly, leaving them as part of the implicit curriculum that is often inaccessible or invisible to many. Furthermore, those classrooms that address self-regulation explicitly generally assume a single model or method for doing so. As in other kinds of learning, considerable individual differences are much more likely than uniformity. A successful approach requires providing sufficient alternatives to support learners with very different aptitudes and prior experience in learning to effectively manage their own engagement and affect. Checkpoints suggesting specific strategies for providing options for self-regulation are listed as follows:

- options that guide personal goal-setting and expectations;
- options that scaffold coping skills and strategies; and
- options that develop self-assessment and reflection.

Part Three: Future Directions and Research

In the sections above, we have provided the basis for the general framework of UDL as well as a summary of the UDL Guidelines. To realize the benefits of UDL, however – to improve actual instruction – UDL must be actualized within a specific lesson or unit. While it will never be possible to evaluate the application of UDL to every lesson, in every content area, in every grade level, and for every type of student, it is important to provide evidence that such applications can be implemented effectively in real classrooms. This kind of research is only in its infancy, but exemplars are emerging.

In the field of literacy, for example, there is a growing body of research demonstrating the effectiveness of digital reading environments that are designed in a manner consistent with UDL. CAST's research in this area began with a study of struggling adolescent readers who were reading digital texts with embedded supports and scaffolds based on the reciprocal teaching strategies of Palincsar and Brown. That study showed that students in the UDL reading environments outperformed peers in printed texts when they later took standardized comprehension tests. These experimental results have now been replicated or extended with other populations who typically struggle in literacy, including students who are deaf, students with cognitive disabilities, and English language learners. In light of these positive results, the US Department of Education has initiated a large-scale efficacy study with the commercial version of *Thinking Reader* (see below). Much more research of this type is needed.

Finally, it is important to recognize that one critical type of research is completely absent: research on full district-wide implementation of UDL. It is not enough merely to show that the core practices and instructional elements of UDL, or even a specific application of UDL, are evidence based. It is essential also to show that the UDL approach can be applied effectively, and at scale, in full district-wide implementations. This is challenging (and necessary) because adequate implementation of UDL will require more than adoption of new technologies or techniques; it will require comprehensive reform throughout a whole school system. As of today, there are no schools or districts where UDL is thus fully realized.

Is that kind of systemic implementation research likely to happen? Three directions are promising. First, there are a number of schools, districts, and even states that have begun to systematically implement UDL at various levels of comprehensiveness. There is, for example, a state-wide UDL initiative in Michigan where schools are incented to adopt UDL practices in their teaching, purchasing, and policies. Many individual districts or schools throughout the country, such as Cincinnati Public Schools in Ohio and Bartholomew Consolidated School Corporation in Indiana, are doing the same.

Second, publishers have recognized the market potential of instructional materials in UDL-type formats. Tom Snyder Productions of Scholastic has released nine award-winning middle school trade books (e.g., *The Giver* ; *Bud, Not Buddy*) in this format, calling them *Thinking Readers*. In early 2009, Pearson produced its core history textbook in a completely digital format with many UDL features. Other publishers are preparing to follow suit.

Third, and most importantly, the US Department of Education recently endorsed a National Instructional Materials Accessibility Standard throughout the United States. This standard – called NIMAS – requires that print instructional materials (e.g., textbooks) must be available in digital formats so that they are more accessible to students of all kinds. This legislation is remarkably revolutionary – the first of its kind to recognize that printed instructional materials are no longer adequate to serve the full population of students in our schools. The Higher Education Bill of 2008 confirms the importance of UDL in the future of education.

While UDL is still in the very early stages of development, it seems clear that there is considerable progress throughout the various sectors of public and private education. Turning that momentum into systemic evidence-based reform will take a great deal more work. There is much to gain in doing that work.

Bibliography

CAST (2008). Universal Design for Learning Guidelines Version 1.0. Wakefield, MA: Author.

Further Reading

Barsalou, L. W., Breazeal, C., and Smith, L. B. (2007). Cognition as coordinated non-cognition. *Cognitive Processing* 8(2), 79–91.

Bloom, B. S. (1984). *Taxonomy of Educational Objectives*. Boston, MA: Allyn and Bacon.

Cytowic, R. E. (1996). *The Neurological Side of Neuropsychology*. Cambridge, MA: MIT Press.

Dalton, B., Pisha, B., Eagleton, M., Coyne, P., and Deysher, S. (2002). Engaging the text: Reciprocal teaching and questioning strategies in a scaffolded learning environment. *Final Report to the U.S. Department of Education*. Wakefield, MA: CAST.

Dalton, B. and Proctor, C. P. (2008). The changing landscape of text and comprehension in the age of new literacies. In Coiro, J., Knobel, M., Lankshear, C., and Leu, D. (eds.) *Handbook of Research on New Literacies*, pp 297–324. Mahwah, NJ: Erlbaum.

Dalton, B. and Rose, D. (2008). Scaffolding digital reading comprehension. In Block, C. C. and Parris, S. R. (eds.) *Comprehension Instruction: Research-Based Best Practices*, 2nd edn., pp 347–361. New York: Guilford Press.

Dalton, B. and Strangman, N. (2007). Using technology to support struggling readers' comprehension: A review of the research. In Reinking, D., McKenna, M. C., Labbo, L. D., and Keiffer, R. D. (eds.) *Handbook of Literacy and Technology*, 2nd edn. Mahwah, NJ: Erlbaum.

Goldberg, E. (2001). *The Executive Brain: Frontal Lobes and the Civilized Mind*. New York: Oxford.

Luria, A. R. (1973). *The Working Brain*. New York: Basic Books.

Moran, J., Ferdig, R. E., Pearson, P. D., Wardrop, J., and Blomeyer, R. L. , Jr. (2008). Technology and reading performance in the middle-school grades: A meta-analysis with recommendations for policy and practice. *Journal of Literacy Research* 40(1), 6–58.

Palincsar, A. S. and Brown, A. L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction* 1(1), 117–175.

Proctor, C. P., Dalton, B., and Grisham, D. L. (2007). Scaffolding English language learners and struggling readers in a universal literacy environment with embedded strategy instruction and vocabulary support. *Journal of Literacy Research* 39(1), 71–93.

Proctor, C. P., Uccelli, P., Dalton, B., and Snow, C. E. (2009). Understanding depth of vocabulary and improving comprehension online with bilingual and monolingual children. *Reading and Writing Quarterly* 25(4), 311–333.

Rose, D. H. and Meyer, A. (2002). *Teaching Every Student in the Digital Age: Universal Design for Learning*. Alexandria, VA: Association for Supervision and Curriculum Development.

Rose, D., Meyer, A., and Hitchcock, C. (2005). *The Universally Designed Classroom: Accessible Curriculum and Digital Technologies*. Cambridge, MA: Harvard Education Press.

Rosenzweig, M. R., Breedlove, S. M., and Watson, N. V. (2005). *Biological Psychology: An Introduction to Behavioral and Cognitive Neuroscience*, 4th edn. Sunderland, MA: Sinauer.

Sanguinetti, V. R. (2007). *The Rosetta Stone of the Human Mind: Three Languages to Integrate Neurobiology and Psychology*. New York: Springer.

Vygotsky, L. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

Relevant Websites

<http://cast.org> – CAST, Universal Design for Learning.

<http://nimas.cast.org> – NIMAS Development & Technical Assistance Centers.

<http://www.udlcenter.org> – National Center on Universal Design for Learning

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