



Universal Design for Learning: An Essential Concept for Teacher Education

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Abstract

This article provides an overview of universal design for learning (UDL) and the principles that support it. Recent legislation, new learning theory, and technological advances have shaped the concept of universal design and made it a reality in contemporary classrooms. Tomorrow's teachers now need the knowledge and skills to work in environments where methods and materials are universally designed. These competencies include a clear understanding of goal setting, a sound working knowledge of how to use technology for teaching and learning, and the ability to develop flexible classroom curriculum. An example of a problem-based learning unit developed as part of a Preparing Tomorrow's Teachers to Use Technology (PT³) project illustrates how teachers can apply principles of universal design in unit development.

Universal Design for Learning (UDL) is an idea whose time has come. Bearing similarities to the concepts of adaptations for learners with disabilities and differentiation for highly able learners, UDL has emerged as an idea that promises to bring together and perhaps subsume these approaches to curriculum modification for exceptional learners. The purpose of this article is to provide some of the background and reasoning behind UDL, to outline recent developments that have brought the idea to fruition, and to consider its implications for teacher education. The last section will provide an example of how one teacher education project incorporates UDL as an inherent component of classroom curriculum development.

Universal Design (UD)

The concept of universal design originated in architecture, with the need to provide persons with physical disabilities access to physical structures. Several factors came together to move this idea forward: legislation resulting from the disability rights movement (especially the Americans with Disabilities Act of 1990), recognition that changes made to accommodate people with disabilities benefited others as well,

and the realization that many such features could be less expensive and considerably more attractive if they were part of the original design rather than retrofitted. So it was that in the field of architecture a movement called universal design grew around the idea of designing physical environments that would be accessible to everyone (Pisha & Coyne, 2001; Story, Mueller, & Mace, 1998). Examples of this movement are plentiful: ramps, automatic doors, and curb cuts, to name just three. If you haven't noticed these conveniences lately, that is as it should be. Their natural appearance and intuitive use are features of universal design.

In 1997, a group of architects, designers, and engineers collaborated to establish seven Principles of Universal Design for a wide range of design disciplines, including environments, products, and communications (N.C. State, 1997). These seven principles (see Table 1) guide the design process and educate both designers and consumers about the characteristics of usable products and environments. They have also served as guides in the design of universal learning environments.

Universal Design for Learning (UDL)

In the same year, 1997, the Individuals with Disabilities Education Act (IDEA) underwent its most recent reauthorization. Amendments to the Act called for the greatest possible access to the general education curriculum for persons with disabilities, and special educators argued that access meant not only physical access, but also access to the methods and materials of instruction. They contended that simply providing physical access to materials would not ensure that students gained "cognitive access" to the content of the curriculum. Soon after the IDEA was reauthorized, Kame'enui and Simmons (1999) wrote about "the architecture of instruction" and used the analogy of ramps to point out that "cognitive ramps" for students with learning disabilities, like physical ramps for persons with physical disabilities, should be designed from the outset to go with the architecture. In the case of learning environments, the architecture is the curriculum and instruction and the information to be learned. Kame'enui and Simmons claimed

Table 1: Principles of Universal Design

Principle	Brief Description
Equitable Use	The design is useful to people with a wide variety of abilities; it avoids segregating or stigmatizing users.
Flexible Use	The design accommodates a wide range of preferences and abilities; it provides choice in methods of use.
Simple and Intuitive Use	Use of the design is easy to understand; it eliminates unnecessary complexity.
Perceptible Information	The design communicates necessary information effectively; it uses different modes of presentation.
Tolerance of Error	The design minimizes hazards and adverse consequences of unintended actions; it provides failsafe features.
Low Physical Effort	The design can be used efficiently and comfortably and with a minimum of fatigue; it minimizes physical effort.
Size and Space for Approach and Use	Appropriate size and space are provided; it makes reach to all components comfortable for any user.

that skillfully designed curriculum can go a long way toward providing cognitive access for the majority of students, including those with disabilities—and benefit other students as well.

Two organizations have been in the forefront of applying the concept of universal design to issues of curriculum and instruction: the Center for Applied Special Technology (CAST) and the National Center to Improve the Tools of Educators (NCITE) at the University of Oregon. CAST, in collaboration with the U.S. Department of Education's Office of Special Education Programs, established a National Center on Accessing the General Curriculum to investigate how technology can be used to expand opportunities for diverse learners, including those with disabilities. At the University of Oregon the mission of NCITE has been primarily to work with publishers in the development of high quality tools and to encourage consumers to demand high quality materials.

Both CAST and NCITE have developed their own sets of principles for UDL as pertinent to their different perspectives. Informed by the pioneering work in architecture, new theories of learning, advances in technology, and their own research and development efforts, CAST coined the term “universal design for learning” and formulated essential features of UDL into three principles (Rose, 2000a; Rose & Meyer, 2002):

- Multiple means of representation. Provide content in different modes—visual, graphic, verbal, auditory, etc.—so that students have a variety of ways to access information.
- Multiple means of expression. Provide students with opportunities to respond in a variety of ways to communicate or demonstrate learning.
- Multiple means of engagement. Provide a variety of ways to involve students in learning.

NCITE researchers concentrated on principles that would guide consumers in the identification of effective curriculum design (Kame'enui & Simmons, 1999). They specified that such material should incorporate:

- Big Ideas. Curriculum should be built around central concepts, principles, or heuristics that represent fundamental understandings in a content area.
- Conspicuous Strategies. Teaching/learning strategies should be explicit, so that students know not only how but also why and when to use them.
- Mediated Scaffolding. Assistance should be provided as needed and removed over time until students are working independently.
- Strategic Integration. Knowledge should be integrated in meaningful ways to promote deeper understanding and higher-level thinking.
- Judicious Review. Opportunities for students to recall or apply previously taught information should be carefully planned and structured.
- Primed Background Knowledge. Preexisting information should be used as a starting point for new learning.

Thus, although architects and engineers are concerned with physical access and educators are concerned with cognitive access, there are two distinguishing features that characterize universal design in both fields:

1. Alternative access is built into the design rather than added on to an existing design, causing it to be more functional and better integrated.
2. UDL has the added value of being useful and valuable to a wide variety of people, not just those with disabilities.

Why? And Why Now?

UDL was made both necessary and possible by the convergence of several issues and advancements, including legal mandates, new knowledge about brain functioning, increased understanding of the nature of learning, and perhaps most importantly, by advances in, and the widespread availability of, new technologies. It is indeed an idea whose time has come.

Legal Mandates

Both education law and civil rights legislation have had a major impact on accessibility issues for individuals with disabilities. The Individuals with Disabilities Education Act (IDEA) is an education law that guarantees special education and related services to eligible children with disabilities. Its most recent reauthorization in 1997 is significant in that it emphasizes that students have access to the general education curriculum and make progress toward meaningful educational goals.

Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act (ADA) of 1990 are civil rights acts that prohibit discrimination on the basis of disability. The ADA, hailed by some as the “Emancipation Proclamation” for people with disabilities, basically says that people with disabilities have a right to access and use any facilities and programs that are available to other members of the public. Section 504 is an older law and applies only to institutions that receive federal funding, but it requires the provision of educational and related services to meet the individual educational needs of children with disabilities. Section 508 of the same Rehabilitation Act as amended in 1998 requires federal agencies to make their electronic and information technology accessible to people with disabilities. This amended Act, less well known to educators, is having a major impact on media specialists and Web designers, and its effect is beginning to be felt in schools as information technology becomes more pervasive.

Brain Structure and Operation

After years of mystery and speculation, neuroscientists using new brain imaging techniques are beginning to understand how the brain works. Although the field is in its infancy, educators are paying close attention to neurological research and are already beginning to apply some of the findings (Rose & Meyer, 2002; Sylwester, 1995). One important finding is that although everyone’s brain functions in roughly the same way, there are wide variations in the interactions of individual systems. These differences are reflected in cognitive styles and clearly indicate that curriculum must be flexible if it is to reach all learners.

Nature of Learning

Recent theories and research regarding teaching and learning have broadened the perspective of educators in the last 20 years. Cognitive psychologists, cultural anthropologists, and activity theorists (e.g., Jonassen & Rohrer-Murphy, 1999; Lave, 1988) have given us new ways to think about learning. The writings of Vygotsky (1978), a Russian psychologist, have been particularly influential. His notion of a “zone of proximal development,” defined as “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (p. 86) has major implications for curriculum design. If we accept the idea of a zone of proximal development, then we must acknowledge the need for a curriculum that is dynamic rather than static, and flexible rather than uniform.

New Technologies

Computer technology is what makes flexible engagement, representation, and expression possible. Without the versatility and flexibility of digital multimedia, UDL would likely be an idea whose time had *not yet* come. Consider that computers give users the ability to write, paint, draw, calculate, and compose music. They allow users to customize text size or color or font, to highlight, to hear text read aloud, and to look up the meaning of unknown words. When digitizing tools and multimedia software became readily available, educators had an alternative to printed books for the first time.

Implications for Teacher Education

In November 1997 the ERIC/OSEP Special Project convened a meeting on universal design. At that meeting a group of researchers submitted a report on what should be the next steps in implementing UDL. They wrote:

“Publishers should prepare and teachers should select instructional materials that are supportive and inclusive of students who have wide disparities in their abilities to see, hear, speak, read, etc. To achieve that end, we recommend that all developers of instructional materials adopt the concept of universal design and implement it in their products. *Furthermore, we recommend that teacher training programs prepare teachers for teaching in environments where the goals, methods, and materials are universally designed*” (italics mine) (from the Developers Group Report, cited in Orkwis & McLane, 1998, pp. 3–4).

Planning for an inclusive environment is not new to teachers. They have been making modifications for students with disabilities and differentiating instruction for gifted students for years (e.g., Bateman & Linden, 1998; Tomlinson, 1995). However, although comparisons can be made between these methodologies and universal design, there is a clear contrast in approach, as noted earlier. The question for teacher training programs is how to prepare teacher candidates for this new approach to developing and using universally designed materials. What do teachers need to know and be able to do in order to create such environments?

At this point, we can identify at least three skills and knowledge bases that teachers must have. First, they must have a clear understanding of the goals of the curriculum; second, they must have a sound working knowledge of how to use technology for teaching and learning; and third, they must be skilled in the development of what Glatthorn (1994) calls classroom curriculum, or units of study.

Understanding Goals

Rose (2000b) makes a strong case for clearly understanding goals when he highlights the distinction between UD for access and UD for learning. He points out that physical access may actually inhibit learning. For example, if an electronic reader always reads text aloud, learning to

read may be inhibited. Good use of UDL requires careful analysis of goals. Is the goal to acquire the information or to decode the text? If it is to acquire information, then using an e-reader may be indicated. If it is to learn to decode, then other methods are indicated. Likewise, when a goal states that students be able to write the steps of the scientific method, is the goal really to *write* the steps or to demonstrate an understanding of the scientific method? If the goal is to demonstrate understanding, then there are multiple ways to demonstrate understanding other than writing. In teacher education, we spend considerable time formulating objectives. Now it is incumbent on us to insist that our teacher candidates develop a deep understanding of goal setting, not simply that they be adept at applying a format.

Using Technology for Teaching and Learning

Teachers need a clear understanding of how technology can support students in accessing, managing, analyzing, and sharing information (Riel & Fulton, 2001; Scardamalia & Bereiter, 1994). It is important that they be able to use—and facilitate their students' use of—virtual libraries, electronic databases, and search engines where information can be accessed as media as well as text. As universally designed classrooms are developed into student-centered and performance-based learning environments, teachers and students will also be involved in real-time data collection. They will obtain information from topographical maps, space probes, and weather satellites that are updated daily. Teachers and students will go into the field with portable computers, electronic probes, and sensors. They will use visualization tools to construct graphs and models so that they can explore multiple representations easily and quickly. Such uses of technology not only allow for multiple representations of information but also provide multiple means of engaging students in learning.

Developing Classroom Curriculum

The third implication, developing universally designed classroom curriculum, is the focus of a project the author is currently working on as part of the Preparing Tomorrow's Teachers to Use Technology (PT³) initiative. The remainder of this article will report how Project T² (Teachers and Technology) attempts to train preservice and inservice teachers to develop technology-enhanced, universally designed classroom curriculum at Elon University, Wake Forest University, and Barton College, three institutions of higher education in North Carolina.

As we began to think about incorporating universal design into the units of study our teacher candidates would be developing as part of Project T², we reviewed the principles outlined by CAST, NCITE, and the Center for Universal Design at North Carolina State University. After a careful review and consolidation of ideas, we decided to adopt the following principles for our units:

- **Conceptual.** Units are built around a central concept or principle, a big idea. Knowledge and skills are strategically integrated to promote deep understanding and high-level thinking.
- **Equitable.** Units can be used with a wide variety of students. Mediated scaffolding is built into instructional design.

- **Flexible.** Units provide multiple means of engagement, representation, and expression. They accommodate a wide range of preferences and abilities.
- **Intuitive.** Content enhancements are built in as part of unit design and are simple and easy to use with minimal teacher direction.

The Alhambra Restoration

One of the units under development as part of Project T², *The Alhambra Restoration*, illustrates how our principles for universally designed units look in practice. A discussion of its development can serve as an example of how we work with teacher candidates to develop a curriculum unit that incorporates these principles. The importance of goal clarification and the use of technology for teaching and learning are evident in each phase of development.

In this problem-based learning scenario, the Alhambra Palace in Granada, Spain, has been damaged by a mild earthquake. Students assume the role of art restoration professionals who have been asked to make recommendations regarding the restoration of panels in the palace. There are constraints, of course, including design, budget, and time. In this unit, as in all our problem-based units, teachers lead students through the engagement, investigation, resolution, and debriefing phases of problem-based learning as outlined by Stepien and Pyke (1997). These are the phases we help teacher candidates carefully plan in their methods classes before going out to use the units in their practicum experience.

Engagement

The goal during the first phase of a problem-based unit is to activate students' background knowledge, to motivate, to rouse interest, and to cause students to ask questions that will lead to subsequent investigation. Of major importance is the problem scenario itself. We work with candidates to identify realistic problems that will call for an understanding of important disciplinary concepts and the use of essential skills. The Alhambra problem opens with this paragraph:

You saw the newspaper article reporting that a mild earthquake occurred last week in Granada, Spain. According to the article, some of the precious mosaic panels in the Alhambra Palace were damaged. Bad news indeed, not only because of the damage to priceless artwork, but also because many of the most beautiful rooms in the palace have had to be closed. This will have a serious impact on tourism and ultimately the economy of the city. This morning the phone rang. It was your director. . .

In preparing for the engagement phase, candidates use the Internet to locate sites that recount some of the history of the Alhambra and that feature vivid photographs of the palace, the gardens, the artwork, and the mosaic tiles. These are marked and downloaded to show students on the first day of the unit. We emphasize with candidates the importance of using visuals and multimedia to stimulate interest in a topic.

Candidates learn how to use concept-mapping software in an introductory lesson to activate students' prior knowledge and to identify

what is known and not known about elements of the problem scenario. We suggest that concept maps can also serve as formative assessments throughout the unit. Periodic concept mapping is a good way to follow and evaluate students' concept development. Used for this purpose, the initial maps become a form of pretest.

Investigation

The goal of the investigation phase is for students to acquire, organize, and analyze the information the problem scenario leads them to gather. During investigation, the Internet becomes an especially valuable tool in the search for information. Candidates are instructed to have a number of relevant sites identified and saved so that students have quick and easy access. We request that classrooms have screen readers, screen enlargers, or text-to-speech software available for students who have visual impairments, reading disabilities, or who use English as a second language. We acquaint teacher candidates with these assistive technologies and how they can be used during a unit of study when information is available primarily through text.

To provide a wide variety of learning opportunities for students during the investigation phase of *The Alhambra Restoration*, faculty worked with candidates to identify three categories of exploration, and we developed 15 different task options for student selection. Several examples give a sense of the variety provided among tasks:

- Learning Task #2, from the Alhambra Palace category: "You are especially curious about why Spain, a European country, reflects such a strong Muslim cultural influence. Investigate the history of Spain, especially that which pertains to Granada and the Alhambra Palace.
 - (a) Make a timeline showing major relevant events.
 - (b) Sketch out a cause-effect chart depicting how historical events resulted in the Islamic art and architecture evident in the Alhambra.
- Learning Task #5b, from the Geometric Patterns category: "You decide to use an Internet site you found to explore possible panel designs." (A URL is given that takes students to a site where they can use a pattern block program to build a design.)
- Learning Task #5d, from the Geometric Patterns category: "You have become interested in the nibbling technique used by M. C. Escher and want to use it in your design along with slides, rotations, and reflections." (A URL is given for a brief tutorial on the use of nibbling in creating tessellations.)
- Learning Task #7, from the Economic Issues category: "You have a restricted budget for restoring the panels. You will need to consider the cost of each design you and your team members develop. Using the Nasrid Tile catalog and price list, develop a spreadsheet that will allow you to quickly and easily determine the cost of each of your design options."
- Learning Task #11, an advanced geometric task, has students use geometry exploration software to investigate transformations and tessellations.

The tasks that teacher education faculty and teacher candidates developed for this unit represent a broad array of learning

experiences. Teachers may suggest particular tasks to particular students, or students may choose tasks. In either case, the task options are designed so that all students can meet the goals of problem investigation, while the means for goal attainment are both equitable and flexible in terms of the principles of UDL. Without the ready availability of technology tools this range of flexibility would not be possible. When developing investigation activities, we communicate to candidates the concept of using computer programs as "mindtools" (Jonassen & Carr, 2000) to emphasize the importance of using technology for learning.

Resolution

The goals of the resolution phase are to have students analyze options and to decide upon a solution (action or decision), and then to communicate that solution to the appropriate audience in an authentic manner. Decision making is an important skill to develop during this phase. Two graphic organizers are available in the Student Investigation Center of *The Alhambra Restoration*, the decision matrix and the force field analysis, both of which are helpful in decision making (Howard, 2001). Candidates learn how to use these with their students as they begin to resolve the Alhambra problem.

Units developed by teacher candidates are posted on the Web, so a variety of graphic organizers and other content enhancements can be stored in what we call the Student Investigation Center for students to download and use if they want. We emphasize with candidates that all students do not need to use these enhancements, but they should be available for students who could benefit from them. Many of the graphic organizers, clarifying tables and frames (Ellis, 2001), mnemonic strategies (Mastropieri & Scruggs, 1991), study strategies and routines (Deschler, Schumaker, Harris, & Graham, 1999) posted in the Student Investigation Center are recommended for students with disabilities, but can be used by anyone. Having them readily available for download by students is a UDL feature built into each of our units.

The final part of the resolution phase involves a student product or performance that communicates the solution in some way. In *The Alhambra Restoration*, a presentation must be made to the Municipal Council. Here students have a variety of options: They can prepare a multimedia show, make a model, give an oral presentation, prepare handouts, draw plans, or write letters. There are quite a few possibilities with this particular scenario. For this phase we prepare candidates to help students arrive at the best decision as to product, and a good understanding of appropriate technology tools plays an important role in the decision. The resolution closes the problem-based scenario, but one final phase is important for generalizing learning.

Debriefing

The goal of debriefing is to have students reflect and generalize. It is during this phase that the conceptual theme of the unit is made explicit, if it has not been to this point. The important idea that underlies *The Alhambra Restoration* is that *pattern recognition is fundamental to problem solving*. The patterns of the designs that students create and the pattern of cost change as a function of pattern both illustrate this idea.

During the debriefing, when teacher and students step out of their roles and out of the scenario, this idea is made explicit and further explored with students. We encourage candidates to spend time during this phase helping students understand the problem-solving process itself and how the tools they used assisted them in the process.

Conclusion

The Alhambra Restoration has been used here to provide an example of a unit constructed by a team of teacher educators and teacher candidates that incorporates principles of UDL. The unit is *conceptual*, built around a big idea. It is *equitable* in that it can be used with a wide variety of students. It is *flexible*, providing multiple means of engagement, representation, and expression, and its UDL features are *intuitive* to use because they are built in as part of the unit design. With the increasingly diverse populations in today's classrooms, it is crucial for teacher educators to make candidates aware of these principles and to give candidates a sound working knowledge of how to use technology to create universally designed learning experiences such as those outlined here. The concept of universal design came about in large part because technological advances made it possible. Now, powerful educational applications and the wide availability of digital materials, combined with our increased understanding of how learning occurs, will carry the concept forward if future teachers are given the skills and the knowledge to do so.

Acknowledgements

The author would like to acknowledge the teacher candidates, Agie Craft and Annique Roy, the teacher education faculty, Ann Cunningham, Barbara Mize, Deborah Long, and Jackie Ennis, and the arts and sciences faculty, Barbara Taylor and Mark Gordon, who contributed to the development of *The Alhambra Restoration*.

Author's Note: Project T² is supported by a grant, PR#342A000266, from the U.S. Department of Education's Preparing Tomorrow's Teachers to use Technology (PT³) initiative.

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Web Sites:

Center for Applied Special Technology
www.cast.org/

Project T²
www.elon.edu/t2project/

The Alhambra Restoration
www.elon.edu/t2project/The%20Alhambra/Introduction.htm

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