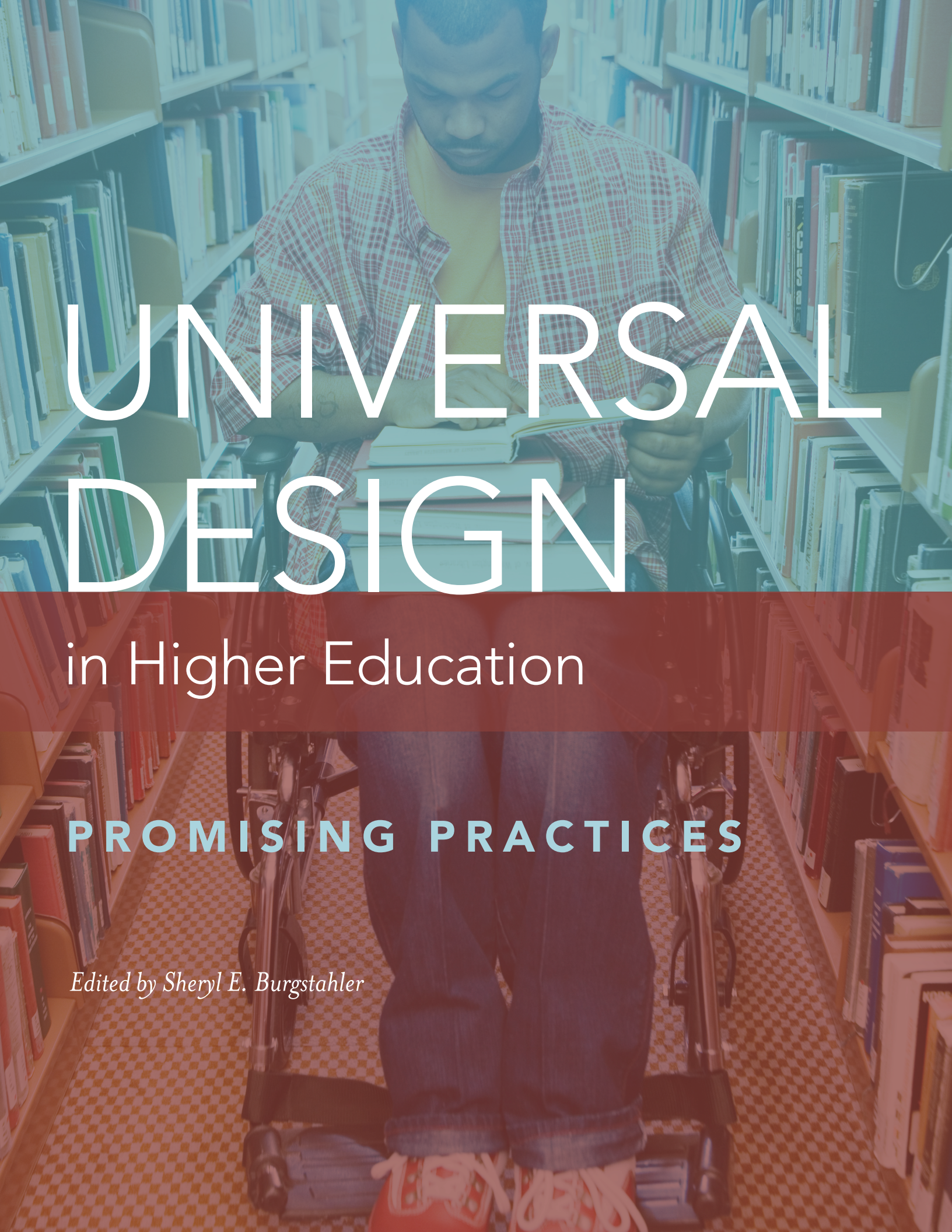

UNIVERSAL DESIGN

in Higher Education

PROMISING PRACTICES

Edited by Sheryl E. Burgstahler

UNIVERSAL DESIGN in Higher Education

PROMISING PRACTICES

Contents

PART 3 PROMISING PRACTICES AND RESOURCES

Preface

Based on the number of invitations I receive to deliver presentations on the topic at conferences and campuses, the interest in applications of universal design (UD) to postsecondary education continues to grow. It seems that everyone—faculty, student service providers, technology leaders—wants to make learning environments welcoming and accessible to the entire student body, including English language learners and students with disabilities. Many have been motivated by the book *Universal Design in Higher Education: From Principles to Practice* (*www.hepg.org/hep/Book/83*), which was published by Harvard Education Press, and for which I am the lead author and editor. But, they want more examples of how UD is being applied to postsecondary settings—from technology resources, learning styles, physical spaces, and student services, to on-site and online instruction.

I hear many examples of applications of UD in postsecondary education. If shared and replicated by others, these practices could have more impact. Toward this goal, I have created *Universal Design in Higher Education: Promising Practices*, an online book that continues to grow as further contributions are made. I invite practitioners and researchers who have applied UD in postsecondary settings to submit articles presenting evidence of their successes.

Article submissions are peer-reviewed by members of the Universal Design in Higher Education Community of Practice, which is managed by the DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center that I founded and continue to direct at the University of Washington in Seattle. Accepted articles have been reviewed and edited.

The most current version of *Promising Practices* is freely available on the DO-IT website at *www.uw.edu/doit/UDHE-promising-practices/*. It is presented as a series of accessible PDF files to make it easy for users to print or download various sections for courses, presentations, and training. To maximize distribution of content, we link articles to summaries that appear as Promising Practices in the DO-IT online Knowledge Base.

I look forward to you joining us in this collaborative work by submitting an article for possible inclusion in this publication. Follow the instructions provided in the next few pages. Together we can contribute to broadening

participation in education and careers through inclusive practices, and enhancing academic and career fields with the talents and perspectives of individuals with disabilities.

Sheryl Burgstahler, Ph.D.
Editor, *Universal Design in Higher Education: Promising Practices*
Founder and Director, DO-IT Center
University of Washington

SUBMISSIONS

Our Online Community of Practice

Those interested in submitting articles for this publication must become members of the Universal Design in Higher Education Community of Practice. This online community is hosted by DO-IT and is open to all interested parties. Subscribe by sending your request to *doit@uw.edu*.

General Guidelines

Articles can be up to eight double-spaced pages in length, including references, tables, and figures; in 12-point, Times New Roman font; and formatted in current APA style (*www.apastyle.org*). Send the article as a Word document in an email attachment to *doit@uw.edu*. Article drafts, after a review by DO-IT staff, are shared with members of the Community of Practice for an open peer review. Authors are encouraged to share drafts of their articles with the Community of Practice for informal feedback before submission.

If determined appropriate for this collection, recommendations for editing the article will be provided to the author. The editor will make the final decision about inclusion of the material; once accepted, the paper will be copyedited and then posted online as an accessible PDF. Authors agree to give readers permission to copy and distribute their contributions for educational, noncommercial purposes, as long as the source is acknowledged.

Content Guidelines

Articles should include:

1. Title and author names and affiliations

2. Need and goal/objective for the activity/product
   Why did you undertake this UD effort?
   What did you want to accomplish?

3. Activity/product description
   What did you do?
   What was the intended audience (e.g., specific academic level/area)?
   How were UD principles/strategies incorporated?
   If available, what is the project URL?

4. Results and discussion
   How did incorporation of UD principles solve the problem identified and/or reach the goal/objective you established?
   What is evidence of impact on your intended audience?
   Why was UD an important aspect of your work?
   What were problems encountered, unintended benefits discovered, and/or lessons learned that can benefit others interested in replicating your practice?

5. Conclusion
   Why is this UD project/activity a promising practice?
   What aspects do you recommend others implement?
6. References

7. Acknowledgments
   Indicate sources of funding or other contributions you would like to acknowledge.
   Also include these statements:

   This article is part of the collection *Universal Design in Higher Education: Promising Practices,* sponsored by the DO-IT Center. The content is based upon work supported by the National Science Foundation under Grant #HRD-0929006. Any opinions, findings, and conclusions or recommendations expressed are those of the author(s) and do not necessarily reflect the views of funding sources or the DO-IT Center.

   Copyright (c) 2013 [your name or institution]. Permission is granted to copy and distribute these materials for educational, noncommercial purposes provided the source is acknowledged.

   Reference: (in APA style). [authors]. [year]. [article title]. In S. Burgstahler (Ed.). *Universal design in higher education: Promising practices*. Seattle: DO-IT, University of Washington. *www.uw.edu/doit/UDHE-promising-practices/*

ACKNOWLEDGMENTS

This content is part of the collection *Universal Design in Higher Education: Promising Practices*, sponsored by the DO-IT Center. The content is based upon work supported by the National Science Foundation under Grant #HRD-0929006. Any opinions, findings, and conclusions or recommendations expressed are those of the author and do not necessarily reflect the views of funding sources or the DO-IT Center.

REFERENCE FORMAT FOR THIS CONTENT

Burgstahler, S. (2013). Preface. In S. Burgstahler (Ed.). *Universal design in higher education: Promising practices*. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/UDHE-promising-practices/preface.html*

UNIVERSAL DESIGN in Higher Education

PROMISING PRACTICES

1 Introduction to Universal Design in Higher Education

Designing any product or environment involves the consideration of many factors, including aesthetics, engineering options, environmental issues, safety concerns, industry standards, and cost. Often the design is created for the "average" user. In contrast, "universal design (UD)" is, according to The Center for Universal Design, "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (*www.design.ncsu.edu/cud/about_ud/about_ud.htm*).

When UD principles are applied in a postsecondary institution, educational products and environments meet the needs of potential students with a wide variety of characteristics. Disability is just one of many characteristics that a student might possess. For example, one student could be Hispanic, six feet tall, male, thirty years old, an excellent reader, primarily a visual learner, and deaf. UD requires consideration of all characteristics of potential users, including abilities and disabilities, when developing a course or service.

UD can be applied to any product or environment. For example, a typical service counter in a career services office is not accessible to everyone, including students who are short in stature, use wheelchairs, and cannot stand for extended periods of time. Applying UD principles might result in the design of a counter that has multiple heights: the standard height designed for individuals within the typical range of height, who use the counter while standing up; and a shorter height for those who are shorter than average, use a wheelchair for mobility, or prefer to interact with service staff from a seated position.

Making a product or an environment accessible to people with disabilities often benefits others. For example, while automatic door openers benefit students, faculty, and staff using walkers and wheelchairs, they also benefit people carrying books and holding babies, as well as elderly citizens. Sidewalk curb cuts, designed to make sidewalks and streets accessible to those using wheelchairs, are also used by kids on skateboards, parents with baby strollers, and delivery staff with rolling carts. When video displays in airports and restaurants are captioned, they benefit people who cannot hear the audio because of a noisy environment as well as those who are deaf.

UD is a goal that puts a high value on both diversity and inclusiveness. It is also a process.

THE PROCESS OF UNIVERSAL DESIGN

The process of UD requires consideration of the application as a whole and its subcomponents. The following list suggests a process that can be used to apply UD in a postsecondary setting:

1. *Identify the application*. Specify the product or environment to which you wish to apply universal design.
2. *Define the universe*. Describe the overall population (e.g., users of service), and then consider their potential diverse characteristics (e.g., gender; age; ethnicity and race; native language; learning style; and ability to see, hear, manipulate objects, read, and communicate).
3. *Involve consumers*. Consider and involve people with diverse characteristics in all phases of the development, implementation, and evaluation of the application. Also gain perspectives through diversity programs, such as the campus disability services office.
4. *Adopt guidelines or standards*. Create or select existing universal design guidelines or standards. Integrate them with other best practices within the field of the application.
5. *Apply guidelines or standards*. In concert with best practices, apply universal design to the overall design of the application, its subcomponents, and all ongoing operations (e.g., procurement processes, staff training) to maximize the benefit of the application to individuals with the wide variety of characteristics.
6. *Plan for accommodations*. Develop processes to address accommodation requests (e.g., purchase of assistive technology, arrangement for sign language interpreters) from individuals for whom the design of the application does not automatically provide access.
7. *Train and support*. Tailor and deliver ongoing training and support to stakeholders (e.g., instructors, computer support staff, procurement officers, volunteers). Share institutional goals with respect to diversity, inclusion, and practices for ensuring welcoming, accessible, and inclusive experiences for everyone.
8. *Evaluate*. Include universal design measures in periodic evaluations of the application; evaluate the application with a diverse group of users, and make modifications based on feedback. Provide ways to collect input from users (e.g., online, in print, through communications with staff).

UNIVERSAL DESIGN PRINCIPLES

At The Center for Universal Design (CUD) at North Carolina State University, a group of architects, product designers, engineers, and environmental design researchers established seven principles of UD to provide guidance in the design of products and environments. Following are the CUD principles of UD, each are paired with an example of its application:

1. *Equitable use*. The design is useful and marketable to people with diverse abilities. A website that is designed so that it is accessible to everyone, including people who are blind, employs this principle.
2. *Flexibility in use*. The design accommodates a wide range of individual preferences and abilities. A

museum that allows a visitor to choose to read or listen to a description of the contents of a display case employs this principle.

3. *Simple and intuitive*. Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. Science lab equipment with control buttons that are clear and intuitive employs this principle.
4. *Perceptible information*. The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. Video captioning employs this principle.
5. *Tolerance for error.* The design minimizes hazards and the adverse consequences of accidental or unintended actions. An educational software program that provides guidance when the user makes an inappropriate selection employs this principle.
6. *Low physical effort*. The design can be used efficiently and comfortably, and with a minimum of fatigue. Doors that open automatically employ this principle.
7. *Size and space for approach and use*. The design provides appropriate size and space for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility. A science lab with adjustable tables employs this principle.

OVERVIEW OF APPLICATIONS AND EXAMPLES OF UD

Applications and examples of UD are given on the following two pages. A reproducable PDF file with this content can be found at *www.uw.edu/doit/CUDE/.*

ACKNOWLEDGMENTS

This chapter was adapted with permission from the publication *Universal Design in Postsecondary Education: Process, Principles, and Applications* by Sheryl Burgstahler at *www.uw.edu/doit/Brochures/Academics/ud_post.html,* and is part of the collection *Universal Design in Higher Education: Promising Practices,* sponsored by the DO-IT Center. The content is based upon work supported by the National Science Foundation under Grant #HRD-0929006. Any opinions, findings, and conclusions or recommendations expressed are those of the author and do not necessarily reflect the views of funding sources or the DO-IT Center.

REFERENCE FORMAT FOR THIS CONTENT

Burgstahler, S. (2013). Introduction to universal design in higher education. In S. Burgstahler (Ed.). *Universal design in higher education: Promising practices*. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/UDHE-promising-practices/part1.html*

Applications of Universal Design in Education

In Instruction

- Class climate
- Interaction
- Physical environments and products
- Delivery methods
- Information resources and technology
- Feedback
- Assessment
- Accommodation

In Services

- Planning, policies, and evaluation
- Physical environments and products
- Staff
- Information resources and technology
- Events

In Information Technology

- Procurement and development policies
- Physical environments and products
- Information
- Input and control
- Output
- Manipulations
- Safety
- Compatibility with assistive technology

In Physical Spaces

- Planning, policies, and evaluation
- Appearance
- Entrances and routes of travel
- Fixtures and furniture
- Information resources and technology
- Safety
- Accommodation

Universal design in education:

- rests on the definition and principles developed at the Center for Universal Design:

"The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design."

ncsu.edu/ncsu/design/cud

- puts high values on diversity, equity, and inclusion.
- strives to make educational products and environments welcoming, accessible, and usable for everyone.
- is a goal, a process, as well as a set of guidelines and strategies for specific applications.
- can be implemented in incremental steps.
- can be applied to instruction, services, information, technology, and physical spaces to ensure welcoming, accessible, and usable products and environments for students, instructors, staff, and others.

The Center for Universal Design in Education uw.edu/doit/CUDE
Founder and Director: Sheryl Burgstahler, Ph.D. University of Washington

DO IT

Examples of Universal Design in Education

In Instruction

- A statement on a syllabus that invites students to meet with the instructor to discuss learning needs
- Multiple delivery methods that motivate and engage all learners
- Flexible curriculum that is accessible to all learners
- Examples that appeal to students with a variety of characteristics with respect to race, ethnicity, gender, age, ability, and interest
- Regular, accessible, and effective interactions between students and the instructor
- Allowing students to turn in parts of a large project for feedback before the final project is due
- Class outlines and notes that are on an accessible website
- Assessing student learning using multiple methods
- Faculty awareness of processes and resources for disability-related accommodations

In Services

- Service counters that are at heights accessible from both a seated and standing position
- Staff who are aware of resources and procedures for providing disability-related accommodations
- Pictures in publications and on websites that include people with diverse characteristics with respect to race, ethnicity, gender, age, ability, and interest
- A statement in publications about how to request special assistance, such as a disability-related accommodation
- A student service website that adheres to accessibility standards (e.g., Section 508 Standards for those of the U.S. federal government)
- Printed materials that are easy to reach from a variety of heights and without furniture blocking access
- Printed publications that are available in alternate formats (e.g., electronic, large print, Braille)

In Information Technology

- Captioned videos
- Alternative text for graphic images on web pages so that individuals who are blind and using text-to-speech technology can access the content
- Procurement policies and procedures that promote the purchase of accessible products
- Adherence to standards for the accessible and usable design of websites
- Comfortable access to computers for both left- and right-handed students
- Software that is compatible with assistive technology
- Computers that are on adjustable-height tables

In Physical Spaces

- Clear directional signs that have large, high-contrast print
- Restrooms, classrooms, and other facilities that are physically accessible to individuals who use wheelchairs or walkers
- Furniture and fixtures in classrooms that are adjustable in height and allow arrangements for different learning activities and student groupings
- Emergency instructions that are clear and visible and address the needs of individuals with sensory and mobility impairments
- Non-slip walking surfaces

ACKNOWLEDGMENT

AccessCollege is directed by DO-IT at the University of Washington and funded by the U.S. Department of Education, Office of Postsecondary Education, Grant #P333A050064, and the State of Washington. Any questions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the government.

UNIVERSAL DESIGN in Higher Education

PROMISING PRACTICES

Evidence-Based Practices from the Field 2

The following peer-reviewed articles report evidence-based practices related to the application of universal design in higher education.

UNIVERSAL DESIGN in Higher Education
PROMISING PRACTICES

Increasing accessibility of college STEM courses through faculty development in Universal Design for Learning

S.J. Langley-Turnbaugh, M. Blair, and J. Whitney, University of Southern Maine

The University of Southern Maine (USM) has seen an increase in students with disabilities in recent years, and recognizes the requirement to modify its curricula, instruction, assessment, and environment to address the diverse needs of its changing population. Older students, veterans, students with disabilities, students for whom English is not their first language, transfer students, and others all bring special needs along with them to the first day of class, and retaining and educating these students means ensuring that courses are designed in a such a way that they are accessible to all students.

The EAST Alliance 2 for Science, Technology, Engineering, and Mathematics (STEM) Students with Disabilities at USM (EAST) (*www.usm.maine.edu/east*) conducted a program of faculty development in UDL that provided USM professors with training and tools to use in creating accessible courses for all their students. One professor summed up the need for this program: "I had no clue about universal design and really very little idea about the range of challenges facing students with disabilities — or even the range of disabilities. I suspect that many colleagues have a similar lack of appreciation for the challenges involved in adequately providing material for students with disabilities." Recognizing that many professors experienced a similar lack of understanding of the effectiveness of Universal Design for Learning principles in ensuring that all students have an equal opportunity to succeed, EAST recruited sixteen STEM faculty members to participate in a five-year program of UDL education, implementation, evaluation, and dissemination.

PHASE 1: UDL EDUCATION

The UDL faculty cohort met in a series of forums geared toward providing education and information on UDL while creating a constructivist learning environment out of which further topics for investigation could emerge. Collective reading and discussion of the book *Universal Design in Higher Education* (Burgstahler, 2008) provided background information and sparked questions that informed further forums. The Director of USM's Office of Support for Students with Disabilities (OSSD) presented a seminar on the mission of her office and their difficulties with the provision of all course materials in an accessible format. As a result of this presentation, two further seminars

were offered. The first was by Dr. Norman Coombs, a nationally recognized expert in accessibility teaching and advocacy, who broadened the faculty's perception of what it means to be blind in the world of higher education, and who demonstrated the means of making a universal, accessible PowerPoint presentation and then adapting it for a lecture, presentation, website, etc. The second seminar that resulted from the initial OSSD presentation was planned as a response to the faculty's request for more information on specific disabilities, and presented a neuropsychological perspective on students with Asperger's syndrome.

In addition to background information on disabilities and UDL, education was also provided on the role of technology in UDL and on adaptive technology. The key concept that technology broadens access by providing flexibility and multiple means of engagement but does not change the content of the curriculum, was reinforced by the faculty participants themselves. Four faculty members instructed their colleagues on the use of vodcasting, podcast/media server/compression issues, the digital pen, and implementing best practices for supporting all students.

PHASE 2: UDL IMPLEMENTATION

The evolving model of active learning by faculty proved to be powerful in keeping faculty engaged and committed. This high level of engagement was a major asset when the time came for implementation. Meeting together in a workshop format, faculty worked with a facilitator from the Center for Applied Special Teaching (CAST) in a guided exploration of brain research and its implication for differentiated instruction and classroom practices, as well as the strengths and weaknesses of various instructional media. Faculty conducted a UDL Redesign Challenge, for which they described an aspect of their course instruction/content that was particularly challenging for students, and shared suggestions for course adjustments guided by UDL principles.

Based on these explorations, faculty then used UDL principles to design, implement, and practice lessons, activities, labs, and revised syllabi. For instance, after examining many different examples of syllabi and evaluating them for adherence to UDL principles, faculty took on the assignment of redesigning their course syllabi to incorporate what they had learned regarding UDL. The following excerpts are taken from a Biology professor's report on the incorporation of UDL into the syllabus for his Introductory Neurobiology course, based on ideas from the Equity and Excellence in Higher Education (2008) project.

A professor of a Fundamentals of Environmental Science course described some of the UDL modifications he made to his methods of instruction as follows:

> ESP 101 uses online tools to allow students to submit their work at convenient times outside of lecture. Lecture includes interactive electronic clickers and quizzes that allow students and I to assess where they are at in a real-time manner and to quickly address concepts that are difficult while allowing the lecture to quickly move through those materials that students tend to grasp more readily. Short videos (less than six minutes) are frequently used to illustrate key concepts and keep students engaged. Finally, I use hands-on exercises in class to allow students to work together and develop a learning community.

UDL Tip	Syllabus Modification Made
Present information in at least two formats.	Calendar for lectures and office hours added. Map of concepts added to illustrate the link between major themes of course.
Give students as many resources as possible.	Online textbook site added; Blackboard website added. Link to campus map added for site of lectures and OSSD. Website and contact info for OSSD and information about EAST added.
Provide lots of background information — but be brief.	Photo of instructor added. Sentence about my interests added to give context to the course.
Build in flexibility.	Weekly schedule calendar graphic added. Office hours added after class, Virtual office hours added. Email submission of homework added. For some assignments the option of a PowerPoint or audio presentation instead of a written piece has been added.
Go digital.	Course materials will all be posted on Blackboard website. This includes PowerPoints of lectures and additional papers. Syllabus will be emailed to all students. Added websites which have podcasts and webcasts which students can consult.
Less is more — don't overwhelm syllabus with details.	Need to trim down text in initial document and place some of it in a secondary document.

PHASE 3: REFLECTION/FEEDBACK

An integral part of sustaining change in teaching practice is reflection and feedback. Faculty observed each other's courses, recorded their observations, and met to discuss how UDL was being incorporated into classroom instruction. Working with Education Development Center, Inc. and CAST, EAST developed a Faculty Universal Design for Learning Observation Tool which gathered data about whether and how an observed course session offered opportunities for students to experience ideas and information in multiple ways, to express their comprehension in multiple ways, and to have multiple opportunities for engagement. Faculty also completed a self-reflection called Faculty Course Redesign Reflection in which they described changes made to courses, what aspects of courses reflect principles of universal design, the perceived impact of the lesson on students, and impact on their teaching practice in general.

To collect feedback, faculty administered a questionnaire to students at the end of each course. The College Student Feedback Survey provided formative feedback to faculty about accessibility of their STEM courses and documented the accessibility features that these courses incorporated.

All of these evaluation instruments, as well as Faculty Pre- and Post-Surveys (Education Development Center, Inc., 2009), are available online.

Professors were provided with a small amount of funding to use for purchasing technology to help them address individual issues that were identified through the evaluation process. A Computer Science professor who learned that she was difficult to understand was able to purchase an amplification system. She reflected,

"I am working in particular on improving my vocalization…which I have learned can be helpful to students who are hard of hearing."

PHASE 4: DISSEMINATION

Over the course of the training, the faculty realized the strong value of technology as a means of providing universal accessibility to information; consequently they developed a website, blogs, vodcasts, and a technology showcase. One of these, featuring use of a digital pen in Chemistry class (Stasko, 2010), can be viewed online.

It was planned that in years four and five, each of the participating faculty would mentor at least two colleagues from their department through a two-year UDL Education/UDL Implementation cycle. This model would result in an ongoing loop of dissemination of Universal Design for Learning throughout the university community. In addition, a rubric for use in evaluating syllabi and courses, a collection of model syllabi and UDL lessons, training in adding captioning to videos, and a monthly brown bag lunch series for sharing of tools and strategies were anticipated. Unfortunately, funding for this phase of the project was eliminated.

IMPACT

The sixteen faculty members who participated in EAST's program for professional development in UDL were responsible for seventy courses and six hundred students, including eighteen in Engineering and Technology, fourteen in Natural Sciences, thirteen in Biology, ten in Mathematics, seven in Chemistry, five in the Humanities, and three in Physical Sciences. The legacy of UDL improvements to courses is being carried on by the faculty who shared in the creation of the UDL education and implementation program.

When asked to describe the key idea they learned through the professional development sessions, sixty-two percent of the faculty cited the benefits of incorporating universal design into their courses. All faculty members reported that they made changes in the design of their courses as a result of participating in professional development in UDL. Sixty-four percent reported that they now provide information in multiple formats, and forty-three percent reported incorporating interactive media.

The following quotes illustrate faculty members' responses:

> I try and think strategically about what I want the students to be learning, and develop different opportunities for the students to engage and display competence. I try and bring in a lot of models and tactile work, more simulations and practical demonstrations, and less equation work.

> I have sought after and/or created information resources that provide information in multiple formats. Slide shows have text outlines to go along with them. Images in lecture slide shows have descriptive text for screen readers.

When asked what impact the changes in their courses had on students, thirty-six percent of the faculty reported more student engagement, thirty-six percent felt it was too early to detect changes, twenty-nine percent reported positive student feedback, and fourteen percent observed more student self-sufficiency. The following quotes are representative of faculty members' responses:

> I think it has had a big impact on all students primarily because it has had a big impact on me and how I think about my teaching and my teaching goals.
>
> I cannot tell yet. It changes with every class. But the students respond to the opportunity to express their knowledge in different ways positively, and (hopefully) this helps them stay engaged and active in the learning.
>
> The course now allows students to learn all the material at their own pace and in a more accessible manner. All the new features were designed to be more useful to any student.

CONCLUSION

This program has proven successful in educating college faculty on utilizing UDL to address the needs of a rapidly changing student population. Involving professors in a constructivist approach is an excellent way to overcome their natural reluctance to embrace change and assistive technology. Collaborating with peers is, by definition, a collegial approach that respects the different places that individuals might be on the road to making their courses universally accessible. As one long-time professor phrased it, professional development in UDL "has had a transformative impact on nearly all aspects of my teaching."

REFERENCES

Burgstahler, S. (2008). *Universal design in higher education: From principles to practice*. Boston: Harvard Education Press.

Education Development Center, Inc. (2009). *EAST faculty pre- and post-surveys*. Retrieved from *cct.edc.org/surveys/EAST/iheFac.html*

Equity and Excellence in Higher Education. (2008). Universal Course Design, UCD Syllabus Tips. Retrieved from *www.eeonline.org/images/stories/eeonline_docs/ud_syll_tips.pdf*

Stasko, D. (2010). Livescribe Pulse Smartpen in a Chemistry classroom [Blog post]. Retrieved from *http://www.livescribe.com/blog/education/2010/02/05/*

ACKNOWLEDGMENTS

EAST is funded under National Science Foundation Award No. HRD 0833567. This article is part of the collection *Universal Design in Higher Education: Promising Practices* sponsored by the DO-IT Center. The content is based upon work supported by the National Science Foundation under Grant #HRD-0929006. Any opinions, findings, and conclusions or recommendations expressed are those of the authors and do not necessarily reflect the views of funding sources or the DO-IT Center.

REFERENCE FORMAT FOR THIS CONTENT

Langley-Turnbaugh S. J., Blair, M., & Whitney, J. (2013). Increasing accessibility of college STEM courses through faculty development in UDL. In S. Burgstahler (Ed.). *Universal design in higher education: Promising practices*. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/UDHE-promising-practices/college_stem.html*

UNIVERSAL DESIGN in Higher Education
PROMISING PRACTICES

Universal Instructional Design of Online Courses

Strategies to Support Non-Traditional Learners in Postsecondary Environments

By Kavita Rao, University of Hawai'i at Mānoa

With its unique position as one of few four-year universities located at a crossroads in the Pacific ocean, the University of Hawai'i at Mānoa serves a diverse population of students from the U.S., Asia, and the Pacific. The university's College of Education (COE) provides teacher education programs for students from various Hawaiian islands and from several Pacific island entities (such as American Samoa, the Marshall Islands and the Federated States of Micronesia). With this geographically-dispersed population, distance learning programs are a necessary and practical way for the COE to reach students. Online courses have created outreach opportunities and enabled students to enroll in certificate and degree programs that they are not otherwise able to access.

Our online teacher education programs attract many "non-traditional students," learners who do not fit the profile of a typical college-age young adult. "Non-traditional students" include students who live in rural and remote communities, students with disabilities, and adult learners who are returning to school to earn certifications or degrees. The COE's non-traditional student population includes individuals who are culturally and linguistically diverse, many from traditional and indigenous backgrounds. These non-traditional students have a range of characteristics and needs, based on their backgrounds, experiences, and life situations.

Universal design (UD) educational models provide useful frameworks to consider when creating courses for the diverse and non-traditional students served by the COE's online programs. With a deliberate application of UD principles during the instructional design process, instructors can proactively develop courses that address the needs of diverse learners. UD principles can be taken into consideration when making determinations about various course elements and pedagogical practices for an online course, including decisions about how to use both asynchronous (e.g. course management systems) and synchronous technologies (e.g virtual classrooms via web-conferencing).

CONSIDERATIONS FOR NON-TRADITIONAL LEARNERS

Our non-traditional learners are often: (a) rural and remote students, some from traditional and indigenous cultures, (b) students with disabilities, (c) adult learners, and (d) students for whom the language of instruction is not a first language (EFL students). These categories are not mutually exclusive; a non-traditional learner may fall into one or more of them. Table 1 lists some challenges that non-traditional students may experience in an online environment, which include ambiguity and uncertainty about expectations, excessive reliance on text-based learning modalities, isolation and lack of community, and technology challenges (Ho & Burniske, 2005; McLoughlin & Oliver, 2000; Rao, Eady, Edelen-Smith, 2010, Zepke & Leach, 2002).

TABLE 1 Common challenges for non-traditional learners

Challenges/Issues	Rural/ remote learners	Students with disabilities	Adult learners	EFL students
Ambiguity/ uncertainty about expectations	✓	✓	✓	✓
Excessive reliance on text-based learning	✓	✓		✓
Isolation/lack of learning community	✓		✓	
Technology challenges	✓	✓	✓	

UNIVERSAL INSTRUCTIONAL DESIGN: APPLYING PRINCIPLES TO PRACTICE

Instructors often design courses before they know exactly who will be enrolled. During the instructional design phase, instructors can include course elements and pedagogical strategies that will address the needs of various types of diverse students who may enroll in their courses. The Universal Instructional Design (UID) framework provides guidelines that instructors can use to proactively building in supports for various learner needs. The eight principles of UID, based on Chickering and Gamson's (1987) principles for effective practices in undergraduate education and modified by Goff and Higbee to further include universal design elements, are:

a. Creating welcoming classrooms
b. Determining essential components of a course
c. Communicating clear expectations
d. Providing timely and constructive feedback
e. Exploring use of natural supports for learning, including technology
f. Designing teaching methods that consider diverse learning styles, abilities, ways of knowing, and previous experience and background knowledge
g. Creating multiple ways for students to demonstrate their knowledge
h. Promoting interaction among and between faculty and students (Goff & Higbee, 2008)

Silver, Bourke and Strehorn (1998) state, "with UID, students may find that many of the instructional accommodations they would request are already part of the faculty members' overall instructional design.

Furthermore, these approaches may benefit all students in the class" (p. 47). Berger and Van Thanh (2004) note that the UID principles can foster equity and inclusion of students with disabilities and create campus environments that respect and value diversity.

Table 2 provides an overview of the pedagogical strategies that instructors can incorporate when designing and implementing online courses in order to address the four challenges presented in Table 1 for non-traditional learners, and maps how the strategies align to universal instructional design principles. Though Table 2 specifically aligns strategies to the UID principles, these course elements and strategies also align to the principles of the other UD educational models of Universal Design of Instruction (UDI) and Universal Design for Learning (UDL). The principles of these three UD educational models have similarities, each stemming from the core universal design philosophy of creating access to learning environments and curricular content. Detailed descriptions of the strategies described in Table 2 can be found in the Rao and Tanners (2011) article in the *Journal of Postsecondary Education and Disability* and in the Rao, Eady, Edelen-Smith (2011) article in *Phi Delta Kappan* magazine.

TABLE 2 Pedagogical Strategies and UID Principles

		A: Welcoming classrooms	B: Essential course	C: Clear expectations	D: Timely, constructive feedback	E: Diverse teaching methods	F: Natural supports	G: Demonstrate knowledge	H: Interaction - students/ faculty
Challenges	**Pedagogical Strategies**	**UID**							
Ambiguity/ uncertainty of expectations	Personalized introduction Consistent and organized use of CMS Provide clear syllabus and rubrics	●	●	●					
Excessive reliance on text-based learning	Provide multimodal sources of information Include digital texts and audio files for reading assignments Provide assignment choices with alternate ways to demonstrate knowledge					●	●	●	
Isolation/ lack of community	Include synchronous class meetings Have short, frequent lower-stakes assignments instead of larger high-stakes assignments Provide timely feedback from instructor on all assignments	●		●	●	●	●	●	●
Technology barriers	Provide proactive tech support Create mechanisms for peer assistance				●		●		●

STUDENT FEEDBACK

Course surveys and interview data indicate that students have favorable perceptions of courses that incorporate elements that align to universal design principles. Non-traditional students from rural and remote communities particularly appreciated the supports that were put in place to address issues of isolation and the excessive reliance on text (Rao, Eady, Edelen, Smith, 2010), such as regular virtual meetings online and course content presented in multimodal formats. Students reported that having audio and video files (prepared by the instructor) about key course concepts in addition to the textbook for the course helped them comprehend content and made the course feel manageable. The instructor provided video and audio files that had captions and transcripts available when possible and created guided notes to accompany many of the video/audio materials, thereby giving students multiple means for accessing course content. Students commented that the guided notes helped them focus on key concepts as they viewed or listened to assigned materials, which was especially helpful in this online learning environment where they had to navigate through and absorb a lot of new information independently.

Weekly synchronous "virtual class" meetings using a web-conference environment (e.g., Elluminate or Blackboard Collaborate) provided a connection with instructors that the students found sustaining and supportive. Students appreciated the fact that during the synchronous sessions, the instructors presented slides and a lecture about the course content and also included engaging activities that fostered active discussion and interaction. During synchronous sessions, instructors used varied methods to foster peer interactions, using the "breakout room" feature of the virtual meeting software to let students discuss course concepts in small groups and then report back to the whole group. Students commented that these peer interactions helped build online community and allowed them to discuss issues relevant to their local and cultural contexts. Students also appreciated consistent and specific feedback from instructors on weekly assignments, noting that feeling consistently connected to the instructor helped them to stay motivated to continue in the online course.

Student data collected on an online course designed for adult learners who were returning to school for teacher certification indicated that students valued various "universally-designed" course elements (Rao & Tanners, 2011). Students commented on the organization of the course, noting that having materials in a consistent format and place each week was helpful. Students highly valued having multimodal sources of information and being given options to complete assignments in various formats (text-based and multimedia). Many commented favorably on the utility of having more frequent low-value assignments, noting that this allowed them to keep up with coursework in their busy schedules juggling school, jobs, and families.

CONCLUSION

The promise of earning advanced degrees and certifications through distance education is appealing to many students who need the flexibility offered by the online format. However, many facets of this format create barriers and challenges for the very students who need distance education options the most. By being open to and aware of students' backgrounds, experiences, and needs, instructors can build supports into their courses, proactively creating online environments that make it possible for students to complete courses and reach their educational goals.

Course design and development takes time and advance planning. Integrating UD-based strategies requires additional forethought, planning, and resources on an instructor's part during the instructional design phase. To make this process manageable, instructors can add UD-based strategies incrementally into their courses, rather than feeling compelled to address every UD principle concurrently; by adding a few UD-based strategies each time they teach a course and assessing what works for their student populations, instructors can create a foundation for an accessible and accommodating learning environment that can be built upon and refined as needed.

REFERENCES

Berger, J., & Van Thanh, D. (2004). Leading organizations for universal design. *Equity & Excellence in Education*, *37*(2), 124–134.

Chickering, A. W., & Gamson, Z. (1987). Seven principles for good practice in undergraduate education. *American Association for Higher Education Bulletin, 40*(7), 3–7.

Goff, E., & Higbee, J. L. (Eds.). (2008). *Pedagogy and student services for institutional transformation: Implementing universal design in higher education*. Center for Research on Developmental Education and Urban Literacy, University of Minnesota.

Ho, C., & Burniske, R. (2005). The evolution of a hybrid classroom: Introducing online learning to educators in American Samoa. *TechTrends, 49*(1), 24–29.

McLoughlin, C., & Oliver, R. (2000). Designing learning environments for cultural inclusivity: A case study of indigenous online learning at a tertiary level. *Australian Journal of Educational Technology, 16*(1), 58–72.

Rao, K., Eady, M., & Edelen-Smith, P. (2011). Creating virtual classrooms for rural and remote communities. *Phi Delta Kappan*. *92*(6), 22–27.

Rao, K., & Tanners, A. (2011). Curb cuts in cyberspace: Universal instructional design for online courses. *Journal of Postsecondary Education and Disability, 24*(3), 211-229. Retrieved January 1, 2013, from *www.eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=EJ966125*

Silver, P., Bourke, A., & Strehorn, K. C. (1998). Universal instructional design in higher education: An approach for inclusion. *Equity & Excellence in Education, 31*(2), 47–51.

Zepke, N., & Leach, L. (2002). Appropriate pedagogy and technology in a cross-cultural distance education context. *Teaching in Higher Education, 7*(3), 309–321.

ACKNOWLEDGMENTS

This article is part of the collection *Universal Design in Higher Education: Promising Practices* sponsored by the DO-IT Center. The content is based upon work supported by the National Science Foundation under grant #HRD-0929006. Any opinions, findings, and conclusions or recommendations expressed are those of the author and do not necessarily reflect the views of funding sources or the DO-IT Center.

REFERENCE FORMAT FOR THIS CONTENT

Rao, K. (2013). Universal instructional design of online courses: Strategies to support non-traditional learners in postsecondary environments. In S. Burgstahler (Ed.). *Universal design in higher education: promising practices*. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/UDHE-promising-practices/uid_online.html*

UNIVERSAL DESIGN in Higher Education
PROMISING PRACTICES

Development of a UD Checklist for Postsecondary Student Services

Sheryl E. Burgstahler and Elizabeth Moore, University of Washington

Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 and its 2008 amendments require postsecondary institutions to provide access to courses and services for qualified students with disabilities. However, little guidance is available to help a student service unit take proactive steps toward becoming more welcoming and accessible to individuals with disabilities.

Administrators from twenty-three postsecondary institutions nationwide partnered to explore ways to make their student services more welcoming and accessible to students with disabilities (DO-IT, 2008). The project was led by the Disabilities, Opportunities, Internetworking, and Technology (DO-IT) Center at the University of Washington. Project participants drafted a checklist of qualities of an accessible student service office based on literature review, experiences at their schools, and preliminary data collected about accessibility issues from participants in fourteen focus groups with a total of seventy-two student service personnel and thirteen groups with a total of fifty-three students with disabilities nationwide (Burgstahler & Moore, 2009).

Project team members piloted the draft instrument on their campuses (Anderson, Cory, Griffin, Richter, Ferguson, Patterson, & Reed, 2008), and with that experience and their professional opinions, produced iterative revisions of the draft checklist over a two-year period resulting in a list of fourty-four accessibility strategies in six application areas (Burgstahler, 2010). Project team members suggested that the checklist would be more useful in the field if it was shortened by retaining only those items that knowledgeable practitioners considered to be both most important and most easily attainable. To take this step and to further test the face validity of the instrument and improve its usefulness, they recommended seeking input from other student service personnel knowledgeable about working with students with disabilities.

METHODS

A questionnaire was developed to seek expert opinions regarding the relevance of items on the student service checklist for accessibility. An invitation to participate in the survey was sent to student service personnel at US two-year and four-year "nonprofit" colleges and universities with enrollments of more than one thousand students.

Mailing labels were purchased from Higher Education Publications, Inc. (HEP) and surveys were sent to "Disability Services Director" and "Director of Career Center/Student Placement" at each institution.

Two hundred ninety-six individuals completed the survey; eighty percent were women; twenty-nine percent had disabilities; and thirty-nine percent worked in a disability service center. Another thirty-nine percent worked in general "student services," student life, counseling, and student affairs. The others were distributed across different units, including academic affairs, instructional services, academic support, learning center, career services, admissions, advising, and general administration. Most respondents worked at four-year institutions with graduate programs (forty-nine percent) or two-year colleges (forty-four percent). A large majority (ninety-three percent) reported having a high or moderate level of responsibility for serving students with disabilities. It is not possible to compute a meaningful response rate, since it is expected that many who received the survey were not part of the target group for the study because of low levels of experience in the content area.

For each strategy on the checklist, respondents rated (1) its importance as a measure of the accessibility of a postsecondary student services unit on a scale from one ("Irrelevant") to four ("Essential"), and (2) the ease of its implementation on a scale from one ("Easily Attainable") to four ("Very Difficult to Attain"). For analysis, the numerical values of the attainability responses were reversed so that one meant "Very Difficult to Attain" and four meant ("Easily Attainable"). In this way higher attainability ratings indicated more attainable strategies, just as higher importance ratings indicated more important strategies.

The importance and attainability ratings of the checklist items were analyzed separately. In addition, the importance and attainability ratings were combined into a single composite rating for each strategy, resulting in composite scores between two (indicating both "Irrelevant" and "Very difficult to attain") and eight (indicating both "Essential" and "Easily attainable"). This composite rating has the disadvantage of giving equal priority to strategies that are "Irrelevant" but "Easily attainable" and those that are "Essential" but "Very difficult to Attain." To overcome this shortcoming, the composite ratings were weighted (multiplied) by their importance rating, resulting in a priority score on a scale from two ("Irrelevant" and "Very Difficult to Attain") to thirty-two ("Essential" and "Easily attainable"). These would be the "high impact" strategies. Through this process strategies considered to be very important and very attainable received the highest scores, while strategies that were seen as unimportant and difficult to attain received the lowest scores. In a final step, a second set of priority scores was produced, which was weighted by attainability instead of importance, pointing to "quick fix" strategies.

RESULTS AND DISCUSSION

Nearly half (forty-five percent) of the items on the checklist were rated as "Essential" for an assessment of the accessibility of a student services unit by more than half of the respondents. One-fourth (twenty-five percent) of the items were rated as "Essential" by at least sixty-five percent of the respondents. Strategies in the Planning, Policies, and Evaluation section were rated as most important, with more than half (fifty-seven percent) of those rated as "Essential" by at least seventy percent of the respondents, but as relatively difficult to attain. Strategies in the Computers, Software, and Assistive Technology section received the fewest "Essential" ratings with between seventeen and thirty-seven percent of the respondents rating these as "Essential."

Section I: Planning, Policies, and Evaluation

ID	Strategy	Importance mean (SD)	% Essential	Attainability mean (SD)	Priority score by importance mean (SD)
I.2	Policies assure access to facilities for people with disabilities (pwd).	3.8 (.40)	86%	3.0 (.61)	26.7 (4.8)
I.4	Policies assure access to computers for pwd.	3.8 (.49)	78%	3.0 (.65)	25.8 (5.5)
I.3	Policies assure access to printed materials for pwd.	3.8 (.48)	79%	2.9 (.75)	25.4 (5.6)
I.5	Policies assure access to electronic resources.	3.7 (.52)	70%	2.8 (.67)	24.3 (5.7)
I.6	Accessibility is considered in the procurement process for resources and equipment.	3.5 (.61)	58%	2.6 (.81)	22.0 (6.2)
I.7	Disability-related issues are addressed in evaluation methods.	3.4 (.67)	46%	2.7 (.78)	21.1 (6.9)
I.1	People with disabilities are included in student service planning, review processes, and advisory committees.	3.4 (.67)	46%	2.7 (.79)	21.0 (7.2)

Section II: Facilities and Environment

ID	Strategy	Importance mean (SD)	% Essential	Attainability mean (SD)	Priority score by importance mean (SD)
*II.7	Wheelchair accessible restrooms are available.	3.9 (.39)	87%	3.1 (.66)	27.1 (4.7)
*II.1	Wheelchair accessible parking areas are identified.	3.7 (.54)	73%	3.5 (.63)	27.0 (6.0)
*II.3	Wheelchair accessible entrances to buildings are clearly identified.	3.6 (.53)	65%	3.3 (.72)	25.3 (6.0)
II.9	Aisles are wide and clear for wheelchair users.	3.6 (.53)	67%	3.0 (.67)	24.4 (5.9)
II.2	Wheelchair accessible pathways are identified.	3.5 (.61)	55%	3.1 (.71)	23.6 (6.4)
II.10	Objects and protrusions are removed or minimized.	3.4 (.62)	41%	3.1 (.72)	23.0 (6.7)
II.14	Telecommunication devices (TTY/TDD) are available for people who are deaf or have speech impediments.	3.3 (.72)	48%	3.1 (.72)	22.2 (7.7)
II.4	All levels of a facility are connected via an accessible route of travel.	3.5 (.62)	46%	2.5 (.83)	21.5 (6.7)
II.8	At least part of a service counter is at a height available to a person in a seated position.	3.3 (.66)	44%	2.8 (.73)	21.1 (6.7)
II.13	Quiet work areas are available where noise and other distractions are minimized.	3.2 (.64)	35%	3.0 (.73)	20.8 (6.8)
II.6	Elevators have auditory, visual, tactile signals, and controls that are reachable from a seated position.	3.3 (.70)	46%	2.7 (.81)	20.7 (7.3)
II.5	High-contrast, large-print signs direct visitors.	3.0 (.67)	23%	2.9 (.80)	18.3 (6.4)
II.12	Window drapes are available to reduce glare.	2.7 (.76)	13%	2.7 (.83)	14.9 (6.9)
II.11	Lighting is adjustable by the individual.	2.7 (.73)	12%	2.3 (.77)	13.9 (6.6)

* indicates “quick fix” items — those in top ten when weighted by attainability.

Section III: Staff

ID	Strategy	Importance mean (SD)	% Essential	Attainability mean (SD)	Priority score by importance mean (SD)
*III.5	Staff members know how to respond to requests for disability-related accommodations.	3.7 (.52)	68%	3.2 (.62)	25.5 (6.0)
III.6	Staff members are aware of issues related to communicating with pwd.	3.5 (.56)	58%	3.1 (.62)	24.1 (6.3)
III.4	Staff members are familiar with the availability and use of alternate document formats.	3.2 (.65)	33%	2.9 (.67)	20.0 (6.7)
III.3	Staff members are familiar with the availability and use of assistive technology.	3.2 (.62)	28%	2.8 (.69)	19.4 (6.5)
III.2	Staff members are familiar with the availability and use of the Telecommunications Relay Service.	3.0 (.71)	23%	2.9 (.69)	18.3 (7.1)
III.1	Staff members are familiar with the availability and use of a TTY/TDD.	2.9 (.71)	18%	2.9 (.68)	17.3 (6.8)

* indicates “quick fix” items — those in top ten when weighted by attainability.

Section IV: Information Resources

ID	Strategy	Importance mean (SD)	% Essential	Attainability mean (SD)	Priority score by importance mean (SD)
*IV.3	Key publications include procedures for requesting disability-related accommodations.	3.6 (.52)	65%	3.5 (.62)	26.2 (6.2)
*IV.2	Key publications include a statement of commitment to universal access.	3.3 (.69)	45%	3.3 (.74)	22.6 (7.6)
IV.6	Electronic resources, including web pages, adhere to accessibility guidelines or standards adopted by your institution or your specific project or funding source.	3.5 (.59)	52%	2.9 (.68)	22.5 (6.3)
*IV.1	Pictures in your publications and website include people with diverse characteristics with respect to race, gender, age, and disability.	3.2 (.70)	36%	3.3 (.69)	21.5 (7.1)
IV.4	All printed publications are available in alternate formats such as Braille, large print, and electronic text.	3.3 (.65)	41%	2.7 (.74)	20.4 (7.1)
IV.5	Printed materials are within easy reach from a variety of heights and without furniture blocking access.	3.1 (.70)	29%	3.0 (.67)	19.7 (7.1)
IV.7	Videos and DVDs are captioned.	3.2 (.73)	37%	2.5 (.67)	18.9 (6.8)

* indicates “quick fix” items — those in top ten when weighted by attainability.

Section V: Computers, Software, and Assistive Technology

ID	Strategy	Importance mean (SD)	% Essential	Attainability mean (SD)	Priority score by importance mean (SD)
V.4	Software to enlarge screen images and large monitor is available at computer workstations.	3.2 (.68)	37%	2.9 (.65)	20.6 (7.0)
V.1	An adjustable-height table is available for each type of workstation.	3.1 (.72)	31%	2.8 (.70)	19.2 (7.1)
V.2	Workstations offer adequate work space for both left- and right-handed users.	3.0 (.71)	24%	2.9 (.66)	18.6 (6.8)
V.5	A trackball or other alternative to a mouse is available at computer workstations.	2.9 (.74)	23%	2.9 (.67)	17.8 (7.2)
V.6	Wrist/forearm rests are available at computers.	2.8 (.77)	19%	3.0 (.70)	16.8 (7.4)
V.3	Large-print key labels are available on computers.	2.8 (.73)	17%	2.8 (.68)	16.2 (6.8)

Section VI: Events

ID	Strategy	Importance mean (SD)	% Essential	Attainability mean (SD)	Priority score by importance mean (SD)
*VI.2	The accessible entrance is clearly marked.	3.6 (.54)	64%	3.3 (.60)	25.4 (6.2)
*VI.1	Events are located in wheelchair-accessible facilities.	3.7 (.50)	69%	3.1 (.62)	25.4 (5.9)
*VI.3	Info about how to request disability-related accommodations is included in publications promoting events.	3.5 (.59)	57%	3.3 (.70)	24.5 (6.8)
VI.4	Accessible transportation is available if transportation is arranged for other participants.	3.5 (.67)	58%	2.7 (.73)	22.2 (6.9)

* indicates “quick fix” items — those in top ten when weighted by attainability.

These tables present the average Importance and (reversed) Attainability ratings of all fourty-four strategies on a scale from one (“Irrelevant”/”Very difficult to attain”) to four (“Essential”/”Easily attainable”), along with the percentage of respondents who rated the strategy as “Essential,” and the strategy’s priority score weighted by importance. Respondents provided a diversity of ratings for each strategy. Each strategy was rated as “Essential” and “Easily attainable” (producing a priority score of thirty-two) by at least one person while the minimum priority scores for these same strategies ranged from two to ten. This diversity indicates that some of the strategies may be more important to some student services units than to others. Despite this diversity, overall trends emerged with average priority scores ranging from a high of 27.1 (II.7 Wheelchair accessible restrooms are available) to a low of 13.9 in the same section (II.11 Lighting is adjustable by the individual). The strategies with the highest ratings also tended to have the least diversity of scores indicating more widespread agreement about the importance and attainability of these strategies.

The strategies listed in these tables are sorted in descending order of "impact" priority within each application areas. These scores appear in the final column of the tables. Items in the table marked with an asterisk (*) are the top ten strategies on the "quick fix" scale. Significantly, none of the strategies in Section I: Planning, Policies, and Evaluation, nor in Section V: Computers, Software, and Assistive Technology appeared in the "quick fix" list. The "high impact" strategies that also appeared at the top of the "quick fix" rating are listed below with their importance-weighted priority rating.

*II.7 Wheelchair accessible restrooms are available (27.1).
*II.1 Wheelchair accessible parking areas are identified (27.0).
*II.3 Wheelchair accessible entrances to buildings are clearly identified (25.3).
*III.5 Staff members know how to respond to requests for disability-related accommodations (25.5).
*IV.2 Key publications include a statement of commitment to universal access (22.6).
*IV.3 Key publications include procedures for requesting disability-related accommodations (26.2).
*IV.1 Pictures in your publications and website include people with diverse characteristics with respect to race, gender, age, and disability (21.5).
*VI.2 The accessible entrance is clearly marked (25.4).
*VI.1 Events are located in wheelchair-accessible facilities (25.4).
*VI.3 Info about how to request disability-related accommodations is included in publications promoting events (24.5).

Overall, the data shows that respondents found the checklist's strategies to be relevant—nearly half were rated as "Essential" measures of accessibility by at least half of the respondents. Further, respondents were discerning—a quarter of the checklist's strategies were rated as less than "Essential" by more than 70% of the respondents.

Policies ensuring access to facilities, printed materials, computers, and electronic resources were given the highest priority ratings, as were wheelchair accessible locations used for student services, including events. Respondents agreed that it is very important for staff members to know how to respond to requests for disability-related accommodations, and that key publications should include procedures for requesting such accommodations. These high ratings may reflect that respondents believe that access to student services, not just classes, are important to the success of all students. The high ratings of strategies in the Planning, Policies, and Evaluation section suggest that these are important strategies to address, but the attainability ratings warn that it will be difficult to make the changes here that will make student service offerings more welcoming and accessible to all students. Student services personnel seeking to transform their units to be more welcoming and accessible to all students might be wise to address some of the "quick fix" strategies, while continuing to work on the important planning and policy strategies. The low ratings for computer-related items (e.g., computers, window lighting) might be because they are not relevant to all student service facilities and/or the particular product/strategy is perceived to be useful to only a small percentage of student service users. The low rating of the need for staff to be familiar with TTY/TDD technology may reflect the now common use of email and texting for long distance communication with a person who is deaf.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Results of the current study were used by the DO-IT Center to fine-tune the UD checklist for student services units. Strategies given the lowest priority ratings for these settings were removed from the instrument. They included the ability of staff to use TTY/TDDs for deaf students as well as the availability of individually-adjustable lighting, window drapes to reduce glare, large-print key labels on computer keyboards, and wrist and forearm rests. Strategies in the now reduced Computers, Software, and Technology section were then combined with Information Resources strategies. To make the checklist more concise, several similar strategies were combined into one—for example, the those related to policy statements for access to printed materials, computers, and electronic resources were combined; as were several strategies related to facilities such as wheelchair accessible parking, pathways, and entrances. In addition, several items were reworded for greater clarity. The revised instrument is provided below and is available online (*www.uw.edu/doit/Brochures/Academics/equal_access_ss.html*). Survey respondents and focus group participants in an earlier study expressed the need for guidance regarding communication with students with disabilities; in response, "Communication Hints" were added to the last page of the checklist.

The checklist can be used by student service offices to assess their baseline accessibility for students with disabilities, to prioritize steps for making their offices more welcoming and accessible to everyone, and to track the progress of their changes. Practitioners and researchers are encouraged to provide suggestions to improve the instrument and to conduct further studies to establish instrument validity and maximize its usefulness.

REFERENCES

Burgstahler, S. (2010). Equal access: Universal design of student services. Seattle: University of Washington. Retrieved from *www.uw.edu/doit/Brochures/Academics/equal_access_ss.html*

Burgstahler, S., & Moore, E. (2009). Making student services welcoming and accessible through accommodations and universal design. *Journal of Postsecondary Education and Disability*, *21*(3), 151–174.

Anderson, A., Cory, R. C., Griffin, P., Richter, P. J., Ferguson, S., Patterson, E., & Reed, L. (2008). Applications of universal design to student services: Experiences in the field. In *Universal design in higher education: From principles to practice* (pp. 177–186). Cambridge, MA: Harvard Education Press.

Disabilities, Opportunities, Internetworking, and Technology (DO-IT). (2008). *DO-IT Admin: A project to help postsecondary campus services administrators work successfully with students who have disabilities*. Seattle: University of Washington. Retrieved from *www.uw.edu/doit/Brochures/Academics/admin.html*

National Council on Disability. (2003). *People with disabilities and postsecondary education*. *Position paper*. Retrieved from *www.ncd.gov/publications/2003/Sept152003*

ACKNOWLEDGMENTS

The development of this article was supported by the National Science Foundation (Grants #CNS-1042260, #HRD-0833504, and #HRD-0929006) and the U.S. Department of Education (Grant #P333A020044).

This article is part of the collection *Universal Design in Higher Education: Promising Practices* sponsored by the DO-IT Center. Any opinions, findings, and conclusions or recommendations expressed are those of the author and do not necessarily reflect the views of funding sources or the DO-IT Center.

REFERENCE FORMAT FOR THIS CONTENT

Burgstahler, S. & Moore, E. (2013). Development of a UD Checklist for postsecondary student services. In S. Burgstahler (Ed.). *Universal design in higher education: Promising practices*. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/UDHE-promising-practices/ud_checklist.html*

UNIVERSAL DESIGN in Higher Education
PROMISING PRACTICES

Promoting the Design of Accessible Informal Science Learning

Lyla Crawford and Sheryl E. Burgstahler, University of Washington

To fill increasing numbers of positions in science, technology, engineering, and mathematics (STEM), the US must draw from a talent pool that includes all demographic groups (American Association for the Advancement of Science, 2001; Committee on Equal Opportunities in Science and Engineering, 2011; National Science Foundation, 2011; Office of Science and Technology Policy, 2006). Today, individuals with disabilities experience far less success in STEM programs and careers (National Science Foundation, 2012). However, success stories in STEM fields demonstrate that opportunities exist for those who successfully overcome barriers imposed by (a) inaccessible programs and technology/media, insufficient accommodations, and low expectations as well as (b) inadequate self-advocacy skills (DO-IT, 1993-2012; Stern & Woods, 2001). Informal STEM learning (ISL) can play an important role in increasing STEM interest and knowledge (Bell, Lewnstein, Shouse, & Feder, 2009; Fenichel & Schweingruber, 2010), as prerequisites to pursuing STEM degrees and careers. However, people with disabilities can receive these benefits only if ISL offerings are accessible to them.

BACKGROUND

Many traditional efforts to include people with disabilities in programs focus on the deficit of the individual. In a medical model of disability, for example, efforts are made to cure, medicate, or otherwise medically treat the individual with a disability. A model centered around functional limitations also focuses on the deficit of the individual with a disability, as well as on how accommodations can be made so that this person can fit into an established environment. In contrast, the "social model" of disability (DePoy & Gibson, 2008) considers variations in abilities—just like gender, race/ethnicity—to be a natural part of the human experience and makes efforts to design products and environments that are welcoming and accessible to all potential users (Gabel & Peters, 2010; Loewen & Pollard, 2010). Universal design (UD)—defined as "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Center for Universal Design, n.d.)—is an approach that is consistent with the social model of disability, addresses other diversity issues as well, and has the potential to minimize the need for individual accommodations (Burgstahler,

2011). For example, if a science facility contains a height-adjustable work surface, then an accommodation will not be needed for a wheelchair user whose chair is too high for standard-height workstations. This workstation will also be comfortable for a visitor who needs to remain seated in a chair or for a very tall or short individual.

Since 1992, the DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center at the University of Washington (UW) has promoted the success of individuals with disabilities in postsecondary education and careers, using technology as an empowering tool. With support from the National Science Foundation, the U.S. Department of Education, the state of Washington, and numerous other funding sources, DO-IT has engaged students, parents, educators, and technology leaders to complete dozens of projects to further this goal. This article reports on one of these projects. Starting in 2010, the DO-IT Center has offered high school and college students with disabilities the opportunity to learn about universal design and conduct accessibility reviews of informal science education programs. The project's objectives are

- to increase awareness of access issues and universal design solutions among students with disabilities and
- to enhance the student's ability to advocate for STEM learning environments that are welcoming and accessible to a diverse audience.

RECRUITING AND TRAINING PARTICIPANTS

Participants are recruited through online e-mentoring communities that DO-IT supports for students with disabilities. They are invited to complete an accessibility review of an informal science program (e.g., the Pacific Science Center) in their community. They are offered a $100 stipend plus the cost of the visit for themselves and up to two guests and an opportunity to win a prize if their review is judged to be one of the best with respect to identification of accessibility issues and recommendations for improvements.

Students interested in completing a review receive guidance in selecting a facility or program, background reading, and instructions for submitting their report. Guidelines are available online (DO-IT, n.d.b).

EVALUATING AN INFORMAL SCIENCE PROGRAM

Participants read the publication *Universal Design: Process, Principles, and Applications* (Burgstahler, 2012) to learn about two approaches to making informal science education offerings accessible to people with disabilities—accommodations and universal design. They learn that

- an accommodation is an alternate format, assistive technology, or other adjustment that allows a person with a disability to use an existing product or environment.
- the goal of universal design is to create products and environments that are usable by everyone, regardless of ability or other characteristics, to the greatest extent possible, without the need for adjustments.
- making accommodations is reactive, whereas universal design is proactive.

A worksheet (DO-IT, n.d.c) guides participants in evaluating how welcoming and accessible the facility or program is for people with disabilities. It asks participants to consider accessibility issues related not just to their own disability but also to other disabilities as they review components such as the website, publications, physical environments, exhibits, activities, and staff knowledge. Examples of items on the worksheet follow:

- Does the website say how you can request disability-related accommodations?
- Are brochures available in any alternative formats such as large print, Braille, or electronic file?
- Are all levels of the facility connected via a wheelchair accessible route of travel?
- Are equipment/exhibit labels in large print with high contrast?
- Can buttons and other controls be reached by individuals who stand at a wide range of heights or by those who use wheelchairs or other mobility devices?
- Are videos captioned?
- Are audio directions and content transcribed?
- Are staff members familiar with how a person with a disability can request an accommodation?

As part of their review, participants also make recommendations for improving the accessibility of the facility or program. They submit their review to project staff who then read each review and determine if it is complete and otherwise acceptable or requires additional information. Once participants submit an acceptable review to project staff, they can request permission to conduct a review of another program.

RESULTS

Thus far, forty-two students from thirteen high schools and sixteen postsecondary institutions have contributed accessibility reviews. Of these participants, twenty were female and twenty-two were male, and they disclosed disabilities that included Asperger's syndrome, visual impairments, learning disabilities, mobility impairments, health impairments, and traumatic brain injuries. The forty-two participants conducted seventy-nine accessibility reviews of facilities and programs in Washington state, including the Seattle Aquarium, the Pacific Science Center, the Museum of Flight, and Woodland Park Zoo (all in Seattle), and the Port Townsend Marine Science Center.

Participants reacted positively to their experiences conducting accessibility reviews, making comments such as, "I learned a lot about how to look at a program and figure out if other people with disabilities can fully participate," and "This was a lot of fun because we got to go to a cool place and contribute to making it better."

Participants made a wide range of observations about the accessibility of the facilities and programs they visited and recommendations for improvements. Some of their suggestions were to:

- Provide alternative formats (Braille, large print, audio) for brochures and exhibits.
- Caption videos.
- Provide multiple-height vantage points for exhibits.
- Ensure that steps or benches for children to view an exhibit can be moved or are positioned to allow a wheelchair user to get close to the exhibit.

- Clearly indicate on the website, in brochures, and at the site how to request disability-related accommodations.
- Include more images of individuals with disabilities in materials.
- Train staff about the types of accommodations available and how to offer assistance.

RECOMMENDATIONS FOR ACTIVITY REPLICATION AND EXPANSION

The success of the reported project—with respect to the enthusiasm, increased knowledge of accessible design, and advocacy skills of the participants—has led the DO-IT Center to offer this activity on an annual basis. We're also encouraging others to replicate the practice. Organizations that are interested in evaluating and improving the accessibility of their local informal science education programs can use the model developed by the DO-IT Center, as well as the guidelines and worksheet on our website (DO-IT, n.d.a).

The activity reported in this article could be developed further into a more comprehensive effort that includes informal science programs in a region as well as a museum science program at a university. Students in the museum science program and students with disabilities in STEM could work with the informal science programs, conducting accessibility reviews and engaging in joint projects to apply what is learned in making the programs more welcoming and accessible to people with disabilities. The project could also take steps to improve museology programs by creating a more welcoming atmosphere towards students with disabilities and integrating universal design content into its curriculum.

CONCLUSION

The DO-IT Center at the UW undertook a project to design an activity that can be used to increase awareness of access issues and universal design solutions among students with disabilities and to enhance their ability to advocate for STEM learning environments that are welcoming and accessible to a diverse audience.

Activities like the one we've described can ultimately contribute to the increased participation of students with disabilities in STEM and improve these academic fields with the perspectives and talents of this underrepresented population.

REFERENCES

American Association for the Advancement of Science. (2001). *In pursuit of a diverse science, technology, engineering, and mathematics workforce*. Washington, DC: Author.

Bell, P., Lewnstein, B., Shouse, A. W., & Feder, M. A. (Eds.). (2009). *Learning science in informal environments: People, places, and pursuits*. The National Academies Press. Retrieved from *www.nap.edu/catalog.php?record_id=12190*

Burgstahler, S. (2011). Universal design: Implications for computing education. *ACM Transactions*, *11*(3). Retrieved from *staff.washington.edu/sherylb/ud_computing.html*

Burgstahler, S. (2012). *Universal design: Process, principles, and applications*. Seattle: DO-IT, University of Washington.

Center for Universal Design. (n.d.). *History of universal design*. Retrieved March 1, 2013, from *http://www.ncsu.edu/ncsu/design/cud/about_ud/udhistory.htm*

Committee on Equal Opportunities in Science and Engineering (CEOSE). (2011). *Broadening participation in America's science and engineering workforce*. 2009–2010 CEOSE Biennial Report to Congress.

DePoy, E., & Gibson, S. (2008). Disability studies: Origins, current conflict, and resolution. *Review of Disability Studies*, *4*(4), 33–40

DO-IT. (n.d.a). *DO-IT*. Seattle: University of Washington. Retrieved from *www.uw.edu/doit/*

DO-IT. (n.d.b). *Facilitating accessibility reviews of informal science education facilities and programs*. Seattle: University of Washington. Retrieved from *www.uw.edu/doit/Stem/accessibility-review.html*

DO-IT. (n.d.c). *Informal Science Education Accessibility Review*. Seattle: University of Washington. Retrieved from *www.uw.edu/doit/Stem/accessibility-review-report.html*

DO-IT. (1993-2012). *DO-IT snapshots*. Seattle: University of Washington. Retrieved March 1, 2013, from *www.uw.edu/doit/Snapshots/*

Fenichel, M., & Schweingruber, A. (2010). *Surrounded by science: Learning science in informal environments*. National Research Council, The National Academies Press. Retrieved from *www.nap.edu/catalog.php?record_id=12614*

Gabel, S., & Peters, S. (2010). Presage of a paradigm shift: Beyond the social model of disability toward resistance theories of disability. *Disability & Society*, *19*(6), 585–600.

Loewen, G., & Pollard, W. (2010). The social justice perspective. *Journal of Postsecondary Education and Disability*, *23*(1), 5–18.

National Science Foundation. (2011). *Empowering the nation through discovery and innovation – NSF strategic plan for fiscal years 2011–2016*. Washington, DC: Author. Retrieved from *www.nsf.gov/news/strategicplan/*

National Science Foundation. (2012). *Women, minorities, and persons with disabilities in science and engineering*. Arlington, VA: Author. Retrieved from *www.nsf.gov/statistics/nsf03312/*

Office of Science and Technology Policy. (2006). *American competitiveness initiative: Leading the world in innovation*. Washington, D.C.: Author.

Stern, V., & Woods, M. (2001). *Roadmaps and rampways*. Washington, DC: American Association for the Advancement of Science.

ACKNOWLEDGMENTS

This article was adapted with permission from an article originally published as Burgstahler, S. & Crawford, L., (2012). Engaging students with disabilities in accessibility reviews. *Dimensions*, November–December 2012, 39–42.

This article is part of the collection *Universal Design in Higher Education: Promising Practices,* sponsored by the DO-IT Center. The content is based upon work supported by the National Science Foundation as part of the *AccessSTEM* project (Award #HRD-0227995 and HRD-0833504). Any opinions, findings, and conclusions or recommendations expressed are those of the authors and do not necessarily

REFERENCE FORMAT FOR THIS CONTENT

Crawford, C., & Burgstahler, S. (2013). Promoting the design of accessible informal science learning. In S. Burgstahler (Ed.). *Universal design in higher education: Promising practices*. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/UDHE-promising-practices/accessible_design.html*

UNIVERSAL DESIGN in Higher Education
PROMISING PRACTICES

Universal Design in Assessments

Cindy Poore-Pariseau, Bristol Community College

In the fall of 2002, a decision was made to begin infusing some strategies of Universal Design for Learning (UDL) from the Center for Applied Special Technology (CAST, 2008) into a group of freshman seminar courses at Bristol Community College. By utilizing UDL strategies (multiple means of representation, expression, and engagement), an effort was made to present the courses and course work in a user friendly manner for all students, regardless of the students' life experiences or abilities.

CASE STUDY

In the freshman course I taught, College Success Seminar, students were given the opportunity to express what they learned throughout the semester in a way that was in alignment with their learning strengths and preferences. The final exam (worth 30% of their final grade) would not be based on, nor hindered by, their ability to write, their creativity, how well they could memorize, or their ability to perform under time constraints.

A goal set each semester for this course was to incorporate a variety of activities that required different learning styles, including

- Captioned videos for those who may learn better by reading or the combination of reading and hearing. This also assists those who are deaf by allowing them to fully access the information without the need for retrofitting.
- Varied assessments (written, verbal, role playing, etc.) that offered students with differing strengths of expression to fully convey to their instructor what they learned.
- Opportunities for reflection such as journaling, verbal expression, recordings, and self-assessments.
- Written information or instructions matched up with audio, allowing for fuller, greater access to the course material.

For the final exam, students were asked to utilize their primary learning style(s)/strengths (which they had identified earlier in the course) to express or represent three pieces of course content they learned during the semester. One month prior to the end of the semester, students were given the following information about their final exam.

Using your primary learning style or styles, (see unit three) demonstrate three significant pieces of course content you learned from this course. Examples of how you may demonstrate what you have learned may include, but are not limited to:

- *an essay,*
- *a poster board (that you can assemble, take a picture of and post),*
- *a video recording (you can work with the eLearning lab on how to post a video),*
- *an audio recording (you can work with the eLearning lab on how to post a recording),*
- *a prearranged phone call to me, or*
- *any combination of the above.*

You may come up with an unlisted way to express what you know, but if you decide to do so, please let me know in advance.

After receiving this information, students were asked to reflect on the activity as part of their discussion question for the week. In particular, students were asked to respond to the following:

Have you ever had an opportunity to decide how you want to present what you have learned? What are your thoughts about this type of assignment as a final exam? Tell us if you think this decision will make your final exam assignment easier, more difficult, or no difference, and why.

What are two significant course concepts that you or your classmates could focus on for this assignment?

Feedback from students was mostly positive. The majority of students had never experienced the opportunity to "make up" a final exam. Over the past decade, in my classes, students have taken advantage of this opportunity for multiple means of expression, including essays, poster boards, phone calls, face-to-face meetings, PowerPoint slides, poems, video, word searches, and photographs. Students tend to take this assignment very seriously and always find unique ways to use their learning style and strengths to express what they have learned.

However, one or two students per semester say they do not like this assignment for several reasons: they would like more guidance, they do not feel they are creative, they fear they will be tested on their creativity, they are good test takers and just want to be tested in a traditional manner. An instructor can work with those who have misgivings and assist them by addressing their concerns. For example, one semester a student wanted to be assessed on her knowledge through the traditional testing format. For this student, a suggestion was made that she review the course material covered over the semester, write an exam and then provide the answers to the exam. The student was delighted with this idea and was able to utilize her strengths to recognize and pull out important information from the course, question the information, and then provide responses to those questions.

To provide guidance regarding this assignment and to inform students how they will be graded, students were given a rubric (Rubric for Final Project) to review and an opportunity to ask questions in case some part of the assignment was unclear.

Rubric for Final Project

Criterion	A-level qualities (90–100)	B-level qualities (80–89)	C-level qualities (70-79)	F-level qualities (below 70)
Purpose	Introduces and presents three items effectively and clearly; information learned is readily apparent to the reader.	Introduces and presents fewer than three items effectively and clearly and/or information learned is readily apparent to the reader.	Introduces and presents items learned somewhat effectively; presentation has a clear purpose but may sometimes digress from it.	Introduces and presents information poorly; purpose is generally unclear.
Development and content	Develops presentation with exceptional care, including all three topics; provides a balanced presentation of relevant information of each item learned and shows a thoughtful, in-depth analysis of the topics; reader gains insights.	Develops presentation with exceptional care, but included fewer than three topics and/or information displays a clear analysis of the significant topics; reader gains some insights.	Does not fully develop presentation as assigned; analysis is basic or general; reader gains few insights.	Presentation is undeveloped and/or does not relate to the assignment and includes very little discussion of the issues discussed in the course; analysis is vague or not evident; reader is confused or may be misinformed.
Cohesion and insight	Ideas are supported effectively; student shows clear evidence of having understood and synthesized three course concepts; the demonstration of knowledge is exceptional.	Ideas are generally supported; student shows evidence of having read, understood, and correctly applied the course concepts; demonstration of knowledge is clear.	Many ideas are unsupported and it may not be clear whether the student has understood or synthesized the concepts; demonstration of knowledge is incomplete.	Presentation is incoherent and shows little or no insight; there is no evidence that the student has understood course concepts.

CONCLUSION

Applying universal design in the classroom has the potential to increase the chance that all students will have opportunities to learn, participate, and express what they know (Burgstahler & Coy, 2008). The activity described in this article allows students to demonstrate to their instructors what they have learned in a way that best matches their learning styles and strengths. Although this approach (variable means of assessment) will not work for all courses, if applied intentionally, may work for many. A question often asked

when this activity is proposed is "how do I fairly grade twenty-five different types of assessments?" The answer to this important question consistently includes: through the use of a carefully thought out and well planned, easy-to-understand rubric. Although the instructor may have many different types of assessment presentations to review, she reviews them based on one set of standards. In using this method of assessment, they are able to evaluate "what" students have learned in class rather than how well students write, take tests, or perform in other specific ways.

NOTE FROM THE AUTHOR

As I worked through my dissertation "Principles of Universal Design for Learning: What is the value of UDL training on accessible pedagogy", I learned that the more one knows about the principles of universal design, the more one tends to proactively consider the needs of students (Poore-Pariseau, 2011). There is a double outcome of applying universal design: it improves learning opportunities for all students and to encourages instructors to consider the needs of students with disabilities who may be in their classrooms.

REFERENCES

Burgstahler, S., & Coy, R. (Eds.). (2008). *Universal Design in Higher Education: From Principles to Practice*. Boston: Harvard Education Press.

Center for Applied Special Technology (2008). Research and development. In *UDL guidelines*. Retrieved from *www.CAST.org/research/index.html*

Poore-Pariseau, C. (2011). *Principles of Universal Design for Learning: What is the value of UDL training on accessible pedagogy?* (Order No. 3473537 Capella University, 2011). Ann Arbor: ProQuest.

ACKNOWLEDGMENTS

The development of this article was supported by the National Science Foundation (Grants #CNS-1042260, #HRD-0833504, and #HRD-0929006) and the U.S. Department of Education (Grant #P333A020044).

This article is part of the collection *Universal Design in Higher Education: Promising Practices* sponsored by the DO-IT Center. Any opinions, findings, and conclusions or recommendations expressed are those of the author and do not necessarily reflect the views of funding sources or the DO-IT Center.

REFERENCE FORMAT FOR THIS CONTENT

Poore-Pariseau, C. (2013). Universal Design in Assessments. In S. Burgstahler (Ed.). *Universal design in higher education: Promising practices*. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/UDHE-promising-practices/ud_assessments.html*

UNIVERSAL DESIGN in Higher Education
PROMISING PRACTICES

Increasing Access to Technical Science Vocabulary Through Use of Universally Designed Signing Dictionaries

Judy Vesel and Tara Robillard, TERC (Technical Education Research Centers), Inc.

BACKGROUND

State frameworks and national standards are explicit about the science and mathematics content that students in grades K-12 must master at each grade level. The Individuals with Disabilities Education Act (IDEA) and the No Child Left Behind (NCLB) Act mandate that students in grades K-12 who are deaf or hard of hearing must have access to this content.

Although individuals who are deaf or hard of hearing are not necessarily considered "print disabled," those who acquire and use American Sign Language (ASL) to communicate tend to internalize a linguistic structure that differs greatly from English. This makes using English similar to working in a foreign language. It also results in significant limitations in English-language literacy that lead to the majority of deaf students leaving high school with reading levels at the fifth grade or below. In fact, the English vocabulary of the average 15-year-old deaf student is about the size of that of a 9-year-old hearing child and will not improve significantly (Karchmer & Mitchell, 2006). Consequently, students who are deaf or hard of hearing often miss many of the age-appropriate science and math learning experiences that provide the foundations for developing the understanding necessary for studying and/or majoring in STEM areas after leaving high school. This may contribute to the small proportion of deaf and hard of hearing people in STEM careers (0.13–0.19%) compared to the general population (11–15.3%) (National Center for Science and Engineering Statistics [NCSES] 1996, 2004, 2009, 2011).

As a response to this situation, TERC, an educational research and development organization, and Vcom3D, developers of SigningAvatar® assistive software, have been collaborating for more than a decade in research and development of universally designed signing dictionaries. Each dictionary contains a minimum of 750 content-specific core-based terms and definitions, most of which include an illustration or example, and utilizes virtual characters—avatars—that sign. Windows-based Web versions and the plug-in are available free at http://signsci.terc.edu/. Apps are available through the Apple App Store on iTunes.

This article focuses on the science dictionaries for grades 9-12—Signing Earth Science Dictionary (SESD), Signing Life Science Dictionary (SLSD), and Signing Physical Science Dictionary (SPSD). We first describe the rationale supporting Universal Design for Learning (UDL) as the approach used for the dictionaries. We then provide evidence of impact of dictionary use in schools. Finally, we suggest possibilities for use in postsecondary settings.

RATIONALE FOR UDL AS THE APPROACH USED FOR THE DICTIONARIES

UDL offers users multiple options, flexibility, and choice. Other salient features are an emphasis on cognitive access and social inclusion. Universal design strives to create experiences that are accessible to learners along a broad spectrum of abilities and disabilities by offering them a choice of options. Its three principles are that instructional materials should provide 1) multiple means of representation; 2) multiple means of action and expression; and 3) multiple means of engagement (Rose & Meyer 2006).

UDL was selected as the approach used for the dictionaries because it enabled the partners to avoid the pitfalls of a one-size-fits-all solution. Instead, multiple options could be offered to an audience with a broad spectrum of abilities and communication needs. For example, levels of hearing loss, language of communication, and science knowledge among the learners for which the dictionaries are intended vary greatly. This variability necessitates a range of methods available for acquiring knowledge and for communicating with hearing and non-hearing teachers and peers. Table 1 shows how each of the three principles of UDL have been integrated into the dictionaries to provide an array of choices that accommodate differences among learners who are deaf or hard of hearing.

Table 1: UDL Principles, Differences Accommodated, and Dictionary Choices

UDL Principle	Differences Accomodated	Dictionary Choices
I: Provide Multiple Means of Representation	Ways deaf or hard of hearing learners approach content to acquire information	Selection of terms and definitions as text, human voice narration, signing, illustrations/examples*
II: Provide Multiple Means of Action and Expression	Ways deaf or hard of hearing learners explain their science thinking and demonstrate what they know	Use of ASL, Word-for-Word translations (SE or SS for Spanish), illustrations, voiced text
III: Provide Multiple Means of Engagement	Ways deaf or hard of hearing learners can be engaged or motivated to learn	Selection from a group of avatars of different ages, ethnicities, and genders; Ability to change the signing speed and text size.

* Available in English for the SESD and in English and Spanish for the SLSD and SPSD

EVIDENCE OF IMPACT OF DICTIONARY USE

A mixed-measurement pre/post design that results in qualitative and quantitative data was used to begin to ascertain the types of vocabulary-learning gains that are possible with the dictionaries. This approach

enabled the partners to examine effectiveness of the interventions in classroom settings under real conditions when used by students who vary greatly in aspects such as hearing-loss level, language use, science knowledge and skills, and reading ability. Although the dictionaries were developed for grades 9-12, they include a set of terms (designated as Level 1) that students should encounter in the middle grades before entering high school. Therefore, the research design also sought to find out about the learning gains of this younger group of users.

Participants were drawn from a pool of teachers who taught at schools for the deaf and had worked with TERC previously. They were also recruited via TERC's and Vcom3D's websites and from newsgroups such as EDUDEAF. Teachers were selected based on grade level, number of students in their class(es), and science content area. The intent was to examine effectiveness under normal-use conditions. To this end, each teacher selected one science unit from their normal teaching sequence to do using the dictionary as an assistive tool. Each teacher also identified 5 to 10 terms from the signing dictionary that were important for developing understanding of the content that was the focus of the unit. Using a vocabulary assessment form, teachers assessed as yes or no each student's pre- and post-unit ability to recognize the English text version of the term; sign, fingerspell, and/or voice the term; and use it in a sentence. Using a 0-3 point scale (where 0=no answer and 3=a complete and accurate explanation), teachers also assessed students' ability to understand or give the meaning of the term. Employing post-use surveys, teachers and students provided feedback about ease of use of the dictionaries and likes and dislikes. Key findings (Vesel 2011, 2012; Vesel & Robillard 2014) from these studies are summarized below. Additional information is available at *signsci.terc.edu*.

Table 2: SLSD & SPSD Users' Mean Pre/Post Change in Vocabulary Knowledge

Group	N	Dictionary	Recognize English Version	Sign/Fingerspell/ Voice	Use in a Sentence	Provide Meaning or a Definition
1	12	SLSD	+30%	+52%	+58%	+67%
2	6	SPSD	+40%	+67%	+10%	+77%
3	1	SLSD	+100	+100%	+100%	+80%
4	7	SLSD	+46%	+63%	+49%	+43%
5	2	SLSD	+50%	+90%	+30%	+43%
6	1	SPSD	+100%	+100%	+60%	+87%
7	6	SPSD	+80%	+43%	+77%	+70%
8	3	SLSD	+47%	+80%	+33%	+50%
9	10	SLSD	+90%	+90%	+8%	+70%
10	8	SLSD	+65%	+53%	+38%	+53%
11	8	SLSD	+35%	+53%	+48%	+40%

Table 3: SESD Users' Mean Pre/Post Change in Vocabulary Knowledge*

Group	N	Sign/Finger-spell/ Voice Term	Use Terms in a Sentence	Understand the Meaning of Terms	Use in a Sentence	Provide Meaning or a Definition
1	3	+74%	+53%	+60%	+58%	+67%
2	8	+46%	+44%	+54%	+10%	+77%
3	6	+37%	+49%	+45%	+100%	+80%
4	9	+49%	+49%	+44%	+49%	+43%
5	15	+15%	+22%	+30%	+30%	+43%
6	9	+37%	+51%	+48%	+60%	+87%
7	6	+61%	+70%	+23%	+77%	+70%

*SESD testing did not include recognition of the English version of the term.

Based on these results, it appears highly likely that, when used as assistive tools, the dictionaries will contribute to giving students who are deaf or hard of hearing access to science vocabulary in their own language. Qualitative survey data indicate that such access may enable this population to work more independently to develop technical earth and space, life, and physical science vocabularies and also may result in teachers having more time to focus on the teaching and learning of the topic content. Findings indicate that the dictionaries' interactive features promote individualized instruction for a wide range of learners with varying levels of hearing loss and learning challenges. Teachers who used the dictionaries found them to be a welcome source of standardized signs for technical terms—they no longer had to spend time making up signs or fingerspelling terms. The dictionaries served to standardize signs used throughout a school and for interpreters who lacked a foundation in STEM to use in mainstream settings and when working individually with students (Vesel, 2011, 2012; Vesel & Robillard 2014).

POSSIBILITIES FOR DICTIONARY USE IN POSTSECONDARY SETTINGS

Accessibility to spoken English—the mainstream language used for communication in postsecondary STEM lecture and lab settings—can be subpar for the target audience (Marschark et. al. 2005). In these instances, real-time captioning (often made available through Communication Access Real-time Translation [CART]) is not always suitable, and an ASL interpreter becomes necessary (Wald 2006). However, interpreters at the postsecondary level, like those in pre-college settings, often have insufficient training in STEM and are unaware of appropriate technical signs to use for communication of accurate information in ASL. This can result in instructors having to prepare interpreters who will be translating for their undergraduate students. Interpreters must be introduced to the key vocabulary terms in ASL that they might encounter as spoken English during lectures and lab sessions. Deaf and hard of hearing graduate students would have the task of preparing their own interpreters. This is a time-consuming undertaking and some-

thing that does not apply for hearing students. An additional complication is that different interpreters may be assigned to different classrooms weekly.

Still, the time that is spent on preparing interpreters appears to be necessary if students who are deaf or hard of hearing and who require information to be presented in ASL are to receive equal access to the same amount and quality of information as their hearing peers (Solomon, Graham, Marchut, & Painter 2013). Prior to the recent emergence of resources such as the signing dictionaries, it had been difficult for those preparing interpreters to locate standardized signs for scientific terminology. Given this situation, and supported by our work in high school settings, it appears that use of the terms in the dictionaries might represent a powerful resource. Instructors and graduate students could use the dictionaries to introduce interpreters in person to the signs and meanings of many of the basic terms they need to know. Alternatively, or in addition, they could supply interpreters with lists of terms from the dictionaries that they are likely to encounter. When used in these ways, the SLSD, SPSD, and SESD could be valuable and effective time-saving resources for preparing interpreters to communicate STEM course material. As such, they might provide a new opportunity for helping postsecondary students receive more equal access to information.

REFERENCES

Karchmer, M., & Mitchell, R.E. (2006). Demographic and achievement characteristics of deaf and hard-of-hearing students. In M. Marschark & P.E. Spencer (Eds.), *Oxford handbook of deaf studies, language and education* (pp. 21–37). New York, NY: Oxford University Press.

Marschark, M., Pelz, J., Convertino, C., Sapere, P., Arndt, M., & Seewagen, R. (2005). Classroom interpreting and visual information processing in mainstream education for deaf students: Live or Memorex? *American Educational Research Journal, 42*(2), 727–761.

National Center for Science and Engineering Statistics [NCES]. (1996, 2004, 2009, 2011). Women, minorities and persons with disabilities in science and engineering (NSF Publication No. 96-311, No. 04-317, No. 09-305, 11-309). Retrieved from *www.nsf.gov/statistics/women/*.

Rose, D., & Meyer, A. (2006). *A practical reader in universal design for learning*. Cambridge, MA: Harvard Education Press.

Solomon, C., Graham, S., Marchut, A. & Painter, R. (2013). Where are the leaks for deaf and hard-of-hearing people in the science, technology, engineering, and mathematics (STEM) pipeline? Paper presented at the annual meeting of the American Educational Research Association. Retrieved November 10, 2013 from the AERA Online Paper Repository.

Vesel, J. (2011). Breaking barriers. International Innovation-North America. December 2011, 122–124.

Vesel, J. (2012). *Signing earth science dictionary: Field test evaluation report*. Retrieved from *signsci.terc.edu/publications/index.html*

Vesel, J., & Robillard, T. (2014). *Signing high school science: Field test evaluation report*. Retrieved from *signsci.terc.edu/publications/index.html*

Wald, M. (2006). Creating accessible educational multimedia through editing automatic speech recognition captioning in real time. *Interactive Technology and Smart Education, 3*(2), 131–141.

ACKNOWLEDGMENTS

The Signing Earth Science Dictionary was funded under National Science Foundation Award #GEO-0913675. The Signing Life Science Dictionary and Signing Physical Science Dictionary were funded under National Science Foundation Award #DRL-1019542. This article is part of the collection Universal Design in Higher Education: Promising Practices, sponsored by the DO-IT Center.

REFERENCE FORMAT FOR THIS CONTENT

Vesel, J., & Robillard, T. (2014). Increasing access to technical science vocabulary through use of universally designed signing dictionaries. In S. Burgstahler (Ed.), Universal design in higher education: Promising practices. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/increasing-access-technical-science-vocabulary-through-use-universally-designed-signing-dictionaries*

Promising Practices and Online Resources

3

The following sections share more promising practices and additional resources related to the application of UD in postsecondary education.

More Promising Practices

DO-IT's Center for Universal Design in Education (CUDE) created an online, searchable Knowledge Base through several projects funded by the U.S. Department of Education Office of Postsecondary Education (Grant numbers P333A990042, P333A020044, and P333A050064, and expanded through grants for the National Science Foundation (Grant numbers CNS-1042260 and HRD-0833504). Included is a rich collection of questions and answers, case studies, and promising practices related to individuals with disabilities and their pursuit of education and careers. Below is a sample of titles, case studies, and promising practices included in the CUDE Knowledge Base. To search the Knowledge Base for these and other articles on universal design, visit *www.uw.edu/doit/CUDE/kb.html* and select the Search Knowledge Base button on the left side of the screen.

- A Smart Board in the Classroom: A Promising Practice for Engaging Students
- *AccessCollege*: A Promising Practice in Making Postsecondary Institutions Welcoming and Accessible to Students with Disabilities
- Accessibility Reviews: A Promising Practice to Improve the Accessibility of Local Science Education Programs
- *AccessIT* Web Design & Development: A Promising Practice in Integrating Accessibility Topics into Curriculum
- *AccessLibraries*: A Promising Practice for Promoting the Accessibility of Libraries
- Asynchronous Instruction: A Promising Practice Using Online Access
- Classroom Performance System: A Promising Practice in Engaging All Students
- DASA and Campus Accessibility: A Promising Practice of a Student Organization
- *DO-IT Admin*: A Promising Practice in Making Student Services Accessible to Students with Disabilities
- *DO-IT Prof*: A Promising Practice in Making Postsecondary Instruction Accessible to Students with Disabilities
- Faculty Learning Communities: A Promising Practice in Faculty Development
- Fife School District: A Promising Practice to Maximize Outcomes of Professional Development for Teachers
- GALL Laboratory: A Promising Practice in Applying Problem-Based Learning

- Homeland Security 508 Compliance Office: A Promising Practice in Promoting Accessible IT
- Integrating Woodshop, Technology and Reading: A Promising Practice in Team-Teaching
- IT + AT: A Promising Practice in Creating a Technology-Rich Experience for All Students
- Landmark College: A Promising Practice on Developing Learning Resources for Students with Learning Disabilities
- MAR*TEC Techno-Briefs: A Promising Practice on Explaining Technology Accessibility to Educators
- MESA: A Promising Practice in Making Math and Science Curriculum Accessible
- OSTA: A Promising Practice of a Professional Organization Promoting Accessible Science
- Purdue University: A Promising Practice in Building Campus-wide Support for Web Accessibility
- RoboBooks: A Promising Practice on Universally Designed Science Materials
- The Signing Science Dictionary Project: A Promising Practice in Creating an Accessible Science Dictionary
- The University of Washington: A Promising Practice in Making Distance Learning Courses Accessible to Students with Disabilities
- The University of Washington: A Promising Practice in User Group Support for Web Accessibility
- Transitional Bridges: A Promising Practice in Using Universal Design and Technology to Promote the Success of Students with Disabilities in STEM
- Accessible Outdoor Table Design: A Case Study in Teaching Design Students to Think Universally
- Balancing Student Needs: A Case Study on Accessibility of Registration Systems
- Distance Learning: A Case Study on the Accessibility of an Online Course
- Electronic Course Reserves: A Case Study on Universal Access to Electronic Information in Academic Libraries
- On the Shelves: A Case Study on Library Access
- Professional Development for Web Accessibility: Case Studies on Higher Education
- Removing Barriers: A Case Study on Classroom Access
- The Equestrian Team: A Case Study on Access to Student Organizations

To add a promising practice or case study to the Knowledge Base, send your submissions to *doit@uw.edu*.

ACKNOWLEDGMENTS

This content is part of the collection *Universal Design in Higher Education: Promising Practices* sponsored by the DO-IT Center. The content is based upon work supported by the National Science Foundation under Grant #HRD-0929006. Any opinions, findings, and conclusions or recommendations expressed are those of the authors and do not necessarily reflect the views of funding sources or the DO-IT Center.

REFERENCE FORMAT FOR THIS CONTENT

Burgstahler, S. (Ed.). (2013). More promising practices. In S. Burgstahler (Ed.). *Universal design in higher education: promising practices*. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/UDHE-promising-practices/pp.html*

Websites, Publications, and Videos

This section includes a sample of printed materials, websites, and videos about universal design that can be used in self-study and group training sessions.

COMPREHENSIVE WEBSITES

The following websites include content related to the application of universal design in higher education.

- Center for Universal Design
  www.ncsu.edu/www/ncsu/design/sod5/cud/
- Center for Universal Design in Education
  www.uw.edu/doit/CUDE/
- National Center on Universal Design for Learning
  www.udlcenter.org/aboutudl
- Universal Design for Learning
  www.temple.edu/studentaffairs/disability/faculty-resources/udl.html
- Universal Course Design
  www.eeonline.org/

BOOKS AND COMPREHENSIVE TRAINING MATERIALS

Bowe, F. G. (2000). *Universal design in education: Teaching nontraditional students*. In Burgstahler, S. (Ed.). (2009). *Building the team: Faculty, staff, and students working together—Presentation and resource materials*. Seattle: University of Washington. *www.uw.edu/doit/TeamN/*

Burgstahler, S. (Ed.). (2009). *Making math, science and technology instruction accessible to students with disabilities*. Seattle: University of Washington. *www.uw.edu/doit/MathSci/*

Burgstahler, S. (Ed.). (2007). *Building capacity for a welcoming and accessible postsecondary institution*. Seattle: University of Washington. *www.uw.edu/doit/cbiN/*

Burgstahler, S. (Ed.). (2006). *Students with disabilities and campus services: Building the team – Presentation and resource materials*. Seattle: University of Washington. *www.uw.edu/doit/AdminN/*

Burgstahler, S., & Cory, R. (Eds). (2008). *Universal Design in Higher Education: From Principles to Practice*. Cambridge, MA: Harvard Education Press.

Gordon, D. T., Gravel, J. W., & Schifter, L. A. (Eds.). 2009. *A policy reader in universal design for learning*. Cambridge, MA: Harvard Education Press.

Higbee, J. L. (Ed.), *Curriculum transformation and disability: Implementing universal design in higher education* (pp. 7–21): Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota, Minneapolis, MN.

Rose, D. H., & Meyer, A. 2002. *Teaching every student in the digital age: Universal design for learning*. Alexandria, VA: Association for Supervision and Curriculum Development.

PUBLISHED ARTICLES

Following are references to articles relevant to the application of universal design in postsecondary academic settings.

Anderson, A., & Litzkow. (2008). Problems and solutions for making multimedia web-based lectures accessible: A case study. In *Universal design in higher education: From principles to practice* (pp. 225–233). Cambridge, MA: Harvard Education Press.

Beckman, P. 2009. Universal design for learning: A field experiment comparing specific classroom actions. *AMCIS 2009 Proceedings*, paper 10. *http://aisel.aisnet.org/amcis2009/10*

Behling, K., & Hart, D. (2008). Universal design: A model for professional development. In *Universal design in higher education: From principles to practice* (pp. 109–125). Cambridge, MA: Harvard Education Press.

Bigelow, K. E. (2012). Designing for success: Developing engineers who consider universal design principles. *Journal of Postsecondary Education and Disability*, *25*(3), 212–231.

Bruch, P. L. (2003). Interpreting and implementing universal instructional design in basic writing. In *Curriculum Transformation and Disability: Implementing Universal Design in Higher Education* (pp. 93–103). University of Minnesota, Center for Research on Developmental Education and Urban Literacy.

Burgstahler, S. (2002). Accommodating students with disabilities: Professional development needs of faculty. *To Improve the Academy: Resources for Faculty, Instructional, and Organizational Development*, 21, 151–183.

Burgstahler, S. (2002). Distance learning: Universal design, universal access. *AACE Journal*, *10*(1), 32–61.

Burgstahler, S. (2002). Universal design of distance learning. *Well Connected Educator*, February issue. *TechLEARNING.com*

Burgstahler, S. (2003). Web-based distance learning and the second digital divide. In M. Hricko (Ed.), *Design and implementation of Web-enabled teaching tools*. Hershey, PA: IRM Press.

Burgstahler, S. (Guest Ed.). (2005). Promising practices: Accessible information technology in education, *Information Technology and Disability, 11*(1).

Burgstahler, S. (2005). Preparing faculty to make their courses accessible to all students. *Journal on Excellence in College Teaching*, *16*(2), 69–86. *http://celt.muohio.edu/ject/issue.php?v=16&n=2*

Burgstahler, S. (2006). The development of accessibility indicators for distance learning programs. *Research in Learning Technology*, *14*(1), 79–102. *www.researchinlearningtechnology.net/index.php/rlt/article/view/10935*

Burgstahler, S. (2007). Accessibility training for distance learning personnel. *Access Technologists Higher Education Network (ATHEN) E-Journa*l, 2.

Burgstahler, S. (2007). Lessons learned in The Faculty Room. *Journal on Excellence in College Teaching*, *18*(3), 103–128.

Burgstahler, S. (2007). Accessibility training for distance learning personnel. *Access Technology Higher Education Network (ATHEN) E-Journal*, 2. *www.athenpro.org/node/56*

Burgstahler, S. (2007). Universal design of instruction: An approach for making your course accessible to all students. *Academe*.

Burgstahler, S. E. (2008). Universal design in higher education. In *Universal design in higher education: From principles to practice* (pp. 3–20). Cambridge, MA: Harvard Education Press.

Burgstahler, S. E. (2008). Universal design of instruction: From principles to practice. In *Universal design of higher education: From principles to practice* (pp. 45–59). Cambridge, MA: Harvard Education Press.

Burgstahler, S. E. (2008). Universal design of student services: From principles to practice. In *Universal design of higher education: From principles to practice* (pp. 167–175). Cambridge, MA: Harvard Education Press.

Burgstahler, S. E. (2008). Universal design of technological environments: From principles to practice. In *Universal design in higher education: From principles to practice* (pp. 213–224). Cambridge, MA: Harvard Education Press.

Burgstahler, S. E. (2008). Universal design of physical spaces. In *Universal design in higher education: From principles to practice* (pp. 187–197). Cambridge, MA: Harvard Education Press.

Burgstahler, S. E. (2008). Promoters and inhibitors of universal design in higher education. In *Universal design in higher education: From principles to practice* (pp. 279–283). Cambridge, MA: Harvard Education Press.

Burgstahler, S. (2011). Universal design: Implications for computing education. *ACM Transactions on Computing Education*, *11*(3). *http://staff.washington.edu/sherylb/ud_computing.html*

Burgstahler, S. (Guest Ed.). (2011). STEM Special Issue. *Journal of Postsecondary Education and Disability*, *24*(4).

Burgstahler, S., Anderson, A., & Litzkow, M. (2011). Accessible technology for online and face-to-face teaching and learning. In T. Cox & K. King (Eds.), *The professor's guide to taming technology* (pp.

201–218). Charlotte, NC: Information Age Publishing.

Burgstahler, S., & Comden, D. (1998). Creating a level playing field for the world wide web. *Ability*, *98*(2), 56–59.

Burgstahler, S., Corrigan, B., & McCarter, J. (2004). Making distance learning courses accessible to students and instructors with disabilities: A case study. *The Internet and Higher Education*, *7*(3), 233–246.

Burgstahler, S., Corrigan, B., & McCarter, J. (2005). Steps toward making distance learning accessible to students and instructors with disabilities. *Information Technology and Disabilities Journal*, *11*(1).

Burgstahler, S., & Doe, T. (2004). Disability-related simulations: If, when, and how to use them. *Review of Disability Studies*, *1*(2), 4–17. *http://staff.washington.edu/sherylb/RDSissue022004.html*

Burgstahler, S., & Doe, T. (2006). Improving postsecondary outcomes for students with disabilities: Designing professional development for faculty. *Journal of Postsecondary Education and Disability*, *18*(2), 135–147.

Burgstahler, S., & Jirikowic, T. (2002). Supporting students with disabilities: What every teaching assistant should know. *The Journal of Graduate Teaching Assistant Development*, *9*(1), 23–30. *http://staff.washington.edu/sherylb/teaching_assistant.html*

Burgstahler, S., Jirikowic, T., Kolko, B., & Eliot, M. (2004). Software accessibility, usability testing and individuals with disabilities. *Information Technology and Disabilities Journal*, *10*(2).

Burgsthler, S., & Moore, E. (2009). Making student services welcoming and accessible through accommodations and universal design. *Journal of Postsecondary Education and Disability*, *21*(3), 151–174.

Campbell, D. (2004). Assistive technology and universal instructional design: A postsecondary perspective. *Equity and Excellence in Education*, *37*(2), 167–73.

Darr, A., & Jones, R. (2008). The contribution of universal design to learning and teaching excellence. In *Universal design in higher education: From principles to practice* (pp. 105-108). Cambridge, MA: Harvard Education Press.

Durre, I., Richardson, M., Smith, C., Shulman, J. A., & Steele, S. (2008). Universal design of instruction: Reflections of students. In *Universal design in higher education: From principles to practice* (pp. 83–96). Cambridge, MA: Harvard Education Press.

Embry, P. B., Parker, D. R., McGuire, J. M., & Scott, S. S. (2005). Postsecondary disability service providers' perceptions about implementing Universal Design for Instruction. *Journal on Postsecondary Education and Disability*, 18, 34–48.

Finn, D. E., Getzel, E. E., Asselin, S. B., & Reilly, V. (2008). Implementing universal design: Collaborations across campus. In *Universal design in higher education: From principles to practice* (pp. 267–277). Cambridge, MA: Harvard Education Press.

Goldstein, E. (2008). Applications of universal design to higher education facilities. In *Universal design in higher education: From principles to practice* (pp. 199–212). Cambridge, MA: Harvard Education Press.

Gradel, K., & Edson, A. 2009-2010. Putting universal design for learning on the higher ed agenda. *Journal of Educational Technology Systems*, *38*(2), 111–121.

Hackman, H., & Rauscher, L. 2004. A pathway to access for all: Exploring the connections between universal instructional design and social justice education. *Equity and Excellence in Education*, *37*(2), 114–123.

Harrison, E. G. (2006). Working with faculty toward universally designed instruction: The process of dynamic course design. *Journal of Postsecondary Education and Disability*, *21*(2), 60–72.

Higbee, J. L. (2008). The faculty perspective: implementation of universal design in a first-year classroom. In *Universal design in higher education: From principles to practice* (pp. 61–72). Cambridge, MA: Harvard Education Press.

Izzo, M. V., Murray, A., & Novak, J. (2008). The faculty perspective on universal design for learning. *Journal of Postsecondary Education and Disability*, *21*(2), 60–72.

Jenner, C. (2008). A change process for creating a universally designed campus. In *Universal design in higher education: From principles to practice* (pp. 255–265). Cambridge, MA: Harvard Education Press.

Johnson, D. M., & Fox, J. A. (2003). Creating curb cuts in the classroom: Adapting universal design principles to education. In *Curriculum transformation and disability: Implementing universal design in higher education* (pp. 7–21): Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota, Minneapolis, MN.

Johnson, J. R. (2004). Universal instructional design and critical (communication) pedagogy: Strategies for voice, inclusion, and social justice/change. *Equity and Excellence in Education*, *37*(2), 145–53.

Kame'enui, E., & Carnine, D. (1998). *Effective teaching strategies that accommodate diverse learners*. Prentice Hall.

Ketterlin-Geller, & Johnstone, C. (2006). Accommodations and universal design: Supporting access to assessments in higher education. *Journal of Postsecondary Education and Disability*, *21*(2), 163–172.

Kortering, L., McClannon, T., & Braziel, P. 2005. What algebra and biology students have to say about universal design for learning. *National Center for Secondary Education and Transition Research to Practice Brief*, *4*(2).

McAlexander, P. J. 2003. Using principles of universal design in college composition courses. In *Curriculum Transformation and Disability: Implementing Universal Design in Higher Education* (pp. 105–114). University of Minnesota, Center for Research on Developmental Education and Urban Literacy.

McGuire, J., & Scott, S. (2006). An approach to inclusive college environments: Universal design for instruction. *Learning Disabilities: A Multidisciplinary Journal*, *14*, 21–31.

McGuire, J. M., & Scott, S. S. (2006). Universal design for instruction: Extending the universal design paradigm to college instruction. *Journal of Postsecondary Education and Disability*, *19*(2), 124–134.

McGuire, J. M., Scott, S. S., & Shaw, S. F. (2004). Universal design for instruction: The paradigm, its principles, and products for enhancing instructional access. *Journal of Postsecondary Education and Disability, 17*(1), 10–20.

McGuire-Schwartz, M. E., & Arndt, J. S. (2007). Transforming universal design for learning in early childhood teacher education from college classroom to early childhood classroom. *Journal of Early Childhood Teacher Education, 28*(2), 127–139.

Mino, J. 2004. Planning for inclusion: Using universal instructional design to create a learner-centered community college classroom. *Equity and Excellence in Education, 37*(2), 154–160.

Moriarty, M. A. 2007. Inclusive pedagogy: Teaching methodologies to reach diverse learners in science instruction. *Equity and Excellence in Education, 40*(3), 252–265.

Myers, K. (2008). Incorporating universal design into administration courses: A case study. In *Universal design in higher education: From principles to practice* (pp. 157–164). Cambridge, MA: Harvard Education Press.

Null, R.L., & Cherry, K.F. (1996). *Universal design: Creative solutions for ADA compliance*. Belmont, CA: Professional.

Ofiesh, N. S., Rojas, C. M., & Ward, R. A. (2006). Universal design and the assessment of student learning in higher education. *Journal of Postsecondary Education and Disability, 21*(2), 173–181.

Ouellett, M. L. 2004. Faculty development and universal instructional design. *Equity and Excellence in Education, 37*, 135–144.

Parker, D. R., & Getty, M. (2009, Fall). PLTL and universal design for instruction: Investigating wider access for students with disabilities. *Progressions Newsletter 10*(1). *pltl.org/articles/315.pdf*

Pedelty, M. 2003. Making a statement. In *Curriculum Transformation and Disability: Implementing Universal Design in Higher Education* (pp. 71–78). University of Minnesota, Center for Research on Developmental Education and Urban Literacy.

Pliner, S.M., & Johnson, J.R. (2004). Historical, theoretical, and foundational principles of universal instructional design in higher education. *Equity & Excellence in Education, 37*, 105–113.

Rickerson, N., & Deitz, J. (2003). Integration of universal design of instruction in occupational therapy professional education: Responding to student diversity. *The American Journal of Occupational Therapy, 57*, 594–597.

Roberts, K. D., Park, H. J., Brown, S., & Cook, B. (2011). Universal design for instruction in postsecondary education: A systematic review of empirically based articles. *Journal of Postsecondary Education and Disabilities Journal, 24*(1), 4–18.

Rose, D. H., Harbour, W. S., Johnston, C. S., Daley, S. G., & Abarbanell, L. (2006). Universal design for learning in postsecondary education: Reflections on principles and their application. *Journal of Postsecondary Education and Disability, 19*(2), 135–151.

Rose, D. H., Harbour, W. S., Johnston, C. S., Daley, S. G., & Abarbanell, L. (2008). Universal design for learning in postsecondary education: Reflections on principles and their application. In *Universal design in higher education: From principles to practice* (pp. 45–59). Cambridge, MA: Harvard Education Press.

Rose, D. H., & Meyer, A. (2002). *Teaching every student in the digital age: Universal design for learning*. Alexandria, VA: Association for Supervision and Curriculum Development (ASCD). (Also available in digital format at *www.cast.org*).

Rose, D. H., Meyer, A., & Hitchcock, C. (2005). *The universally designed classroom: Accessible curriculum and digital technologies*. Cambridge, MA: Harvard Education Press.

Schelly, C. L., Davies, P. L., Spooner, C. L. (2011). Student perceptions of faculty implementation of universal design for learning. *Journal of Postsecondary Education and Disabilities Journal, 24*(1), 19–37.

Scott, S., & McGuire, J. (2008). A case study approach to promote practical applications of universal design for instruction. In *Universal design in higher education: From principles to practice* (pp. 135–143). Cambridge, MA: Harvard Education Press.

Scott, S., McGuire, J., & Shaw, S. (2003). Universal design for instruction: A new paradigm for adult instruction in postsecondary education. *Remedial and Special Education, 24*, 369–379.

Scott, S. S., Loewen, C. F., & Kroeger, S. (2003). Implementing universal design in higher education: Moving beyond the built environment. *Journal of Postsecondary Education and Disability, 16*(2), 78–89.

Scott, S. S., McGuire, J. M., & Foley, T.E. (2003). Universal design for instruction: A framework for anticipating and responding to disability and other diverse learning needs in the college classroom. *Equity & Excellence in Education, 36*, 40–49.

Silver, P., Bourke, A.B., & Strehorn, K.C. (1998). Universal instructional design in higher education: An approach for inclusion. *Equity & Excellence in Education, 31*, 47–51.

Souma, A., & Casey, D. (2008). The benefits of universal design for students with psychiatric disabilities. In *Universal design in higher education: From principles to practice* (pp. 97–104). Cambridge, MA: Harvard Education Press.

Spencer, A. M., & Romero, O. (2008). Engaging higher education faculty in universal design: Addressing needs of students with invisible disabilities. In *Universal design in higher education: From principles to practice* (pp. 145–156). Cambridge, MA: Harvard Education Press.

Street, C. D., Koff, R., Fields, H., Kuehne, L. Handlin, L., Getty, M., & Parker, D. R. (2012). Expanding access to STEM for at-risk learners: A new application of universal design for instruction. J*ournal of Postsecondary Education and Disabilities Journal, 12*(4), 391–408.

Story, M. F., Mueller, J. L., & Mace, R. L. (1998). *The universal design file: Designing for people of all ages and abilities*. Raleigh, NC: Center for Universal Design, North Carolina State University.

Thompson, T. (2008). Universal design of computing labs. In *Universal design in higher education: From principles to practice* (pp. 235–244). Cambridge, MA: Harvard Education Press.

Thompson, T., Burgstahler, S., & Comden, D. (2003). Research on web accessibility in higher education. *Information Technology and Disabilities Journal, 9*(2).

Thompson, T., Burgstahler, S., & Moore, E. (2007). Accessibility of higher education web pages in the Northwestern United States: Current status and response to third party outreach. In Proceedings of the *First International Conference on Technology-based Learning With Disability* (pp. 127–136). Dayton, Ohio, Wright State University.

Thompson, T., Burgstahler, S., & Moore, E. (2010). Web accessibility: A longitudinal study of college and university home pages in the northwestern United States. *Disability & Rehabilitation: Assistive Technology, 5*(2), 108–114.

Thompson, T., Burgstahler, S., Moore, E., Gunderson, J., & Hoyt, N. (2007). International research on web accessibility for persons with disabilities. In *Managing worldwide operations and communications*

with information technology. Hershey, PA: Information Resources Management Association.

Thurlow, M. I., Johnstone, C. J., & Ketterlin-Geller. (2008). Universal design of assessment. In *Universal design in higher education: From principles to practice* (pp. 73–81). Cambridge, MA: Harvard Education Press.

Welch, P. (Ed.). (1995). *Strategies for teaching universal design*. Boston: Adaptive Environments.

Wilkoff, W., & Abed, L. (1994). *Practicing universal design: An interpretation of the ADA*. New York: Van Nostrand Reinhold.

Yager, S. (2008). Small victories: Faculty development and universal design. (2008). In *Universal design in higher education: From principles to practice* (pp. 127–133). Cambridge, MA: Harvard Education Press.

Zeff, R. (2007). Universal design across the curriculum. *New Directions for Higher Education, 137*, 27–44.

Q&A'S FROM THE KNOWLEDGE BASE

DO-IT's Center for Universal Design in Education (CUDE) created an online, searchable Knowledge Base as part of several projects funded by the U.S. Department of Education Office of Postsecondary Education (Grant numbers P333A990042, P333A020044, and P333A050064), and expanded through grants from the National Science Foundation (Grant numbers CNS-1042260 and HRD-0833504).

Included is a rich collection of questions and answers, case studies, and promising practices related to individuals with disabilities and their pursuit of education and careers. Below is a small sample of questions included in the CUDE Knowledge Base. To search the Knowledge Base for answers to questions related to universal design, visit *www.uw.edu/doit/CUDE/kb.html*. Under type of article, select Q&A. Using additional search terms can narrow your search. Below are examples of some titles included in the Knowledge Base.

General

- What is the difference between accessible, usable, and universal design?
- What is universal design?

Distance Learning

- What are some of the barriers students with disabilities face in distance learning courses?
- What do distance learning professionals need to know about accessibility?
- What are some steps that distance learning program administrators can take to ensure the accessibility of their courses?
- What are the benefits of universal design of a distance learning course for students without disabilities?
- Where can I find resources for making distance learning courses accessible?
- What are steps a distance learning program can take to assure the accessibility of courses?
- What considerations should be made in order to develop accessible web-based distance learning courses?

Web Accessibility

- Are there resources to help me in planning my web accessibility training?

- Are text-only web pages an accessible alternative?
- Can I make accessible web pages using web authoring tools such as Dreamweaver?
- Does CSS positioning eliminate the need for a "skip navigation" link?
- Does making our school web content accessible mean I cannot use multimedia on my site?
- How can I develop accessible web-based forms?
- How can I make web page navigation accessible?
- How can I select a web accessibility software tool?
- How can I test my website for accessibility?
- How can my educational entity deliver accessible webcasts?
- How do I make websites accessible?
- How do my choice and use of color affect the accessibility of my website?
- How can data tables be made accessible?
- How can educational entities determine if their websites are accessible?
- How does accessible web design benefit all web users?
- How well do screen readers support web accessibility guidelines?
- Is Flash content accessible?
- Is it a good idea to make "skip navigation" links invisible?
- Is it possible to develop an accessible dynamic menu?
- Is Java accessible?
- Is PDF accessible?
- Is XML accessible?
- What access challenges might visitors to a web page experience?
- What is a "skip navigation" link?
- What is the current recommendation for providing long descriptions for complex graphics?
- What is the difference between the W3C guidelines and the Section 508 standards for web accessibility?
- What is Web Accessibility Initiative (WAI)?
- What is wrong with using HTML tables for layout?
- What web accessibility evaluation and repair tools are available?
- Where can I locate the results of studies that test the accessibility of web pages?
- Which educational entities have developed web accessibility policies?
- Which set of web accessibility standards or guidelines should I comply with?
- How do cascading style sheets affect web accessibility?

Other Specific Technologies

- Are chat rooms accessible to people with disabilities?
- Are electronic whiteboards accessible to people with disabilities?
- Are frames accessible?
- Are Personal Digital Assistants (PDAs) accessible?
- Are there standards or guidelines for providing audio description?
- Are there standards or guidelines for providing captions?
- Are touch screens accessible?

- How accessible are Microsoft Word documents?
- How can educational entities plan an accessible video production?
- How can I tell whether a software application is accessible?
- How do courseware products differ on accessibility?
- How do I develop accessible educational software?
- How do I make my online PowerPoint presentation accessible?
- How does accessibility differ across operating systems?
- Is instructional software typically accessible to students with disabilities?
- Is it better to caption or transcribe educational multimedia?
- Is Linux accessible?
- What accessibility features are available within the Macintosh operating system ?
- What accessibility features are provided with the Windows operating system?
- What efforts are computer hardware and software companies making toward making their products accessible?
- What Internet-based communication methods are accessible to people with disabilities?
- What is rich media and how can I learn more about its accessibility?
- What is the difference between open and closed captioning?
- How can publishers create accessible math textbooks?

Student Services, Physical Spaces

- How can a financial aid office make services accessible to a student who is blind or has low vision?
- How can I communicate with colleagues regarding making our library accessible to patrons with disabilities?
- How can our career services office work with employers to ensure program access to students with disabilities?
- How can principles of universal design be used to construct a computer lab?
- How can printed resources in libraries be made accessible?
- How can student services offices make campus events accessible to participants with disabilities?
- How can we create more accessible campus tours?
- What accessibility issues should I address when planning student events?
- What are issues related to the accessibility of a library facility?
- Are there standards for developing or purchasing accessible fax machines, photocopiers, and other office equipment?
- How do cascading style sheets affect web accessibility?
- What is the difference between open and closed captioning?
- How can publishers create accessible math textbooks?

CONTRIBUTE TO THE KNOWLEDGE BASE

Submit questions you would like added to the Knowledge Base to *doit@uw.edu*.

CUDE PUBLICATIONS

The Center on Universal Design in Education, hosted by DO-IT, maintains a collection of free publications and videos that are designed for self-instruction and for use as handouts in presentations. Publications are available in printable (PDF) and accessible (HTML) formats and videos include captions and audio description. Permission is granted to copy these materials for educational, noncommercial purposes provided the source is acknowledged. In the following list of publications, those labeled "publication and video," include a video presentation with the same title.

- *Universal Design in Postsecondary Education: Process, Principles, and Applications*
- *Self-Examination: How Accessible Is Your Campus?*

UD of Instruction

- *Equal Access: Universal Design of Distance Learning*
- *Equal Access: Universal Design of Instruction* (publication and video)
- *Universal Design of Instruction Definition, Principles, and Examples*
- *Equal Access: Universal Design of an Academic Department*

UD as a Topic of Instruction

- *Universal Design of Web Pages in Class Projects*

UD of Student Services

- *Equal Access: Universal Design of Student Services* (publication and video)
- *Equal Access: Universal Design of Advising*
- *Equal Access: Universal Design of Career Services*
- *Equal Access: Universal Design of Financial Aid*
- *Equal Access: Universal Design of Housing and Residential Life*
- *Equal Access: Universal Design of Libraries*
- *Equal Access: Universal Design of Recruitment and Undergraduate Admissions*
- *Equal Access: Universal Design of Registration*
- *Equal Access: Universal Design of Student Organizations*
- *Equal Access: Universal Design of Tutoring and Learning Centers*

UD of Technology

- *Access to Technology in the Workplace: In Our Own Words* (publication and video)
- *World Wide Access: Accessible Web Design* (publication and video)
- *Web Accessibility: Guidelines for Administrators*

UD of Physical Spaces

- *Equal Access: Universal Design of Physical Spaces*
- *Equal Access: Universal Design of Computer Labs*
- *Making Science Labs Accessible to Students with Disabilities*

UD of Professional Organizations, Projects, Conference Exhibits, and Presentations

- *Equal Access: Universal Design of Conference Exhibits and Presentations*
- *Equal Access: Universal Design of Professional Organizations*
- *Equal Access: Universal Design of Your Project*
- *Broadening Participation in Science and Engineering by Welcoming Participants with Disabilities*

VIDEO PRESENTATIONS

The following video presentations are freely available online. They are useful for self-instruction and professional development.

- *Best Practices Through Universal Design for Learning*
  www.youtube.com/watch?v=j7eUf_7dZVM
- *Equal Access: Student Services*
  www.uw.edu/doit/Video/index.php?vid=11
- *Equal Access: Universal Design of Computer Labs*
  www.uw.edu/doit/Video/index.php?vid=12
- *Equal Access: Universal Design of Instruction*
  www.uw.edu/doit/Video/index.php?vid=13
- *Real Connections: Making Distance Learning Accessible to Everyone*
  www.uw.edu/doit/Video/index.php?vid=22
- *Self-Examination: How Accessible is Your Campus*
  www.uw.edu/doit/Video/index.php?vid=37
- *Universal Design*
  www.youtube.com/watch?v=4FE1CLS7i3k
- *Universal Design Applications in Biology*
  www.uw.edu/doit/RDE/udl_videos.html
- *Universal Design for Learning*
  connect.csumb.edu/udl1
- *Universal Design for Learning: Cases Stories*
  elixr.merlot.org/case-stories/understanding--meeting-students-needs/universal-design-for-learning-udl?noCache=920:1306947204
- *Universal Design and Online Accessibility*
  www.youtube.com/watch?v=zYFrCXATXLI
- *Universal Learning Design: Empowering the Next Generation*
  www.youtube.com/watch?v=7SG1IwzHhiU
- *Why Universal Design in an Educational Setting?*
  www.youtube.com/watch?v=aYg7NtDHoEA
- *World Wide Access: Accessible Web Design*
  www.uw.edu/doit/Video/index.php?vid=35

ACKNOWLEDGMENTS

This content is part of the collection *Universal Design in Higher Education: Promising Practices* sponsored by the DO-IT Center. The content is based upon work supported by the National Science Foundation under Grant #HRD-0929006. Any opinions, findings, and conclusions or recommendations expressed are those of the author and do not necessarily reflect the views of funding sources or the DO-IT Center.

REFERENCE FORMAT FOR THIS CONTENT

Burgstahler, S. (2013). Websites, Publications, and Videos. In S. Burgstahler (Ed.). *Universal design in higher education: Promising practices*. Seattle: DO-IT, University of Washington. Retrieved from *www.uw.edu/doit/UDHE-promising-practices/resources.html*