UNIVERSAL DESIGN in Higher Education

PROMISING PRACTICES

Evidence-Based Practices from the Field

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

Graduation Station: A Game for Professional Development in Universal Design

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Our Universal Design Team at Central New Mexico Community College (CNM) created a role-playing game for use in an annual professional development conference. This engaging activity is a way to explore barriers to student success and open a dialogue about universal design (UD) and how it supports student success. CNM is an urban community college in the greater Albuquerque, NM area, with an enrollment of approximately 29,000 students. This article describes an activity introducing instructors to the need for and principles of UD at a community college with a population of non-residential and largely non-traditional students. Many of our students have jobs and families in addition to the responsibilities of being a student, and these considerations are part of their lives, and need to be factored into our design and delivery of instruction. UD provides a framework for doing that. Faculty at community colleges typically serve as the front line, and are often the only contact that students may have with the broader institution (Grubb, 2013). Therefore, professional development for community college faculty in UD principles is crucial to helping them support students with disabilities (Sweener & Kundert, 2002).

Methods

The Cooperative for Teaching and Learning (CTL) conference at our school is a venue for instructors to present the best and most promising practices to their colleagues. Training allows faculty to stay updated on current pedagogy, theory, and practice. For community college faculty, having the tools to deal with diverse students in the classroom is essential to achieving successful learning outcomes (Outcait, 2002). The Universal Design Team decided to deliver a presentation at the conference. The presentation objectives were for faculty participants to be able to identify challenges students with disabilities face inside and outside of the classroom as well as UD strategies they can implement to promote the learning of all students in their classes. We modeled the application of UD principles in our presentation, just as we encourage faculty members to do in their classrooms. Specifically, we created various ways for participants to learn about disabilities and UD. We provided an overview of UD, including its nine principles (Burgstahler, 2015), as a framework to improve learning for all students. That part of the presentation was visual along with some audio elements. It was followed by a UD-focused game, which was both an active learning experience and an example of a UD strategy that increases awareness of disability-related issues. Throughout the training we created a welcoming and understanding environment, which is also an important part of a universally designed class.

"In order for someone to be really effective, they must walk in another person's shoes, even if it's for a few minutes. Those few minutes will leave a lasting impression on one's mind." This is a quote from a former CNM student with a disability. In one of his classes, he gave a presentation on what it was like to have his disability by having his classmates do a role-playing experience. The members of the class left with a much better idea of what he experiences on a daily basis and could then better relate to him as a person, student, and classmate. We decided to expand that idea in the design of our role-playing game. The purpose of the game was to help instructors understand the challenges some students have in and outside of class. Many students are perfectly capable of learning the material that we present to them, but we might need to consider making adjustments in timelines and modes of presentation to facilitate students' demonstration of their knowledge and capabilities. Barriers can intentionally or accidently prevent students from reaching their goal of graduation (Cheng, 2013).

In our game, there are four volunteer players who represent students. The object of the game is for the four "students" to reach a mortarboard on the other side of the room and graduate. One student has a visual impairment, another uses a wheelchair, the third has a hearing impairment, and the fourth has a psychiatric disorder. Each student has a volunteer guide who has a set of color-coded cards (see Appendix) that they read in sequence to the student and the rest of the audience. Necessary props include: a mortarboard, a blindfold, a rolling chair, noise dampening headphones, and the cards. We printed the cards in color, one color for each student and laminated the cards for ease of use. Cards should be pre-sorted and read in sequence by each guide. Approximate number of students, guides, and audience members should ideally be 10 people. This can be done with fewer players. The organizer acts as the master of ceremony (MC) and referee. This can be done in front of a larger audience.

The cards describe events that might happen to a student. The student is instructed to move towards or away from the mortarboard depending on the event described on the card. Some of the events are specific to the student's disability, while others are things that could happen to any student. In some cases, the player is asked a question and has to make a decision. The audience then decides, based on their reaction to the student's decision, what the consequence will be. Does the student move forward toward graduation or take a step back?

For example, the guide could read the following card,

Uh-oh! You're a statistic! Your car is stolen, along with your textbooks and laptop.
Take three steps back.

The "student" then moves away from the prized mortarboard. Similarly, other cards prompt the student to move forward. However, some cards prompt the "student" to make decisions.

Your specially-equipped van breaks down. You are unable to get to class for a week.
What do you do?

Here the student has to make a decision. Once the student shares their decision with the group, the audience then determines how many steps forward or backward the student should take. This is based on their professional determination, as educators, of the wisdom of the decision. The MC acts as referee, and then directs the student to move the recommended number of steps.

Outcomes

In January of 2015, we piloted the UD Game at our annual CTL conference. Like many academic conferences, our sessions run 75 minutes. This afforded us ample time to run the UD Game. Approximately 30 faculty members attended our session. After our initial overview of universal design and the project, we started the game.

We explained the rules, the roles and the guidelines to the audience. Four faculty members stepped up to play the students; four guides stepped up as well. Both veterans and new faculty served as volunteers. For about 30 minutes, we played the game. Players lined up on the right side of the conference room.

We began with steps forward for the blind student. He quickly moved ahead through cards that offered him bonuses for support and outreach to campus resources. Our student in the wheelchair (a veteran faculty member) quickly became frustrated. She wasn't moving ahead toward the goal of graduation, symbolized by the mortarboard on the left side of the room. The audience started chiming in: "The student lost her backpack! That happened to one of my students this semester." The audience jumped in, especially keen to support the "students" and offering advice when they drew cards that created crossroads. We even had one student ask to move ahead a bit further than the audience recommended! The audience supported her, feeling for the student facing all the challenges outlined in her cards.

In sum, the game resulted in one student touching the mortarboard and winning the game. The crowd was inspired by the exercise. At the start of our session, folks remained silent, listening to our slide overview of the principles of universal design. By the time we ended the game and opened the floor to questions, participants were lively and asked provocative questions about UD, policy, and challenges in supporting students on our campuses.

As an outcome, the faculty identified UD principles and how they could be used in assisting students and managing their classrooms. From the feedback and numerous questions at the end of the session, the faculty expressed the ability to identify student challenges and determine how UD practices could benefit all students in their classes. Specifically, their questions included everything from how to support students with respect to classroom layout: "How do we organize our classroom so that all students can see the instructors? How do we keep the chair reserved for disabled students from being used by other students? Where can we go to have our materials closed-captioned? Where do we find out about how the Americans with Disabilities Act applies to students?"

Conclusion

The success of the UD Game encouraged us to continue this method of professional development in raising awareness of UD principles and best practices at CNM. In our upcoming academic year, we will offer our game again at Faculty Focus Day, our opening professional development event at the College. After this presentation, we made a few modifications. Moderators will clarify that the audience must determine the number of steps backward or forwards based on the student's crossroad decision. That is, some cards require the "student" player to make a decision as to what they would do under the circumstances presented by the card. The audience then "judges" this decision, rewarding a good decision with steps forward or a poor decision with steps (or rolling) backward.

We feel strongly in modeling the behavior that reflects the most effective practices for universal design in professional development. A multi-modal approach to faculty training allows for a more interactive experience that encourages engagement with UD principles on a personal level. Many of our faculty members only interact with information about students' disabilities when a student presents an ADA accommodation letter. The game is a way to encourage dialogue about how UD practices can alleviate some of the challenges students with disabilities face in their classes. We invite others to use this game to promote campus understanding of challenges students with disabilities face and how the universal design framework can be used as a tool for student engagement and success.

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Appendix

"Visually Impaired" Game Cards

You get a note-taker who hands you a stack of handwritten notes. Take two steps back.	The early bird gets the worm and a seat on the Sun Van. You need to be ready by 6 am for a 9 am class, but you end up sleeping in. Take two steps back.
You have "Non-24," a sleep cycle disturbance, and you become exhausted. Take one step back.	You meet with your DRC counselor and instructors for the upcoming semester. Modifications are made that will allow you to succeed in your courses. Take three steps forward.
Your DRC counselor finds a screen reader for you that you find easy to use. Take three steps forward.	You find help at the tutoring center. They make manipulatives that aid in your learning. Take two steps forward.
Your instructor plans assessments that effectively measure your learning without discriminating against your disability. Take two steps forward.	An instructor refuses to email assignments and notes to you. You have difficulty accessing this information. Take two steps back.
Your math instructor does not provide alternate means of assessment. It is difficult for you to demonstrate your knowledge of the subject. Take one step back.	Your instructor uses supplemental videos for your course. Although you can hear the audio, the video is not described. Take one step back.
You form a study group with other members of your class. The support is amazing! Take two steps forward.	Your note-taker does not transcribe your responses correctly, and you have no way to check them. You miss points unnecessarily. Take one step back.
You meet with your instructor in office hours, and discover that you're doing better than you thought. Take one step forward.	You find that you can use an open source e-book for your class. Save money, and have an accessible text! Take two steps forward.
Your instructor describes the graphics shown to the class in lectures. You understand what is going on! Take two steps forward.	You find a medication that works for your "Non-24." To sleep, perchance to dream… Take 3 steps forward.

"Psychiatric Disorder" Game Cards

Congratulations! You won the Lottery! (Scholarship, that is). Pays for your tuition, but not books. Take two steps forward.	The Early Bird gets the worm, and a seat on the Sun Van. Be ready by 6 am to get to your 9 am class. Take a nap on the van, and one step back.
Uh-oh! You're a statistic! Your car is stolen, along with your textbooks and laptop. Take three steps back.	Bummer! A hold was placed on your financial aid, and all your classes were dropped. Take three steps back.
Way to Go! You passed all your classes, and you keep your scholarship. Take two steps forward.	Your medication stops working. You fall into a depressed state. What do you do?
Work, family and school commitments seem overwhelming! You drop all your classes. Take three steps back.	You discover that you have AD/HD, and find appropriate therapies. Your grades and relationships improve. Take three steps forward.
You join a study group at school. The support is amazing! Take two steps forward.	You have problems getting to sleep at night. You miss your early morning classes frequently. Take two steps back.
Your new job pays more, but the schedule conflicts with one of your classes. Take two steps forward and one step back.	"He Who Must Not Be Named" tells you that you'll never make it. What do you do?
You meet with your instructor in office hours, and discover that you're doing better than you thought. Take one step forward.	You miss several deadlines for a class. Rather than talk to the instructor about possible options, you drop the class. Take two steps back.
You have a panic attack and miss three days of school. What do you do?	You have a custody hearing with your ex. You lose custody of your children. What do you do?
Your instructor helps you figure out how you learn most effectively. Your grades soar! Take three steps forward.	You are on top of the world! You register for 18 hours of classes. Take three steps forward.

“Mobility Impairment” Game Cards

Congratulations! You won the Lottery! (Scholarship, that is). Pays for your tuition, but not books. Roll forward 3 feet.	The first day of classes, you can’t find the appropriate access point to the buildings. You’re late! Roll back 2 feet.
Your specially-equipped van breaks down. You are unable to get to class for a week. What do you do?	You get in touch with DRC, and get an access map. You can get to all your classes now! Roll forward 3 feet.
Way to Go! You passed all your classes, and you keep your scholarship. Roll forward 3 feet.	Workstudy funds run out. You no longer have enough money to pay for DSL at home. Roll back 2 feet.
Your teacher helps you figure out how you learn most effectively. Your grades soar! Roll forward 5 feet.	You discover that you have AD/HD, and find appropriate therapies. Your grades and relationships improve. Roll forward 5 feet.
Your teacher gives you clearly defined assignments and rubrics. Knowing what is expected of you, you rise to the occasion and get an A. Roll forward two feet.	Your teacher uses supplemental videos for your course that are closed-captioned. You have three modes of “input.” Roll forward 3 feet.
Your new job pays more, but the schedule conflicts with one of your classes, so you must drop it. Roll three feet forward and two feet back.	Your parents have always told you that you’re a loser. You get the flu and miss a week of school. What do you do?
You meet with your instructor in office hours, and discover that you’re doing better than you thought. Roll two feet forward.	Bummer! A hold was placed on your financial aid, and all your classes were dropped. What do you do?
You share with your instructor that you have difficulty hearing. She makes sure to face you when speaking to the class, and asks you to sit closer to the front. Roll two feet forward.	You tell the DRC that you would like to take a laboratory class. They find an accessible classroom and appropriate section for you. Roll forward 3 feet.
Your instructor helps you figure out how you learn most effectively. Your grades soar! Roll three feet forward.	

"Hearing Impaired" Game Cards

Congratulations! You won the Lottery! (Scholarship, that is). Pays for your tuition, but not books. Take two steps forward.	Your interpreter doesn't show up for your first day of class. You feel lost. What do you do?
Your car breaks down. You are unable to get to class for a week. What do you do?	You get into a custody dispute with your ex. This causes stress, and some of the required court dates cause you to miss class. Take three steps back.
Way to Go! You passed all your classes, and you keep your scholarship. Take two steps forward.	Workstudy funds run out. You no longer have enough money to pay for DSL at home. Take one step back.
You find a mentorship program at school in your field of study. Transfer assistance and internship opportunities abound! Take two steps forward.	You discover that you have AD/HD, and find appropriate therapies. Your grades and relationships improve. Take three steps forward.
You begin to take advantage of the free tutoring services offered at school. Your grades improve. Take two steps forward.	Your backpack with your books and notes is stolen. Some of the materials are not replaceable. Take two steps back.
Your new job pays more, but the schedule conflicts with one of your classes and you must drop it. Take two steps forward and one step back.	Your parents have always told you that you're a loser. You get the flu and miss a week of school. What do you do?
You meet with your instructor in office hours, and discover that you're doing better than you thought. Take two steps forward.	Bummer! A hold was placed on your financial aid, and all your classes were dropped. What do you do?
You share with your instructor that you have difficulty hearing. She makes sure to face you when speaking to the class, and asks you to sit closer to the front. Take two steps forward.	You tell the DRC that you would like to take a laboratory class. They find interpreters and an appropriate section for you. Take two steps forward.
Your instructor helps you figure out how you learn most effectively. Your grades soar! Take three steps forward.	You become depressed and start missing class. You can't keep up with the material on your own. Take two steps back.

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

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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."

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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.

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Development of a UD Checklist for Postsecondary Student Services

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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 forty-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, 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.

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Promoting the Design of Accessible Informal Science Learning

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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.

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Universal Design in Assessments

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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.

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

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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/Finger-spell/ 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 Sen-tence	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 something 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.

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Impact of Faculty Training in Universal Design of Instruction on the Grades of Students with Disabilities

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Increasing numbers of students with disabilities are participating in college and university courses. However, as a group, they experience far less academic and career success than their nondisabled peers (National Center for Education Statistics, 2008; National Council on Disability and Social Security Administration, 2000; National Science Foundation, 2012).

A small but growing body of research suggests the efficacy of universal design of instruction (UDI) as a collection of instructional strategies that support the success of students with diverse characteristics. UDI practices include making expectations clear, employing multiple methods to deliver instruction, offering outlines and other scaffolding devices to support learning, and using multiple types of assessments (Burgstahler, 2015). A few studies have examined the effects of UDI for both faculty and students. Langley-Turnbaugh, et al. (2013) found positive outcomes among faculty receiving UD training to improve their teaching, Smith (2012) has reported a positive relationship between student interest and engagement and the application of UDI practices, and others have reported benefits of the practices as perceived by students (Kumar & Wideman, 2014; Zhong, 2012).

Reports of research studies that compare overall student outcomes of the same course taught with and without the application of UD are beginning to appear in the literature. For example, Beckman (2009) offered two versions of a graduate course in information management, teaching one “traditional” section using lectures as the primary instructional method and one “treatment” section supplementing the lectures with small group discussions. Though the groups performed similarly on multiple-choice and fill-in-the-blank exam questions, suggesting comparable mastery of factual material in the two sections, students in the treatment group performed better on essay exam questions, suggesting an enhanced ability to use the information, and these students more frequently reported that “the instructor was open to a variety of points of view.” However, this study did not compare the relative benefit of UD practices for students with disabilities as compared to those without disabilities. The purpose of the current study is to test the hypothesis that UD teaching techniques can support students with disabilities in earning better grades, making them closer to those of their nondisabled classmates.

BACKGROUND

Three projects over a period of 10 years were hosted by the DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center at the University of Washington and funded by the U.S. Department of Education under the Office of Postsecondary Education (Grant #P333A050064, P333A990042 and P333A020044). These projects, collectively referred to as the AccessCollege initiative, engaged a leadership team of faculty and administrators representing a diverse set of 2- and 4-year postsecondary institutions from more than 30 states (DO-IT, 2012). One project objective was to increase the knowledge and skills of faculty in a variety of disciplines to strengthen their ability to fully include students with disabilities in their courses. Activities undertaken to meet this objective included development of the following resources:

- *The Faculty Room* website and complementary short publications to help instructors employ effective accommodations and UD strategies;
- the book *Universal Design in Higher Education: From Principles to Practice* through Harvard Education Press, whose second edition was published in 2015;
- comprehensive professional development materials, *Building Capacity for a Welcoming and Accessible Institution*; and
- *The Center for Universal Design in Education*.

As *AccessCollege* activities unfolded, faculty requested examples for the application of UDI to specific instructional products (e.g., textbooks, videos, websites) and environments (e.g., classrooms, computer labs, online learning). In response to these requests, DO-IT, with input and vetting from project partners, operationalized UDI into a checklist of promising practices that demonstrate how UD can be applied to the overall design of instruction and specific aspects of the learning environments. In addition, this material assists with the determination of accommodations when universally designed instruction does not fully address the needs of a specific student with a disability, such as when a student needs a sign language interpreter or extra time on tests. The publication that listed UDI practices was distributed in most professional development offered to faculty as part of the *AccessCollege* project (Burgstahler, 2015).

The third *AccessCollege* project focused on outcomes and impact of faculty training. It included the delivery of 184 professional development presentations and workshops to more than 2,210 faculty and 126 teaching assistants on campuses and at professional conferences nationwide. Researchers in the project sought an answer to the question: Does the application of UDI practices result in leveling the academic playing field for students with disabilities? This question was operationalized into the following research question: Does applying UDI techniques in a class result in reducing the gap between the grades of students with disabilities and those without?

METHODS AND RESEARCH DESIGN

Instructors at six Washington State colleges volunteered to receive UD training and participate in this study. Training was provided by an *AccessCollege* Team member who was hired to train faculty on multiple campuses on UDI methods. She also worked with the project evaluator to collect grade data for students in these instructors' classes and in the classes of their "matched" colleagues as described below. The training, which ranged from 1–3 hours in length, took place at a variety of community and technical colleges. Faculty who engaged in the training did so voluntarily once the training option was announced. The presentations included a description of UD and of UDI, examples of UDI strategies, a video demonstrating UDI strategies, and further resources on the Universal Design in Education website. Each presentation was followed by a discussion.

Trained faculty taught a wide variety of courses as summarized in Table 1. A contact at each school provided GPA data for the students in the classrooms of each of the trained instructors, as well as for the students in classrooms of comparison instructors teaching comparable classes.

Table 1. Classes taught by UD-trained instructors and matched comparison instructors

Treatment group courses	Comparison group courses
HIST 221, 222 (College 1 and College 2)	HIST 102 200 221 222 (College 1 and College 2)
MATH 070, 072, 097, 102, 107 (College 1 and College 3)	MATH 062, 070, 072, 097, 107, 124, 125, 156 (College 1 and College 3)
COMM 101, 110 (College 1)	COMM 100 101 110 215 234 238 (College 1)
PHYS 101 110 201 202 203 (College 1 and College 4)	PHYS 101 110 201 (College 1 and College 4)
NATRS 100, 180, 181, 284, 286, 292, 293 (College 1 and College 4)	NATRS 117 121 161 172 182 183 197 272 285 (College 1 and College 4)
BIOL 100, (College 1)	BIOL 100 (College 1)
AP 100 (College 5)	AP 100 (College 5)
BA 200 205 (College 1)	BA 155 156 200 201 205 (College 1)
ENGL 081 090 108 (College 6)	ENGL 081 090 108 (College 6)
MED TERM (College 6)	MED TERM (College 6)
READ 094 104 (College 6)	READ 094 (College 6)

Data collection and analysis involved 6,550 grades from 269 classes taught by 42 instructors who received training and 55 instructors who did not, but who taught comparable classes in the same department in the same institution during the same time period. The 42 instructors who received training assigned grades to 1,379 students (65 with documented disabilities) in targeted classes prior to the training they received, and to 1,457 students (95 with documented disabilities) after they received training. The comparison faculty assigned 1,611 students (102 with documented disabilities) prior to their colleagues' training and to 2,103 students (129 with disabilities) after their colleagues' training.

A subset of this dataset was used for the analysis. Only classes with grades available for at least one student with a documented disability were included in this analysis and, of these, only those with data collected from classes taught both before and after the faculty training period. Of these, the only classes included in the study had at least one matched comparison instructor whose classes also met these data requirements. After the application of these restrictions, 126 classes remained, yielding 264 grades for students with disabilities and 3,066 grades for students without documented disabilities. Forty-three of these classes were taught by faculty who received training (16 of the classes were taught prior to the training; 27 after), and 83 of the classes were taught by matched comparison instructors (30 of them prior to their faculty match's training, and 53 after).

The research question—Does applying UDI techniques in a class result in reducing the gap between the grades of students with disabilities and those without?—was investigated using a quasi-experimental 2X2X2 research design. The three factors in the design were student disability status (students with vs. students without a disability); faculty group (trained faculty vs. "matched" faculty without training); and timing (before and after the training period). The dependent variable was average course grade.

Figure 1. 2X2X2 quasi-experimental design

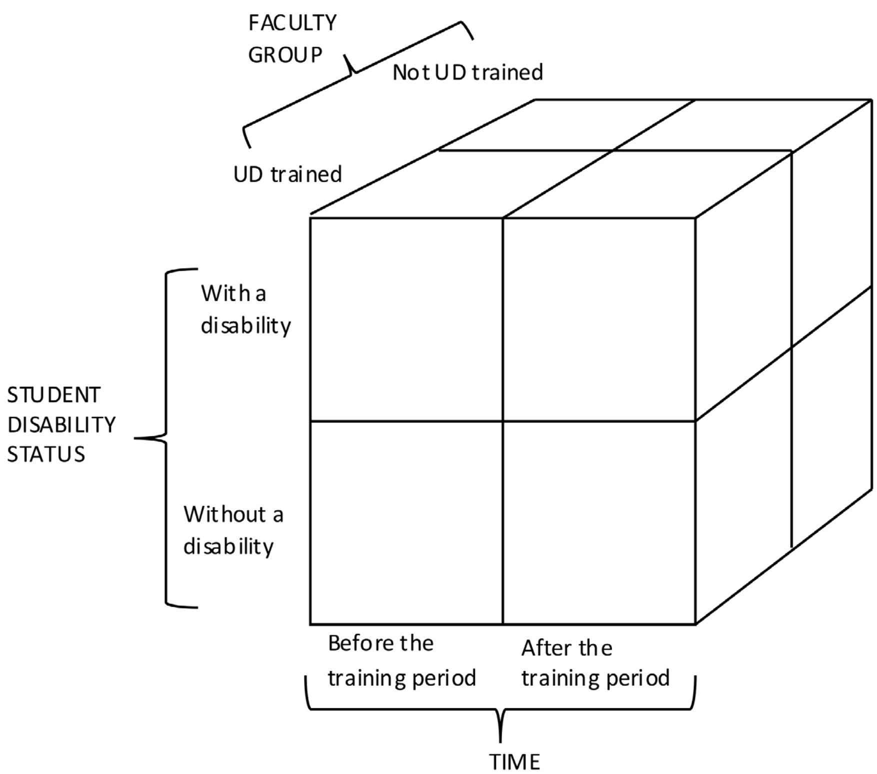


Figure 1 illustrates the design, showing each two-way dichotomy. The first (top-bottom) dimension represents Student Disability Status. The top four cells hold the GPAs of the students with disabilities while the bottom four cells hold the GPAs of the students without disabilities. The second (front-back) dimension represents Faculty Group. The front four cells hold the GPAs of the students in classes of UD-trained instructors and the back four cells hold the GPAs of the students of the comparison instructors who did not receive UD training, but taught similar courses. Note that the UD-trained instructors (front four cubes) taught students with disabilities (top two cubes) and students without disabilities (bottom two cubes), as did the comparison instructors. The third (left-right) dimension represents the pre-post dimension of the design. The left four cubes hold the students' GPAs before the training period and the right four cubes hold the students' GPAs after the training. Looking again at just the front four cubes (the classes of the UD-trained instructors), the top two cells hold the GPAs of the students with disabilities before the training (left cube) and after the training (right cube). The bottom two cubes represent the same information for their classmates without disabilities. The back four cubes provide the same information, for students with and without disabilities, during the same timeframe, but in the classes of the comparison instructors.

The reason the researchers gathered pre and post data for the comparison instructors when they received no intervention between the two periods was to ensure that any changes found in the GPAs of students in the UD-trained classes were not due to some campus-wide or community level phenomenon. Thus, the average GPA of students with disabilities and the average GPA of students without disabilities were computed and recorded for each course, before the training period (left half of the cube) and after the training period (right half of the cube).

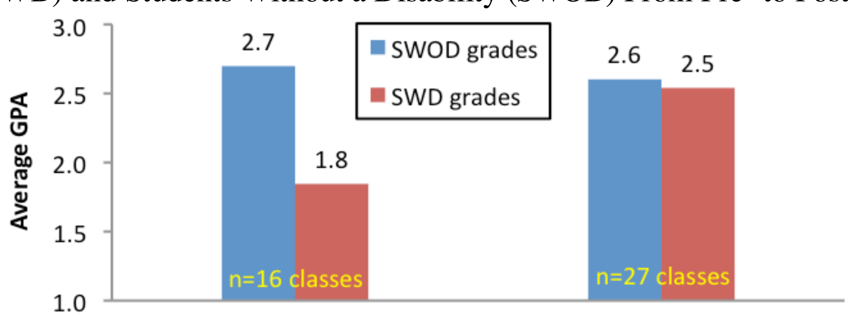
For analysis, the patterns of change in average GPA of students with vs. without disabilities from pre- to post-training were compared to determine whether the grade gap between students with and without disabilities decreased after the training. These GPA changes were compared with those in the classes of comparison instructors who did not receive training but taught similar courses to ensure that any changes found could not be explained by some campus- or community-wide change during that time period.

Class was the unit of analysis. Thus, the analytic database consisted of the average GPA for students with disabilities and the average GPA for students without disabilities for each class.

RESULTS, DISCUSSION, AND LIMITATIONS

Figure 2 presents data from the classes of faculty who received training. It illustrates the change from before the training to after the training in average course GPA for students with disabilities and for students without disabilities.

Figure 2. Students in Trained Faculty Course: Change in Average GPA for Students with a Disability (SWD) and Students Without a Disability (SWOD) From Pre- to Post-Training Period



The average GPA of the students without disabilities (the first bar in each pair) was about the same pre-and-post faculty training (2.7 and 2.6, respectively). The average GPA of the students with disabilities in the same classes (the second bar in each pair) increased from an average of 1.8 to an average of 2.5. This change brought the average GPA of the students with disabilities close to that of the students without disabilities. Analysis of data presented in this figure reveals that, overall, the grades of the students with disabilities were significantly lower than those of their non-disabled classmates ($F(1,41)=7.9$; $p<.01$) and that the increase in average GPA from pre- to post- faculty training among the students with disabilities is unlikely due to chance: ($F(1,41)=5.9$; $p<.05$).

Figure 3. Students in Untrained Faculty Courses: Change in Average GPA for SWD and SWOD From Pre- to Post-Training Period

Figure 3 presents similar information for the classes taught by the matched comparison instructors who did not receive training. It shows that, overall, the average GPAs of the students with disabilities are significantly lower than those of their non disabled classmates ($F(1,81)=5.7$; $p<.05$). However, unlike the classes of the trained instructors, the lower grades of the students with disabilities did not improve to match those of their non-disabled classmates over the same time period. This result suggests that the training had a significant impact on the ability of the instructors to better teach students with disabilities.

In summary, the grades of students with disabilities in classes taught by faculty who received training increased while the grades of their non-disabled peers did not change. In contrast, the grades of both groups of students in courses taught by untrained faculty stayed the same or decreased somewhat. Thus, only the grades of the students with disabilities in the classes of the trained faculty increased significantly after the instructor received the training, bringing the performance of students with and without disabilities taught by the trained faculty to similar levels in the post-training period. It should be noted that the pre-training grades of students with disabilities were much lower than those of students with disabilities in the comparison faculty classes. It is unknown whether this was random fluctuation in the data or due to systematic differences between faculty in the two groups. It is possible that the faculty who received the training recognized that they needed it and found it effective, or it could be that the results are simply due to random fluctuation in the data and regression to the mean. Replication of this study might shed light on this issue.

A weakness of a study like this is that it was conducted in courses that do not include enough students with a wide range of disabilities to analyze an intervention's success with specific sub-groups. Also, although the results indicate an apparent effect of the intervention, no assessment was made to determine which UD practices, if any, the trained instructors employed nor the value of specific UDI strategies. More and larger research studies are needed to further explore these issues.

CONCLUSION

UDI is often promoted as a means for leveling the playing field for students with disabilities in higher education. However, research reported in the literature rarely addresses the question of whether employing UDI practices brings the performance of students with disabilities closer to that of other students. Data collected in this study suggests that professional development and resources offered to faculty as part of the *AccessCollege* initiative increased their ability to level the academic playing field, resulting in decreasing the gap between the earned grades of students with and without disabilities.

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An Exploratory Study of the Accessibility of Chinese Provincial Government and Postsecondary Institution Websites

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China has more than 82.96 million people with disabilities (PWD) and the population age 60 and above is greater than 194 million (Guo, 2009). With the rapid development of online content, access to Internet resources is critical to Chinese citizens, including students. However, a 2016 study (Zhao, Marghitu, & Mou) indicated that many websites from Chinese postsecondary institutions are inaccessible to a wide range of PWD. The study reported in this article gains further insights regarding the accessibility of websites that people access in China for legal, educational, and resourceful content; the results of this study are then compared to the prior study on the accessibility web resources at postsecondary institutions. The authors chose a sample of websites that are maintained by Chinese government institutions because, as a collection, they provide a large amount of online information and services. Specifically, this study evaluates the accessibility of Chinese province-level portals, analyzes their current accessibility issues, compares the findings with those of postsecondary institution websites, summarizes implications, proposes strategies and shares promising practices for improving the accessibility of websites in China.

Government portals are the primary gateway for residents, including students in higher education, to access information about laws, regulations and policies, services, and community participation. According to the latest statistic of CNNIC (China Internet Network Information Center; 2015), by June 30, 2015 the number of domains registered under gov.cn reached 57,923. All of the provinces, autonomous regions, municipalities, and special administrative zones; 99% of the cities; and more than 85% of the counties have built their own websites. However, many people with visual, hearing, physical, cognitive, neurological, and other challenges experience difficulties in using the web when it is not designed accessibly. For example, people who are visually impaired rely on screen readers to “see” a page, but screen readers cannot provide relevant information for image or video without the provision of text alternatives; people with colorblindness might have trouble filling out an online form that designates required fields in red; and some individuals may have difficulty controlling a mouse to activate small controls on a web page. Addressing the special needs of all PWD by reducing the barriers imposed by websites helps to ensure equal opportunities in education, employment, and community engagement.

LITERATURE REVIEW

Website accessibility has become a focus of governments, scholars, and practitioners worldwide. The United Nations Convention on the Rights of Persons with Disabilities recognizes access to the web as a basic human right (United Nations, 2006). The World Wide Web Consortium (W3C) launched the Web Accessibility Initiative (WAI) to encourage everyone to make their websites accessible. WAI released the Web Content Accessibility Guidelines (WCAG) 1.0 in 1999 and WCAG2.0 in 2008. These guidelines have become the templates for many countries establishing their own web accessibility standards. WCAG 2.0 is organized around four principles: for websites to be perceivable, operable, understandable, and robust. Listed under each of these four principles are 12 guidelines and testable success criteria. For each success criteria, there is a list of techniques on how to meet the success criteria. WCAG 2.0 has been heavily referenced in web accessibility legislation and practices in many countries, including China (Yang & Chen, 2015).

China has realized the importance of web accessibility in the digital information age, as evidenced by its annual Information Accessibility Forum, which has promoted web accessibility since 2004 (Sun, Zhang, & Wang, 2007). In addition, the Ministry of Industry and Information Technology of China released the first version of the Information Accessibility—for People with Physical Disabilities—Technical Requirements for Web Accessibility (YD/T 1761-2008) in 2008 and updated it in 2012 to account for various existing and emerging technologies. Some local governments in China have made great efforts to make their websites accessible. In 2010, the Shanghai government portal "Shanghai China" became the first fully accessible Chinese province-level portal (Xiao & Chen, 2011). It provides pure-text, accessible navigation, voice prompts, and browsing tools; China started the "Beautiful China—Public Action for Chinese Government Information Accessibility" in 2013 and initiated "Beautiful China—Public Action for 100 Chinese Cities' Government Information Accessibility" in 2014.

During the past decade, many scholars researched the accessibility of Chinese government and university websites. Phoenix-sem (Guo, 2009) investigated the accessibility of government websites of 22 provinces, 5 autonomous regions, 4 municipalities and 2 special administrative regions in 2008 and found only the portal of Hong Kong Special Administrative Region met the testing standards. Zhao (2013) studied the accessibility of the government websites of Jiangsu province and the subsidiary 13 cities based on WCAG 1.0 and found that none of the websites passed the accessibility standards used in the study. Zhang (2015) evaluated the accessibility of 32 provincial government websites and found that nearly 50% of the websites met the requirements of WCAG Level A. Chinese universities are organized into 5 categories: the 985-project universities, the 211-project universities, the provincial key universities, the ordinary universities, and the vocational colleges. Many of the best Chinese higher education institutions are situated in Beijing, the Chinese capital. In the preliminary evaluation conducted by the authors of this article, of the accessibility of the portals of 10 institutions from each category (with the exception of 8 project universities in Beijing, since there are only 8 total), none of the 48 websites passed the evaluation. Based on previous studies, the overall accessibility of Chinese government and post-secondary education institutions websites, compared with other developed countries, is still lagging. More studies should be conducted to investigate the current status, uncover the existing problems, and identify and implement solutions for improving web accessibility in China. These efforts will improve opportunities in education, employment, and other life activities for individuals with disabilities.

METHODOLOGY

Chinese provincial governments manage the affiliated cities and are led directly by The State Council of The People's Republic of China. Compared with the websites of the central government, the relationship between provincial government portals and citizens is much closer and the page views of provincial government portals are also much higher. The authors of this article have observed that, compared with the local city-level government portals, the design and development of provincial government portals is more in line with the WCAG 2.0 Level A.

Since most people enter the home page to navigate website content, if the home page is not accessible, then the accessibility of other pages may not be relevant. The home page is often the best planned, designed and managed page on a website; if the home page is not accessible, then it's fair to conclude that other pages of the site are not accessible either. Therefore, this study evaluated only the home pages of Chinese provincial government portals. China has 34 provincial administrative regions including 23 provinces, 5 autonomous regions, 4 municipalities and 2 special administrative regions. The provincial government portals' addresses were obtained from the official website of The State Council of China (http://english.gov.cn/).

In this study, WCAG 2.0 Level A was used as the evaluation standard. The websites were evaluated with a combination of automated testing tools and manual testing. The open source web accessibility evaluation tool AChecker from the University of Toronto Adaptive Technology Resource Center was adopted in this study. It can review the accessibility of web pages based on a variety of international accessibility guideline such as WCAG 2.0 (International), Section 508 (U.S.), BITV 1.0 (Germany), and supports three ways to evaluate a web page, including entering a URL of a web page, uploading an HTML file, or pasting HTML from the clipboard, and generates detailed result reports. AChecker is widely used in web accessibility evaluation. AChecker reports 3 types of problems: known problems, likely problems and potential problems. Only known problems are identified with certainty as accessibility barriers. Likely problems and potential problems are those which AChecker cannot identify (e.g., any check that requires the evaluation of meaning, such as whether link text accurately describes the purpose of a link, or whether alt text sufficiently describes the meaning contained in an image. In these cases, a human being made judgments on problems AChecker cannot identify.

FINDINGS

The accessibility of the Chinese provincial government portals were evaluated between February 22 and 25, 2016. Results are shown in Table 1. Thirty three websites were evaluated successfully. Sixteen out of the 33 websites provided accessible versions. The other 17 websites without separate accessible versions were tested based on WCAG 2.0 Level A standards, and only 2 of the websites, of Tibet and Hong Kong, complied with WCAG 2.0 Level A requirements.

	Total Websites	Invalid Websites	Effective Websites	Accessible Websites	WCAG2.0 Level A Evaluation		
					Total	Passed	Not Passed
Result	34	1	33	16	17	2	15

Table 1: Evaluation results

Sixteen provincial portals (e.g., Beijing, Shanghai, Guangdong, and Xinjiang) built accessible versions for PWD or who are elderly. Among these 16 websites, 5 (31%) websites provided site maps and 10 (63%) provided alternate text pages. Fifteen (94%) websites, excluding the website of Chongqing, provided various assistive functions for accessible browsing (e.g., font size setting, color setting, reading auxiliary lines and big subtitle). Eight (50%) out of the 16 websites provided complete keyboard shortcuts enabling users relying on keyboards to more easily access pages. Eleven (69%) out of the 16 websites provided voice prompts, and 12 (75%) websites implemented content reading functions. Without installation of extra screen reader software and hardware, people with visual impairments can easily access and listen to the content of these websites. Moreover, Beijing, Qinghai, Hainan, and Xingjiang provincial portals were equipped with voice-activated functions. Users could give instructions by voice to control the browsing of the pages once they downloaded and installed the voice client. The combination of voice-activated and content reading functions provides assistance to people who are blind and those who have difficulty controlling the mouse and keyboard. The statistics of the assistant functions implemented by the 16 websites is shown in Table 2.

Province	Pure Text	Site Map	Font Setting	Colors Setting	Reading Assistance	Voice Prompt	Content Reading	Keyboard Shortcuts	Voice Activated
Beijing		X	X	X	X	X	X	X	X
Shanghai	X		X	X	X			X	
Chongqing	X								
Hebei	X		X	X	X	X	X		
Gansu			X	X	X				
Qinghai		X	X	X	X	X	X	X	X
Anbui	X		X	X	X	X	X	X	
Hunan			X	X	X		X		
Jiangsu	X		X	X	X	X	X		
Sichuan	X		X	X	X				
Yunnan	X		X	X	X	X	X		
Jianxi	X		X	X	X	X	X	X	
Guangdong	X	X	X	X	X	X	X	X	
Gujian	X		X	X	X	X	X		
Hainan		X	X	X	X	X	X	X	X
Xinjiang		X	X	X	X	X	X	X	X

Table 2: Assistant functions implemented by Chinese prvincial government portals

According to the testing results, nearly 50% of the Chinese provincial government portals provided special web accessibility related implementations (e.g., pure text version and assistant tools). If we consider these 16 websites with special accessibility constructions to be in line with WCAG 2.0 Level A standards, then 18 provincial portals met the requirements of WCAG 2.0 Level A, whereas 15 provincial websites failed to comply with WCAG 2.0 Level A with an overall passing rate of about 55%. Results are shown in Table 3.

	Total Websites	Invalid Websites	Effective Websites	Passed	Not Passed
Result	34	1	33	18	15

Table 3: Overview of the Chinese provincial government portals web accessibility

Table 4 summarizes the evaluation results of the 15 websites that failed to meet the WCAG 2.0 Level A standards. As seen in Table 5, the home pages of Jilin and Ningxia government portals each have more than 200 errors, and Tianjin and Liaoning provinces each have exceeded 400 errors. On average, 154 errors occurred on the home pages of the websites that failed to comply with WCAG standard. More than 50% of these sites' home pages have over 100 errors and none of the 15 websites' home pages has less than 10 errors. This data suggests the Chinese portals without special instructions for accessibility generally contain accessibility barriers that make it difficult, or even impossible, for many PWD, to benefit from the resources and e-services provided by these government websites.

Province	WCAG 2.0 Level A		
	Error Instances	Success Criteria Violated	Error Types
Liaoning	489	6	12
Tianjin	420	7	16
Ningxia	238	7	12
Jilin	216	5	7
Shanxi	178	7	10
Guangxi	138	7	13
Shanxi	119	6	8
Guizhou	107	7	10
Zhejiang	84	5	5
Hubei	75	5	6
Henan	73	8	10
Henongjiang	62	6	7
Macao	60	5	7
Shandong	30	6	7
Neimenggu	23	6	7

Table 4: The number of error instances, success criteria violated and error types of Chinese provincial government portals

From the perspective of WCAG 2.0 Level A guidelines, among the 15 websites that failed to pass the evaluation, every home page violated at least 5 success criteria with an average of 6 instances per website.

AChecker constructs a detailed report for each success criteria, and every check corresponds to a specific error type. Each of these 15 home pages has an average of 9 kinds of errors, 47% of the evaluated websites have more than 10 types of errors, and the home page of Tianjin contains up to 16 types of errors. The data shows that these inaccessible websites not only contain extensive errors, but also involve a large number of error types. There are two main kinds of errors: the first kind of error frequently appears on a website and seriously influences the accessibility of the website; the second kind of error is not as frequently encountered within a website but it appears in many websites and is a common but neglected problem. As shown in Table 5, there are 3 accessibility success criteria most often violated by websites. The first is success criteria 1.1.1: provide text alternatives for any non-text content, which has been violated 1350 times. The second is success criteria 2.4.4: provide clear link purpose to help users navigate, find content, and determine where they are, which has been broken for 473 times. The third success criteria with the highest amount of errors is success criteria 2.1.1: make all functionality available from a keyboard, which occurred 359 times. The total number of errors related to these three types of success criteria is 2182 and accounts for 95% of the total errors. Among the 15 websites that failed to pass the WCAG 2.0 Level A standard, 87% of websites have errors of success criteria 1.1.1, 75% have errors conflicted with success criteria 2.1.1, and all the 15 websites have errors related to success criteria 2.4.4. These 3 types of errors are frequently encountered, have high probability of occurrence, and are the main problems affecting the accessibility of Chinese provincial government websites. The other two common errors come from success criteria 3.1.1 and 2.4.1. 93% out of the 15 websites do not provide pages with language information as required by criteria 3.1.1, which is likely to cause assistant tools, such as screen readers, to fail to recognize correctly the page content. All 15 websites have neglected criteria 2.4.1 and fail to provide "skip to content" link, which will cause users relying on keyboard to have a hard time skipping navigation to the main content.

Success Criteria	Description	Website Instances	Error Instances	Percentage (%)
1.1.1	Provide text alternatives for any non-text content	13	1350	58.9
1.2.3	Provide audio description or media alternative	3	3	0.1
1.3.1	Ensure that information and structure can be separated from presentation	8	40	1.7
2.1.1	Make all functionality available from a keyboard	11	359	15.7
2.2.2	Provide users enough time to read and use content	2	2	0.1
2.4.1	Provide bypass blocks to help users navigate and find content	15	15	0.7
2.4.4	Provide clear link purpose to help users navigate, find content and determine where they are	15	473	20.6
3.1.1	Specify language of page	14	14	0.6
3.2.2	Make web pages appear and operate predictable	2	30	1.3
3.3.2	Provide labels or instructions for input	7	7	0.3

Table 5: Success criteria violated by Chinese provincial government portals

The distribution of the Chinese provincial government website errors on AChecker check points is shown in Figure 1. The check points with a huge number of errors are numbers 1, 174, 107, 178 and 106; the corresponding numbers of errors that occurred are 1036, 473, 237, 170 and 114. The total number of these 5 kinds of errors is 2030 and accounts for 89% of the total errors. The distribution of the websites that failed to pass WCAG 2.0 Level A evaluation on AChecker check points is shown in Figure 2. 87% of the 15 accessible web sites have errors on check 1, 93% have problems conflicting with check 48, and all 15 websites fail to meet the requirements of check 28 and check 174. Check points 107, 7, 106 and 188 are also frequently violated. More than 50% of the 15 websites violate check 107, 7 and 106; nearly 50% of the 15 websites fail to comply with check 188. These errors with huge quantity and high probability are the crux of the improvement of Chinese provincial government portals' accessibility. The descriptions of the main AChecker check points violated by Chinese provincial government websites are listed in Table 6.

The results of the preliminary accessibility study of 48 Chinese universities websites that used the same methodology are similar with the study of Chinese provincial government. The distribution of the 48 website errors on AChecker check points is shown in Figure 3 and can be compared with Figure 1. The distribution of the websites that failed to pass the WCAG 2.0 Level A evaluation on AChecker check points is shown in Figure 4 and can be compared with Figure 2. The descriptions of the main AChecker check points violated by the 15 postsecondary educational websites are listed in Table 7 and can be compared with Table 6.

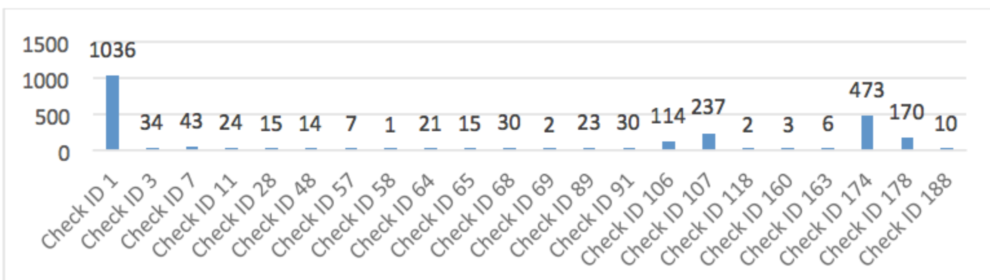

Figure 1: The distribution of the Chinese provincial government websites accessibility errors on AChecker check points

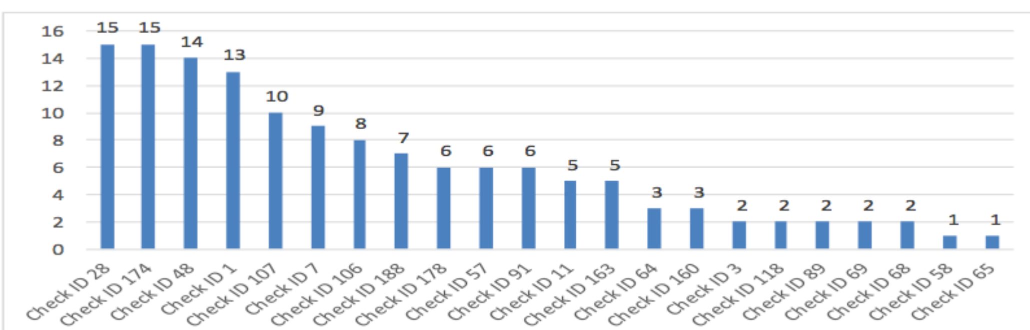

Figure 2: The distribution of the websites failed to pass the WCAG 2.0 Level A evaluation on AChecker check points

Success Criteria	Check ID	Descriptions
1.1.1	1	All “img” elements have an “alt” attribute
	178	Alt text for all “img” elements that are not used as source anchors conveys the same information as the image
	7	Alt text for all “img” elements used as source anchors is not empty when there is no other text in the anchor
2.1.1	107	All “onmouseup” event handlers have an associated “onfocus” event handler
	106	All “onmouseout” event handlers have an associated “onblur” event handler
2.4.1	28	A “skip to content” link appears on all pages with blocks of material prior to the main document
2.4.4	174	Each source anchor contains text
3.1.1	48	Document has required “lang” attribute(s)
3.3.1	188	Each label associated with an “input” element contains text

Table 6: Descriptions of the main AChecker check points violated by Chinese provincial government websites

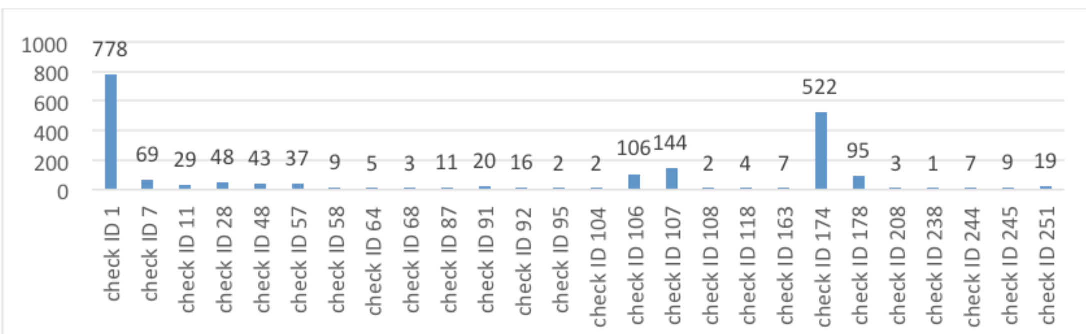

Figure 3. The distribution of the Chinese postsecondary websites accessibility errors on AChecker check points

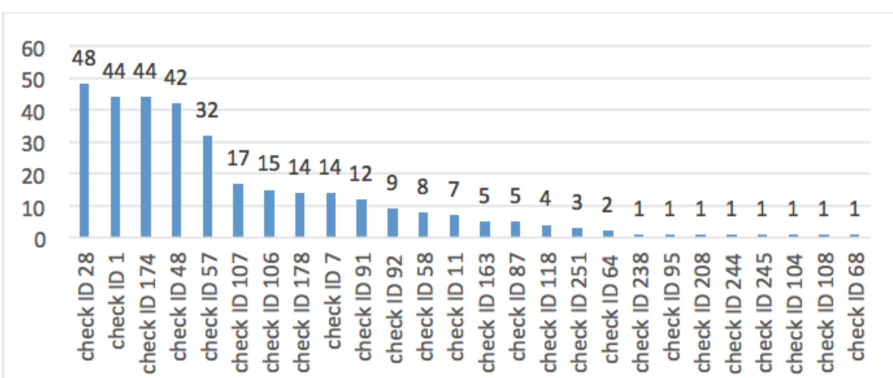

Figure 4: The distribution of the postsecondary education websites failed to pass the WCAG 2.0 Level A evaluation on AChecker check points

Success Criteria	Check ID	Descriptions
1.1.1	1	All "img" elements have an "alt" attribute
	178	Alt text for all "img" elements that are not used as source anchors conveys the same information as the image
	7	Alt text for all "img" elements used as source anchors is not empty when there is no other text in the anchor
1.3.1	57	All "input" elements, "type" of "text", have an explicitly associated label
	91	All "select" elements have an explicitly associated "label"
2.1.1	107	All "onmouseup" event handlers have an associated "onfocus" event handler
	106	All "onmouseout" event handlers have an associated "onblur" event handler
2.4.1	28	A "skip to content" link appears on all pages with blocks of material prior to the main document
2.4.4	174	Each source anchor contains text
3.1.1	48	Document has required "lang" attribute(s)

Table 7: Descriptions of the main AChecker check points violated by Chinese postsecondary education websites

RECOMMENDATIONS, PROMISING PRACTICES, AND IMPLICATIONS

The accessibility levels of Chinese provincial government portals and of postsecondary institution websites cover a wide range. However, the major accessibility problems detected are problems that could be easily prevented and corrected (e.g., adding alternative text for images, specifying the language for page content). These are indications that web developers and managers lack awareness of web accessibility and do not sufficiently recognize and consider the accessibility issues for people who are aged or disabled. Many websites are simply not designed and managed in accordance with the relevant policies, regulations, and standards for web accessibility. Creators often just provide an alternative site for PWD —which can often leave out information, not highlight the same information, or leave PWD feeling disconnected—rather than provide one accessibly-designed site for everyone.

To improve the accessibility of provincial government and postsecondary portals, further work is needed, particularly in three areas of effort. First, it is important to promote web accessibility with more vigor. For example, most of the government website developers and managers are not concerned with accommodations for PWD and the idea of web accessibility has not been fully integrated into government services. Significant promotion of the need for web accessibility will help convince the web developers to move toward a people-oriented web design approach.

Second, web accessibility standards need to be enforced. Although China has formulated state standards for web accessibility such as Information Accessibility-for People with Physical Disabilities—Technical Requirements for Web Accessibility, Information Accessibility—for People with Physical Disabilities-

Testing Specification for Web Content Accessibility Evaluation, local governments do not implement these standards voluntarily. Only legal enforcement of the state standards for web accessibility can make the developers and managers comply with the requirements and create accessible web environment.

Third, the accessibility education and training of related personnel (e.g., website developers and managers) needs to be strengthened. Website developers are responsible for designing and developing a website while the manager is responsible for the daily maintenance of the web content. Their knowledge of web accessibility directly determines the accessibility of websites. Websites without these accessibility errors can only be built by equipping these designers, developers, and managers with the sufficient knowledge and skills. In terms of personnel training, web accessibility should be added into college courses (e.g. information technology and web programming).

Public postsecondary educational institutions enroll 93.4% of the Chinese post-secondary students, and many of these top institutions are working side-by-side with the government institutions toward maximizing web accessibility. Promising activities include the following:

1. The Special Education College of Beijing Union University, founded in September 2000 (Special Education College, 2010) is committed to accessibility training. It provides undergraduate and postgraduate students with web accessibility courses such as Introduction to Information Accessibility and Information Accessibility Assistive Technologies.
2. In January 2009, Zhejiang University in collaboration with China Disabled Persons' Federation, created the "China Information and Accessibility Technology Research Center of Persons with Disabilities" (2009), which has become one of the most important center for information accessibility research and personnel training.
3. In January 2013, Beihang University became the newest institution to host W3C toward offering enhanced opportunities for collaboration among Chinese companies, web developers, research institutes, and W3C's full international community, including members from more than 40 countries (W3C Beihang University, 2013).
4. In January 2016 the W3C Chinese Web Accessibility Community Group was created toward helping Chinese developers and designers to build an accessible web (W3C Chinese Web Accessibility Community Group, 2016).
5. In April 2016, Tsinghua University in cooperation with the China Disabled Persons' Federation, established the Accessibility Development Institute, which is committed to the theoretical and applied research and personnel training for the construction of a barrier-free environment (Accessibility Development Institute, 2016). It will provide great intellectual and manpower support for the boosting the accessibility in China. Web accessibility, as an important part of the barrier-free environment of today's digital society, will be one of the main goals of this initiative.

CONCLUSION

Government websites play an important role in the life and work of all citizens, including students in postsecondary education. Hence, it is critical that government websites be accessibly designed in order to guarantee equal access to information and services for everyone, including postsecondary students with disabilities. The study reported numerous types of web accessibility errors on provincial government and postsecondary institution websites in areas that can be easily rectified with increased awareness and training. In order to further enhance the accessibility of these websites, practices should be implemented to promote the ideas of web accessibility, legally enforce the implementation of the state standards for web accessibility, and strengthen the education and training for web accessibility techniques. In such efforts the government can present an excellent role model for all Chinese websites and, ultimately, promote the successful participation in postsecondary education, careers and community life for Chinese citizens with disabilities.

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The Development of Accessibility Recommendations for Online Learning Researchers

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Attracting more individuals from underrepresented groups can help the United States meet the demand for science, technology, engineering, and mathematics (STEM) professionals. As stated by the director of the National Science Foundation (NSF), "Science is too important and rewarding to be exclusive, and too vital to the nation's future to leave anyone out" (Cordova, 2017). Those often left out of STEM opportunities include people whose disabilities impact sight, hearing, mobility, learning, social interactions, and other abilities. There is little evidence that inclusive practices are routinely applied to ensure access to STEM for this group. The accessibility of learning opportunities is often only considered after a person with a disability reports accessibility barriers (e.g. lack of captions, inaccessible PDF or other documents). This approach can result in expensive and unsatisfactory accommodations.

Technological innovations at the intersection of learning theory and emerging technologies—often referred to as digital learning or cyberlearning—are used in growing quantity and variety in academic courses and research. Almost overnight, the pandemic of 2020 required that educators convert learning opportunities from those primarily offered on-site to online, with a range of success as reported by students, parents, and instructors. Most educators aimed to make these online opportunities available to all potential students, but many fell short due the accessibility barriers their course designs created for some students and a lack of understanding for how to avoid the creation of these barriers. For example, educators who previously only provided instruction in-person now had to navigate creating online content that was accessible to screen readers and possibly provided audio descriptions for students with visual impairments. In addition, they had to consider that students might be trying to access content via smartphones, tablets, or other devices, which have varying screen sizes and user interfaces for accessing content.

Emerging technologies used to deliver online learning provide promising opportunities for inclusive learning by offering multimodal representation of information, interactive learning environments, and data science-driven personalized learning. When designers assume that students will have a variety of abilities, understand challenges individuals with disabilities often face, and engage in inclusive design approaches, the result is online learning technologies and pedagogies that are engaging and effective for all learners. Arguably the most inclusive and well developed approaches center around universal design (UD). UD requires that a broad spectrum of abilities and other characteristics of potential users be considered when developing products and environments, rather than simply designing for the average user and relying on accommodations alone when a product or environment is not accessible to an individual with a disability. UD is defined by the Center on Universal Design 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” (1997).

UD is underpinned by seven basic principles for the inclusive design of any product and environment: equitable use, flexibility in use, simple and intuitive use, perceptible information, low physical effort, and size and space for approach and use. UD-inspired instructional practices are based upon a common finding in educational research that learners are highly variable with respect to their interests, abilities, and responses to instruction. The Universal Design for Learning (UDL) approach, developed by the Center for Applied Special Technology (2018), promotes three principles: that learning activities and resources offer students multiple means of engagement, representation, and action and expression. A third set of principles that offer specific guidance for online educators and technology developers are those that underpin the internationally developed Web Content Accessibility Guidelines (WCAG) of the World Wide Web Consortium (2018); the principles require that IT components be perceivable, operable, understandable, and robust.

Online learning pedagogy and technology that are guided by the principles that underpin UD, UDL, and WCAG minimize the creation of barriers to digital tools and online content for individuals with disabilities. Together, these principles require that students are offered multiple, accessible ways to learn, demonstrate their learning, and interact in an online course using tools with features that are designed to be accessible to students with a wide variety of abilities. With this approach, the need for accommodations for individual students are minimized.

ACTIVITY

The DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center at the University of Washington (UW) has worked since 1992 to increase the success of individuals with disabilities in postsecondary studies and careers with interventions that include the use of digital technologies as empowering tools. Beginning in 2015, the DO-IT Center undertook two projects that were funded by the National Science Foundation’s Cyberlearning and Future Learning Technologies program. The AccessCyberlearning project (Grant #IIS-1550477) conducted a capacity building institute (CBI) and online community of practice that engaged leaders representing a wide variety of stakeholders with respect to digital learning to address disability-related issues to help researchers and educators make the online experiences of learners effective for students with diverse characteristics. AccessCyberlearning 2.0 project (Grant #DRL-182540) sought to answer four research questions:

1. What challenges do learners with different types of disabilities face in using current and emerging digital learning tools and engaging in online learning activities?
2. How do current digital learning research and practices contribute to the marginalization of individuals with disabilities?

3. What advances in digital learning design are required to support multi-modal learning and engagement that is fully accessible to and usable by students with disabilities?
4. What specific actions can digital learning researchers, funding agencies, educators, and other stakeholders take to systematically address issues with respect to disabilities?

Participants were recruited nationwide; they formed a pool of 22 individuals representing stakeholder groups that included faculty, researchers, administrators, IT accessibility specialists, and project directors. Before the AccessCyberlearning 2.0 capacity building institute (CBI), held in Seattle on January 16–18, 2019, participants began to engage in an online community of practice and reviewed relevant materials to prepare them for the work before them, which encouraged them to zero in on specific areas to which they felt best suited to contribute. At the CBI, participants explored how to make digital learning research, products, activities, and resources welcoming to, accessible to, and usable by those with disabilities, as well as began to develop project products. Recommendations for cyberlearning researchers emerged from a literature review, an online community, and presentations and discussions in the AccessCyberlearning 2.0 CBI (2019). Although participants in the project agreed that digital learning opportunities should be made available to all potential students, including those with disabilities, they revealed different opinions regarding how much effort it is reasonable to expect researchers and practitioners should be expected to make toward accessible design and how they can gain the expertise they need to do so.

The following sections of this paper share recommendations that evolved from the AccessCyberlearning 2.0 collaboration that apply to researchers developing technology tools and pedagogy to be used in online learning. For comprehensive information about these findings, consult Accessible Cyberlearning: A Community Report of the Current State and Recommendations for the Future (Burgstahler & Thompson, 2019a), Designing Accessible Cyberlearning: Current State and Pathway Forward (Burgstahler & Thompson, 2019b), Guidelines For Cyberlearning Researchers (Burgstahler & Thompson, 2019c), and 20 Tips for Teaching an Accessible Online Course (Burgstahler, 2020).

RESULTS AND DISCUSSION

Participants considered whether new design principles are needed, but concluded that it is less about new principles and more about ensuring that researchers and practitioners apply existing UD, UDL, and WCAG principles as technologies and pedagogical practices are developed and applied. Most agreed that getting more researchers and practitioners to routinely consider accessibility in their work will be difficult because researchers are unfamiliar with accessibility principles and have little or no experience applying them. The recommendations listed below are adapted from the more general digital learning recommendations developed through a brainstorming and iterative process with project collaborators to include those specifically relevant to online learning pedagogy and technology. They are organized into two groups: Those that can be implemented immediately in existing projects and products, and those that may take longer to implement.

Recommendations for Immediate Actions

Immediately, online learning researchers should

- become familiar with the UD, UDL, and WCAG principles and established guidelines and practices they support as they apply to the design of inclusive learning tools and pedagogy;
- explore how online learning practices supported by the science of learning can be overlaid with UDL, UDL, and WCAG principles to make them inclusive of individuals with disabilities;
- invite specialists with IT accessibility knowledge to be members of their research teams;
- ensure project staff are trained on basic accessibility principles and standards-compliant coding practices;
- establish internal policies and guidelines for accessibility within their projects, and, if relevant, their departments or institution;
- consider a broad range of learning styles and disability types during the earliest phases of conceiving and designing a project;
- analyze the experiences of participants with different types of disabilities along with other demographic groups when reporting research results; and
- when reporting limitations of their studies, include those related to accessibility.

Recommendations for Future Actions

In the future—both in near-term (1-3 years) and longer-term (3-5 years) timeframes—online learning researchers should develop and promote practices related to the following suggestions that fully embrace disability-related considerations into their research workflows. They should

- implement an agile, iterative design process that involves users with a wide variety of disabilities and other human characteristics in all phases of the research and design process;
- actively participate in collaboration and communication among academia and industry on issues pertaining to the accessible design of online learning tools and instructional practices;
- contribute to the development and sharing of guidelines for accessible design of online learning tools and pedagogy;
- avoid being deterred by cost. Low-cost interventions can provide great benefits to users. On the other hand, early designs of innovative technologies may be quite expensive, but long term, if widely adopted and/or if adjustments are made to the design, the cost per user can drop significantly;
- articulate the broad characteristics of potential users in the design of a tool or pedagogy being developed or studied, and specify how the characteristics of various groups of individuals with disabilities will be addressed in the research design;
- resist generalizing all people who share a specific disability when designing technology to improve access for a population—for example, designing something to improve access for people who are blind should consider that not all people who identify as “blind” have the same vision capabilities or personal preferences for learning. Technology design should allow the user to customize their experience;

- if instructor guidelines will be created as part of the study, share information about accessibility issues for students with disabilities, including how some activities/products developed in the project may not be accessible to certain groups (e.g., students who are blind) along with suggested accommodations that might be provided (e.g., working with a sighted person); and
- integrate accessibility recommendations into existing project management practices to keep them on the forefront, rather than being an afterthought. Doing so will allow accessibility to be addressed as an integrated part of the project.

LESSONS LEARNED

Two lines of research can make important contributions to the online learning field: (1) building products and pedagogy that benefit individuals with specific disabilities and (2) creating mainstream technology and pedagogy that are accessible to all students, including those with a wide range of disabilities. In particular, online learning researchers are encouraged to pursue research in both learning science and technology design that specifically addresses the unique needs of individuals who have a wide variety of abilities and other diverse characteristics. Research is needed to evaluate accessibility implications of current and emerging technologies, solve accessibility problems that exist with current technologies, and harness emerging technologies into solving accessibility challenges. Research is also needed that helps to reduce the cost of accessibility implementation so that it can be more feasible on a large scale.

The ideal state for future online learning research is that researchers routinely include individuals with disabilities and accessibility considerations within every phase of research, design, development, and evaluation processes. Reaching this goal requires a paradigm shift from designing for some to designing for everyone. In order for online learning to be effective for all students, including those with disabilities, many stakeholders need to be involved to work together toward a common goal. Roles of various stakeholder groups in supporting positive change are suggested in the paragraphs that follow.

- *Researchers*: The availability of inclusive online learning technology and practices will increase if online learning researchers routinely include individuals with disabilities and accessibility considerations within every phase of their design, development, and evaluation processes.
- Students with disabilities and their allies: Students who report accessibility barriers with respect to an online learning activity can encourage instructors to design more accessibly, especially when they not only register a concern, but suggest a solution. Instructors, in turn, can share the need for research in this area with researchers in their field.
- *Online learning designers and instructor*s: Practitioners can apply practices supported by the science of learning overlaid with UD, UDL, and WCAG principles and related guidelines and practices throughout their course development workflows. They can ensure that all tools used for online learning are tested and verified for accessibility and work around inaccessible features, perhaps in collaboration with disability service personnel through accommodations for specific students with disabilities.

- *Instructors of K-12 and postsecondary computing courses*: The creation of more accessible cyberlearning tools of the future can be promoted when those who teach computer science and other IT-related courses teach about access issues for individuals with disabilities, including barriers that are erected by IT, and how they can be avoided through standards-compliant and other inclusive design practices.
- *Disability services staff*: Disability services staff should be responsive to requests for accommodations from students with disabilities and provide reasonable accommodations that give them access to online course content and activities in a timely manner. In their interactions with faculty and designers, they can encourage the application of inclusive technologies and teaching practices in research and practice.
- *Educational administrators and other leaders*: Educational leaders at all levels who value diversity, equity, and inclusion can ensure that policies and processes in all areas of the organization reflect this view by proactively addressing potential access issues for individuals with disabilities. Specifically, they can implement policies, guidelines, and procedures related to accessibility, as well as ensure that sufficient staffing, training, and resources are available to support these efforts.
- *Personnel who procure online learning products*: To ensure that institutions meet their legal anethical obligations for access, procurement administrators can put processes in place for those who procure IT and related products and services to ensure that online learning technologies are tested and verified for accessibility prior to purchase and deployment.
- *Technology companies*: To develop expertise within IT companies, company leaders can include accessibility knowledge and skills among the qualifications in job announcements and demonstrate a preference for hiring people who meet these qualifications. They can also offer training opportunities to current staff and encourage colleges and universities to teach about accessibility in computing courses.
- *Funding agencies*: Agencies that fund online learning projects can require those projects to develop technology and pedagogy that is accessible to individuals with disabilities. Funded projects could be required to design prototypes and project products that comply with WCAG, apply UD principles to on-site and online environments, incorporate UDL practices in learning activities, and share the participation and experiences of individuals with disabilities in project reports and published articles. In cases where innovative designs are in early stages of development and there are not enough resources to make the designs fully accessible, projects should, within their reports and published articles, recommend future research that would address accessibility issues.

CONCLUSION

Attracting more individuals with disabilities can help the United States meet the demand for professionals in critical fields of study and application, including those in STEM. With increasing rates of educational opportunities delivered online, it is critical that they be made accessible to individuals who have disabilities. In order to ensure the accessibility of online education in the future, researches that focus on technology and pedagogy must consider accessibility issues in all aspects of their research and those who develop and teach online courses must use accessible IT and employ inclusive pedagogical practices.

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