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Special Issue: Including Disability-Related Topics in Postsecondary Courses and Professional Development

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From the Guest Editor: Sheryl Burgstahler, Ph.D.

Special Issue on Including Disability-Related Topics in Postsecondary Courses and Professional Development

The articles in this special issue of the *Journal of Postsecondary Education and Disability (JPED)* reflect diversity of scholarship regarding how disability-related topics can be included in the curriculum of academic courses and professional development offered by postsecondary institutions. I'm hoping that the inclusion of such content in educational offerings will increase the number of practitioners, educators, and researchers who understand how to design products and environments that are accessible to and inclusive of people with disabilities. Authors make it clear that disability services professionals can contribute to the implementation of these practices by leading them, supporting them, and promoting them on their campuses.

I was somewhat surprised to discover that the vast majority of practices reported in papers submitted for this issue employed universal design (UD) approaches to the creation of physical environments, to teaching and learning activities, and/or to technologies. Therefore, I think it would be good for me to share the history and meaning of UD as well as the Universal Design in Higher Education (UDHE) Framework that I developed. This Framework is detailed my book—*Creating inclusive Learning Opportunities in Higher Education: A Universal Design Toolkit* —that is reviewed by Margo Izzo at the end of this issue[2]. The three subsections that follow cover the history and meaning of UD, the UDHE Framework, and a description of each article included in this JPED issue.

History of UD

Many design practices stem from ableist thinking by focusing only on the average or typical user; they can ignore design considerations important for people with disabilities and those with another marginalized status. In addition, most efforts to support students with disabilities on postsecondary institutions are designed to support accommodations for individual students. The universal design (UD) approach has been promoted by educators world-wide to reduce the need for accommodations by eliminating deficits in products and environments—e.g., online and onsite components of courses, technology, services, and physical spaces—that make them inaccessible to some people. Embracing UD reduces systemic barriers and exclusionary practices in order to create more accessible and inclusive spaces, technology, instruction, and services.

Ronald Mace—a wheelchair user who was also an internationally recognized architect, commercial product designer, and educator—coined the term "universal design" to refer to the design of products, environments, and services so that they are accessible to, usable by and inclusive of all people, regardless of age, ability, and other characteristics. As presented in Figure 1, any UD practice is designed to be accessible, usable, and inclusive. Among the beneficiaries of the proactive practice of UD are individuals who have disabilities but do not disclose them, people with various learning preferences and technological expertise, those whose native language is not English, the elderly, people from different cultures, and everybody else!

Since the work of Mace, UD has been applied to a wide variety of products and environments and various definitions and principles and guidelines have emerged to address unique aspects of specific fields of application.

The UDHE Framework

Infusing UD into all aspects of higher education can reduce ableist attitudes and practices, destigmatize disability, and make all that we do more inclusive of everyone. UDHE:

- is a goal to make all offerings accessible and usable for faculty, staff, students, and visitors with diverse characteristics.
- supports diversity, equity, and inclusion goals for the design of all on-site and online products and environments found in higher education.
- considers differences in ability, as with other diversity characteristics, to be part of the normal human experience.
- is a process for developing flexible educational

[2] This book review was accepted through regular editorial process independent of the development of this special issue. It was originally requested during Dr. Wessel's editorship, and Drs. Wells and Kimball accepted it for publication. They then saw an opportunity for it to speak to the content of this special issue, and placed it here purposefully. The special issue editor and the author of the reviewed book, Dr. Sheryl Burgstahler, played no role in the solicitation, acceptance, or publication of this book review.

Figure 1

Characteristics of Any UD Practice (Source: Burgstahler, 2021, p. 2)

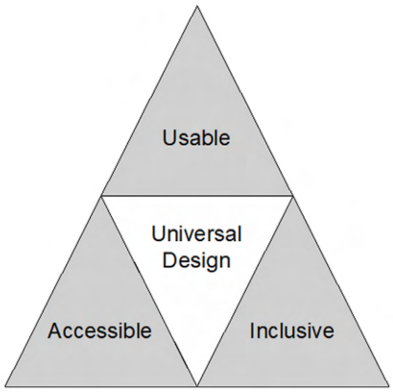


Figure 2

Aspects of the UDHE Framework (Source: Burgstahler, 2021, p. 2)

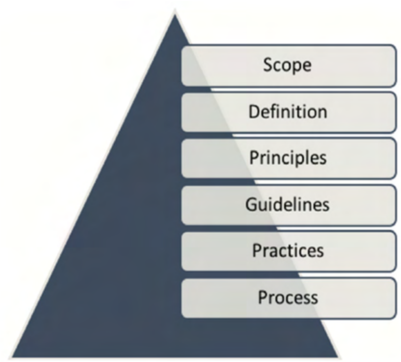
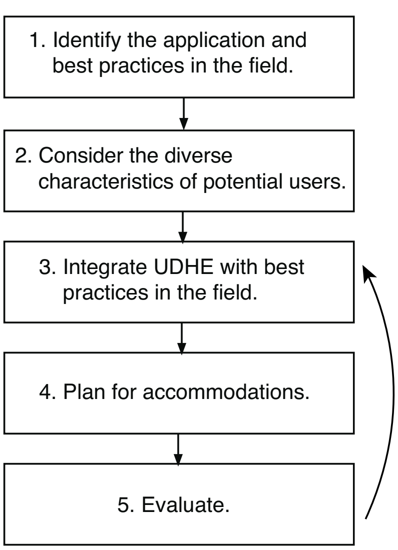


Figure 3

Process for applying UDHE (Source: Burgstahler, 2021, p. 5)



products and environments that are welcoming to, accessible to, and usable by everyone.
- improves any design by making it more inclusive.
- reduces the need for disability-related accommodations.

Aspects of the UDHE Framework that can be applied campus-wide or to any specific application in higher education (e.g., to online learning) are listed in Figure 2. Each component of the Framework is discussed below.

Scope. Define the application area to which UDHE is to be applied.

Definition. Use the general definition of UD developed by Ron Mace or one that better fits your application area and campus culture.

Principles and Guidelines. The basic UD definition, coupled with seven principles and their corresponding guidelines, have been applied extensively to physical environments, instructional practices, services, and technology. Although the general principles and guidelines can be used to guide work in any area, additional principles for important application areas have emerged as well. The ones I consider to be most relevant to postsecondary education are the Universal Design for Learning (UDL) principles and guidelines that apply to the design of curriculum and pedagogy and the four principles that support the Web Content Accessibility Guidelines (WCAG) and guide the design of technology. Applying all three sets of principles has the potential to make all offerings in higher education more accessible, usable, and inclusive.

- UD principles lead to products and environments that are equitable, are flexible, are simple and intuitive, present information that is perceptible by everyone, have a high tolerance for error, require low physical effort, and are of an appropriate size and space for approach and use.
- WCAG principles lead to IT products and the materials they create that are perceivable, operable, understandable, and robust.
- UDL principles remind educators to offer students multiple means of engagement, of representation, and of action and expression.

Practices. Develop practices underpinned by UDHE principles and guidelines. Examples of practices supported by UDHE principles are listed in Table 1.

Processes. Develop a process for applying UD principles and guidelines to applications within the scope of your application area; an example of a process is presented in Figure 3.

For more information about how UD can be applied to all aspects of postsecondary education, consult the online Center for Universal Design in Education (CUDE, n.d.) which is hosted by the Disabilities, Opportunities, Internetworking, and Technology (DO-IT, n.d.) Center at the University of Washington (UW) and primarily funded by the U.S. Department of Education and the National Science Foundation.

Articles in This Issue of JPED

Six promising practices and two research studies are presented in this issue. They are summarized in the paragraphs that follow.

In the first research article, Anastasia Angelopoulou, Rania Hodhod, Kristin Lilly, and Ann Newland point out that computing courses do not often include content about designing and developing accessible and inclusive applications. In their study, students learned to design, develop, and evaluate accessible applications, but also reported that they would consider designing and developing accessible and inclusive applications in their future work. In the other research study, Michele L. Thornton, Rebecca W. Mushtare, Laura J. Harris, and Kathleen M. Percival described how their campus Workgroup on Accessibility Practices created a motivating 10-day accessibility challenge, implemented it on campus, and evaluated its effectiveness using a mixed methods research design. They conclude that challenge-type interventions can reach diverse constituencies, build greater familiarity and utilization of existing resources, and increase participant confidence around their ability to contribute to a culture of accessibility and inclusion.

One article shares how the application of universal design can improve physical access at colleges and universities. Lauren Copeland-Glenn and Christopher Lanterman, Northern, created the Accessibility Expedition, in which disabled individuals and individuals knowledgeable of principles for accessible and universal design engage participants in an exploration of campus spaces followed by a debriefing session to discuss barriers to equitable participation, evidence of accessible or universal design practices, and steps that can be taken to make a more accessible campus.

The other five practice articles share specific applications of accessible, inclusive, and universal design to instructional practices. The authors—Erin Leif, Elizabeth Knight, Jessica Buhne, Elicia Ford, Alison Casey, Annie Carney, Jennifer Cousins, Stuart Dinmore, Andrew Downie, Mary Dracup, Jane Goodfellow, Meredith Jackson, Noor Jwad, Dagmar Kminiak, Darlene McLennan, Mary-Ann O'Donovan, Jessica Seage, Mirela Suciu, and David Swayn—of one article report on a practice that was designed to

Table 1

Examples of UDHE Practices (Source: Burgstahler, 2021, p. 4)

UDHE Principle	Example of UDHE Practices
UD 1. Equitable use	Career services. Job postings are in formats accessible to people with a great variety of abilities, disabilities, ages, racial/ethnic backgrounds, and technologies.
UD 2. Flexibility in use	Campus museum. An exhibit design allows a visitor to choose to read or listen to descriptions of the contents of display cases.
UD 3. Simple and intuitive	Assessment. Testing is conducted in a predictable, straightforward manner.
UD 4. Perceptible information	Dormitory. An emergency alarm system has visual, aural, and kinesthetic characteristics.
UD 5. Tolerance for error	Instructional software. An application provides guidance when a student makes an inappropriate selection.
UD 6. Low physical effort	Curriculum. Software includes on-screen control buttons that are large enough for students with limited fine motor skills to select.
UD 7. Size and space for approach and use	Science lab. An adjustable table and flexible work area is usable by students who are right- or left-handed and have a wide range of physical characteristics.
UDL 1. Multiple means of engagement	Courses. Multiple examples ensure relevance to a diverse student group.
UDL 2. Multiple means of representation	Promote services. Multiple forms of accessibly designed media are used to communicate services provided.
UDL3. Multiple means of action and expression	Course project. An assigned project optimizes individual choice and autonomy.
WCAG 1. Perceivable	Student service website. A person who is blind and using a screen reader can access the content in images because text descriptions are provided.
WCAG 2. Operable	Learning management system (LMS). A person who cannot operate a mouse can navigate all content and operate all functions by using a keyboard (or device that emulates a keyboard) alone.
WCAG 3. Understandable	Instructional materials. Definitions are provided for unusual words, phrases, idioms, and abbreviations.
WCAG 4. Robust	Application forms. Electronic forms can be completed using a wide range of devices, including assistive technologies.

increase knowledge and skills of Australian educators to help them avoid erecting barriers by applying UD principles. They describe how they brought together a diverse a team of educators, learning designers, accessibility advocates, and people with disabilities from multiple institutions collaborated to co-create an accessible eLearning program to build workforce knowledge and skill in making courses more inclusive.

Brian W. Stone and Deana Brown focus more narrowly on the need for specialized instructional products, in this case the need for 3D educational resources for students who are blind, while simultaneously teaching students about accessibility and universal design. They designed and taught the experimental course in which students learned about disability in general and blindness in particular; explored technology used by people who are blind; heard from many blind individuals; studied UD; and designed 3D printable educational tactile models in collaboration with blind community members. This practice can serve as a model for those who wish to teach students from any major about disability and UD as they meaningfully contribute to addressing real educational barriers.

Two articles focus specifically on how to make more online learning courses accessible to and inclusive of students with disabilities. The work of authors Mohan Yang, Victoria Lowell, Yishi Long, and Tadd Farmer was motivated by the fact that online learning environments can present especially challenging circumstances for disabled students despite the advantages they could potentially bring. They present the design and development of three self-paced e-learning modules that teach instructional design students to create accessible online learning content and share lessons learned. Christa Miller describes two practices and shares their results in making accessibility concepts a natural part of training in online tools and teaching at a postsecondary institution. One practice integrated accessibility training within existing professional development requirements and the other used a multi-session accessibility training addressing knowledge gaps.

A final brief shows how postsecondary education can have an impact on making precollege instruction more inclusive. While more universities are including IT accessibility in their computer science programs for undergraduate and graduate students, there is little training in accessibility available for K-12 teachers. In their article, Rachel F. Adler and Devorah Kletenik introduce an activity they created and tested that can be used as part of the curriculum in courses for K-12 teachers who are learning to teach computer science content.

It is my pleasure to share this collection of articles with JPED readers. Collectively, the practices they support can contribute to a paradigm shift from design for the typical person to design for everyone.

Sheryl Burgstahler, Ph.D., University of Washington
Guest Editor

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About the Guest Editor

Dr. Sheryl Burgstahler founded and continues to direct Accessible Technology Services—which includes the DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center and the IT Accessibility Team (ITAT)—at the University of Washington. These groups (1) support the success of students with disabilities in postsecondary education and careers and (2) promote the universal design of learning opportunities. She teaches online an hybrid courses on disability studies. Her latest book is *Creating Inclusive Learning Opportunities in Higher Education: A Universal Design Toolkit*.

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Introducing Accessible Design to Students in Computer Science

Anastasia Angelopoulou[1]
Rania Hodhod[1]
Kristin Lilly[1]
Ann Newland[1]

Abstract

People with disabilities rely on a range of accessible technologies to interface with the digital world. However, their needs are often not considered when developing applications in introductory computer sciences courses. These courses traditionally focus on teaching technical skills that do not include those for designing and developing accessible and inclusive applications. Thus, there is a critical need to enhance students' understanding of designing, developing, and building applications with the needs of people with disabilities in mind early in the computer science program. In this work, we introduced students to designing, developing, and evaluating accessible applications over three academic semesters. We then assessed the impact of accessibility-related activities and the course delivery mode on students' knowledge about accessibility in computer science courses. Our study involved students enrolled in undergraduate computer science courses (*N*=76) and analyzed students' feedback to provide insights that can inform the decision of teaching accessible application design in higher education settings. The results indicate that students became more confident, interested, and familiar with accessible technology after attending a workshop that introduced them to accessibility measures and how they can be included in the software development process. Moreover, students reported that they would consider designing and developing accessible and inclusive applications in their future work.

Keywords: accessibility, computer science, undergraduate courses

Section One: Introduction

Traditionally, computer science courses focus on teaching programming, technical, and problem-solving skills. Students enrolled in computer science programs have few opportunities to learn about designing and developing accessible applications that meet the needs of people with disabilities. According to the Teach Access fact sheet (Teach Access, 2020), the percentage of engineering and computing technology course descriptions that reference "accessibility" or "people with disabilities" is less than 3%. Examples of courses that have incorporated accessibility in their curriculum include (Shinohara et al. 2018) software engineering (Martin-Escalona, 2013), web development (Ko & Ladner, 2016), Human Computer Interaction (HCI), and design courses. However, introductory and first-year programming courses in computer science focus mostly on how to learn the basics of programming and not on how to develop accessible and inclusive applications. Although people with disabilities rely on a range of accessible technologies to interface with the digital world, their needs are usually not considered when developing applications in such introductory courses. Therefore, there is a critical need to enhance students' understanding of designing, developing, and building applications with the needs of people with disabilities in mind early in the computer science program.

One way to enhance students' understanding is for instructors to consider new components for teaching how to design and develop accessible applications, evaluate applications in terms of accessibility, and create accessible data visualizations. Data visualization gives us a clear idea of what the information means by giving it visual context through maps or graphs (Ryan et al., 2019). Visual context makes the data more nat-

[1] *Columbus State University*

ural for the human mind to comprehend and therefore makes it easier to identify trends, patterns, and outliers within large data sets. However, creating accessible data visualization is usually a challenge. A typical practice for creating accessible data visualizations is to provide alternative text or a data table. This practice may be limited to simple charts and not support analytical tasks or more advanced designs (Siu et al., 2021). Also, many visualization tools do not support accessible design or, even when they do, they can be difficult or confusing to learn (Joyner et al., 2022).

In this paper, we surveyed students enrolled in introductory computer science courses before and after being introduced to accessibility-related activities and teaching materials. We conducted this study to assess the impact of accessibility-related activities and the course delivery mode on students' knowledge about accessibility in undergraduate computer science courses. The objective is to understand if students' knowledge about accessible design increased after being introduced to the accessibility-related activities and identify any changes in students' knowledge due to the course delivery mode and the addition of an accessibility workshop. The study also aims to study students' decisions on accessible design by having them evaluate applications that they commonly use. This paper presents the results and student feedback of the study. Although we may not be able to generalize the results due to the scope of the research, the findings can still suggest recommendations and insights to computer science instructors and institutions on how to select and implement accessibility-related activities in their courses.

The paper presents a case study of accessibility-related material and activities adopted in two computer science courses. More specifically, the course instructors of the Computer Science I and the Data Structures course at our university developed accessibility-related material and introduced students to a workshop in the Fall 2020, Spring 2021, and Fall 2021 semesters. Our study is expected to contribute to further exploratory or descriptive research in the area of teaching accessibility in computer science. Even though our research is solely based on student surveys, the authors expect that instructors and academic experts will be able to find the results and student feedback useful and identify any changes in student knowledge due to the course delivery mode and the type of accessibility-related materials. The outcomes identified in this study provide useful insights that can inform faculty decisions when adopting or creating accessibility-related activities in their courses.

The remainder of the paper is organized as follows: Section Two describes related work on teaching accessibility in computer science courses. Section Three provides an overview of the study design and participants along with a description of the courses and the activities related to teaching accessible design. Section Four describes our assessment of the impact of these activities through student surveys administered before and after instruction about accessibility and presents results from Likert-scale and open-ended feedback from students about their experience teaching accessibility course enhancements. Finally, Section Five reflects on lessons learned and recommendations for future efforts to teach accessibility.

Section Two: Background

The demand for accessible software has continuously increased over the past years. For example, in the United States (U.S.), Section 508 of the Rehabilitation Act (https://www.section508.gov/) requires all electronic technology procured, developed, and used by the federal government to be accessible to people with disabilities. However, most software engineers and designers are not taught about accessibility (Velasco et al., 2004) and overlook the accessibility of software products and services. Thus, educational institutions nationwide and, particularly, computer science programs need to educate the general student population to understand the needs of people with disabilities so that they can design accessible applications.

A number of postsecondary instructors have begun teaching accessibility as part of computer science courses. A survey conducted by Shinohara et al. (2018) examined the extent to which computing and information science faculty in the U.S. teach accessibility. The study had a representative sample of at least one response from 318 institutions, for a total of 1,857 responses. The results indicated that half of the institutions (50%) had at least one instructor teaching accessibility and approximately 2.5% of faculty overall teach accessibility.

Other efforts reported by faculty involved the incorporation of assistive technology or teaching accessibility into computer science courses (Cohen et al., 2005; Shinohara et al., 2017; Zhao et al., 2020). Moreover, consortiums such as Teach Access (https://teachaccess.org/) and AccessComputing (https://www.washington.edu/accesscomputing/) develop accessibility learning materials and offer professional development workshops and resources to faculty to help them teach more about accessibility. Work has also been done on documenting accessibility courses to provide insights on how to create a course on accessibility and what is needed to maintain it. For example, El-Glaly (2020) described the development process for teaching accessibility within a graduate software engineering course. The results from this study revealed that software engineering students became more engaged with accessibility through programming and technical problems rather than through educational activities used in design and HCI courses.

In this paper, we present a case study of adopting accessibility-related material and activities in two computer science courses, aiming to assist computer science faculty in their decisions to adopt or create accessibility-related activities to include in their courses.

Section Three: Study Design

This research involved surveying students from two computer science classes before and after being introduced to accessibility-related material. The pre- and post-accessibility surveys included questions about the students' accessibility knowledge, interest in the field, and exposure to accessibility-related technology. Most of the questions were multiple-choice with a couple of open-ended questions related to the students' overall thoughts about the accessibility-related material used in class. The study was designed to assess the impact of accessibility-related activities and the course delivery mode on the students' knowledge about accessibility in computer science courses. The study can provide insights and further recommendations on the introduction of accessible design in computer science courses during the first years of study.

Procedure

We collected data through online surveys that were distributed to undergraduate students enrolled in the Computer Science I course during the Fall 2020, Spring 2021, and Fall 2021 semesters and to students enrolled in the Data Structures course during the Fall 2021 semester. To achieve higher response rates and reduce bias in sampling, the instructors offered extra credit points to complete the survey. Sixty-one (N=61) students (51%) completed the survey. All students participated voluntarily, with the assurance of anonymity. A list of the courses included in this work is provided in Table 1.

Courses and Accessibility Workshop

Computer Science I is an undergraduate programming course that introduces students to computers and programming, problem solving, and algorithm development. Through course and lab assignments, students deliver functional command-line Python applications and develop two essential skills: problem solving and programming skills. Data Structures is an undergraduate course that aims to extend the concepts of primitive data structures that pervades both the theoretical and practical domains of computer science. The Computer Science I course is the first course in the sequence of programming course while Data Structures course is the third.

During the Fall 2020, Spring 2021 and Fall 2021, students in Computer Science I were introduced to newly developed modules related to accessible design principles using the Python 3 programming language. The class was taught online during the Fall 2020 semester (synchronously), online during the Spring 2021 semester (asynchronously with pre-recorded video lectures), and face-to-face during the Fall 2021 semester. The pre-recorded video lectures were available to students across all delivery modes. The students completed surveys before and after they were introduced to the modules. The lectures for all delivery modes included the same accessibility content: presentations of accessibility-related definitions, tools, and applications; videos of people with disabilities interacting with technology; and hands-on programming activities. For more information about the materials and content taught in the course, readers can refer to the project website (Angelopoulou, 2020a) and/or the related LibGuide (Angelopoulou, 2020b).

During the Fall 2021, students in Computer Science I and Data Structures courses were introduced to accessibility through a workshop conducted by the university's accessibility specialist. During the workshop, students were introduced to the benefits of accessible applications for people with disabilities and accessibility standards with examples of the implementation of accessible design in different phases of the software development cycle. Students were provided with resources including accessible design tutorials.

In order to compare the students' confidence, interest, and familiarity with respect to the use of accessibility in the software development cycle, the students were asked to complete pre- and post-surveys. After attending the accessibility workshop, students in both courses completed a group project that involved looking at an application that they often use and evaluating the aspects of that application with respect to accessibility. Students in the Data Structures course completed an additional assignment that involved the development of accessible data structure visualizations while providing rationale for the accessibility measures/aspects they used.

Section Four: Data Analysis and Results

This section summarizes the results from the pre- and post-accessibility online surveys and the assignments/projects that the students completed per

Table 1

Overview of Courses Included in this Work (OS = Online Synchronous, OA=Online Asynchronous, F2F = Face-to-face)

Course Name	Semester	Students (pre, post)	Delivery Method	Accessibility Lectures
Computer Science 1	Fall 2020	(24,11)	OS	2
Computer Science 1	Spring 2021	(26,24)	OA	2
Computer Science 1	Fall 2021	(17,16)	F2F	3
Data Structures	Fall 2021	(9,8)	F2F	1
Total	**All semesters**	**(76,59)**	**OS, OA, F2F**	**8**

course. The survey items used a Likert-scale of 1 to 5, with 1 being "Strongly Disagree/Not at all confident" and 5 being "Strongly Agree/Highly Confident." The students' responses and feedback were analyzed by course, delivery mode (i.e., face-to-face, online synchronous, online asynchronous), and inclusion of an accessibility workshop as part of the course content to better understand the impact of each factor on the students' knowledge about accessibility in computer science courses and provide further insights to faculty interested in introducing accessibility in computer science courses.

Analysis by Course

Computer Science I. For the pre-survey, there were a total of 24 responses in Fall 2020, 26 in Spring 2021, and 17 in Fall 2021. For the post-survey, there were a total of 11 responses in Fall 2020, 24 in Spring 2021, and 16 in Fall 2021. The results from the student surveys for Fall 2020, Spring 2021, and Fall 2021 are summarized in Tables 2-4, respectively. The results from student surveys indicate that students' knowledge about accessibility design increased across all semesters. Usage of assistive technologies also significantly increased.

In Fall 2020, all students felt more confident after being introduced to accessibility-related lectures, assignments, and materials. More specifically, students felt more confident about giving examples of universal design, accessible technologies, and technological barriers that people with disabilities might face, as well as about defining the Web Content Accessibility Guidelines (WCAG). These differences between the pre- and post- confidence around examples of accessibility and universal design were statistically significant ($p < 0.05$) using two-sample t-tests. Table 2 summarizes the results for Fall 2020.

The results from the Spring 2021 semester surveys indicate that, in some cases, student confidence decreased after being introduced to accessibility-related topics. More specifically, student confidence for giving an example of describing a type of disability decreased. Moreover, students' interest in learning more about designing or developing technologies for and with people with disabilities or in pursuing a job or research in accessible technology and the development of accessible applications decreased. However, these differences in students' confidence and interest in accessibility were not statistically significant.

On the other hand, students felt more confident in giving examples of inclusive or universal design and how accessible technology can be used by people with disabilities. They were also more confident in defining the purpose of the Americans with Disabilities Act and the Web Content Accessibility Guidelines (WCAG). Table 3 summarizes the results for Spring 2021.

The results from the Fall 2021 semester surveys indicate that students' confidence and familiarity with accessibility-related concepts and features was increased. More specifically, students felt more confident about giving examples of inclusive or universal design, defining the purpose of the Americans with Disabilities Act, and explaining the Web Content Accessibility Guidelines (WCAG). These differences between the pre- and post- confidence around examples of accessibility and universal design were statistically significant ($p < 0.05$) using two-sample t tests. However, students' interest in learning more about designing or developing technologies for and

Table 2

Pre- and Post-Survey Results for the Computer Science I Course During Fall 2020

Statement	Pre (*N*=24)	Post (*N*=11)	Delta
Give an example of a type of disability	3.75 (1.29)	4.50 (0.85)	+20%
Define "accessibility" as the term relates to technology and media	3.30 (1.26)	3.90 (0.99)	+18.03%
Give an example of inclusive or universal design	2.54 (1.25)	4.00 (1.25)	+57.38% (*p*-value = 0.00452)
Give an example of how accessible technology is used by people with disabilities	3.39 (1.12)	4.60 (0.70)	+35.64% (*p*-value <0.001)
Give an example of how assistive technology is used by people with disabilities	3.21 (1.21)	4.00 (1.25)	+24.68%
Give an example of a technological barrier somebody with a disability might face	3.42 (1.44)	4.40 (1.07)	+28.78% (*p*-value = 0.0335)
Define the purpose of the Americans with Disabilities Act	2.38 (1.24)	3.30 (1.34)	+38.95%
Explain the Web Content Accessibility Guidelines (WCAG)	1.88 (0.99)	3.00 (1.49)	+60% (*p*-value = 0.039)
Learning more about designing or developing technologies for and with people with disabilities	3.42 (1.17)	3.91 (1.22)	+14.41%
Pursuing a job or career in accessible technology	3.38 (1.31)	3.27 (1.49)	-3.03%
Pursuing research in the development of accessible technologies	2.96 (1.30)	3.18 (1.25)	+7.55%
Have you ever used assistive technology (such as a screen reader for blind or low vision users)?	4.17%	18.18%	+336.36%
How familiar are you with the accessibility features built into devices (such as smartphones, computers or smart TVs)?	3.33 (1.20)	3.18 (1.07)	-4.55%

Table 3

Pre- and Post-Survey Results for the Computer Science I Course During Spring 2021

Statement	**Pre (*N*=26)**	**Post (*N*=24)**	**Delta**
Give an example of a type of disability	4.40 (1.08)	4.08 (1.35)	-7.20%
Define “accessibility” as the term relates to technology and media	3.88 (1.11)	3.83 (1.34)	-1.32%
Give an example of inclusive or universal design	3.08 (1.55)	3.26 (1.51)	+5.98%
Give an example of how accessible technology is used by people with disabilities	3.69 (1.29)	3.83 (1.34)	+3.82%
Give an example of how assistive technology is used by people with disabilities	3.80 (1.32)	3.96 (1.40)	+4.17%
Give an example of a technological barrier somebody with a disability might face	4.08 (1.26)	4.13 (1.23)	+1.10%
Define the purpose of the Americans with Disabilities Act	3.42 (1.52)	3.58 (1.28)	+4.68%
Explain the Web Content Accessibility Guidelines (WCAG)	2.65 (1.41)	3.00 (1.53)	+13.04%
Learning more about designing or developing technologies for and with people with disabilities	3.58 (1.24)	3.29 (1.56)	-7.97%
Pursuing a job or career in accessible technology	3.38 (1.50)	2.96 (1.49)	-12.59%
Pursuing research in the development of accessible technologies	3.42 (1.42)	3.13 (1.45)	-8.71%
Have you ever used assistive technology (such as a screen reader for blind or low vision users)?	19.23%	33.33%	+73.33%
How familiar are you with the accessibility features built into devices (such as smartphones, computers or smart TVs)?	3.46 (1.27)	3.46 (1.61)	0%

with people with disabilities decreased. Table 4 summarizes the results from the pre- and post-surveys during Fall 2021.

Overall, the applications that the students developed during all semesters in the CS1 course became more accessible compared to the previous years' applications. Students' programs had more descriptive prompts that were clear to the user and allowed for input interactivity. Also, when students were asked if there is content relating to disability or accessibility that they wished had been covered in this course that was not, all students answered that they felt well-informed. They also provided examples of how they will apply what they learned about accessible design and development in their future education, career, or personal life, such as being more aware of the needs of people with disabilities and making sure to include more accessible content when designing their software or web applications.

Overall, all students' confidence and interest in accessibility increased in all semesters, except during the Spring 2021 semester, when the confidence was lower. The decrease in students' confidence and interest in accessibility during the Spring 2021 course may be due to the different format of the class and the pandemic. During the Fall 2020 semester, students were introduced to the concepts online via synchronous delivery. During the Spring 2021 semester, the course format was asynchronous online, so students may not have watched the video or completed the relevant activities on their own. Also, two students in the post-survey answered with "1" across the board, which may indicate that they thought 1 was the highest score rather than the lowest or they just completed the survey without reading the questions properly. We further investigate the impact of the course format on the students' confidence and interest in the next subsection.

Impact of course format on student confidence. We performed a one-way analysis of variance (ANOVA) test to determine if differences in the mean scores of the students' confidence and familiarity with accessibility could be attributed to the course delivery (i.e., face-to-face, online synchronous, or online asynchronous). We further explored if there are differences by conducting pairwise comparisons among the three course delivery modes via the Tukey HSD test.

The results from the tests indicate that there are no significant differences in the mean scores of the students' confidence and familiarity with accessibility based on the course delivery mode. However, it was observed that the confidence in giving examples of inclusive or universal design, of how accessible technology is used by people with disabilities, and of a type of disability, as well as the interest in pursuing a job or career in accessible technology was lower during the online asynchronous delivery mode compared to the other two course delivery modes. Moreover, students' confidence in defining accessibility and the purpose of the Americans with Disabilities Act was lower during the face-to-face course compared to other two course delivery modes. Finally, the students' confidence and interest in accessibility were higher when the course was delivered online synchronously.

Data Structures course. The accessibility-related activities were introduced in the Data Structures course in the Fall 2021 semester for the first time. For the pre-survey, there were a total of 9 responses in Fall 2021. For the post-survey, there were a total of 8 responses. The results from the student surveys are summarized in Table 5.

The results from the Fall 2021 semester surveys indicate that the confidence in some cases was lower after the students were introduced to accessibility-related activities. More specifically, student confidence for giving an example of type of disability or a definition for disability decreased. Students' confidence in defining the purpose of the Americans with Disabilities Act or giving an example of how assistive technology is used by people with disabilities was also decreased. Moreover, students' interest in learning more about designing or developing technologies for and with people with disabilities or in pursuing a job or research in accessible technology and the development of accessible applications decreased. However, these differences in students' confidence and interest in accessibility were not statistically significant.

On the other hand, students felt more confident in defining the Web Content Accessibility Guidelines (WCAG) (p = 0.0281), and became more familiar with the accessibility features built into devices (p = 0.047).

Analysis of Results for Both Courses and the Workshop During Fall 2021

In this section, we analyze the results for both courses separated by confidence, interest, and familiarity questions. During the Fall 2021 semester, we received a total of 26 pre-survey student responses and 24 post-survey responses.

The confidence questions asked how confident students felt about various accessibility aspects from a scale of 1 (Not at all confident) to 5 (Extremely confident). The results of the confidence questions are presented in Table 6.

Table 4

Pre- and Post-Survey Results for the Computer Science I Course During Fall 2021

Statement	**Pre (N=17)**	**Post (N=16)**	**Delta**
Give an example of a type of disability	4.29 (0.92)	4.50 (0.73)	+4.79%
Define "accessibility" as the term relates to technology and media	3.24 (0.90)	3.75 (0.93)	+15.91%
Give an example of inclusive or universal design	3.00 (1.00)	3.75 (0.93)	+25% (*p*-value = 0.033)
Give an example of how accessible technology is used by people with disabilities	3.35 (0.93)	3.88 (1.02)	+15.57%
Give an example of how assistive technology is used by people with disabilities	3.47 (1.12)	3.88 (0.89)	+11.65%
Give an example of a technological barrier somebody with a disability might face	3.94 (1.03)	3.94 (1.06)	0%
Define the purpose of the Americans with Disabilities Act	2.29 (1.10)	3.06 (1.00)	+33.49% (*p*-value = 0.0434)
Explain the Web Content Accessibility Guidelines (WCAG)	2.06 (0.90)	3.00 (0.89)	+45.71% (*p*-value = 0.00509)
Learning more about designing or developing technologies for and with people with disabilities	3.35 (1.22)	3.13 (1.02)	-6.80%
Pursuing a job or career in accessible technology	2.65 (1.32)	3.06 (1.29)	+15.69%
Pursuing research in the development of accessible technologies	2.35 (1.22)	2.88 (1.15)	+22.14%
Have you ever used assistive technology (such as a screen reader for blind or low vision users)?	41%	56%	+36.61%
How familiar are you with the accessibility features built into devices (such as smartphones, computers or smart TVs)?	2.65 (0.93)	3.31 (1.01)	+25.14%

Table 5

Pre- and Post-Survey Results for the Data Structures Course During Fall 2021

Statement	Pre (N=9)	Post (N=8)	Delta
Give an example of a type of disability	4.33 (1.12)	4.00 (1.41)	-7.69%
Define "accessibility" as the term relates to technology and media	3.67 (1.00)	3.50 (1.31)	-4.55%
Give an example of inclusive or universal design	2.89 (0.93)	3.25 (1.28)	+12.50%
Give an example of how accessible technology is used by people with disabilities	3.78 (1.30)	4.13 (1.46)	+9.19%
Give an example of how assistive technology is used by people with disabilities	3.78 (1.30)	3.25 (1.28)	-13.97%
Give an example of a technological barrier somebody with a disability might face	4.00 (1.12)	4.25 (1.39)	+6.25%
Define the purpose of the Americans with Disabilities Act	2.33 (1.41)	2.25 (1.04)	-3.57%
Explain the Web Content Accessibility Guidelines (WCAG)	1.89 (0.93)	3.25 (1.28)	+70.06% (*p*-value= 0.0281)
Learning more about designing or developing technologies for and with people with disabilities	3.56 (1.33)	3.13 (1.25)	-12.11%
Pursuing a job or career in accessible technology	2.78 (1.30)	2.63 (1.06)	-5.50%
Pursuing research in the development of accessible technologies	3.22 (0.97)	2.88 (0.99)	-10.78%
Have you ever used assistive technology (such as a screen reader for blind or low vision users)?	25%	25%	0%
How familiar are you with the accessibility features built into devices (such as smartphones, computers or smart TVs)?	2.67 (0.50)	3.50 (0.93)	+31.25% (*p*-value= 0.047)

In general, all students felt more confident after the workshop regarding accessibility issues. This confidence was most pronounced for explaining the Web Content Accessibility Guidelines (WCAG), and the difference was statistically significant ($p < 0.001$) using the Wilcoxon Signed-Rank survey. Students felt moderately more confident about defining accessibility in technology, giving examples of universal design and accessible technologies, and defining the American with Disabilities Act. There was a very little increase in confidence for students to give examples of a disability, an assistive technology, and a technological barrier.

The second part of the pre-survey and post-survey was gauging student interest on further opportunities regarding accessibility, including pursuing a career or doing research involving accessibility technologies. The scale for the interest questions ranges from 1 (Not interested at all) to 5 (Extremely interested). Table 7 shows summary results for the second part of the surveys.

As can be seen from Table 7, students were more interested after the workshop in pursuing a job or career and doing research in accessible technology. However, students were slightly less interested in learning more about designing or developing technologies for people with disabilities after the workshop. Perhaps, this could be explained by the fact that the students did learn more during the workshop, so after the workshop they may be less interested, as they had just learned quite a bit.

The last section of the survey had one last question about student familiarity with accessible technology in devices, such as TVs and phones. The answers ranged from 1 (Not at all familiar) to 5 (Extremely familiar). The results from this question are shown in Table 8. The difference in familiarity from the pre-survey to the post-survey is statistically significant ($p = 0.017$) using the Wilcoxon Signed-Rank survey. This implies that the workshop greatly increased student familiarity with accessibility features built into devices.

In addition, students had a chance to evaluate the workshop by answering three questions. The students were allowed to respond on a scale of 1 (Not at all) and 5 (Extremely) to the following questions. The results are in Table 9.

Overall, students were mostly moderately interested, as the averages were all slightly above 3 (Moderately). A majority of students (54.16%) would recommend the workshop to other computer science students, while a slightly higher percentage (58.33%) would recommend the workshop to all students.

Students also had the chance to write-in answers regarding how they would apply what they learned from the workshop in the future. Approximately 15 students did explain further, and a majority (53.33%) said they would be more aware of people with disabilities and make sure to include more accessible content. A few more mentioned specific strategies, including being aware of color contrasts for colorblind people, making audio available so closed captioning could be provided for hard-of-hearing or deaf people, and making font sizes larger for people that are hard-of-seeing or use glasses. In summary, the students did become more confident, interested, and familiar with accessible technology after the workshop, and the students implied they would be more aware and more inclusive in their future work.

Section Five: Conclusions

In this paper, we summarized our efforts in introducing accessibility in introductory computer science courses and analyzing the results from student surveys before and after being introduced to accessibility-related activities and teaching material. We provided a detailed description of our findings about the impact of accessibility-related activities and the course delivery mode on students' knowledge about accessibility.

In general, students' confidence and knowledge about accessible design increased after being introduced to accessibility-related activities across all semesters during the pandemic. Our key findings are summarized below:

- Students' confidence in giving examples of universal design and accessible technologies, defining the purpose of the Americans with Disabilities Act, and explaining the Web Content Accessibility Guidelines (WCAG) significantly increased after the introduction of accessibility-related activities
- Students' interest in pursuing a job or career in accessible technology decreased in most of the cases. The interest was increased when the Computer Science I course was offered via face-to-face delivery with an accessibility workshop addition during the Fall 2021 semester
- The course delivery mode did not have a statistically significant impact on the students' confidence and interest in accessibility in technology. However, the students' responses indicated higher confidence and interest when the course delivery mode was online synchronous
- The addition of the workshop on accessibility increased students' confidence, interest, and familiarity with accessible technology. In par-

Table 6

Average Pre- and Post-Survey Responses to Confidence Questions for Both Courses in Fall 2021

Statement	Pre (N=26)	Post (N=24)	Difference
Give an example of a type of disability.	4.31 (0.97)	4.33 (1.01)	0.03
Define accessibility as the term that relates technology and media.	3.38 (0.94)	3.67 (1.05)	0.30
Give an example of an inclusive or universal design.	2.96 (0.96)	3.58 (1.06)	0.62
Give an example of how accessible technology is used by people with disabilities.	3.50 (1.07)	3.96 (1.16)	0.46
Give an example of how assistive technology is used by people with disabilities.	3.58 (1.17)	3.67 (1.05)	0.09
Give an example of a technological barrier somebody with a disability might face.	3.96 (1.04)	4.04 (1.16)	0.08
Define the purpose of the Americans with Disabilities Act.	2.31 (1.19)	2.79 (1.06)	0.48
Explain the Web Content Accessibility Guidelines (WCAG) (or other guidelines for accessible design and development).	2.00 (0.89)	3.08 (1.02)	1.08 (*p*-value <0.001)

Table 7

Average Pre- and Post-Survey Responses to Interest Questions for Both Courses in Fall 2021

Statement	Pre (N=26)	Post (N=24)	Difference
Learning more about designing or developing technologies for and with people with disabilities.	3.42 (1.24)	3.13 (1.08)	-0.30
Pursuing a job or career in accessible technology.	2.69 (1.29)	2.92 (1.21)	0.22
Pursuing research in the development of accessible technology.	2.65 (1.20)	2.88 (1.08)	0.22

Table 8

Average Pre- and Post-Survey Responses to Familiarity Question for Both Courses in Fall 2021

Statement	Pre (N=26)	Post (N=24)	Difference
How familiar are you with accessibility features built into devices?	2.65 (0.80)	3.38 (0.97)	0.72 (p-value =0.017)

Table 9

Average Responses in the Post-Survey to Evaluate the Workshop in Fall 2021

Statement	Post (N=24)
Did you find the workshop interesting?	3.17 (1.09)
Did you find the workshop applicable to your current academic career?	3.21 (1.14)
Did you find the workshop beneficial to your future studies and career?	3.21 (1.02)

ticular, the workshop significantly increased student familiarity with accessibility features built into devices

One limitation of the study is that, although offering extra credit points to students to complete the survey can reduce bias in sampling and increase response rates, it may limit the generalizability of the research findings (Padilla-Walker et al., 2005) and does not determine the reliability of the study. A second limitation of this study is that we did not work with people with disabilities or a disability service provider during the development of the lecture and assessment materials in the first two semesters of introducing accessibility in the courses. During the last semester, we collaborated with an accessibility specialist to offer a workshop about accessible design. Our recommendation to faculty developing or adopting accessibility content in their classes is to involve disability service units in the process. A third limitation is that the courses did not have content addressing user experience, which may have an effect on the results of this study.

As the demand for digital accessibility consideration and best practices in software design and development increases, so does the demand for teaching accessibility as part of the computer science curriculum. In our future work, we will seek collaboration with disability services offices during the development of content for our classes as they can serve as advisors or help faculty find students with disabilities to work on course development. A future study can explore the impact of exposure to accessibility in the curriculum on student behavior, without having accessibility as a requirement in projects and assignments. Another follow-up study could examine the effect of course context on the results by introducing similar accessibility-related content across various courses.

We hope that the present work and our findings can provide recommendations and insights to computer science instructors and institutions on how to select and implement accessibility-related activities in their courses.

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10-Day Campus Accessibility Challenge

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Abstract

The need to create accessible digital materials became evident when the COVID-19 pandemic shifted nearly all learning online in 2020 and early 2021. Inspired to create professional development that was sensitive to our campus needs at a challenging time, the campus Workgroup on Accessibility Practices created an intervention in the form of a 10-day accessibility challenge. To keep participants (N = 198) motivated and engaged, the 10-Day Accessibility Challenge was designed with self-determination in mind. In this work, we describe the practice and use a mixed methods approach to evaluate its effectiveness. We find that shifting the campus culture toward accessibility and inclusion is an on-going process. To do so requires that campuses commit both time and tangible resources to increasing knowledge and implementation of accessibility principles. Challenge-type interventions can reach diverse constituencies, build greater familiarity and utilization of existing resources, and increase participant confidence around their ability to contribute to a culture of accessibility and inclusion.

Keywords: accessibility, culture change, inclusion, campus initiative

Faculty professional development in postsecondary institutions often take one of two forms: (a) long, multi-module courses that may take a semester or year to complete; or (b) short, intensive offerings such as a brief one-to-two hour presentation and one-to five-day workshops. Longer programs may include multiple modules that cover topics such as disability awareness (including barriers faced by individuals with disabilities), universal design (UD), online accessibility, and laws and regulations (Hsaio, 2019; Moriña et al., 2020; Murray et al., 2014; Open SUNY, n.d.; Rodesiler & McGuire, 2015; Roth et al., 2018). These programs are often voluntary and serve motivated and interested faculty well.

Setting

Professional development related to accessibility on our campus, similar to many others, has typically focused on serving two key audiences: web content editors and faculty. Web content editors often receive one-on-one or small group training as part of onboarding into the role and when updates to the content management system necessitate it. Faculty have been served through a workgroup on accessibility practices. The workgroup began as a collaboration between the Center for Excellence in Learning and Teaching (CELT) and campus instructional designers in 2016 to increase digital accessibility campus-wide. The group has since expanded to include student representatives, faculty, and staff from accessibility resources, the library, communications and marketing, campus technology services, and the Institute for Equity, Diversity, Inclusion and Transformative Practice. Members of the workgroup routinely offer workshops and departmental trainings and maintain the campus digital accessibility website (Workgroup on Accessibility Practices at SUNY Oswego, 2020). A faculty accessibility fellow program was launched in 2019 to expand advocacy, research, and accessibility practices into the disciplines (SUNY Oswego, 2022). Fellows function as accessibility advocates within departments, schools, and disciplinary professional

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organizations to help expand the reach of the workgroup. Campus accessibility efforts are coordinated through the digital accessibility steering committee, which includes representatives from the workgroup, web steering committee, faculty accessibility fellow program, and relevant administrators.

COVID-19 Pandemic

In March 2020, our campus, like many others, shifted to emergency remote instruction. The workgroup responded by increasing its offerings of workshops for faculty on digital, universal design for learning (UDL), and inclusive pedagogy. The group also expanded resources and asynchronous training to include videos and written tutorials on the institution's accessibility website.

Students with disabilities disclosed a wide range of barriers to education during the first year of the Pandemic. Barriers included increased family caretaking obligations, no quiet or distraction-free space for learning, unreliable wi-fi, not receiving their approved accommodations, lack of access to campus resources and technology, lack of synchronous contact with peers and instructors, poorly organized online materials, delayed posting of accessible materials, and lack of accessibility features such as captions on videos (Gierdowski, 2021; Mushtare & Fisk, 2021). Gin et al. (2021) reported similar barriers, including those related to students' access to course content:

> … [I]n-person courses typically allow for multiple ways of accessing course material. For example, if an instructor said something that students did not hear in an in-person course, they could ask a student sitting next to them, raise their hand and ask the instructor to repeat what was said, or approach the instructor after class. … [Online,] there were often fewer ways to access course content that they missed or would want to access again… Additionally, students mentioned that they no longer had access to informal help and resources that they previously had been able to access when courses were taught in-person…(p. 8)

Our team was aware that nationwide, a significant number of students with disabilities (44%) choose not to disclose their disability status (Gierdowski et al., 2020). There are even higher rates of non-disclosure among students with certain types of disabilities. Newman et al. (2011) reported that 76% of students with learning disabilities choose not to disclose, and Mental Health America (2020) reported that 70% of students with mental health disabilities do not disclose. Gierdowski et al. (2020) found that for many students, "The stigma of disability keeps them from applying for services. Some respondents said they have 'anxiety' about contacting the disability services office, are 'uncomfortable' or 'embarrassed,' or are afraid of being turned away, not believed, or being labeled." It was important to our team to support this somewhat invisible group as well as the growing number of other campus community members who were facing Pandemic-related stressors with the potential to impact mental and physical health.

The need for increased accessibility was and remains clear. In March 2020, our campus Accessibility resources office had a staff of two (a coordinator and assistant coordinator) and our campus technology services division had one full-time digital analyst who (in coordination with the accessibility resources office and our instructional design staff) remediated inaccessible course content for a specific subset of online courses. The shift to remote learning increased the number of courses that met these criteria, and it was obvious that remediation at such a large scale would not be fiscally feasible or sustainable. This was an opportunity to empower campus community members to assume responsibility for the accessibility of what they create and distribute.

Structure of the Accessibility Challenge

During the fall 2020 semester, the workgroup designed a professional development opportunity within the context of the Pandemic—in which people were overworked, overwhelmed, and tired. In order to manage participants' cognitive load, the group decided that the program should feel positive, upbeat, supportive, social, informal, and low-stakes. The team identified the following goals for our challenge participants (including students, faculty, staff, and administrators): to increase confidence and skills in applying basic accessibility principles; to increase skills in creating accessible documents; to provide an online space and structure for participants to connect, communicate, and network around the idea of digital accessibility; and to expand our outreach beyond faculty to specifically include students as well as administrators who could work toward institutional change and advocacy at all levels of the institution. To reach these goals, the team applied self-determination theory (SDT) and UDL to create an effective and supportive program. Additionally, existing health and wellness "challenges" that focus on behavior change were used for inspiration.

SDT is a meta-theory that describes motivation on a continuum: on one end of the spectrum is a lack of motivation, followed by different types of external motivations, and at the other end is pure internal motivation (Deci & Ryan, 2000). The more self-determined a behavior is, the more likely that behavior will fulfill three psychological needs (Deci & Ryan, 2000). Patrick and Williams (2012) describe these needs as follows:

> The need for autonomy reflects the need to feel choiceful and volitional, as the originator of one's actions. Competence involves the need to feel capable of achieving desired outcomes... Finally, relatedness reflects the need to feel close to and understood by important others. (p. 3)

Self-determination theory has been extensively studied in the contexts of sports and exercise (Ng et al., 2012), but the qualities described above are also seen in successful games. In the book *Reality is Broken: Why Games Make us Better and How They Change the World*, McGonigal (2011) discusses why games captivate and engage us effectively and can be used to impact positive social change. She also highlights the need for agency (autonomy), satisfying work (competence), and social connectivity or the desire to be a part of something bigger than ourselves (relatedness). The workgroup believed a gamified experience or a challenge with a playful feel and emphasis on skill acquisition and mastery, rather than a typical workshop or workshop series, could bring people together in a time when they felt isolated and afford a change in the community.

UDL principles include offering learners multiple means of engagement, multiple means of representation, and multiple means of action and expression (CAST, 2018a). Each of these principles is organized further into three categories of guidelines: access ("ways to increase access to the learning goal by recruiting interest and by offering options for perception and physical action"), build ("ways to develop effort and persistence, language and symbols, and expression and communication"), and internalize ("ways to empower learners through self-regulation, comprehension, and executive function") (CAST, 2018). The team worked to make sure the program applied all three principles and their related guidelines, with an emphasis on guidelines that overlapped with the motivational strategies informed by SDT. Examples of guidelines with strong alignment with SDT include: 3.1 Activate or supply background knowledge; 5.3 Build fluencies with graduated levels of support for practice and performance; 6.1 Guide appropriate goal-setting; 6.4 Enhance capacity for monitoring progress; 7.1 Optimize individual choice and autonomy; 8.3 Foster collaboration and community; 8.4 Increase mastery-oriented feedback. The implementation of UDL for this Challenge offered us the opportunity to model how to apply UDL framework in learning situations outside of a traditional classroom environment. This opportunity was particularly important when many activities including professional development, meetings, and cocurricular activities were shifting to an online format.

Design, Content, and Logistics

The 10-Day Challenge ran from January 11-January 15 and January 18-January 22, 2021. The second two weeks of January are routinely used for faculty and staff professional development through the campus's CELT office. The workgroup decided to leverage this opportunity, anticipating that utilizing a timeframe faculty, staff, and administrators already set aside would boost awareness and participation. Additionally, this period coincided with winter break for students.

Recruitment and Onboarding. Recruitment for the Challenge began in December 2020. Our campus Office of Communications and Marketing sent initial recruitment email messages to all students, faculty, and staff, and published a campus-wide news story about the Challenge (SUNY Oswego Office of Communications and Marketing, n.d.). Information about the Challenge and how to register was also distributed through communication channels like the Campus Technology Services blog and CELT's digital distribution list. These messages directed potential participants to a Google sign-up form, which collected basic information on each registrant. This information was then exported to a Google spreadsheet that was used as our participant list. The Google add-on program Yet Another Mail Merge (YAMM) (Sàrl, 2021) used information from the spreadsheet, such as first name and email address, to send daily communications to the nearly 200 participants. YAMM allowed the team to track email messages and determine how many were opened, clicked, or bounced.

On the Friday leading up to the Challenge (i.e., three days ahead of the Challenge period), registered participants received an onboarding email message. It included the 30-minute daily commitment suggestion, an overview of the schedule, an invitation to join the virtual kickoff session the first day of the Challenge, and their first task—the completion of a survey. This survey asked basic questions about the participant's familiarity with accessibility-related resources and their confidence in their accessibility-related skills. The survey applied UDL guidelines related to internalization (e.g., self-regulation, comprehension, and executive functions). For example, completing the survey functioned as a metacognitive exercise that offered participants an opportunity to self-reflect on their own experience and knowledge and review of topics to be explored throughout the Challenge. It also helped participants identify areas on which they may want to focus their learning.

The Challenge. The Campus Accessibility Challenge launched just before 6 a.m. on Monday morning when participants received their first daily email of the Challenge. This first day was designed to orient participants to the Challenge and to the wider accessibility efforts on campus. Participants were asked to read the brief article, "From Accommodation to Accessibility: Creating a Culture of Inclusivity" (LaGrow, 2017), to provide historical context and clarify the relationship between accessibility and accommodation. An optional virtual discussion session was offered later that afternoon. To recruit interest and provide immediate relevance, participants were encouraged to choose one public-facing document that they were responsible for (such as a syllabus, handbook, agenda, flier, or assignment) to work on incrementally throughout the Challenge. Improving one document over the course of two weeks seemed like a reasonable and achievable goal with tangible results. It was recommended that beginners start their accessibility journey with a document created in Microsoft Word or Google Docs. Participants were also invited to attend optional live virtual sessions (which were also recorded and shared) including an overview of accessibility efforts at SUNY Oswego and a kickoff event. Both sessions were designed with the SDT concept of relatedness and the UDL guideline of fostering collaboration and community in mind. The events were well-attended and facilitated a sense of belonging around a shared goal, a collaborative commitment to cultural change, and the development of a network of support by identifying more experienced advocates and peers equally committed to this work. The team intentionally designed this critical first day to leverage different motivational factors to get participants to commit to the Challenge, including relevance, actionable and meaningful work, belonging with and connecting to peers, and the desire to make a difference.

Each day of the Challenge, participants were introduced via email message to a single topic or skill related to accessibility (see Table 1). The daily messages arrived about 6 a.m. each day, were structured consistently throughout the Challenge, and were designed to meet the Web Content Accessibility Guidelines (WCAG) 2.1 at the AA level (W3C, 2022). Each message contained the following elements: (a) an overview of the topic, including its relevance, and how its implementation can affect multiple audiences; (b) specific tasks related to the topic, such as reading a written tutorial or watching a video that explained how to properly incorporate that aspect of accessibility into digital documents; and c) login information for the day's synchronous virtual sessions.

Varying levels of participant experience and knowledge were expected. To welcome participants without prior knowledge about accessibility, daily email messages began with a brief overview of the topic written in plain language with a novice in mind. Daily tasks included first steps for beginners followed by more challenging options for those more experienced. Tasks were designed to be small and achievable so participants could experience early and frequent success throughout the program, and could see how the incremental improvements being made would positively impact their audiences. For example, the beginner task for Day 3 was to implement headings using the style feature in Microsoft Word or Google Docs. A more advanced task on Day 3 was revising a table with accessibility principles in mind. Tutorials provided instruction for multiple software applications were provided in multiple formats (i.e., video tutorials, written tutorials, live interactive virtual sessions, and asynchronous videos) to support the completion of each task. Supplementary materials and experiences were also suggested for those who wanted to continue to increase their skills. In the case of Day 3, a live virtual screen-reader demonstration was offered. The team was aware of how daunting the scope of accessibility can be and wanted to ensure enough structure was in place to reduce some of the cognitive overhead of learning a new set of skills.

The workgroup recognized that the pandemic impacted the cognitive load participants could handle and placed many constraints on time and access to various tools and technology. To accommodate, email messages were formatted to allow different levels of engagement based on individual preferences and needs. This included brief exposure to concepts by reading the executive summary of the day's topic at the top of each email, and more time-intensive tasks like creating accessible materials. Additionally, participants were afforded flexibility in how and when to participate. There was choice in format as well as choice around when in the day to participate and what activity or task they would complete. Each day balanced flexibility with structure and scaffolding to ensure that participants did not get lost, continued to feel supported, and could consistently see and feel their own progress. Having options was important for keeping participants motivated (in keeping with the SDT concept of autonomy) and ultimately for facilitating a more grassroots approach to institutional change.

Table 1

Description of Daily Challenge Topics

Day	Topic	Description
Day 1	About this Challenge	Overview of what this challenge will cover and where to start, including a beginning survey
Day 2	What is Accessibility?	Background information about what accessibility is and why it's important
Day 3	Creating Headings, Subheadings, and Lists	Basic steps for correctly setting content types in documents. Advanced Level: Using Tables
Day 4	Embedding Descriptive Hyperlinks	Basic steps and best practices of how to correctly embed links within text
Day 5	Using Color and Contrast	Best practices for correctly using color combinations that pass accessibility standards
Day 6	Providing Text Equivalents for Images	Basic steps and practices for adding alt text to images in documents
Day 7	Providing Captions	Basic steps for how to add and edit captions using YouTube, Panopto, and Zoom
Day 8	Checking Accessibility	Basic steps for using the automated accessibility checkers in Word, Google, and PowerPoint. Advanced Level: Saving as a PDF
Day 9	Help Shift the Culture	Tips and suggestions of how to share the knowledge gained during this challenge
Day 10	Reflection	Ending survey and self-reflection to gauge comfort level and familiarity with accessibility practices

The last two days of the Challenge were focused on taking action, setting goals, and reflecting. Day 9 emphasized that the skills built during the Challenge should be shared with peers, colleagues, and students. Day 9 also underscored the idea of being part of an institutional effort of accessibility and inclusion. The last day of the Challenge asked participants to complete a survey very similar to the one they completed during onboarding to reflect on how much their confidence and skill levels improved over the course of the Challenge. Once participants submitted the post-survey, they received a certificate of completion to document their participation and congratulate them on their important efforts.

Evaluation Methods

Participants

All individuals across campus over 18 were eligible to and invited to participate in the Challenge (N = 198). Of the Challenge participants, 108 completed the pre-survey (54.55%) and 41 completed the post-survey (20.71%). Detailed responses on study participant characteristics can be found in Table 2. Just over half (55.56%) of participants were under the age of 50. There were overwhelmingly more female participants (70.37%) as compared to male (13.89%). The largest proportion of participants were in the role of "staff" on campus (39.81%), followed by faculty (24.07%), students (13.89%) and administrators (5.56%).

Data Collection

Data for the evaluation were collected through three mechanisms: a pre- and post-survey fielded through Qualtrics online survey software (2020), YAMM (Sàrl, 2020) and Google Analytics of our website for utilization rates. The pre-and-post survey tool included both quantitative and qualitative data. The study was reviewed and approved by the university's Human Subjects Committee. Participants in the educational 10-Day Challenge were not required to also participate in the study portion; however, those who did provided consent during the survey process.

Quantitative variables of interest include age, gender, role on campus, and personal experience with disability. In the pre-post surveys participants were

Table 2

Summary Characteristics of Challenge Participants

Characteristics		Frequency (*n*)	Percentage (%)
Total		108	100.00%
Age Group			
	39 or under	33	30.56
	40-49	37	25.00
	50-59	16	14.81
	60 and above	18	16.67
	No response	14	12.96
Gender			
	Female	76	70.37
	Male	15	13.89
	Other	1	0.93
	No response	16	14.81
Personal Disability Experience			
	Significant	12	11.11
	Moderate	16	14.81
	Limited	17	15.74
	None	48	44.44
	Prefer not to say	1	0.93
	No response	14	12.96
Role on Campus			
	Staff	43	39.81
	Faculty	26	24.07
	Student	15	13.89
	Administration	6	5.56
	Other	4	3.70
	No response	14	12.96

asked to rate their familiarity with key digital accessibility resources, tools, and concepts on campus. Resources included the campus accessibility fellows, the institution's digital accessibility website, online accessibility checkers and Deque University (Deque, 2021), an online educational tool that was procured by the university to provide content and web-based trainings on core accessibility competencies. Participants also rated confidence in six skills or competencies related to digital accessibility, including defining the term accessibility, identifying technological barriers, using alternative text for images, captioning videos, using structured content and headings, and the careful use of color (See Figure 1 for specific scales utilized in pre-post survey).

Analysis

Given that the 10-Day Accessibility Challenge was a pilot, the development team employed a mixed methods approach to describing and evaluating its effectiveness. Mixed methods use both quantitative and qualitative approaches to examine data and integrates the findings to draw inferences (Tashakkori & Creswell, 2007).

Quantitative responses from each of our measurement tools were used to report descriptive statistics including frequency counts, proportions, means, and

Figure 1

Sample Survey Question Used

Each of the following statements is related to your experience and knowledge about disability and accessibility as it relates to classes and the campus environment. Please read each statement and assess how confident you are that you could do each of the following at this time.

a. Define "accessibility" as the term relates to technology and media
b. Give an example of a technology barrier somebody with a disability might face
c. Provide appropriate alternative text for an image
d. Add captions to a video
e. Add appropriate heading levels to a Microsoft Word or Google document using styles
f. Implement a color scheme for a slide presentation that would meet accessible color contrast ratios

Participants were given the following scale to choose from:
(1) not confident at all
(2) slightly confident
(3) moderately confident
(4) very confident
(5) extremely confident

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standard deviation. Confidence scores were calculated using a 5-point Likert scale and then subsequently compared between periods using a paired t-test to assess change within groups over time. We report mean change, the test *p*-value, and effect size. All quantitative analyses were done in STATA (StataCorp, 2019).

Following our quantitative analysis of the participants' scores on familiarity and confidence, analysis of qualitative data from five text-based survey responses was used to derive meaning, understand potential motivations and contextualize our quantitative results (Ellingston, 2011). Qualitative questions in the surveys followed three lines of inquiry: motivation to participate, concerns about accessibility during the pandemic, and biggest benefits from participation in the Challenge. Using a grounded theory approach, three individual coders from the study team reviewed all qualitative responses, developed independent themes, and then discussed until agreement was achieved. Illustrative quotes for each of the themes from participant responses were identified and shared within this article.

Results

Participant Motivations and Drivers

The sudden shift to online learning in the spring of 2020 was a significant adjustment for many people, and it revealed barriers that many had previously been unaware of. When asked what concerns participants had, or challenges they experienced when moving to online learning, they mentioned technology issues, time constraints, and a general feeling of being overwhelmed.

The Pandemic also exacerbated some pre-existing issues, such as Internet connectivity. One participant noted that students may not all be in a "...conducive learning environment. Wi-Fi issues. Using video and sound at the same time affects bandwidth." Another commented that while they were familiar with the necessary technology and comfortable using it on campus, "...not being there, I've struggled to find efficiency in creating accessible content." These and similar statements indicate that a change in environment can have a large impact on how someone creates, consumes, or interacts with information. Prior to the Pandemic, faculty and students were typically on campus in an environment designed for learning and teaching, and with appropriate technology and resources to access online materials. However, once students were forced to learn from off-campus during the period of emergency remote learning, especially those at a significant distance from campus, those circumstances may have changed.

Changing the modality of how courses were taught was new to some faculty and posed new challenges.

While people tend to confuse accommodations and accessibility as the same thing, participants of our challenge began to realize that accessible materials were a proactive way to engage and support a broader audience. One professor stated, "It is more difficult to clarify and respond to questions instantly when teaching asynchronously, so it is even more important that materials are clear, organized with headings, and accessible to all." This highlights that making materials more accessible can be beneficial to more people, regardless of their ability status or situation.

Numerous respondents commented about feeling overwhelmed and not previously understanding the importance of accessible materials to learning and participating in aspects of the institution. One professor summed up their new commitment this way: "[I want to be] able to make everything as accessible for all students in general. I do not want to leave anyone out or make a doc or [PowerPoint] that is inaccessible for some and have them miss out on the learning process." Generally, faculty expressed that they want the students to have a positive learning experience. However, many were very concerned with the amount of time involved with learning and implementing something new.

When asked what motivated them to join the Challenge, participants typically responded in one of three ways: joy of learning, need/desire for professional development, or a desire to participate in a collective action. As an institution of higher education, it is not surprising that our community is full of lifelong learners who enjoy the pursuit of knowledge and are motivated by their curiosity. For example, one participant wrote, "I am the type of person that always wants to learn new things…" and another summarized this sentiment by stating, "[The 10-Day Challenge] addresses topics I haven't thought about before."

Perhaps this is an unsurprising perspective from faculty and staff who self-selected to participate in a professional development opportunity. One subtheme, though, that emerged were students who clearly saw long-term benefits of participation and the need for digital accessibility skills both now and in the future. One student noted, "[I'm participating] to better prepare myself for finding an internship this coming summer and a job after graduation," and another stated, "Since I'm a freshman I thought I might learn something useful for my college career."

Within this category, faculty, staff, and administrators focused more on personal responsibility and developing confidence and efficiency. One respondent noted, "I wanted to increase my knowledge base in this area to ensure I am not creating unintentional barriers for students." This response, and others like it, point to the value placed on diversity, equity, and inclusion and the realization that accessibility is part of that work. Other participants were focused on "[building] accessibility into my regular workflow" and "putting accessibility into things as they are made," which acknowledge the need to embed accessibility into processes and routines. There was also a desire to "be more comfortable and confident about making accessible materials" pointing to this need to practice and continually develop expertise.

Although not as prevalent as the theme of professional development, there were threads of solidarity and community that also emerged like, "I feel that it is important for our campus to commit to this challenge as a collective" that were amplified in our posttest (see Key Benefits to participants section below).

Utilization and Familiarity of Resources

Several key findings were observed by examining results for validating utilization of resources. Google analytics data indicated that traffic to the campus' Digital Accessibility website spiked during the Challenge period, as compared to the same time the year prior. Data collected from YAMM determined that an average of 62% of emails were opened throughout the campaign. Open rates varied from 73% at the beginning and declined to 43% towards the end of the Challenge. The click-through rates followed a similar pattern with a high of 55% at the beginning to the lowest rates towards the end (7%), with an overall average of 25%.

In the surveys, participants were asked to rank their familiarity with a series of 12 accessibility-related resources both before and after the 10-day intervention on a 5-point Likert Scale. In the pre-period, mean scores across the group ranged from 1.29 to 2.84. The Deque University platform had the lowest starting familiarity mean score, even though the tool had been available on campus for nearly 12 months prior to the Challenge. The highest reported level of familiarity ahead of the Challenge was with the campus accessibility resources office.

There was significant growth in familiarity across all listed resources (except for LinkedIn Learning) between the periods. There were five resources that had a greater than 1 point average change from the pre to the post period: Accessibility Fellows, Campus Digital Accessibility website, CELT Trainings, online accessibility checkers, and Deque University. The largest magnitude change (1.5 points) was related to Deque University.

Benefits to Participants

In the follow up survey, participants were asked what they considered to be the greatest benefits of participating in the Challenge. Their responses, while varied, fell into four main categories: (a) better understanding of disability and available campus resources, (b) appreciation for the flexible format of the learning opportunities, (c) feeling of momentum and accomplishment, and (d) sense of community.

The Challenge's early modules attempted to give participants exposure to and understanding of why accessibility is important. This exposure included contextual readings, examples of student challenges, as well as the opportunity to hear from students directly about the barriers they experienced in the classroom. Participants suggested, "Gaining a new perspective on accessibility was the most beneficial aspect of the Challenge." Another respondent reflected on how their perspective shifted,

> Before I participated in this challenge, I was not very familiar with accessibility topics such as different disabilities and how the internet is available but not accessible to everyone. But after this challenge I am much more knowledgeable than I was before.

Many participants also noted their increased awareness of campus resources to address these barriers, and their own growing skill sets for addressing content delivery issues. Many participants felt the content was novel, and that it was an opportunity to learn "many useful new things that [they] didn't know that even mattered before."

The second theme that emerged showcases participants' appreciation for the format of the Challenge. They were pleased to find that it was flexible and accessible with synchronous and asynchronous options. The content was described as "hands-on" and "relatable, very doable." Given that the Challenge was conducted outside of the normal school semester, being able to access content on one's own schedule was valuable. One participant noted, "The biggest benefit was how the program was set up. Information was provided both in the [in-person] seminars I was able to attend and available for those I was unable to attend."

Our third theme that came through from the follow up survey was a sense of pride and accomplishment in taking small, but meaningful, steps to make content and the classroom more accessible. Initial exposure to accessibility can feel overwhelming. One participant noted that they had "no idea the depths of how much I really needed to learn." Anticipating this response, participants were encouraged throughout the Challenge to start with something small and attainable. This incremental mindset was echoed by respondents stating that their participation "raised my awareness" and that it was not "hard to start implementing even small changes right away." The small wins resulted in excitement and a sense of pride which, when internalized, bolstered motivation, and created a more long-term sense of commitment. One participant shared, "It was very helpful to see how students use screen readers and therefore [understand] barriers that they experience when materials are not set up well. I am proud of the new syllabus that I created with a high accessibility score."

The final theme that emerged in the participants' report of Challenge benefits was the recognition that they were now part of "building a community on campus" around a commitment to improving accessibility. They were excited about "seeing the number of people participating" and "the awareness increasing." Having this sentiment reflected in the experience of participants was rewarding for the Challenge designers who have wanted to cultivate culture change toward collective responsibility and hint at the sustainability of these practices as the number of campus advocates increases.

Confidence in Accessibility-Related Skills

In addition to sharing their responses about the benefits experienced, participants were also asked to rate their confidence with regards to six different digital accessibility skills or competencies (see Table 3). Participants reported a range of confidence levels coming into the challenge in accessibility-related skills on a scale of 1 to 5. At the start of the Challenge participants rated the highest level of confidence (3.54 out of 5.0) in their ability to give an example of a technology barrier that someone with a disability might face. All other pre-score means for confidence rating were below the 3.0 mark, suggesting relatively low confidence. The lowest level across the group as a whole before the Challenge was related to the ability to implement color schemes for a slide presentation that would meet accessible color contrast ratios (2.31 out of 5.0). Conversely, in the post period, all confidence scores across the whole group ranged from 3.25 (adding captions to a video) to 4.21 (naming a technology barrier).

The lowest confidence pre-scores for each accessibility-related skill were reported by the oldest groups of participants (50-59 and 60+). This aligned with the group overall, showing the lowest scores for color scheme implementation and the highest for ability to give an example of a technology barrier. When looking at differences by gender, female respondents consis-

Table 3

Pre- and Post-Survey Confidence Score (Scale Of 1-5) in Accessibility-Related Skills According to Demographic Factors

		Define "accessibility" as the term relates to technology and media		Give an example of a technology barrier somebody with a disability might face		Provide appropriate alternative text for an image		Add captions to a video		Add appropriate heading levels to an MS Word or Google Doc using styles		Implement a color scheme for a slide presentation that would meet accessible color contrast ratios	
Characteristics	*n*	Pre-test mean (*SD*)	Post-test mean (*SD*)	Pre-test mean (*SD*)	Post-test mean (*SD*)	Pre-test mean (*SD*)	Post-test mean (*SD*)	Pre-test mean (*SD*)	Post-test mean (*SD*)	Pre-test mean (*SD*)	Post-test mean (*SD*)	Pre-test mean (*SD*)	Post-test mean (*SD*)
Total	108	2.87 (.92)	3.69 (.97)	5.54 (1.09)	4.21 (.85)	2.65 (1.19)	3.71 (1.17)	2.54 (1.26)	3.25 (1.18)	2.70 (1.26)	3.90 (1.06)	2.31 (1.22)	3.44 (1.13)
Age Group													
39 or under	33	2.88 (.93)	3.54 (1.27)	3.70 (1.02)	4.31 (.95)	2.67 (1.22)	4.00 (1.29)	2.82 (1.33)	3.92 (1.31)	2.70 (1.19)	4.00 (1.08)	2.61 (1.39)	3.31 (1.44)
40-49	27	3.04 (.90)	3.83 (.94)	3.81 (.96)	4.33 (.89)	2.93 (1.07)	4.00 (.95)	2.89 (1.09)	3.42 (1.08)	3.19 (1.18)	4.33 (.98)	2.30 (1.14)	3.75 (.96)
50-59	16	2.75 (.58)	3.40 (.52)	3.38 (.89)	3.90 (.57)	2.31 (1.01)	3.20 (1.14)	1.81 (.75)	2.60 (.84)	1.75 (.77)	3.70 (.95)	1.63 (.89)	3.40 (.97)
60 and above	18	2.83 (1.25)	3.82 (.98)	2.94 (1.30)	4.18 (.98)	2.28 (1.18)	3.45 (1.29)	1.94 (1.21)	2.73 (1.45)	2.89 (1.41)	3.45 (1.21)	2.33 (1.24)	3.18 (1.17)
Gender													
Male	15	3.27 (1.03)	3.60 (.70)	3.80 (1.21)	4.40 (3.80)	2.80 (1.01)	4.10 (.74)	2.93 (1.28)	3.60 (1.07)	3.00 (1.25)	4.20 (.79)	2.80 (1.42)	3.80 (1.03)
Female	76	2.83 (.91)	3.67 (1.04)	3.49 (1.06)	4.14 (.87)	2.54 (1.18)	3.58 (1.27)	2.38 (1.18)	3.11 (1.21)	2.66 (1.25)	3.81 (1.14)	2.18 (1.16)	3.31 (1.17)
Personal Disability Experience													
None	48	2.77 (.99)	3.89 (.90)	3.4 (1.15)	4.28 (.83)	2.56 (1.24)	3.89 (1.18)	2.58 (1.18)	3.11 (1.32)	2.93 (1.24)	3.78 (1.17)	2.46 (1.34)	3.44 (.98)
Limited	17	2.71 (.59)	3.36 (1.22)	3.12 (.78)	3.86 (1.03)	2.47 (.94)	3.71 (1.33)	1.94 (.97)	3.21 (1.05)	2.24 (.83)	4.00 (1.11)	2.00 (.87)	3.07 (1.44)
Moderate	16	3.13 (.96)	3.50 (.84)	4.06 (.85)	4.67 (.52)	2.69 (1.08)	3.67 (1.51)	2.75 (1.48)	3.67 (1.63)	2.69 (1.54)	4.00 (1.10)	2.00 (1.21)	3.50 (1.05)
Significant	12	3.25 (.97)	3.71 (.76)	3.83 (1.19)	4.14 (.69)	2.75 (1.22)	3.14 (.69)	2.67 (.40)	3.14 (.90)	2.41 (1.24)	3.86 (1.07)	2.50 (1.38)	3.71 (.95)
Role on Campus													
Staff	43	3.19 (.90)	4.00 (.84)	3.81 (1.02)	4.57 (.68)	2.81 (1.20)	4.14 (.79)	2.65 (1.38)	3.67 (1.15)	3.07 (1.56)	4.43 (.75)	2.42 (1.47)	3.90 (1.04)
Faculty	26	2.63 (.95)	3.28 (.75)	3.44 (1.03)	3.72 (.75)	2.53 (1.01)	2.94 (1.11)	2.30 (.96)	2.61 (1.04)	2.51 (1.08)	3.33 (1.14)	2.09 (.87)	3.00 (.91)
Student	15	2.83 (1.17)	4.67 (.58)	3.50 (1.64)	5.00 (0.00)	2.33 (1.21)	4.67 (.58)	2.17 (1.17)	3.33 (1.53)	2.33 (1.03)	3.67 (1.53)	1.50 (.84)	3.67 (.58)
Other	10	3.06 (.80)	3.00 (1.41)	3.26 (1.10)	4.00 (1.22)	2.53 (1.41)	4.00 (1.73)	3.00 (1.65)	3.60 (.89)	2.60 (1.12)	3.80 (.84)	3.00 (1.60)	2.80 (1.79)

tently scored their skill confidence lower than the male group. Pre-scores of females ranged from .31 (naming a technology barrier) to .62 (implement color scheme) points lower than those of males. Females reported post-scores from .07 (defining accessibility) to .52 points (providing alternative text) lower than males.

Regarding personal experience with disability, overall the group reporting a significant level of experience with disability had the highest self-reported confidence score across all accessibility-related skills. This pattern did not hold in the post scores, where often the highest level of confidence in the post period was reported by the group identified as having "no" personal experience with disability.

Finally, there is not a clear pattern of confidence level across the subgroups based on role. For example, we find the lowest pre-score confidence for defining accessibility among faculty members (2.63), but students have the lowest pre-score for providing alternative text (2.33).

In the paired *t*-test, statistically significant increases in confidence were found when comparing across the whole group means before and after the Challenge for all six skills (see Table 4). There was a greater than 1 point increase, with the largest effect sizes (above .80) in three areas: Use of alternative text for images (1.06, $p < .001$, effect size .91), use of headings and structured content (1.19, $p < .001$, effect size 1.12), and the careful use of color (1.13, $p < .001$, effect size 1.00) (Cohen, 1988). The next largest gains in confidence were observed in Defining accessibility (.81, $p < .001$, effect size .84) and giving an example of a technology barrier (.67, $p < .001$, effect size .79). The smallest gain, with only a medium effect size was observed for confidence related to adding captions to a video (.60, $p < .01$, effect size .60).

When examining the differences by subgroups, there were a variety of notable changes. Participants identifying as female had significant increases in confidence level across all skill areas, between the two reporting periods. Large effects were observed in defining accessibility (.81), providing alternative text (.82), adding structured content/headings (1.01) and use of color (.96). Although male participants reported higher levels of confidence across the board in the pre-period, they only showed a significant increase in confidence in providing alternative text for images and using structured content and headings, both with effect sizes over 1.0.

There was a clear pattern by self-reported personal experience with a disability. Statistically significant increases in all accessibility-related skill confidence were seen in participants with little or no experience, with the exception of adding captions to a video. The largest effect was observed in defining accessibility (1.24). Not surprisingly, participants that came into the Challenge reporting moderate or significant experience with a disability had less confidence growth in this area—suggesting that they had previously been exposed to these topics and skills. Individuals in these two groups did report a statistically significant positive change in confidence in two areas: structured content/use of headings, and implementation of color schemes in a slide deck that would meet accessible color contrast ratios, with large effect sizes all above 1.0.

Looking at the difference in confidence by role on campus, staff members had the most consistent increase in confidence among all skill areas. Faculty members reported statistically significant increases in their confidence in defining accessibility (.65, $p < .01$), in addition to structured content/use of headings (.82, $p < .01$) and implementation of color schemes (.91, $p < .001$). Notably, students had some of the largest magnitude of changes in confidence scores across the entire population in three skill areas: Define Accessibility (+1.83, $p < .05$, effect size 3.16); Alternative text for images (+2.33, $p < .01$, effect size 4.02); and implementation of an accessible color scheme (+2.17, $p < .01$, effect size 3.74). No other subgroups reported a greater than 2-point increase in confidence in any of the skills reported.

Discussion

The 10-Day Accessibility Challenge was conceptualized with the principles of self-determination theory and UDL in mind. In our quantitative results, there is strong evidence that this structure and approach was effective–creating large changes in effect size related to confidence around accessibility skills. Here, we contextualize these results along with our qualitative findings, which suggest that the participants experienced autonomy, competence, belonging and support as they engaged with the material and events over the course of the two-week period.

Participant Autonomy

Autonomy was critical to the success of this Challenge. The Challenge was conducted during the winter break for students and faculty. As such, the schedule needed to be flexible and customizable to individual needs, interests, and motivations. Participants engaged with events and activities voluntarily and were able to choose to work on materials important and relevant to them. Participants expressed appreciation for the flexible format, including the ability to choose either or both asynchronous and synchronous experiences. The increased traffic to the video and written

Table 4

Mean Change in Confidence Score, Effect Size, and Significance Results of Paired T-Test (P)

		Define "accessibility" as the term relates to technology and media			Give an example of a technology barrier somebody with a disability might face			Provide appropriate alternative text for an image			Add captions to a video			Add appropriate heading levels to an MS Word or Google Doc using Styles			Implement a color scheme for a slide presentation that would meet accessible color contrast ratios		
Characteristics	*n*	Change in Score	Effect Size	*p*	Change in Score	Effect Size	*p*	Change in Score	Effect Size	*p*	Change in Score	Effect Size	*p*	Change in Score	Effect Size	*p*	Change in Score	Effect Size	*p*
Total	108	0.81	0.84	***	0.67	0.79	***	1.06	0.91	***	0.71	0.60	**	1.19	1.12	***	1.13	1.00	***
Age Group																			
39 or under	33	0.66	0.52		0.61	0.64		1.33	1.03	**	1.10	0.84	**	1.30	1.20	**	0.70	0.49	
40-49	27	0.80	0.85	*	0.52	0.58		1.07	1.13	**	0.53	0.49		1.15	1.17	**	1.45	1.51	***
50-59	16	0.65	1.25	**	0.53	0.93		0.89	0.78	*	0.79	0.94	*	1.95	2.05	***	1.78	1.84	***
60 and above	18	0.98	1.00	*	1.24	1.27	*	1.18	0.91	*	0.78	0.54		0.57	0.47		0.85	0.73	
Gender																			
Male	15	0.33	0.47		0.60	0.16		1.30	1.76	**	0.67	0.63		1.20	1.52	*	1.00	0.97	
Female	76	0.84	0.81	***	0.65	0.75	**	1.04	0.82	***	0.73	0.60	**	1.15	1.01	***	1.12	0.96	***
Personal Disability Experience																			
None	48	1.12	1.24	***	0.86	1.04	**	1.33	1.13	***	0.53	0.40		0.84	0.72	**	0.99	1.01	**
Limited	17	0.65	0.53	*	0.74	0.72	*	1.24	0.93	**	1.27	1.21	***	1.76	1.59		1.07	0.74	**
Moderate	16	0.38	0.45		0.60	1.15		0.98	0.65		0.92	0.56		1.31	1.19	*	1.50	1.43	**
Significant	12	0.46	0.61		0.31	0.45		0.39	0.57		0.48	0.53		1.44	1.35	*	1.21	1.27	*
Role on Campus																			
Staff	43	0.81	0.96	**	0.76	1.12	**	1.34	1.70	***	1.01	0.88	**	1.35	1.80	***	1.48	1.42	***
Faculty	26	0.65	0.87	**	0.28	0.37		0.41	0.37		0.31	0.30		0.82	0.72	**	0.91	1.00	***
Student	15	1.83	3.16	*	1.50	0.00		2.33	4.02	**	1.16	0.76		1.33	0.87		2.17	3.74	**
Other	10	0.07	0.05		0.73	0.60		1.47	0.85	*	0.60	0.67		1.20	1.43	*	0.20	0.11	

Note. * $p<.05$; ** $p<.01$; *** $p<.001$

tutorials on the campus' accessibility website during this period demonstrated active use of the a la carte training materials and our professional development workshops on accessibility had high attendance rates. The Challenge modeled how to build in choice for learners by employing UDL principles, including providing multiple formats of the materials, allowing participants to choose pathways and projects that made sense for them individually, and offering various options of tools and workflows to create accessible materials (CAST, 2018a). This approach also leveraged participant's desire for professional development and joy for learning by allowing them to make choices that felt most relevant to them at every interval of the Challenge.

Competence and Support

Although most participants expressed a desire to learn new things, there was also an undercurrent of uncertainty and unfamiliarity with the technology and skill sets necessary to make an impact on accessibility. Many participants expressed feeling overwhelmed at first. While ability or competence were not directly measured, participants were allowed to gauge their confidence in the technical skill areas at two points in time. Confidence increased significantly with strong effect sizes in all six technical skill areas across participant groups, demographics, and roles. It is notable to mention that differences were observed by gender, with the female participants joining the Challenge at a higher rate and showing greater growth than their male counterparts. This dynamic has been shown in other studies as well, where female faculty members were found to be twice as likely to teach accessibility in their computing courses as their male colleagues (Shinohara et al., 2018).

The participants' growth in confidence was echoed in a feeling of momentum and accomplishment, reported in the text-based answers—particularly through the use and encouragement of an incremental approach to both learning and remediating materials. UDL reminds us to "vary demands and resources to optimize challenge" and game design reminds us to provide just enough challenge (CAST, 2018a; McGonigal, 2011). As participants become aware of various accessibility barriers, they could be easily overwhelmed by the scope of having all digital materials and virtual experiences at the institution meet Web Content Accessibility Guidelines (WCAG). As such, Challenge organizers found it important to remind participants to work iteratively and to start their work on accessibility by taking one small first step. One way the team attempted to do this was by starting with a shared frame of reference including terms and definitions and then introducing one new skill each day. Likewise, each day's email was written to help participants at different levels by providing a clear point of entry into a skill for beginners and pathways for those already familiar to explore and level up.

Participants also needed to feel supported. Our campus has invested significant time and financial resources in creating a foundation to support digital accessibility. However, prior to the Challenge, familiarity with many of the available tools and resources was low. By using the Challenge to promote and re-introduce the variety of supports already in place, participants gained an understanding of the campus' readiness for cultural change and the breadth of what would be at their disposal moving forward in their accessibility journey.

Providing a scaffolded structure to introduce participants to accessibility practices, combined with reminding participants of the significant supports available, helped participants experience the Challenge as something doable rather than impossible. Small experiences of competence by successfully accomplishing an accessibility task helped to sustain motivation to participate in the Challenge and to integrate these practices into everyday workflows.

Belonging and Relatedness

Creating an inclusive campus with a focus on accessibility cannot be achieved by a small, isolated group of individuals. Building community through a shared sense of advocacy for accessibility practices was something Challenge designers felt was integral to the long-term success of the Challenge and the sustainability of campus efforts of inclusion. Many participants expressed excitement around the number of people participating and their shared sense of purpose. Participants who engaged in synchronous sessions had the opportunity to interact with and build relationships with local accessibility advocates running workshops and sessions. These connections form a safety net of real people available and willing to help.

Participants discussed examples of behavior change. Faculty members described new syllabi and course materials they developed. Staff members shared their enthusiasm over their newfound ability to change meeting agendas, create accessible emails and an overall feeling of responsibility to the community of learners. Student participants talked about the Challenge as an investment in their future and the ability to impact change—not just on campus but also in their careers. Individuals making their own behavioral shifts are committing to something bigger than themselves. Collectively they are creating a community of change-makers.

Long-Term Culture Shift

Although the foundation for a cultural shift on campus was laid years prior to the Pandemic, this moment of remote learning and uncertainty provided a catalyst for our community to launch our accessibility momentum forward. Our campus became aware of how pervasive barriers to access are for students, faculty, and staff. Evaluation of the 10-Day Challenge suggests that we were able to begin to dismantle some barriers and have advanced a greater sense of inclusion of social responsibility.

As more groups and individuals within the community learn about accessibility, conversations about disability will increase and become familiar. These shifts may reduce the stigma of disabilities and the need for individuals to disclose their disability status. As our foundation of accessibility advocates grows to include faculty, staff, and students, the recognition of everyone's responsibility to the community to minimize barriers to inclusive learning can become the norm. With an increasing number of accessibility advocates, the pressure on the Accessibility Resources office, the workgroup, and individuals with disabilities eases a bit because more individuals have the information necessary to speak up and ask questions when key campus decisions are made about technology purchases, policy decisions, and curriculum. For example, in Spring 2022, our campus expanded the withdrawal period to extend from the end of the drop period to the last day of classes and eliminated the need for documentation for withdrawals later in the semester. A desire to eliminate barriers like the requirement to disclose health and disability information was a part of that conversation.

Participants expressed their desire to create space for inclusion. More importantly, their confidence increased in being able to provide examples of barriers that someone with a disability might face and how they personally might be able to address and reduce those barriers beyond providing accommodations. This increased individual accountability allows our community to lean into the social model of disability in all the work we do as an institution.

Limitations

This study has several important limitations. Given that this was an evaluation of a pilot 10-Day Accessibility Challenge and only conducted at one specific university, during a Pandemic, the results may not be generalizable to other institutions under different circumstances. There is likely to be selection bias in the participant group, as we assume that individuals that joined the Challenge were already interested in, or open to the idea of, accessibility. This was probably further exacerbated by those of that group who chose to participate in the study and related surveys. In addition, to protect the privacy of campus colleagues, the pre-post Challenge survey responses are not linked by identifiers, so we can only see aggregate, not individual changes. This analysis is additionally limited given that the post-survey shows a high drop off rate.

Implications for Practice/Policy

It is important for colleges and universities to move toward socially focused models of disability, recognizing institutional and structural barriers that infringe upon the rights and participation of people with disabilities. Viewing disability as a diversity issue that recognizes the wide variability of the human experience can also help to shift the narrative to one that is more inclusive. Instead of labeling people and their bodies as broken, we can focus on designing (and redesigning) processes, procedures, experiences, and opportunities that consider people with disabilities from their inception. This shifts assumptions from "people with disabilities do not belong" to "people with disabilities are and need to be a part of the academy and knowledge building." Key takeaways include the following:

- Shifting the campus culture toward accessibility and inclusion is an on-going process. As such, to reach this goal campuses need to commit time and tangible resources to increasing knowledge and implementation of accessibility principles.
- Accessibility should be addressed within, not separate from, larger institutional diversity, equity, and inclusion efforts.
- Challenges and interventions that build in elements of community-building, choice and fun can reach diverse constituencies, build greater familiarity and utilization of existing resources, and increase participant confidence in their ability to contribute to a culture of accessibility.
- Needs are unique to an institution and change over time; interventions should evolve accordingly. The exact intervention used by our campus may not be appropriate for others and our own interventions continue to evolve along with the campus culture.
- Students have a lot to offer to and gain from accessibility training. As students become more aware, they increase their expectations of themselves, those around them, and the institutions with whom they interact. Insti-

tutions should consider ways to help students build their knowledge of disability and accessibility within the curriculum and through co-curricular activities like professional development of student club leaders. Additionally, students will bring this skillset to the organizations and industries they work in professionally beyond graduation.

- Being mindful of the ongoing and cumulative stresses caused by the Pandemic, campus leaders should consider making interventions fun, flexible, iterative, and attainable. Start small. People under high stress can handle a much smaller cognitive load.

Disability services personnel have much to contribute and gain from a similar Challenge at their institution. Their expertise is necessary in the development of resources, providing context, and initiating this work. They are also uniquely positioned to support initiatives like a Challenge by facilitating connections between advocates as well as bringing in and amplifying the perspectives of students with disabilities. Recruiting campus members to engage in proactive design practices through Challenges and other initiatives reduces the need for accommodations, helps to foster a sense of belonging for students with disabilities, and supports a more equitable learning environment.

Conclusion

At SUNY Oswego, the 10-Day Accessibility Challenge met an important need at a critical moment for our community. The COVID-19 pandemic illuminated the need to expand our support, training, and efforts around digital accessibility. Although the development of this program was challenging and labor intensive, we found that it was a successful approach to meeting the needs of our community. Together with participants across campus, we were able to harness the principles of Self-Determination Theory to motivate learning and action, UDL to create a variety of points of entry and dynamic content for all participants to grow in their familiarity and confidence related to digital accessibility, and best practices in accessible design to increase knowledge and skills in making technology accessible to individuals with disabilities. The Challenge was an important step toward making our campus more accessible and inclusive, and thus better reflect a social model of disability. Members of our community came together to understand the barriers that people with disabilities face, take responsibility for learning how to address them, and begin to realign the culture to be more accessible and inclusive. Through sharing our successful program, we encourage other campuses to recognize and incorporate accessibility in all of its diversity, equity, and inclusion efforts. Fun, engaging, and meaningful initiatives like this are critical to move the goal of campus inclusiveness forward.

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The Accessibility Expedition: Viewing Design Through the Disability Lens

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Abstract

Physical accessibility at colleges and universities is a perennial and challenging issue. Some campuses have made efforts to address these challenges through a variety of advocacy initiatives, while others have used disability simulations to bring greater awareness of physical accessibility to campus communities. An alternative approach to disability simulations and other accessibility awareness exercises is the Accessibility Expedition (AE). The AE engages participants in an exploration of campus spaces facilitated by disabled individuals and individuals knowledgeable of ADA Standards for Accessible Design and/or universal design (UD). The exploration is followed by a debriefing session to discuss barriers to equitable participation, as well as evidence of accessible or universal design practices. The description, rationale, steps for implementation, and observed outcomes of the AE practice are discussed.

Keywords: accessibility, physical spaces, facilities, postsecondary

Summary of Relevant Literature: Simulations and Universal Design

Physical accessibility at colleges and universities is a perennial and challenging issue (Gilson & Dymond, 2012; Salmen, 2011; Woods, 2016). While some campuses have made efforts to address these challenges through a variety of advocacy initiatives (e.g., Agarwal et al., 2014), disability simulations are often used in attempts to increase awareness about the experiences of individuals with disabilities within the physical environment (Burgstahler & Doe, 2004; Levett-Jones et al., 2017; Nario-Redmond et al., 2017; Silverman et al., 2014). Many simulations have focused on physical or vision impairment (Flower et al., 2007) or hearing loss (Nario Redmond et al., 2017). Disability simulations often position participants in wheelchairs, or have them wear blindfolds, or earplugs as they complete a set of tasks (Nario Redmond et al., 2017).

Disability simulations can create stereotypical, incomplete, or inaccurate perceptions of the experience of individuals with disabilities (Burgstahler & Doe, 2004). In their meta-analysis of disability simulation studies, Flower et al. (2007) found that outcomes of such simulations are mixed. For example, simulations may increase empathy among those who participate in them (Nario-Redmond et al, 2017), but can increase participant sympathy toward those with disabilities as well (Silverman et al., 2017). They can create distress among participants (Nario-Redmond et al., 2015), negatively impact participant judgment regarding the capabilities of individuals with disabilities (Silverman et al., 2017), and perpetuate pity and negative stereotypes of individuals with disabilities (Lalvani & Broderick; 2011; Valle & Connor, 2019) because simulations do not represent an authentic experience of disability. The potential negative outcomes of disability simulations (Burgstahler & Doe, 2004) suggest that alternative approaches must be considered that can lead to action toward more accessible and inclusive college campuses.

The Accessibility Expedition (AE) builds on the work of Burgstahler and Doe (2004) to offer an innovative approach to promoting accessible design that avoids negative outcomes from some of the typical simulation activities and offers a facilitated exploration of design features that enable or constrain equitable access and participation for individuals with and without disabilities. The goal of the AE is to help participants see their environment through a lens of

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equity and inclusion rather than through simulated experiences. The AE uses UD, which is 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" (North Carolina State University, 1997, n.p.). Embedding UD within the AE is significant because "[u]niversal design is ultimately a process that empowers people by giving them more control over their lives and choice in the things that they do or the way in which they do those things" (Salmen, 2011, 15). Providing participants with opportunities to explore ways in which a design can constrain control provides a strong foundation for advocacy and change.

The Accessibility Expedition engages participants in a guided conversation about various features of a public space, such as a university campus, through a UD lens. Disabled individuals, personnel knowledgeable of ADA Standards for Accessible Design, and UD advocates lead groups of participants through specifically selected areas of campus and discuss features of physical and landscape design, including paths of travel, building features and amenities, ingress and egress, and other temporal design considerations, such as the placement of event signage, that may present various challenges to accessibility, usability, and safety. Each group follows a carefully designed set of tasks (see Appendix A) that takes them through buildings into restrooms, on elevators, into classrooms and lecture halls, across pedways, and into coffee shops. Groups are asked to experience and evaluate the levels of access afforded to individuals within the group and infer who may or may not be able to access the spaces, and to reflect on the characteristics of people who were likely considered in the design process. During the AE, participants take photos and share them via a designated Twitter hashtag to discuss and process the campus exploration during the AE debrief.

The Accessibility Expedition helps to educate the participants in basic design requirements in the Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) and in the basic principles of UD. Through its approach to engage with design guidelines AND the lived experiences of people with disabilities, AE has the potential to positively impact accessibility efforts and systemic thinking for institutions and their disability resources offices, as well as those who focus on the physical environment.

According to Watchorn et al. (2014), "Universal design continues to be relevant to the design of built environments in today's society as a means of addressing the broadest needs of people and populations regardless of abilities, needs and roles" (p. 71.). Indeed, understanding that equitable participation means that ALL are able to participate together is one of the main foci of the AE. Facilitators of the AE bring their knowledge of ADA design standards and UD to demonstrate that the ADA requires minimum levels of accessibility for disabled persons, while UD intends to create spaces that are inclusive and usable for all people.

Background and Participation

The Accessibility Expedition originated at Northern Arizona University (NAU) as part of events sponsored by the NAU 4 All student organization, whose mission encompasses advocating for the creation of inclusive spaces and reduction of attitudinal barriers across the campus. While the AE has ostensibly focused on physical and wayfinding characteristics of the campus, conversations resulting from the AE also involve dialogue around attitudinal barriers to equitable participation and inclusion for all marginalized groups. When the AE was first conceived, and for many years at many AHEAD conferences, this event was known as the Accessibility Scavenger Hunt. Feedback from Indigenous individuals on campus suggested that the word scavenger could be offensive to some constituents. As a result, a re-envisioning of the name took place. The Accessibility Expedition was chosen to imply and foreground an adventure of the unknown and a feeling of discovery.

NAU 4 All and NAU's Commission on Disability Access and Design (CDAD)[2] partner to organize and facilitate each AE. Since the event's inception, the partnership between NAU 4 All and CDAD has resulted in a semi-annual AE, exploring different areas of the campus each semester. During the fall semester, the AE is an anchor event with NAU's Disability Pride and Heritage Month (DPHM) in October, which features a series of events to highlight and privilege the disability experience, to confront ableism in all its forms, and to bring attention to the contributions of individuals with disabilities to society. In the spring, the AE shifts to south campus to ensure full coverage of the campus environment, including historic and modern spaces.

Description of the AE Practice

An integral element of helping AE participants explore design features is the embedded investigation of features of physical and exterior spaces that reflect the application of UD. Universal design was con-

[2] NAU's Commission on Disability Access and Design is a body that serves as advisory to the Office of the President on issues related to individuals with disabilities, accessibility, design, and other disability-related matters. Membership in CDAD is voluntary and is representative of staff, students, and faculty from across the institution.

ceptualized by Ronald Mace, a wheelchair user and architect, along with colleagues from North Carolina State University (Story et al., 1998). Mace found that many of the design solutions mandated by the Architectural Barriers Act, were valuable for many users, not just those with disabilities. Additionally, he found that most design solutions were cost-effective and aesthetically pleasing when implemented appropriately at the beginning of a design project. In their work to articulate principles of effective design, Mace and his colleagues established the Seven Principles of Universal Design (see Table 1). The Center for Universal Design (CUD) at North Carolina State University, which Mace helped to establish, defines these principles and provides basic guidelines for each of The Seven Principles of Universal Design (Center for Universal Design, 1997).

As participants in the AE arrive at a designated, central location to begin the exploration, they are randomly assigned to a group, 1-5 depending on the number of group facilitators; ideally groups are not larger than 20. The AE facilitator provides a welcome and outlines the event and rules. Each group is provided an initial set of tasks to complete and a path to follow. The task sheets (see Appendix A) include questions to consider and expectations for equitable participation. These considerations and expectations are designed to bring attention to accessibility challenges that individuals without disabilities might take for granted (see Table 2).

Each group is asked to make numerous observations and document their observations with photos along the way. Photos are sent to a predefined Twitter hashtag for review during the debrief. At the end of the first leg of the route, the next task is located in an envelope bearing the active International Symbol of Accessibility (ISA) with a raised tactile outline of the shape (see Appendix B). Groups are provided relevant sections of the "ADA Checklist for Existing Facilities" (Institute for Human Centered Design, 2016) on the AE for guidance on properly measuring features, such as the height of a counter or turning radius in a restroom stall. Tools such as measuring tapes and smart levels for gauging slope are also provided to the groups. The use of tools helps participants understand the difference between meeting a minimum requirement, such as the ADA Standards for Accessible Design, and thoughtful, inclusive design, as suggested by the principles of UD. Group leaders help to point out features in spaces that are examples of design barriers, minimally accessible design, and inclusive design. These experiences allow participants to become better advocates when they encounter a potential barrier and to provide suggestions for changes to improve the physical and social inclusion of people with disabilities in every space on the campus.

Following the exploration, participants meet to process the findings and dialogue the pros and cons of certain environmental features discovered on the AE. This conversation focuses on design considerations for accessibility, usability, and safety, rather than simply an imagined challenge faced by people with disabilities. An integral and critical element of the AE and conversation is the participation of individuals with various disabilities. These referents allow for a grounded dialogue that exposes stereotyped and pity-based perspectives of disability experiences and foregrounds the lived experiences of people with disabilities. Individuals versed in ADA accessible design standards and UD are also an integral part of the discussion to provide guidance to help participants understand why some decisions may have been made and how better design could go beyond minimum code compliance.

Outcomes

While no formal qualitative or quantitative analysis of the AE has yet been completed, positive outcomes are suggested by dialogue that occurs in the activities that suggests that participation in AE results in increased knowledge about UD of the physical environment, increased understanding of the lived experience of disabled individuals, and concrete suggestions for making physical environments more accessible.

Positive outcomes observed also include increases in advocacy by students, faculty, and staff in key areas across campus. Participant discussions reflect an understanding of aspects of designs that result in spaces that are either accessible or inaccessible to disabled individuals, as well as design that creates equitable and inclusive environments for all institutional constituents. Additionally, participants gain an awareness of barriers to equitable participation for which project cost or complexities of barrier remediation create implementation limitations. Evidence of a shift in understanding and focus on UD is seen in regular advocacy for UD by the Facility Services project managers in their interactions with outside design firms and construction companies selected for capital projects on campus. The ADA Coordinator and members of the CDAD are no longer the main (or only) entities ensuring compliance with code and advocating for UD.

Other outcomes of the AE include positive increases in knowledge and understanding that led to intentional, well-informed advocacy from students, staff, and faculty in a way that does not create pity for people with disabilities. Rather, such advocacy

Table 1

The Seven Principles of Universal Design

Principle	Description
Principle 1: Equitable Use	The design is useful and marketable to people with diverse abilities.
Principle 2: Flexibility in Use	The design accommodates a wide range of individual preferences and abilities.
Principle 3: Simple and Intuitive Use	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
Principle 4: Perceptible Information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
Principle 5: Tolerance for Error	The design minimizes hazards and the adverse consequences of accidental or unintended actions
Principle 6: Low Physical Effort	The design can be used efficiently and comfortably and with a minimum of fatigue.
Principle 7: Size and Space for Approach and Use	Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Note. Adapted from the Center for Universal Design (1997)

Table 2

Accessibility Expedition Considerations and Expectations

Questions to Consider	Expectations for Participation
• Who is, and who is not, able to use this? Why? • Who is, and who may not be, considered in this design? Why? • Who is, and who is not, able to participate in an activity here? Why? • Who do you think was involved in the design decision here and who might not have been? What makes you think this? • What does this design enable and what does it constrain? Why?	Participants should: • Not take stairs. • Not step off of or onto curbs. • Ensure that everyone gets to the destination in the same way. • Follow stated campus rules (e.g., use crosswalks).

foregrounds the need for full inclusion in all design conversations. Over the more than 10 years of this semi-annual event, important observations and findings have led to powerful student advocacy. Most notably, student participants in the AE identified barriers to accessibility in the university bookstore and post office. The post office, located in the basement of the bookstore building, did not have an accessible entrance. Wheelchair users were assigned separate post office boxes at the top of the stairs and had to ring a doorbell to call an attendant to retrieve parcels too large to fit in the boxes. Additionally, the only access to the bookstore was through a locked side entrance at the top of an exterior ramp.

After the bookstore site was included as a stop on the AE, it became apparent to the participants that it needed extensive but important renovations for accessibility. Students wrote letters advocating for more accessible access to both levels of the building. As a result of their advocacy, the installation of an elevator that provided access from street level to the lower post office level and the main level of the bookstore was subsequently completed.

Another example that illustrates the importance of collaboration and partnerships developed from participation in the AE is the construction of an all-gender restroom in the campus library. After the exploration of the campus library, the debrief conversation centered on the observation that the existing restrooms are a challenge for those needing an attendant or a service animal or more space for a larger wheelchair, among other observations. The library accepted the challenge to fix the problem and engaged in a collaboration with CDAD, and others, to advocate for the renovation of an unused custodial space into a single stall, all-gender restroom.

The elevator at the campus bookstore and the library restroom are only two examples of many improvements that the university has made as a result of the AE. Some of these projects have been larger capital projects, such as adding braille signage throughout the campus library or replacing and expanding existing concrete paths of travel to address slope, width, detectable barriers, and maintenance. The advocacy from the AE has also led to less costly improvements, though no less valuable. For example, weekly updates are now provided during the summer months of construction to report specific information regarding construction updates, alternate paths of travel, and other wayfinding information. Specific and targeted participation has also yielded advocates in important areas of campus, such as project managers in construction, design, code enforcement, and space planning professionals. Further, academic administrators and faculty in relevant departments (e.g., construction management, civil engineering) are also critical participants in the AE.

Engaging the Community

A secondary outcome of the AE is the broad interest and participation of the university community. Each year, scores of participants join the AE from various units and classes to learn about the continuing design challenges and progressive design solutions across campus.

NAU's Facility Services department participates regularly and has taken an active role in processing the findings and taking action to respond to issues raised in the AE. The facility services staff who join the AE take pride in the positive design features highlighted during the event. The Accessibility Expedition is also used as a professional development opportunity for people in the construction trades, environmental sustainability, and project management.

Facility services is only one constituent participating in the AE. Students from disciplines all over campus join the event, including those from construction management, education, and the disability studies academic programs. Staff and faculty members, some with disabilities themselves, from a variety of departments also join the AE each semester. Facilitation in the AE for individuals with mobility impairments is mandated by the protocols of the AE (e.g., all participants must use the same path of travel). For participants with sensory impairments, participation is facilitated with sighted guides or ASL interpreters, not as accommodations for participation but as a model for inclusion.

The continuous development of the AE suggests an increasing interest in accessibility and UD across campus. For example, the dean of students office requested that AE be included in homecoming events last year to highlight for alumni and parents the history, growth, and continuing opportunities for development of campus design.

The Accessibility Expedition has further evolved to include a greater emphasis on the features of campus that reflect the university's commitment to UD. The additional emphasis on UD features also helps to bring increased consciousness to participants of the ways in which design can positively impact a diverse population of community members. When potential barriers are discussed following the actual campus walk, participants begin to view these barriers as new opportunities for remediating physical barriers and facilitating inclusive participation. While the AE is not intended to constitute a stand-alone curriculum, the conversations about disability, representation, barriers, and UD persist and infiltrate the work of faculty, staff, and students from across campus in disciplines stretching from health and human services to engineering to education to history. Participants learn from one another and explore how to apply these experiences in their own disciplines and work.

Another outcome of the AE is its incorporation of UD practices and other disability-related topics into course curriculum for disciplines that have a direct impact on design and construction. For example, NAU's construction management program requires attendance and participation in the AE by students in its introductory course. During the COVID-19 pandemic, the AE was modified into a self-directed project students could complete from home, investigating their homes and neighborhoods. While not as effective without the discussion, it still provided an opportunity for students to engage with their environments using a new lens. Students in the construction management program go on to work for large and small construction firms, universities, and to open their own businesses. Experiencing the AE provides first-hand understanding of the barriers created for people with disabilities when they are not considered in design from the beginning, or how often simple design changes can eliminate those barriers and make spaces better for everyone. Including a framework of UD provides students a vocabulary to use in their future roles. This larger attitudinal shift for students is important because most often have not considered the ways in which design of the environment continues to disable people.

Implications and Transferability

The Accessibility Expedition has wide-reaching implications for institutions interested in establishing their own events. The model is straightforward, easy to follow, and can result in a level of empathy, understanding, and empowerment not available through typical simulations. It is also flexible enough to be implemented in a variety of contexts including conference sessions and course modules. The AE model avoids creating or exacerbating pity for people with disabilities. Instead, it sheds light on real barriers experienced by real people. The model is nimble and can be applied to any environment, including virtual environments, as long as four conditions are met:

1. People with disabilities lead and participate in each group.
2. People with significant experience in code compliance (i.e., ADA, WCAG) and universal design construct the tasks and participate in each group.
3. Both barriers and examples of accesible and/or universal design are included in each group's physical or virtual destinations.
4. The AE ends with a debriefing that consists of a discussion of observations and experiences centering the voices of people with disabilities.

NAU has worked hard to ensure that disability is included in the diversity, equity, inclusion, and justice framework of the university. The disability resources office does not directly manage or run the AE. However, staff from this office provide invaluable expertise on disability-related and accessibility topics as groups traverse campus and then discuss their findings. Other institutions may need to rely solely on the disability resources office to design an AE. Regardless, disability resources offices are key constituents in a successful event. Other groups who may have vested interests in accessibility, UD, and the experiences of disabled individuals may also be invited to participate in an AE. Each institution will be able to identify its own set of interested collaborators, based on its composition, needs, and accessibility/UD allies. The following are groups, other than facility services, that are invited to participate in NAU's AE:

- Student organizations (especially student organizations on disability or diversity)
- Committees, working groups, and others focused on disability inclusion
- Academic programs like construction management, civil engineering, computer science (for virtual events), architecture or landscape architecture, informatics, health and human services, geodesign/parks and recreation management, geography and planning
- Library
- Education, special education, and disability studies programs
- Community partners
- Administration
- Parking services

Conclusion

Full inclusion of people with disabilities on university and college campuses takes more than a committed disability resources office. A substantial shift in the continuum from pity to power will require a critical examination of the physical and attitudinal barriers that are foundational to the ways in which we construct our environments. Allies from across campus must come together to enact change. The Accessibility Expedition is a promising practice for advocacy and ally building. Providing students, staff, and faculty with tools to evaluate their environments promotes lasting change across the institution. Outcomes of the AE suggest that it is an effective tool to educate and engage a wide range of campus constituents from students to administrators. The grassroots nature of the AE centers the voices of people with disabilities and empowers them to move from passive user to central advocate. Through participation in the AE, a deeper understanding of both the power and the pitfalls of laws such as the ADA is gained and then built upon using the framework of UD.

The Accessibility Expedition forces disability to the forefront and creates empowered advocates and allies. The diversity of representation among participants from various units and groups across the institution also helps to build partnerships between groups and departments that may not normally engage. Students gain knowledge in the complicated functioning of the university and begin to see where their power lies in advocating for change. Longer-term effects are reflected in the quality collaborations and engagement of people with disabilities in university-wide conversations on master planning, inclusion on hiring committees, and requests for advice and consultation from across campus. The Accessibility Expedition at its core is a tool for inclusion with a mission to meet people where they are and provide guided and supportive movement toward understanding and advocacy.

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Appendix A

Tasks

Group 1: Task 1

Tweet pictures and location description using #NAUDPHM

1. Start at the SAS building
2. Go to the Aquatic and Tennis Complex (ATC) (20 minutes)
    a. How did you get there? Describe the path of travel and entrance. Can everyone travel together?
    b. Find the All Gender changing/restroom. Was it easy to find? Could you get to the pool deck easily? Could you find it again from the pool deck?
    c. How about a soak in the hot tub? Who is, and who is not, able to participate in an activity here? Why?
    d. Are you hungry after your trip to the pool? Visit the vending machines.
    e. Find the viewing area and your next task. What do you notice about who is included in this space? Is anyone excluded?

Proceed to Your Next Task!

Appendix A (Continued)

Tasks

Group 1: Task 2

Tweet pictures and location description using #NAUDPHM

3. Make your way to the West Entrance of the HLC (main entrance) (10 minutes)

   a. What do you notice about the crosswalk?
   b. Describe the entrance? Can everyone travel together?
   c. Find the Directory and your next task. How do you get to Disability Resources? Is this signage accessible and clear for everyone? Why or why not?

Proceed to Your Next Task!

Appendix A (Continued)

Tasks

Group 1: Task 3

Tweet pictures and location description using #NAUDPHM

4. Find the East Entrance of the Bookstore (20 minutes)

    a. Was the entrance accessible? Can everyone travel together?
    b. Exit the building on the west side. Is the signage clear? How did you get there?
    c. Before you leave go to the Post Office and find your final task. How did you get there? Can everyone get their mail?

Proceed to Your Next Task!

Appendix A (Continued)

Tasks

Group 1: Final TASK

5. Go to the SAS auditorium patio on the south side of the building for debriefing and snacks! (10 minutes)

Take note of any barriers you encounter along the way!
Send pictures!

Appendix B

ISA for Task Envelopes

Building Australian Tertiary Educator Knowledge and Skill in Universal Design for Learning

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Elicia Ford[3,4,5]
Alison Casey[4]
Annie Carney[7]
Jennifer Cousins[8]
Stuart Dinmore[9]
Andrew Downie[10]
Mary Dracup[11]
Jane Goodfellow[12]
Meredith Jackson[13]
Noor Jwad[4,5]
Dagmar Kminiak[4]
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Abstract

Students with disabilities continue to experience barriers to accessing tertiary (i.e., postsecondary) education in Australia. Using the principles of Universal Design for Learning (UDL) may help educators proactively address barriers through the design of more accessible and inclusive educational experiences. However, at present, references to UDL appear in only a small number of Australian educational policies and tertiary institute websites, and few tertiary educators use UDL in practice. In this article, we describe how a team of educators, learning designers, accessibility advocates, and people with disabilities from multiple institutions across Australia collaborated to co-create a free, accessible eLearning program to build workforce knowledge and skill in UDL. We first describe how the advisory group was established, how the Knowledge to Action cycle was used to guide the activities of the advisory group, and the evaluation framework that was used to assess the outcomes of the eLearning program. We share potential future activities to raise awareness of UDL and influence policy and practice in local contexts and propose directions for future work in this area.

Keywords: postsecondary education, higher education, vocational education, disability, Universal Design for Learning

Australians with disabilities still struggle to access tertiary education (Grant-Smith et al., 2020), despite that Australia has signed and ratified the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD, United Nations, 2006), which asserts that all people with a disability have the right to access education on the same basis as their non-disabled peers (Article 24). In Australia, the UNCRPD is enacted in policies and legislation at the federal and state/territory level, and the right to education is articulated in local laws including the Disability Discrimination Act (Australian Government, 1992) and the Disability Standards for Education (Australian Government, 2005). However, research including the student voice has suggested that course technologies are inaccessible, students with disabili-

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ties have difficulty navigating the online or physical learning environment, and students lack support to get appropriate and needed accommodations (Kent, 2015). Compounding concerns raised by students, the 2020 review of the Australian Disability Standards for Education (Australian Government, 2021) found that tertiary educators were not confident about how to implement adjustments for students with disability.

At present, to receive accommodations in tertiary education, students with disabilities are typically asked to provide medical documentation as evidence of need and then negotiate individual accommodations (Pitman et al., 2021). This reactive approach to providing accommodations to individual students is challenging for several reasons. First, the approach places the responsibility on the individual student. In other words, it requires students to self-identify and advocate for their learning support needs. Doing so may require students to possess self-advocacy skills and a mature understanding of their educational needs (Kraglund-Gauthier et al., 2014). Secondly, this approach requires educators to develop and implement a suite of adjustments to suit each identified student need, which can be time and resource intensive (Lombardi et al., 2015). Finally, this approach might exclude students who may not be aware of their disability or who might not want to disclose their disability for fear that disclosure would be stigmatising or place them at a disadvantage (Moriña, 2016).

Given these challenges, the exploration of a proactive and systematic approach to building workforce capability in the design and delivery of inclusive education in Australian tertiary education institutions was deemed to be important. One way to support the inclusion of students with disability in tertiary education is to incorporate the principles of Universal Design for Learning (UDL) into the design and delivery of tertiary curriculum. Terms such as *universal design, inclusive design,* and *design for all* have been used to describe "the design of products and environments to be usable to all people, to the greatest extent possible, without the need for adaptation or specialized design" (Centre for Universal Design, 2008, p. 1). UDL is an application of universal design that aims to ensure that learning content and activities allow the maximum number of learners to participate and learn, regardless of their age, cognition, physical ability, cultural background, or learning preferences (Pisha & Coyne, 2001). UDL's proactive approach to learning and teaching design aims to give all students equal opportunities to succeed by providing students with flexible pathways for learning, such as multiple representations of content, multiple ways to actively engage with content, and multiple ways to demonstrate their learning (CAST, 2018). In addition, UDL is not prescriptive about the specific teaching strategies to be used, and might be used in conjunction with goal setting, structured activities and lessons, scaffolding, multiple exposures to concepts and ideas, frequent formative feedback, self-monitoring, and other high-impact learning and teaching strategies (Hattie, 2009).

UDL might be considered an optimal strategy for addressing barriers faced by students with disability in tertiary education for several reasons. First, UDL has been demonstrated to improve student retention and participation in tertiary education (Capp, 2017; Seok et al., 2018). Second, UDL takes the onus off students to identify and request accommodations and places responsibility on institution and educators to proactively design more accessible and inclusive learning experiences (Chardin & Novak, 2020). Third, UDL is non-categorical; in other words, it can be applied flexibly to meet the diverse needs of learners across settings, subjects, age groups, cultural backgrounds, and disability types (Lowrey et al., 2017). Finally, UDL can be implemented strategically and systematically within a tertiary education institution as part of the provision of a continuum of support for students (Fovet, 2021), rather than as individual activity on part of educators.

At present, references to UDL appear in only a small number of Australian educational policies and tertiary institute websites, as indicated by a review of Australian tertiary education policies completed as part of this project (Jwad et al., 2021). The limited reference to UDL in policy and practice resources in the tertiary education sector, and lack of reinforcement in government policies in higher education and within the Vocation Education and Training (VET) sector, may partly explain the slow uptake of UDL in Australia. Australian policy and practice resources primarily advocate for the provision of individualised reasonable adjustments to students with disabilities (Fossey et al., 2015), although Fossey et al. point to universal design as a useful framework for Australian institutions to explore. In addition, there are few Australian courses, programs, or professional learning opportunities specifically designed to build educator knowledge and skill in UDL.

Setting and Participants

In response to the 2020 Review of the Australian Disability Standards for Education (Australian Government, 2021), the Australian Disability Clearinghouse on Education and Training (ADCET) and the Australian National Disability Coordination Officer

(NDCO) Program convened an advisory group of key representatives across the tertiary education sector to explore ways to increase support for and adoption of UDL in tertiary education in Australia. The project was coordinated by five core members representing ADCET, the NDCO Program, and Technical and Further Education (TAFE) South Australia. The expert advisory group was composed of members across Australia representing both vocational and higher education. Advisory members were recruited through the direct invitation of those with known experience with UDL, as well as through an expression of interest process shared through an Australian Tertiary Education email list subscribed to by over 700 tertiary education disability practitioners. The broader advisory group membership included teaching and learning specialists, learning designers, learning technology developers, disability services managers, accessibility consultants, researchers, and lecturers, all of whom are co-authors of this brief. Within the advisory group, several members had lived experience of disability. Advisory group members represented tertiary education institutions and/or programs from New South Wales, Victoria, Queensland, South Australia, Tasmania, and Western Australia.

Depiction of the Problem

In Australia, it is estimated that 7.3% of university students and 5% of VET students have a disability (Australian Government, 2022; National Centre for Vocational Educational Research, 2022). This represents an increase in the enrolment share of domestic students with disability by 64.9% over the past decade. However, research has shown that students with disability are less likely to complete their studies than their non-disabled peers, and, if they do graduate, are less likely to engage in meaningful and competitive employment post-graduation (Grant-Smith et al., 2020). In Australia, tertiary education attainment may increase the likelihood of employment, be associated with a higher income, and be related to greater social benefits (Deloitte Economics Access, 2016). Thus, there is an urgent need to identify strategies to support the inclusion and full participation of students with disability in tertiary education institutions, as successful completion of a certificate, diploma or degree may facilitate entry into the workforce and build social and economic capital.

Description of Practice

This project was conducted across several stages using the Knowledge to Action (KTA) cycle (Graham et al., 2006). The KTA cycle is a conceptual framework designed to facilitate the translation of knowledge into sustainable evidence-informed practices in real-world settings (Field et al., 2014). The KTA cycle includes several stages: (a) identification of the problem, (b) determining potential solutions, (c) selecting a solution, (d) identifying possible barriers and facilitators to implementing the solution, and (e) creating tools to translate the solution into action. In what follows, we illustrate how the KTA cycle was used to guide the development of the UDL eLearning program.

Phase 1: Identifying the Problem

The 2020 Review of the Australian Disability Standards for Education acknowledged that the "integration of UDL and other accessibility principles (into tertiary education) would require the collaboration of many stakeholders, including governments, providers, regulators, and curriculum and assessment authorities" (Australian Government, 2021, p. 43). This statement was the impetus for convening the advisory group and initiating this project. Members of the team who conceptualised this project were motivated by the shared sense that Australian tertiary education institutions can and should do more to support the equal participation of students with disability. One specific problem that the advisory group was interested in addressing was a lack of preparedness and confidence on the part of educators with respect to implementing adjustments for students with disabilities.

Phase 2: Determining Potential Solutions

After the problem was identified and defined, the advisory group brainstormed potential solutions. To do so, advisory group members drew on their collective professional wisdom and reviewed information from several sources, including (a) international published research on strategies and tactics for building the capability of educators to address the needs of students with disability, (b) published Australian policy documents and reviews related to supporting students with disability in tertiary education settings (e.g., Australian Government, 2021; Kent, 2015; National Centre for Vocational Educational, 2022), and (c) publicly available tertiary education institution policy and practice documents pertaining to the provision of adjustments for students with disability (Jwad et al., 2021). Advisory group members acknowledged that no one solution was likely to be sufficient to address the range of needs of students with disability in tertiary education, and that, for a proposed solution to be successful, it would need to be realistic, achievable, and effective.

Phase 3: Selecting a Solution

The final report of the 2020 Review of the Australian Disability Standards for Education (Australian Government, 2021) recommended that UDL be explored as a potential way to increase access to education for students with disability in Australia. Collectively, the members of the advisory group felt that UDL was a suitable framework for supporting the participation of students with disability in tertiary education because it is flexible, adaptable, and can benefit all learners. In addition, UDL was highlighted as a potential approach for use in the tertiary education sector in multiple government reports (see Australian Government, 2021; Fossey et al., 2015). Members of the group also highlighted that UDL was advantageous because it offered a proactive approach for designing more inclusive educational experiences that reduced the need for students with disability to request individual accommodations and disclose their disability, thus addressing challenges associated with the more typical reactive approach commonly used. Thus, the identification of new ways to build educator capability in the use of UDL in practice (the solution) was determined to be important and needed.

Phase 4: Assessing Barriers and Facilitators to Implementing the Solution

Members of the advisory group were able to draw on their own experiences working in the tertiary education sector to identify some of the potential barriers to building educator capability in UDL. One commonly identified barrier for educators was time and another was pressure associated with ever-increasing workloads. Advisory group members noted that through adoption of the UDL framework, the time and workload associated with reactively addressing individual student needs might be reduced in the long-term. Advisory group members also considered barriers that tertiary educators might face when developing knowledge and skill in UDL. Barriers might include time to develop new skills in UDL, opportunities to participate in professional learning opportunities related to implementing UDL, cost of professional learning opportunities and supplemental resources, and assistance with putting the principles of UDL into practice on the job.

A UDL eLearning training program was determined to be a cost- and time-efficient way for tertiary educators to build their knowledge and skill in UDL. The members of the advisory group worked together to co-create a free, accessible eLearning program (Disability Awareness, 2022) to build workforce knowledge and skill in UDL (see Table 1). Several steps were taken to make the program as accessible to as many educators as possible. First and foremost, the program was made available at no cost and is currently housed on an online, freely accessible learning management system. Secondly, the program was designed to be self-paced and modularised, so participants could choose when and where to complete it. The total duration of the eLearning program is approximately 2 hours to allow participants to complete it in one or a few sittings. Third, user testing was undertaken before the launch of the program to ensure it met accessibility standards (Web Content Accessibility Guidelines 2.0) and was easy to use and navigate. Finally, to facilitate knowledge transfer, the program illustrated the principles of UDL in action by providing multiple means of representation of content (for example, all videos are accompanied by captions and transcripts) and multiple ways for participants to engage with the content (video clips, practice examples, printable resources, links to external sources that provide more in-depth information, etc.). Providing multiple means of representation also allowed to ensure specific accessibility standards were met, such as providing captions and transcripts for video content, alternative text for images, and printable documents that could be read by screen reader software.

Phase 5: Creating Tools to Translate the Solution to Action

The eLearning program was created by the members of the advisory group. Subcommittees were formed to (a) develop and film video content for inclusion in the eLearning program, (b) build the eLearning program on the learning management system, (c) develop supplemental resources to accompany the eLearning modules, (d) undertake user testing of the eLearning program to ensure it was easy to navigate and accessible (this subcommittee included members of the group with lived experience of disability), (e) develop a framework for evaluating the eLearning program (user surveys and focus groups), and (f) planning a public online event (a free webinar) to correspond with the launch of the eLearning program and raising awareness about the program in the tertiary education sector via social model posts, an email to the over 700 practitioners on the Australian Tertiary Education email list, and by individual advisory group members sharing information about the program within their professional networks.

Evaluation of Observed Outcomes

Enrolment and completion data provide demographic information, module quizzes provide participants with formative feedback on their learning

Table 1

*Description of the Content Included in Each of the Four Modules that Comprise the Universal Design for Learning in Tertiary Education Elearning Program**

Module Name	Module Content
Introduction to Universal Design for Learning	1. Introduction to inclusive education 2. Principles of Universal Design 3. Universal Design for Learning (UDL) 4. Benefits of UDL 5. UDL and reasonable adjustments
The Universal Design for Learning Framework and Guidelines	1. The Universal Design for Learning framework 2. The Affective, Recognition and Strategic networks 3. UDL principles, guidelines, and checkpoints 4. Multiple means of engagement 5. Multiple means of representation 6. Multiple means of action and expression
Universal Design for Learning in Practice	1. Design, development, and delivery considerations 2. Course design 3. Unit, topic, and session planning 4. Development of materials and resources 5. Learning tools and technologies 6. Facilitation of learning 7. Assessment 8. Evaluation and feedback
Getting Started with Universal Design for Learning	1. How can I start? 2. Try the plus-one approach 3. Additional considerations to support UDL 4. Identifying and addressing implementation challenges

Note. * The full eLearning program can be accessed at https://disabilityawareness.com.au/elearning/udl-in-tertiary-education/

and provide program administrators with information about the degree to which participants are demonstrating new knowledge, and a post-program survey provides qualitative and quantitative data about participant learning and confidence with UDL, intention to apply their new learning in their practice, and overall satisfaction with the eLearning course. The course was launched in December 2021. As of 30 June, 2022, 644 people enrolled in the program. Of these, 409 people partially completed the program and 255 people completed the program in full. Whilst 61.6% of participants are yet to complete the training in full, many of these program participants continue to log in either regularly or sporadically, taking advantage of the self-paced nature of this program to complete the course in their own time or access learning materials as needed. Additionally, completion of the program is currently entirely voluntary.

Seventy-one participants also completed the post-program survey. Preliminary survey data suggest that participants who have completed the program have improved their understanding of UDL principles and are likely to make changes in their practice to implement and apply UDL. Before completing the course, only 34.9% of participants reported having a good or excellent understanding of UDL principles. After completing the course, 90.4% of participants reported having a good or excellent understanding of UDL principles. In addition, 92% of training participants reported feeling mostly or very confident to apply UDL practices and approaches to their work following completion of the course.

Implications and Transferability

By bringing together an advisory group, we were able to draw on the expertise and lived experiences of individual champions of UDL from across Australia to explore new ways to build tertiary educator knowledge and skill in the use of UDL. The design of a free eLearning program allowed us to disseminate information about UDL and how it can be used to deliver inclusive and accessible education in the tertiary education sector to tertiary educators, administrators, and learning designers. The eLearning program promotes a stepped approach to UDL, in which small changes may be introduced by individual educators that are gradually expanded as educators gain confidence (Moore et al., 2018). This might be considered a "bottom-up approach" to promoting practice change; that is, it relies on individual educators to complete the course, decide how to incorporate UDL into their own practice, and then share the impact of their implementation efforts with others to raise awareness of benefits and facilitate wider adoption of UDL within their local context.

However, a "top down" approach driven by policy change may also be required if the tertiary education sector is to embed UDL into practice in more systemic ways. Members of the advisory group discussed the importance of serving on committees or working groups designed to influence institutional policy change or working collaboratively with others within their institution (including students with lived experience of disability) on projects and initiatives around the provision of inclusive education for students with disability and articulating the role of UDL in action/strategic plans.

Limitations and Future Directions

The development of the UDL eLearning program was a first step towards building awareness of UDL in the Australian tertiary education sector. At present, we do not have much information about how individuals who have completed the program are translating their new learnings into their professional practice, or the barriers they encounter when doing so. We identified several future directions to continue to build on the work completed to date. First, we will supplement the eLearning program with a community of practice to support educators to translate their new learnings into their practice. This will provide a way for educators to access ongoing support from community of practice leaders and from other educators who are implementing UDL. Through these sessions, we will be able to identify barriers to implementation and generate potential solutions to these barriers. We will also gather practical examples of how UDL is implemented in Australian tertiary education institutions, develop new resources to support implementation, and share new resources through newsletters, social media groups, presentations, institution-specific professional development events, and the media. To extend this work and contribute to a growing body of international research on UDL, we plan to conduct focus groups with participants who completed the eLearning program to explore their perceptions of the barriers and enablers to using UDL in practice. We also plan to identify and describe examples of successful implementation of UDL looks like in Australian tertiary education institutions through the collection and analysis of case studies.

Some members of the advisory group had lived experience of disability (a strength of this project), which allowed us to capture the perspectives of people with disability during all phases of the project. However, we recognise that, in the development of the eLearning program and resources, the voices of students were mostly heard second hand, through the stories of their educators (although students do feature in some of the videos included in the program). We recommend centring the voices of students with disability, as the major stakeholders, as part of future efforts to integrate UDL into tertiary education classrooms. It is important to identify if and how UDL addresses the needs of both students with disability to identify if there are areas that students need more support. This might be accomplished by inviting students with disabilities to participate in focus groups and communities of practice to provide feedback on resources and to share their lived experiences. In addition, students with disabilities should be invited to participate in the planning and user testing of new program materials and technologies to ensure they are accessible and usable. The active involvement of students with disabilities should be an integral part of future efforts to implement and evaluate UDL in the Australian tertiary education sector and education systems worldwide.

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Anyone Can Learn Universal Design: An Interdisciplinary Course Centered Around Blindness and Visual Impairment

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Abstract

Courses at the postsecondary level continue to rely heavily on visual material that is accessible only to fully or partially sighted students. Tactile graphics work for many pedagogical purposes, but in some cases are insufficient; other information and concepts may be better conveyed through haptic exploration of 3D printed objects. However, there is a dearth of 3D-printable open educational resources for college-level content. To address this need while simultaneously teaching students about accessibility and universal design, we designed and taught an experimental course in which students (a) learned about disability in general and blindness in particular (including history and advocacy); (b) explored technology used by people with visual impairment; (c) heard from many blind voices, including guest experts and community members; (d) studied universal design; and (e) designed 3D-printable educational tactile models in collaboration with blind community members. By the end, students demonstrated significantly less bias and more positive attitudes about blindness and people with visual impairment, and were more confident with accessibility, universal design, and assistive technology. We believe this course can serve as a model for similar courses elsewhere as a strategy to teach students from any major about disability, accessibility, and universal design.

Keywords: universal design, accessibility, blindness, OER, 3D printing

Postsecondary instructors who receive little to no pedagogical training related to disability, accessibility, or universal design may, as a result, unintentionally create learning barriers for their students. While some accommodations to remove barriers and provide equitable educational access are simple (e.g., additional time for exams), other accommodations are much more complicated (e.g., remediating inaccessible documents).

Blind and partially sighted students in particular are often denied the same educational resources as their sighted peers because many disciplines make heavy use of graphics, pictures, charts, animations, and other visuals (Bell & Silverman, 2019). It can be challenging for instructors to find or create non-visual ways to fully convey the same information, such as high-quality tactile graphics or hands-on 3D models. However, if such pedagogical materials already existed for a wide variety of courses and were released online as open educational resources (OER), then instructors and/or disability services staff could access open databases of these materials and print them at negligible cost using tactile graphic printers or 3D printers.

In this paper we describe a course that may serve as a model for how to address the need for such OER in a scalable way. The course was designed to be interdisciplinary, showing that students from any major can be taught about disability and universal design in a way that has a lasting influence on their own perspective and behavior, in addition to providing valuable real-world, project-based experience that contributes toward a genuine need.

As an aside, we use the terms blind, blindness, and blind people throughout this paper in a broad and inclusive manner (i.e., this definition includes people with some amount of vision), though there is no universally accepted definition of those terms, nor for related terms like visually impaired, partially sighted, low vision, and so on. For example, Kenneth Jernigan, long-time president of the National Federation of the

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Blind, famously eschewed legal and ophthalmologic definitions of blindness (e.g., less than 20/200 acuity after correction or very small field of vision) for a more functional and sociological definition:

> One is blind to the extent that the individual must devise alternative techniques to do efficiently those things which he would do if he had [ophthalmologically] normal vision. An individual may properly be said to be "blind" or a "blind person" when he has to devise so many alternative techniques--that is, if he is to function efficiently--that his pattern of daily living is substantially altered. [...] I believe that the complex distinctions which are often made between those who have partial sight and those who are totally blind [...] are largely meaningless. In fact, they are often harmful since they place the wrong emphasis on blindness and its problems. Perhaps the greatest danger in the field of work for the blind today is the tendency to be hypnotized by jargon. (Jernigan, 2005, p. 1)

Whether using the terms blind, visually impaired, or partially sighted, the important thing for the purposes of this paper is that non-visual learning material is absolutely essential for many students but can also be beneficial for all other students (including those with various types and amounts of vision).

Summary of Relevant Literature

While textual material is easily converted to another modality using text-to-speech screen reader programs, the ubiquity of other non-text visual material in postsecondary classrooms is a common barrier for blind students, who in turn are less likely than their peers to complete a degree (Erickson et al., 2022). In some cases, describing an image in words (i.e., "alt text") may be sufficient to convey essential information. However, for a lot of material that is normally presented visually, the best way to learn a concept, process data, or develop a mental model is to explore a tactile representation (Jones & Broadwell, 2008). Tactile graphics can be created with a Braille embosser, thermoform plastic from a mold, or thermal capsule paper that creates raised lines or bumps when passed through a special printer (this last solution being the cheapest and fastest).

However, in many cases, visuals at the postsecondary level have information density or complexity that makes tactile graphics an inelegant or incomplete solution (i.e., a single diagram may need to be manually converted into many sub-graphics, say, to overcome the limitations of detail for the modality of touch; Braille Authority of North America and Canadian Braille Authority, 2011). Very simple color can be represented with texture, but with many different textures and line types it may be hard to clearly convey the same information as the visual modality allows. Certainly it is not as easy as automated conversion of a picture file to a tactile printer file by a computer program.

In many cases, a better way to convey information non-visually to help students understand and create mental models is hands-on exploration of 3D objects (Jones & Broadwell, 2008; Klatsky & Lederman, 2011). Indeed, basic perceptual research has shown that 2D tactile graphics made with raised lines are often inferior to 3D objects (Lederman et al., 1990; Loomis, 1981; Shimizu et al., 1993). As Ballesteros and colleagues (1997) point out, "Raised-line stimuli reduce the effectiveness of the [tactile] system, forcing it to use only a very small part of its encoding capability, and thereby limit its performance" (p. 49).

However, while proprietary hands-on 3D models are common in some disciplines (e.g., a plastic brain or heart to teach anatomy, stick-and-ball models in chemistry), these do not exist for most of the visually-presented material in any course, and in many cases these are proprietary, expensive, use color, or cannot be adapted or improved on by instructors (Chakraborty & Zuckerman, 2013; Griffith et al., 2016; Groenendyk, 2016).

On the other hand, 3D printing has become relatively cheap and simple at the consumer level and most campuses either have a 3D printer or are near a public library or makerspace that offers 3D printer access (Ford & Minshall, 2019). With 3D printing, the design for a hands-on educational model can be shared as an online file and then printed from anywhere. In many cases, these are shared on a general purpose open database for 3D designs (e.g., Thingiverse.com) or a specialized database (e.g., National Institute of Health's 3D Print Exchange; Coakley et al., 2014) under a Creative Commons license that allows freely using, sharing, and altering or improving the design. Groenendyk's (2016) cataloging of educational 3D printable designs on the internet found that they overwhelmingly tend to be shared for free. Such freely shared and remixable designs can be considered open educational resources (OER), meaning they are educational materials under an open copyright license or in the public domain (Wiley et al., 2014).

Metalibraries (e.g., BTactile.com) allow searching across many different databases, although most designs are for basic objects (e.g., a lion, a soccer ball, the Eiffel Tower) or simple concepts relevant to primary and secondary school. A big challenge going forward will be creating and iterating open access 3D-printable files at scale for the wide variety of courses found in the many disciplines of postsecondary education. A solution is needed that scales up this design process in a distributed manner. To the extent that some disciplines have started using 3D printed artifacts for teaching (e.g., Rossi et al., 2015), there are currently far too few, and researchers have called for the creation of more extensive open-access libraries of 3D models (Horowitz & Schultz, 2014; Groenendyk, 2016). Below we describe our model for an innovative solution: to have groups of students create (or test and improve) 3D-printable hands-on educational models and release them freely as OER online.

Notably, such design work cannot be done well without the appropriate background knowledge and context. For example, students may not be familiar with the wide diversity of visual function and impairment and may see blindness as a binary (sighted vs. no vision; Jernigan, 2005), so some basic information about the visual system and visual impairment is important.

Students may also need to learn how processing and learning work differently in the tactile channel than they do in the visual channel. Vision is more holistic and parallel, while haptic exploration with touch is sequential, slower, and taxes working memory to a greater degree (Ballesteros et al., 2005). Visuals used in postsecondary curricula often utilize depth, perspective, and other three-dimensional visual cues and these are simply not interpreted in the same way when presented in the tactile modality (Lederman et al., 1990; Wijntjes et al., 2008). Thus, converting a visual representation of a 3D scene or object into a 2D tactile graphic fails when that visual representation relies on cues that won't be interpreted the same way by touch (Klatsky & Lederman, 2011). Designing tactile educational objects requires some understanding of tactile learning (Pawluk et al., 2015).

Additional context comes from understanding accessibility, the extent to which objects, services, or environments can be accessed (specifically by those with disabilities). For example, ramps, elevators, and curb cuts in sidewalks all provide users of wheelchairs access to environments they otherwise would have trouble accessing. Braille signage, tactile maps, and audio signals at pedestrian crossings all allow those with visual impairments to navigate new spaces. To design for accessibility is to remove barriers and increase access, not just for physical mobility, but for employment, education, voting, housing, access to private businesses, and so on (Karellou, 2019; Syed et al., 2022; Oishi et al., 2010).

Designing well for people with disabilities also means understanding the kinds of technology used by people with disabilities (assistive technology) to accomplish functions that would otherwise be challenging or impossible. For example, many blind people use white-tipped canes for mobility, refreshable Braille displays to type and read Braille, and screen readers to convert digital text to synthesized speech (Hersh & Johnson, 2008). Likewise, magnification devices may make visual material originally designed for high-acuity vision (e.g., a handout printed with typical font size) accessible to those with less visual acuity.

While some of these technologies are specifically adapted to the needs of one specific user group (adaptive technology, a subset of assistive technology), many of these technologies are helpful not just to those with disabilities but to everyone (Hersh & Johnson, 2008). Tactile pavement provides cues alerting people to approaching streets, train tracks, or surface hazards; this benefits people who are blind or visually impaired but also sighted walkers who are distracted in conversation or on their phone. Text-to-speech programs and audiobooks are popular with sighted people as well as those with visual impairments. Captions and subtitles benefit not just Deaf and hard-of-hearing individuals, but those learning a language, those with learning or auditory processing differences, viewers in distracting or loud environments, and so on. Curb cuts benefit people pushing baby strollers or rolling luggage in addition to those using wheelchairs. Good design benefits everyone (Oishi et al., 2010).

Universal design (UD) has been defined by Ronald Mace as "the design of products and environments usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (The Center for Universal Design, 2008). This means following design principles such as equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and appropriate size and space for use. UD assumes that designers are better off integrating human change and range into design from the start instead of isolating less-common ability ranges as "disability". By adopting a universal design framework, students creating educational materials with the goal of making visually-presented material accessible in the tactile modality will provide benefits not just blind and visually impaired students, but potentially all students (Burgstahler & Cory, 2008; Estevez, et al., 2010; Reiner, 2008).

Finally, designing well for people with disabilities means listening to their voices, understanding something about disability history and advocacy, and including people with disabilities in the design process (Mankoff et al., 2010; Spiel et al., 2020). In a postsecondary course, this could include hearing directly from blind and visually impaired voices (as guest speakers or through podcasts, readings, and videos) and via collaborative interactions with blind community members.

An added benefit of an interdisciplinary version of such a course would be to weave disability, accessibility, and universal design into the wider postsecondary curriculum, not just in the handful of disciplines it more commonly shows up in (e.g., computer science, education, disability studies, engineering, design). Students in general go on to join a diverse workforce where they will interact with disabled colleagues, supervisors, and clients, create and carry out processes, and make products and render services. Educating students about disability may thus have far-reaching downstream effects that increase equity in the wider world. Additionally, employers increasingly seek candidates with accessibility skills (PEAT, 2018), so these skills make for more competitive graduates as well.

Setting and Participant Demographics

Our course was an experimental interdisciplinary course at a state university in the Northwestern United States with around 20,000 undergraduates enrolled (Carnegie classification: doctoral granting, high research activity), though such a course would likely work just as well at a community college, liberal arts college, or other institution. The course was team-taught by a faculty member in Psychology and a faculty member in the library; it was cross-listed by the registrar as an offering through the Psychology Department and through the College of Innovation and Design and was open to anyone. Students were made aware of the course through fliers posted around campus and emails with a description of the course sent out to advisors around the university. Seventeen undergraduates enrolled (8 male, 9 female; age not collected), and they represented many majors (biology, psychology, communication, health science, graphic design, criminal justice, English, and so on). The course was a standard 3-credit hour class that met twice a week for 75 minutes across a 15-week semester.

We collaborated with the campus' Educational Access Center while designing the course and to secure a guest speaker. We also collaborated with the state's Commission for the Blind and Visually Impaired, both to bring in guest speakers and experts and so students could meet and collaborate directly with blind community members as part of their team projects to create new 3D-printable designs. Community members were recruited through word of mouth by Commission staff. Finally, we collaborated with the makerspace in our campus' library to assist students with 3D printing their designs.

Depiction of the Problem

As mentioned above, there is currently a dearth of resources when it comes to tactile graphics and especially to 3D-printable models covering postsecondary educational material in many fields of study. Of the content that does currently exist (usually only for simple concepts), it is often made by hobbyists rather than in an academic realm, and designs may not be informed by knowledge of disability or UD. Thus, a scalable solution is needed where, say, college students who have taken a thermodynamics course or a historical geography course learn enough about UD to create accessible 3D models (or tactile graphics, where appropriate) for those subjects.

Another problem addressed by a course like ours is the distinct shortage of existing accessibility training in postsecondary curricula. Even in computer science, most faculty do not teach accessibility in their courses (Shinohara et al., 2018) and fewer than 3% of engineering and computing course descriptions mention anything related to accessibility (Teach Access, 2018). Likewise, in the field of education, undergraduates studying to become teachers generally feel unprepared to teach students with disabilities (Carroll et al., 2003). In many other majors, these topics come up even less, leaving students unprepared to address disabling barriers in their future lives and careers.

Description of Practice

We believe that a course like this, at its heart, should come at the problems described above from at least two angles: (a) the students learn about disability and accessibility, specifically as it relates to blindness and visual impairment, and (b) the students learn about design and 3D printing in general and universal design in particular. To address the first, students in our course learned and read about the following:

- Definitions and models of disability (e.g., the moral/religious model, the tragedy/charity model, the medical model, the social model, the cultural model, universalism)
- Visual impairment and blindness (including cultural constructions of blindness)
- Disability rights and advocacy (including relevant history and law such as the Inde-

pendent Living Movement, the Architectural Barriers Act of 1968, the Rehabilitation Act of 1973, the Capitol Crawl, the Americans with Disabilities Act of 1990/2008, the UN Convention on the Rights of Persons with Disabilities, the history of the National Federation of the Blind, and so on)
- Assistive technology
- Perception and processing in the non-visual vs. visual modalities

Obviously, many of these topics could take up an entire postsecondary course of their own, so in some cases we focused most heavily on information most relevant to blindness and visual impairment. For example, in a reading and discussion about person-first language and person-centered language, students encountered common person-first perspectives as well as perspectives from the autism community and Deaf community, but also read a statement from the National Federation of the Blind about why they as an organization rejected person-first language. Likewise, in learning about assistive technology, most of the time was spent focusing on assistive technology designed for people with visual impairments in particular (e.g., Braille systems such as Unified English Braille, contracted Braille, and Nemeth; tactile graphics; refreshable Braille displays/notetakers; DAISY; screen readers; audio description; magnification devices; electronic eyewear; optical character recognition; machine learning and artificial intelligence-based apps; personal assistant services; white canes; smart canes; Braille signs; tactile pavement; tactile maps; mapping and GPS apps; vibrotactile wearables; and sensory substitution devices). One particular focus was on failures in past design of assistive technology when sighted people had designed for blind users without consulting with them (for example, the long history of attempts at smart canes and sensory substitution devices). Activities and assignments in the course included the following:

- Using and creating tactile graphics (including learning best practices, as well as struggling to make sense of visuals when forced to see only a tiny portion at a time, analogous to the 'fingertip window' experience of tactile graphics);
- Experiencing Braille handouts and books, as well as Braille notetakers;
- Practicing with a screen reader to successfully navigate the web;
- Analyzing textbook visuals and graphics (one chapter of any college-level textbook);
- Doing sightless classroom observations (sitting in on another course with instructor permission and spending much of it without sight of the instructor, whiteboard, or screen);
- Identifying an environment or product that fails some principles of universal design
- Creating alt text for various images (and evaluating each others' alt text for best practices);
- Filling out reflections after all readings, videos, and assignments.

Blind voices were centered in the course: Students heard from and interacted with blind guest experts (including employees of the campus Educational Access Center and the state's Commission for the Blind and Visually Impaired), watched blind vidcasters (e.g., Tommy Edison, Molly Burke, and many others), listened to blind podcasters, and read essays and speeches by blind authors and leaders (e.g., Kenneth Jernigan and other presidents of the National Federation of the Blind). The students also collaborated directly with blind and visually impaired community members to get feedback on their design ideas and iterations. Based on past research and theory (e.g., Contact Theory), we hoped that this experience–combining cooperative contact between sighted and blind individuals with information provision and education–would lead to more healthy attitudes about blindness and accessibility (Allport, 1954; Corrigan & Penn, 1999; Horne, 1988).

To accomplish the design goals of the course, students also learned about design. Specifically, they first learned the basics of design thinking and the methods popularized in the business world by design firm IDEO (Brown, 2008), as well as user-centered design (as popularized by Norman, 1988). Students then learned more deeply about universal design (described above).

Since students did not come in with extensive knowledge of 3D design and printing, we partnered with the university library's makerspace to access their 3D printers and get technical help during printing. In and out of class, students worked in teams to learn how to use a simple and free 3D design software (primarily Tinkercad, but some students explored alternative free software). In a semester-long team project using these skills, they designed and iterated 3D-printable models such as a hands-on model of stereoisomers (chemistry) or an interactive tactile histogram graph maker (introductory statistics). At the end of semester, teams presented their designs (and failed iterations) as well as testing results in an accessible (multimodal, hands-on) poster session open to a variety of stakeholders from on and off campus (including members of the blind and visually impaired community).

While 3D modeling and printing may seem like imposing skill for non-technically-inclined instructors to teach their students, the logistics are less complicated than one might expect (Stone et al., 2020). Modern software is quite intuitive and comes with extensive help in the form of tutorials, documentation, and eager help from an extensive hobbyist community. Likewise, the campus library, a local library, or a local makerspace may provide support; 3D printing has become much more commonplace in all of these locations (Scalfani & Sahib, 2013).

Evaluation of Observed Outcomes

With approval of the Institutional Review Board of the university, we collected some survey data from the students in the course. They were not asked about their own disability status, but were surveyed on how much interaction they had previously had with people who are disabled (M = 3.0, SD = 1.0 on a scale of 5 = very much to 1 = not at all) and with people who were blind or partially sighted (M = 2.3, SD = 0.9 on the same scale). We collected pre-course and immediate post-course survey data from the students and they also consented to the use of written excerpts from their coursework for this study. All 17 students consented to participate, but one did not finish part of the pre-semester survey and one did not submit the post-semester survey; their data were not included in the relevant analyses.

Students were administered a 20-item psychometrically validated measure of attitudes about blindness and blind people called the Social Responsibility About Blindness Scale (SRBS; Cronbach's α = .76; Bell & Silverman, 2011; Rowland & Bell, 2012; Stone et al., 2021). The SRBS consists of statements such as "It is irresponsible of blind people to have children" and "Blindness is just a normal characteristic like being tall or short." By the end of the course, students showed significantly more positive attitudes about blindness (N = 15, M_{post} = 69.2, SD_{post} = 9.1, M_{pre} = 64.4, SD_{pre} = 6.8, paired $t(14)$ = 2.04, p = .030, Cohen's d = 0.53).

They were also asked some supplemental questions (Table 1) developed by Teach Access, a non-profit organization focused on building collaborations between academia, industry, and disability advocacy organizations to address gaps in accessibility skills (teachaccess.org). Students came out of the course significantly more confident that they could give examples of inclusive or universal design, define accessibility, give examples of assistive technology, and explain accessible design guidelines (all p-values $< .004$, significant even after conservative Bonferroni correction; Table 1), suggesting students will be more likely to consider these aspects of accessibility in their future lives and careers. Indeed, as one student wrote in anonymous feedback during a reflection assignment: "My design work will now be filtered through accessibility guidelines/standards." Another noted, "I now understand the things in our world need to be universally designed for everyone to use."

Implications and Transferability

This course presents one model for successfully integrating disability, accessibility, and universal design into the postsecondary curriculum in a way that also serves the additional purpose of providing increased accessibility for future students in the form of accessible OER that benefits blind learners but also sighted learners (information presented in multiple sensory modalities helps all students develop better mental models: Reiner, 2008). Similar courses at other institutions could replicate this, having student groups design (or user test and iterate) 3D-printable models and share them freely online as OER so that they can be used widely and further improved. Alternatively, students in a course like this could design or improve tactile graphics. Previous work has found significant errors in tactile graphics meant to replace textbook visuals (Smith & Smothers, 2012), and educational visuals in many courses simply have no tactile graphic equivalent. Regardless of the specifics of such a course, the key is for student creations to be OER so that others–especially busy or technically-disinclined instructors who find themselves teaching a blind student for the first time–do not have to "reinvent the wheel," but have access to existing well-designed learning materials.

While the course enrollment (and thus our sample size) was small and students self-selected by choosing to register for the course as an elective, our results provide a proof of concept that the model, if replicated and scaled up, could be effective for both creating much-needed OER for accessible course material and integrating disability, accessibility, and universal design into the wider postsecondary curricula. The results also suggest that students' experience in such a course could instill lasting attitude changes about disability and accessibility. Based on social network theory, we can expect these changes to have downstream benefits that spread through the students' future social and professional networks (Daly, 2010).

Based on our experience teaching this experimental course for the first time, we offer some suggestions about what could be done better to improve outcomes in future courses like this. First, students should col-

Table 1

Teach Access Questions

Question	Pre/Post Mdn	Wilcoxon	*p*-value
1. How confident are you that you could give an example of a type of disability?	5 / 5	z = -1.1414	0.157
2. How confident are you that you could define "accessibility" as the term relates to technology and media?	3.5 / 5	z = -2.873	0.004*
3. How confident are you that you could give an example of inclusive or universal design?	3 / 5	z = -3.370	0.001*
4. How confident are you that you could give an example of how accessible technology is used by people with disabilities?	3 / 4	z = -2.699	0.007
5. How confident are you that you could give an example of how assistive technology is used by people with disabilities?	3.5 / 5	z = -.2994	0.003*
6. How confident are you that you could give an example of a technological barrier somebody with a disability might face?	4 / 5	z = -2.373	0.018
7. How confident are you that you could define the purpose of the Americans with Disabilities Act?	3.5 / 3	z = -0.660	0.509
8. How confident are you that you could explain the Web Content Accessibility Guidelines (WCAG) (or other guidelines for accessible design and development)?	1 / 3	z = -2.914^	0.004*
9. How much interest do you have in learning more about designing and developing technologies for and with people with disabilities?	4 / 4	z = -0.905	0.366
10. How much interest do you have in pursuing a job or career in accessible technology?	3 / 3	z = -0.942	0.346
11. How much interest do you have in pursuing research in the development of accessible technologies?	3 / 4	z = -1.408	0.159
12. Have you ever used assistive technology (such as a screen reader for blind or low vision users)? [Y/N]	12.5% / 81.25%		
13. One a scale of 1-5, how familiar are you with the accessibility features built into devices (such as smartphones, computers or smart TVs)?	3 / 3	z = -1.540	0.124

Note. For questions 1-8, the scale was: 1 is not at all confident, 5 is extremely confident. For questions 9-11, the scale was: 1 is no interest, 5 is very high interest. ^ n = 15 for this question since one student left it blank. * $p < 0.0042$ (significant with Bonferroni correction for family-wise alpha of 0.05).

laborate with blind users and stakeholders as early as possible in the design process to avoid initially ideating plans that do not align with real-world needs and practices. Participatory and inclusive design practices lead to better designs (Gooda Sahib et al., 2013; Newell et al., 2011). Indeed, in a reflection at the end of our course, students gave advice such as, “Get info from actual [blind and visually impaired] people”, “Don't assume [you] know problems”, “Not everything that sounds great will be helpful”, and “You must test your product with the people you want to use it.” A course like this simply will not work well if students are not meeting and collaborating with those from the community they are designing for.

The National Federation of the Blind has chapters in all states and many localities and we suggest reaching out to an advocacy organization such as this in addition to any state agencies or commissions. Perhaps even more useful would be if campus disability services recruited any interested volunteers on campus (e.g., blind or visually impaired students currently taking college-level courses in which they might have experienced barriers from vision-centric pedagogy or a lack of hands-on learning artifacts).

For instructors or for staff at a disability services office on campus, we suggest making early contact with local makerspaces (be it on campus, at a local library, or in the community) not just for access to 3D printers, but for the community support so that students can learn and develop skills in a more realistic context than always asking the instructor for help.

Disability services staff might consider reaching out to faculty around their campus to gauge interest in teaching a course like this. The model works well as an interdisciplinary course open to all (perhaps even team-taught by instructors from different disciplines) but could also work great as a project-based course for students in design-related fields (engineering, computer science, graphic design, etc.) or in teaching-related fields (education, special education, etc.).

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Designing for Accessibility in Online Learning: A Design Case

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Abstract

Despite laws in the United States (e.g., Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990 and its 2008 Amendments), students with various disabilities continue to experience access barriers to instructional content and inclusion in course activities. Online learning environments can present especially challenging circumstances for disabled students despite the advantages they could potentially bring. In this article, we present the design and development of three self-paced e-learning modules following a three-phased design process to prepare instructional design students to create accessible online learning content. The instructional design planning and development process can provide rich experiences for learning. In this design case, the authors tell the stories of the design team to delineate the recursive three-phased design process, aiming to present (a) the ideation, design, creation, and implementation of the accessibility modules to teach novice instructional designers the importance and methods to create accessible online instructional content and (b) the lessons learned by the design team as a result of the design process.

Keywords: disability, accessibility, online learning, instructional design

Summary of Relevant Literature

Over the past few decades, online learning has continued to grow in both K-12 (Barbour, 2013; Carter et al., 2020; Cavanaugh et al., 2009) and higher education settings (BestColleges, 2020, 2021; Seaman et al., 2018), and it has been perceived as a viable solution to many educational problems (e.g., increase in the enrollment of nontraditional students, financial constraints), especially in the wake of the COVID-19 pandemic. However, it is imperative to design learning experiences for all learners, including individuals with various physical, sensory, mental, and cognitive disabilities, which may affect their ability to learn and interact with online content (Burgstahler, 2014). In 2019, the Annual Report on People with Disabilities in America found that 13.2% of the U.S. population had disabilities (Houtenville & Rafal, 2020). The estimated number of disabled postsecondary students reached 2.4 million in 2016 (Accredited Schools Online, 2016). Despite the dramatic increase in online learning enrollments in general, researchers suggest that the rate of participation in online programs by disabled persons may be lower than expected, possibly due to problems with access (Huss & Eastep, 2016; Moisey, 2004). According to the National Center for Education Statistics, 7.3 million students aged 3-21 received special education services under the Individuals with Disabilities Education Act (IDEA) in 2019-2020 (Irwin et al., 2021). The transition to online learning has exposed many barriers to this group of students, such as a lower level of comfort with technology (Schaeffer, 2020). Disabled students might be more likely to enroll in and remain enrolled in online programs if access barriers were removed, including providing sufficient accommodations for online content.

The World Health Organization's (WHO) definition of a person's disability as a dynamic interaction between their health conditions (e.g., disorders, injuries) and contextual factors (WHO, 2001, 2011), has been adopted by the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD)

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and put into force in 2008. In other words, society's creation of such barriers in combination with people's health conditions results in disabilities. This shift from a "medical model" to a combination of "medical + social model" calls for actions to design accessible content for learners in online education. However, when developing online learning content, students with accessibility needs are often not considered (Kinash et al., 2004; van Rooij & Zirkle, 2016), resulting in significant learning barriers and challenges. Barriers include lack of screen reader support, text that is challenging to read, missing visual and non-visual orientation clues, small touch targets, lack of volume control, omitted closed captions, repetitive navigation, lack of alternative text for graphics, lack of meaningful labels in the markup for forms, and confusing heading structure (Lewis et al., 2007).

As the creators of instructional content developed for online courses, instructors and instructional designers should be aware of principles and guidelines for accessible design such as Universal Design for Learning (UDL; CAST, 2018), Universal Design of Instruction (UDI; Burgstahler, 2009), and the principles (perceivable, operable, understandable, robust) that underpin the Web Content Accessibility Guidelines (WCAG; Web Accessibility Initiative, 2018) and how to implement them to ensure online education is accessible to a diverse population of learners. While formal training represents an ideal opportunity to learn accessibility principles and practices, the existing curriculum in online learning design programs often fails to include accessibility topics. By providing opportunities for learners to develop competencies in accessible design in postsecondary courses, they will be prepared to transfer these competencies into practice in their jobs. Therefore, by teaching principles of accessible design through and tasks within real-life projects students are working on, we can create a more accessibility-aware workforce capable of understanding and meeting the needs of diverse learners.

Methodology: Design Case

As a method of disseminating design precedent (Boling, 2010; Howard et al., 2012), design cases differ from traditional naturalistic inquiry studies, research on design, or design-based research by focusing on the design product and contributing to the accumulation of design knowledge (Boling, 2010; Collins et al., 2004; Howard et al., 2012; Smith, 2010). In the following paragraphs we present our design case with consideration of five critical elements identified by Howard (2011): (a) situating the design; (b) describing the design; (c) depicting the experience of the design; (d) developing trustworthiness of the design through transparency, analysis, and reflection; and (e) removing aspects of design which confound the purpose.

Setting and Participants Demographics

The design team included a lead faculty member and three Ph.D. students in a Learning Design and Technology (LDT) program at a large public Midwestern university. Although our team members were well-versed in instructional design, we were not experienced in accessible design. We educated ourselves as we moved through the design process as a team.

After comparing different courses, we decided to implement the project in a graduate course focused on e-learning design: *Introduction to e-Learning*. Students in this course include full-time professionals in the instructional design field and those intending to transition into an instructional design position. The design team defined the target audience of this design case to include instructional designers who design instructional materials and content for online courses, students in the field of instructional design who are about to start a related career, and instructors in K-12 and higher education who teach online courses. Students in the *Introduction to e-Learning* course are required to develop an online course module on a topic of their choice. Before implementing this design project, instruction on accessibility was limited to a reading and a narrated PowerPoint on disability law and prevalent learner disabilities. Under the initial course design, students did not develop accessibility awareness and were not asked to create fully accessible online modules.

With the financial support of a small grant from Teach Access (Teach Access, n.d.), an organization with a mission to promote the teaching of accessible design in postsecondary courses, we engaged in iterative design, development, and engagement of a set of learning modules focused on developing accessibility knowledge competencies for the *e-Learning* course. The modules were embedded into the graduate course and students were encouraged to implement accessibility principles in the culminating course design project.

Description of Practice

This two-year-long design project underwent three major phases: (a) planning, (b) iterative design, and (c) iterative development. In reflecting on our design process, we adapted the Successive Approximation Model (SAM) to show the recursive process, as shown in Figure 1. Unlike a traditional ADDIE process, our development, implementation, and evaluation underwent several iterations. Therefore, we categorized the iterative process, including the development, implementation, and evaluation into the iterative development phase.

Design Phases and Decisions

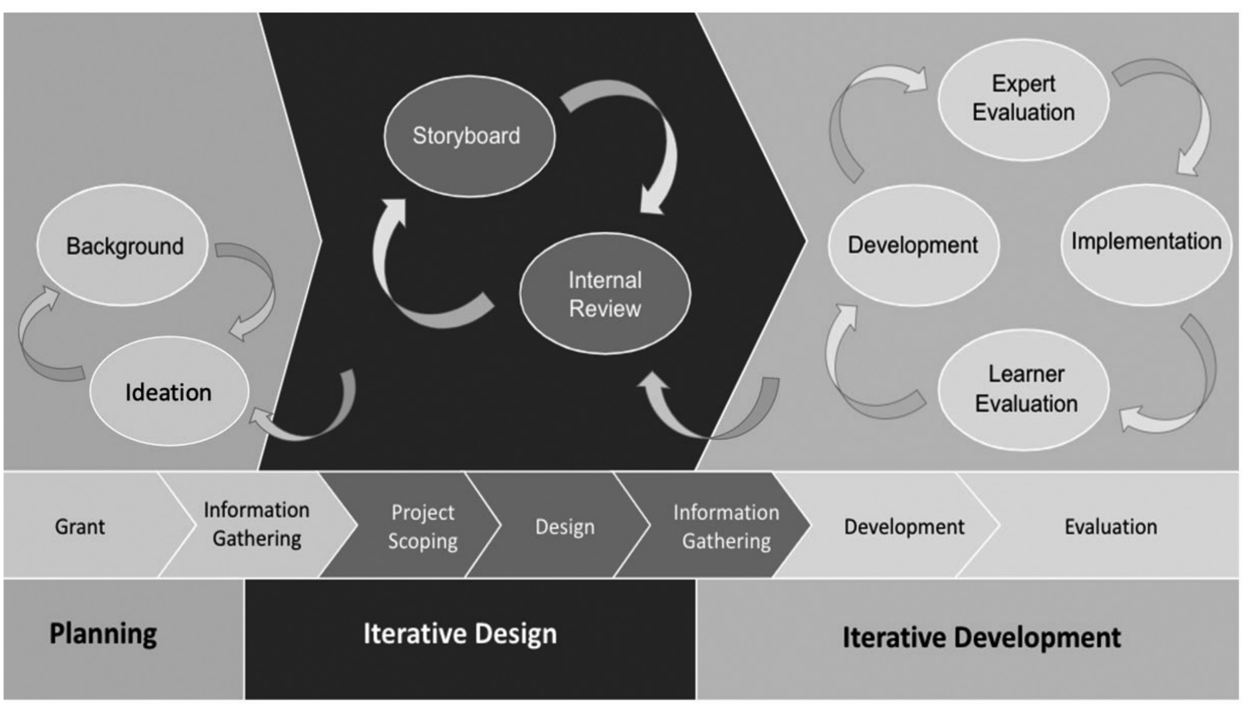
Planning

The three-phased design process started with Planning. To apply for the grant, we brainstormed potential possibilities and finalized a common vision of what we wanted to accomplish. Building on that, we started defining roles for each team member, determining initial module topics, deciding on the software platform, and identifying potential resources (e.g., computers, subject-matter experts). Specifically, the activities included:

1. Information gathering: As novices, we familiarized ourselves with accessible design by reviewing the content on major websites (e.g., the Web Content Accessibility Guidelines 2.0 A/AA Compliance) and searching for research including journal articles on disabilities and accessibility relevant to online learning. We also sought accessibility resources from our institution's accessibility design specialist and attended a training workshop conducted by the campus Disability Resource Center.
2. Selecting the technology: We determined that developing content through an authoring tool would enable us to create an engaging, self-paced training module. After comparing the features of different authoring tools, we decided Articulate Storyline was the most promising option due to its interactivity, device compatibility, layout system, navigation, multimedia capabilities, assessment tools, and learning management system (LMS) compatibility. Although Storyline generally supports WCAG standards, we learned that some Articulate Storyline features are not fully accessible (e.g., drag-and-drop interactions). Camtasia and PowToon were selected for making instructional videos.
3. Setting the goal: While our initial goal was to help instructional designers understand principles of accessibility and how to design and evaluate accessible instructional content, our planning led us to adopt three specific goals for potential students: (a) learners will understand the legal and historical principles surrounding disability and accessibility; (b) learners will be able to evaluate accessibility issues and user interface facilitators; (c) learners will be able to apply best practices for developing accessible learning modules.

Figure 1

The Design Process



4. Selecting the context: We wished to ensure that the learning context reflected the complexity of the performance context to ensure the successful transfer of learning. In selecting the context where the project would be implemented, we compared different courses taught by the lead faculty member of our team. The best fit was *Introduction to e-Learning*, in part because it requires students to create an online learning module, and they were encouraged to create modules based on a real-world need related to their personal, professional, or civic contexts.
5. Ideation: Our design team met regularly to scope the design project and ideate potential solutions to identified problems. Some ideas we discussed in one of the planning meetings regarding the scope are shown in Figure 2.

Iterative Design

Though project scoping was in the design phase as shown in Figure 1, it was actually an ongoing step since we started the ideation process. Based on the overarching goal, we discussed and finalized the objectives and scope of the project. The scope of the project was to train instructional design students on accessible design, which in turn impacts the widest population possible. One vision-impaired expert we consulted during the external review process mentioned, "I am impressed with the scope of this project. It covers a wide range of topics." With specific objectives clearly stated, we identified three individual modules aligned with our generated ideas during the ideation process. We divided the modules across the team of designers with each designer taking the lead on one module and providing guidance and feedback on the other modules.

To guide our design and streamline the process, an initial design process flowchart was created, as shown in Figures 3 and 4, to drive the design of content and activities. For example, the Flowchart Part 1 (Figure 3) delineated the goal, subgoals, key points upon which the team could make decisions, and the (sub)topics identified based on the determined scope. In Flowchart Part 2 (Figure 4), we focused on the challenges, decisions, and context to determine the methods we envisioned to adopt.

We started storyboarding iteratively with the collected information about the topics based on the visualized flow of potential content and outlined the navigation strategy (see Figures 3 and 4). Since the content of modules two and three built on the earlier modules, we created the initial storyboard for Module 1, which further informed the development of storyboards for modules 2 and 3. The initial storyboard of Module 1 was described in bullet points with detailed content notes based on a site map (see Figure 5), based on which Modules 2 and 3 storyboards were drafted. Besides describing the notes in bullet points, we also explored high-fidelity storyboards without affording interaction features to aid the prototyping design. Figure 6 presents an example of a high-fidelity storyboard. In creating detailed storyboards, we followed a table-based template to detail the exact on-screen content. Table 1 shows an example of Module 1. Each of the storyboards at different stages in the design project were reviewed by all members of the design team; revisions that incorporated feedback were made by the lead designer for the storyboard.

During the design process, we continued gathering relevant information. Questions regarding the project scope emerged, causing us to reconsider our objectives and potential content. For example, our research revealed the prevalence of disabilities among learners and introduced us to various types and categorizations of disabilities that could be considered as we developed our modules. This discovery required us to revisit our objectives and project scope to ensure that the project remained relevant and manageable.

Iterative Development

Our self-training with the selected authoring tools began in the *Planning* stage. Without previous experience with Articulate Storyline and Camtasia, we began learning by practice, relying heavily on the resources provided in Articulate's user community and other online tutorials. For example, the high-fidelity storyboard helped the team jumpstart our modules' development by exploring the features to determine the navigation and interactivities while keeping them accessible. The development phase underwent several rounds of iteration with feedback from reviewers (experts) and learners (graduate students in instructional design).

- Development: Once storyboards were developed and finalized, a full draft of the narration scripts for all module slides and videos was developed. Once scripts were completed and reviewed by the designers and other experts, two narrators were recruited through open recruitment email messages based on the designed characters (i.e., a male and female) in the modules. The modules were developed via Storyline and Camtasia by different designers simultaneously, who checked in with each other periodically during the development process for consistency (e. g., navigation, layout, graphic design). After the

Figure 2

Design Ideas

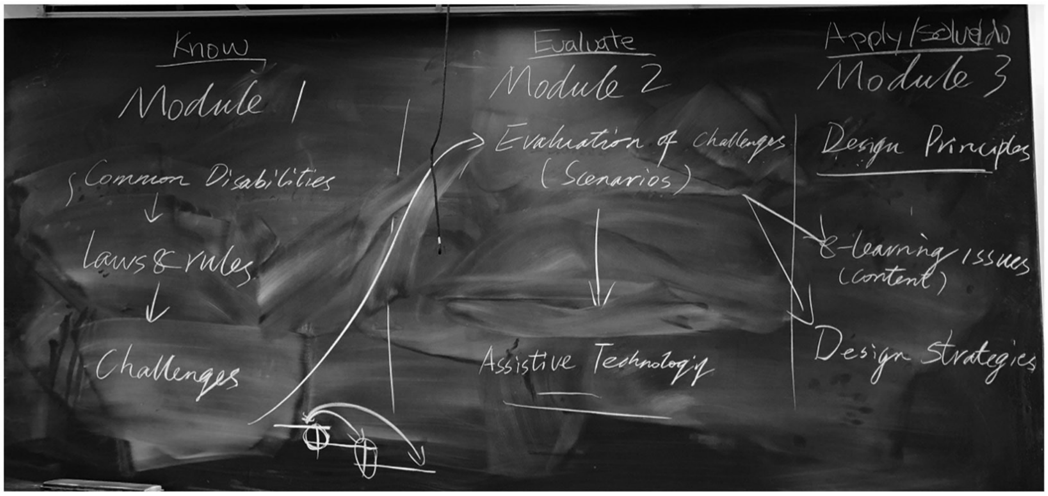


Figure 3

Design Process Flowchart Part 1

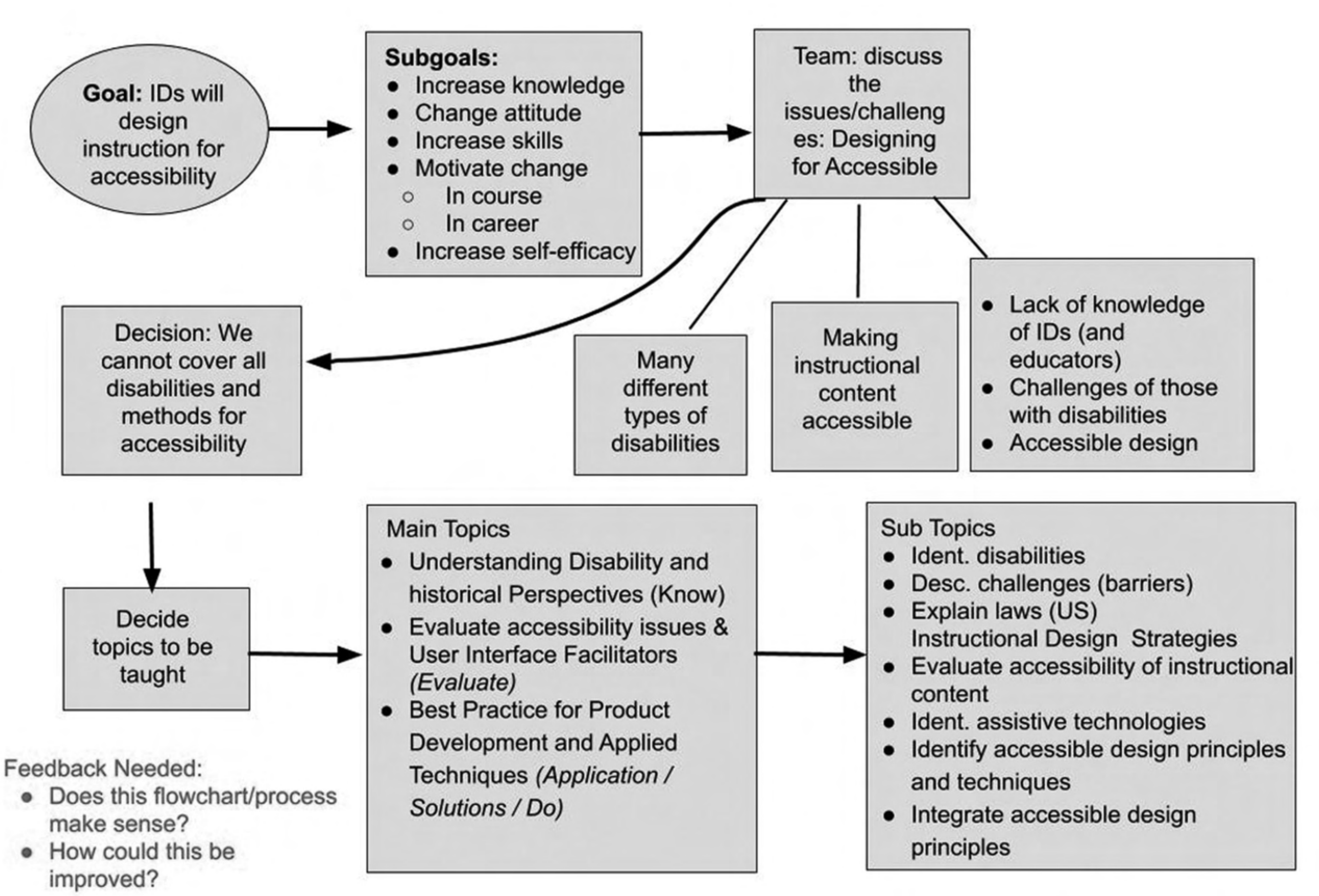


Figure 4

Design Process Flowchart Part 2

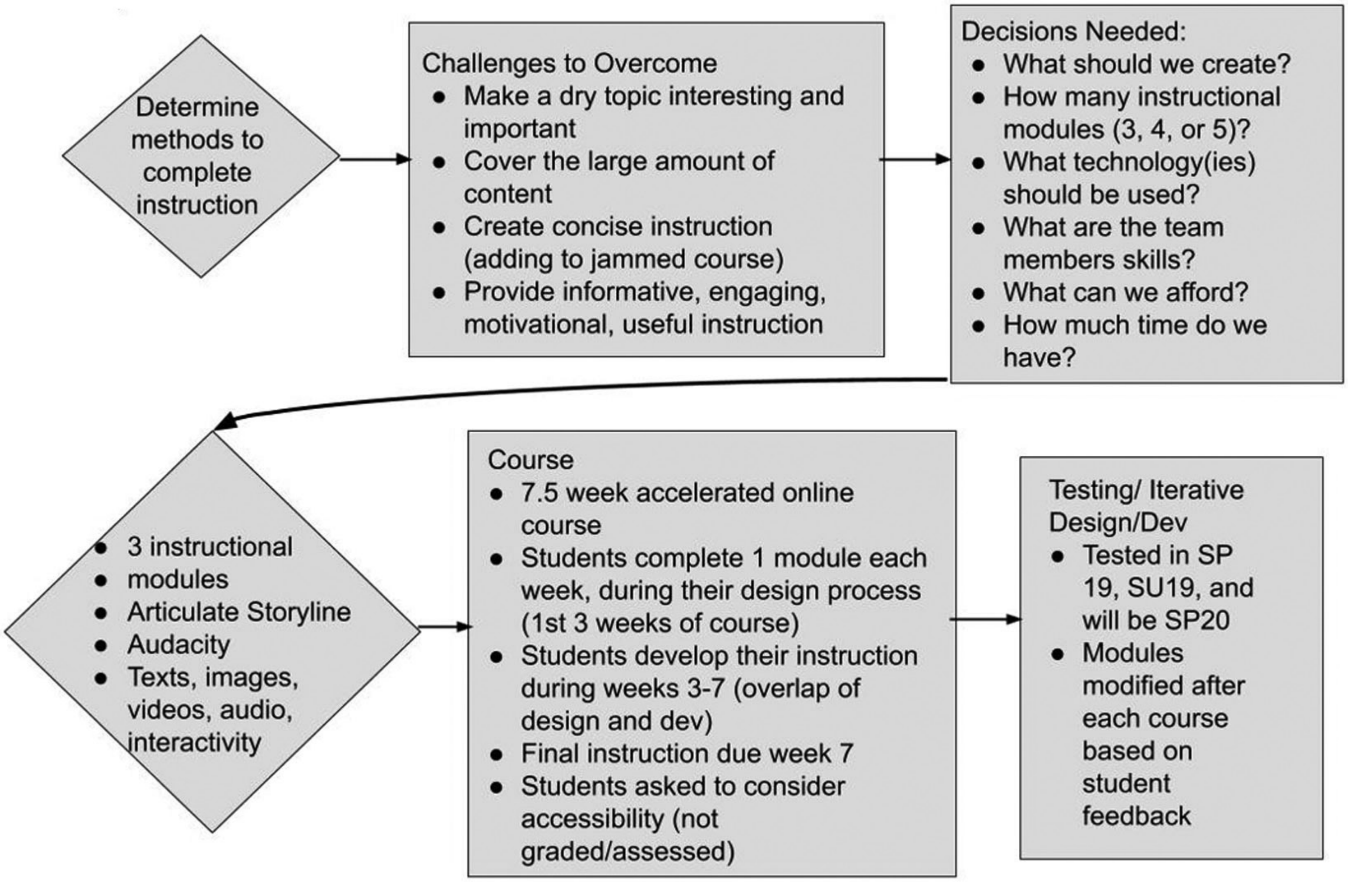


Figure 5

Module 1 Site Map

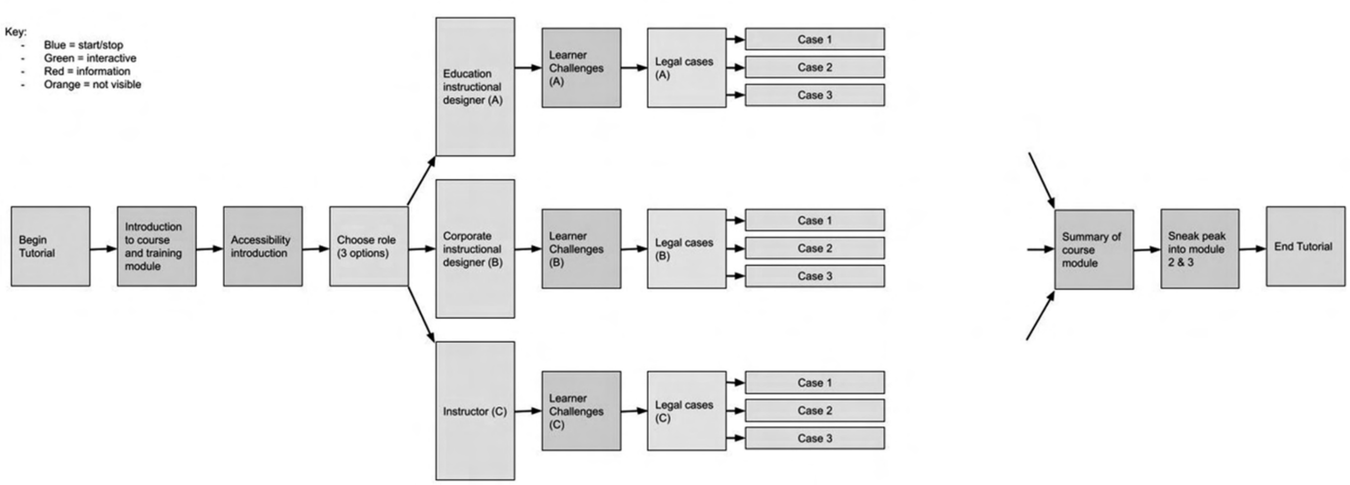


Figure 6

High-Fidelity Storyboard Without Interaction Example

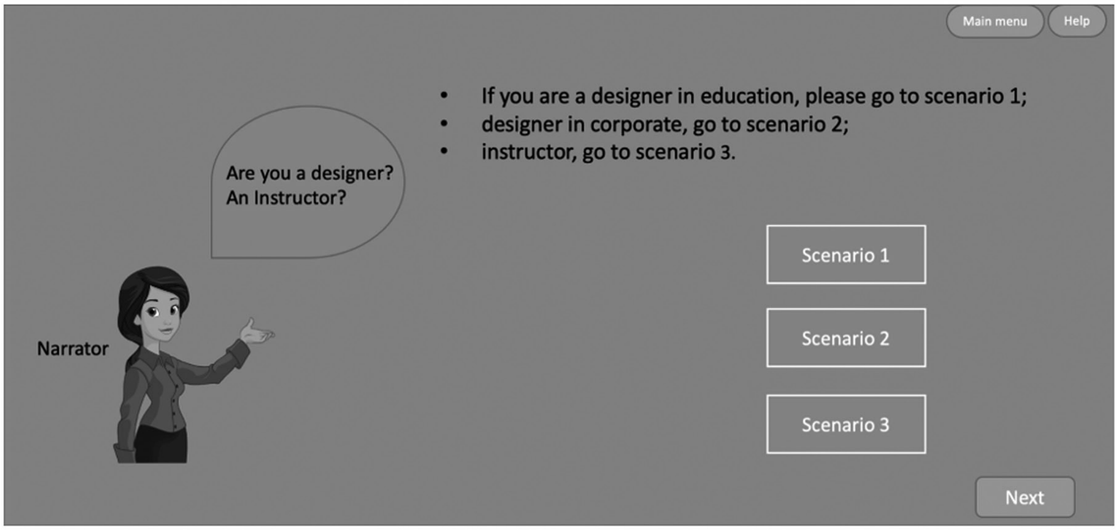


Table 1

An Example of the Table-Based Storyboard

Objective	Slide ID	Visual Display	Auditory Info/Narration	Element Timing/ Behavior
0	2.1 Introduction	(Text appears on the screen as it is read out loud) 1. Identify common disabilities that affect online learners 2. Describe specific challenges a learner might experience using computers and online instructional content 3. Explaining current laws and standards regulating the accessibility of online instruction	[audio file: 2.1] (narration) Hey there! I'm Peter. I'm guessing you want to learn a thing or two about designing for accessibility. Am I right? There's a lot to learn but we'll start with the basics, including: • Identifying common disabilities that affect online learners • Describing specific challenges a learner might experience using computers and online instructional content • Explaining current laws and standards regulating the accessibility of online instruction. "After these basics, you'll be able to put them into practice in the later modules. Let's get started!"	Let the bullets appear one at a time when the narration occurs

modules were developed in Storyline, they were tested with instructional design students recruited through our network via email, who shared similar backgrounds and experiences with our target learners.

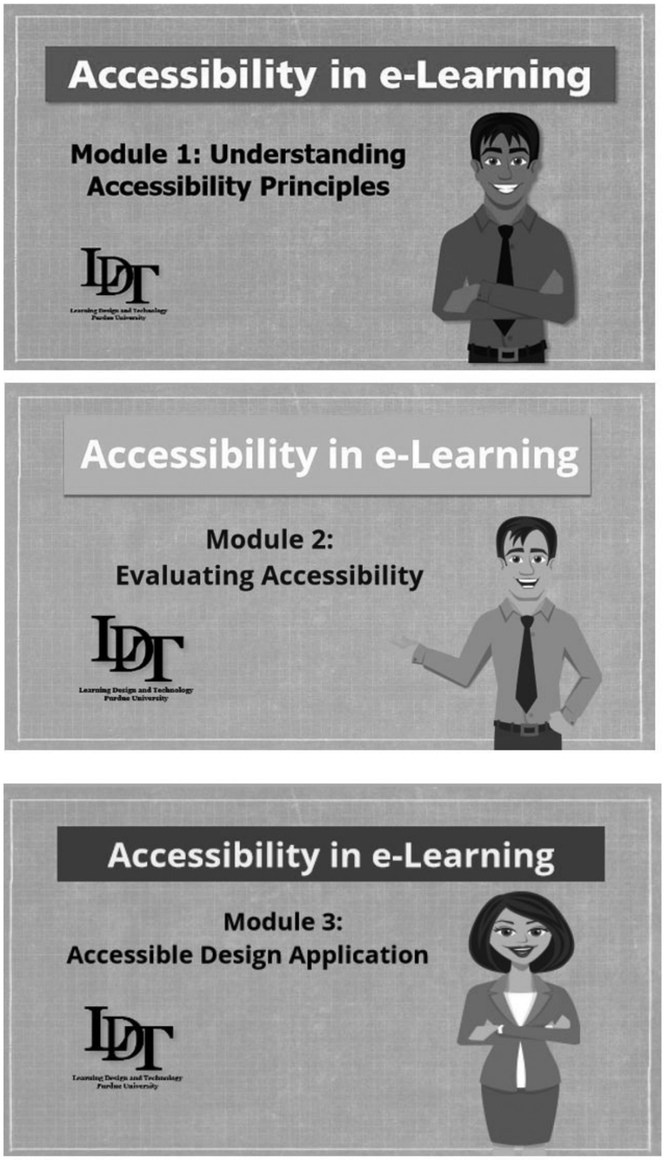
- Subject matter experts (SME) evaluation and revisions: A month before the course's implementation, the modules were sent to four SMEs identified and recruited via email with the help of the Teaching and Learning Technologies (TLT) department, two SMEs in online learning and two SMEs in designing for accessibility. Each of the SMEs had graduate degrees and significant working experience in their areas of expertise. Each module was reviewed by at least one SME in online learning and one in accessibility. The SMEs went through the modules and provided detailed feedback. For example, one expert in online learning said, “It would be a great discussion for learners to have - Storyline is a great tool. How can instructors/instructional designers use this tool and make it accessible to satisfy ethical and statutory responsibilities?” Although Articulate is making progress towards ensuring their products are designing content for accessibility, Storyline still was not fully accessible. For example, an accessibility SME said, “Storyline is not particularly accessible initially. When I evaluated this tool about a year ago, it did not play well with screen reader software. Try enlarging the browser by selecting CTRL+ (CTRL and + at the same time) until the enlargement is 300%. I am unable to see most of the content in the Storyline window.” Each comment was taken into consideration as we modified the modules. Once revisions were completed, we recorded each comment along with what we did in response to them; this information was recorded to track our design process.
- Implementation: the revised modules were implemented in the online course as part of the instructional content. The course is an 8-week accelerated course on the topic of designing and developing e-learning instructional materials. Students reviewed the designing for accessibility modules during the design phase of their module, with the first module introduced in Week 2, the second module in Week 3, and the third module in Week 4. After reviewing the modules, students were asked to reflect on modules in the online course discussions and to consider the design attributes relevant to accessibility in their design documents. They were then asked to apply them to the e-learning instructional content for their course requirement to design and develop an e-learning module.
- Evaluation of the design: As part of the design process, students' feedback on the design and content of the modules as well as their attitudes towards designing for accessibility modules were collected through pre-, mid-, and post-course surveys. A knowledge check through open-ended questions was included in the pre-and post-course surveys to determine the potential impact of the training modules on students' designing for accessibility knowledge.
- Revisions: Revisions on the developed modules were made at different points as feedback came in from different perspectives. For instance, feedback from SMEs was focused on accessibility of the module, wording, navigation, content selection, etc. We addressed each of the comments respectively. Target learners' feedback focused on the instruction clarification, their need for more resources and examples, navigation, and skill gap to be covered. One example of facilitating students' easier navigation was recreated assessments. In module 2 videos were created to show different examples of accessibility issues. The original assessment asked learners to point out principles of accessibility that the case violated. The videos were chunked and included in the corresponding assessment slide to make the navigation easier and relieve their cognitive load so that they do not have to revisit the videos on the other slide during the assessment stage.

Project Management

The lead faculty member served as the project manager and developed a RACI matrix to help us manage the project while holding each team member accountable. RACI stands for responsible, accountable, consulted, and informed. The RACI matrix was created using an online spreadsheet. The researchers were added in rows in the matrix with content to the right of the researchers' names being assigned tasks and due dates. Columns of the matrix included major topics (e.g., project modules, research design, literature review). In addition, the team met bi-weekly and detailed meeting notes were kept on team discussions and decisions. The detailed notes were used to track the team's progress and update the RACI matrix spreadsheet. This matrix provided the team with a dashboard to refer to as the project was implemented.

Figure 7

Screenshots of Final Modules



Outcomes, Discussion, and Implications for Transferability

The Products

The final project consists of three separate self-paced Storyline modules hosted on an external website for dissemination. The team investigated options for hosting the modules. One option was to embed them into the courses and the other was to have them hosted on a web server and linked to the courses. The benefit of embedding them in the courses would be an easier collection of user and assessment data from the LMS, which prompted us to try to embed the modules into the Blackboard courses first. However, several challenges arose. We needed to be able to quickly make changes to the modules if a problem was reported. However, if the modules were embedded in courses, each time an issue was reported, we needed to fix it and re-embed the module into each course section (sometimes we had more than 10 sections), which would be very time-consuming. As we did not plan to collect user and assessment data at this stage, and due to the challenges of embedding the modules in the LMS and the need to access and modify the modules easily if issues were found, the design team decided in each course to insert links to the modules hosted on an external website during the initial implementation stages.

The modules included several innovative features designed to make them engaging and relevant. First, students could choose an instructional design "role" (e.g., corporate designer, educational designer) to ensure that the accessibility modules focused on content relevant to their career goals. Second, the modules included interactive characters who engaged students through a story as they proceeded through the modules. Finally, students were presented with various activities, including reading, listening, watching videos, and completing interactive assessments while completing the modules. Below is a summary of each module with a screenshot of each module, as shown in Figure 7.

1. Module 1. Understanding Disability and Historical Perspective (Why).
   Module 1 introduces learners to the concepts of disability, accessibility, and accessibility design. After defining disability and identifying the categories of disability that impact engagement in online learning, the module introduces accessible design using examples from the physical environment (e.g., curb cuts, automatic door openers) and within learning contexts. These examples emphasize that accessible design in any setting may be essential for some individuals while also extending benefits for all. Additionally, laws regulating accessibility practices are explained, including Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 and its 2008 Amendments. The module concludes with three video-based cases modeled after real-life legal cases. Cases are differentiated by educational or industry settings and learners are able to select cases based on their professional roles. As the introductory content in this series, this module is designed to describe why accessibility practices are essential in effective instructional design practice.
2. Module 2. Evaluate accessibility issues and User Interface Facilitators (What).
   Module 2 presents the common accessibility issues of online content and allows learners to evaluate real-world educational and corporate e-learning content. Videos introducing accessibility issues include examples (e.g., an existing inaccessible online course) covering various aspects regarding the accessibility of documents, images, tables, forms, videos, audio content, links, hyperlinks, navigation, interactivity, etc. Multiple assistive technologies were introduced, and links to additional content were provided.
3. Module 3. Best Practice for Product Development and Applied Techniques (How).
   Module 3 teaches learners how to integrate accessible design techniques in designing e-learning content. The module introduces Web Content Accessibility Guidelines (WCAG) to help learners conceptualize the design and development processes. Then it moves beyond the accessibility techniques to four fundamental principles of accessible design to strengthen learner understanding. Content in the module also explains how the principles work for educational and industry settings. Links to external videos and resources are included. The module concludes with a summary of an accessibility checklist (which links to external websites) to prepare learners to design accessible e-learning content, including that presented in HTML, PDFs, Microsoft documents, and Google Docs. An open-ended question is offered at the end of the module to help learners think about their own projects, such as audience, focus, scope, and how the three modules support their projects.

Learners' Design Consideration of Accessibility

The self-paced modules were offered four times from spring 2019 to summer 2020. Pre-, mid-, and post-surveys were implemented during each of the four offerings to track students' changes and progress. The number of students ranged from 90 to 130 students each semester. Reflections were built into the discussion board and final project. Students' final projects were evaluated to determine their accessibility. The collected data were analyzed on a semester basis. Based on data collected from spring 2019, over half of the students had never heard of "accessible design" before this class. At the end of this class, 90%-92% of students perceived the modules as "helpful" or "very helpful" in understanding the meaning, purpose, needs, importance, and methods of accessible design. About 82% of students believed the modules helped them to understand what they needed to know for accessible design. About 90% of students said they attempted to make their projects accessible. About 94% of students reported they would make their future projects accessible, an increase from 73% recorded in the pre-survey.

Lessons Learned

Reflecting on our design challenges and successes, we as designers obtained new design insights. Some lessons we learned include the following:

- Collaborative design. With the growth of online enrollment and available technologies for learning, we can reach a much wider population of learners. Ensuring the accessibility of online content is essential to facilitating a positive learning experience for diverse learners. To do so, instructional designers must collaborate with each other within the design team to provide awareness of all parts of the design and include multiple perspectives and different expertise for high-quality designs. In addition, instructional designers should collaborate with other stakeholders (e.g., accessibility experts) as needed to ensure content is accessible to a diverse audience enrolling in online programs. More specifically, our team learned the following:,
    - Our team realized that although each of the designers was working on a separate module, they needed to be cognizant of the other modules being created to ensure all content was covered without overlap, a consistent style and format was maintained, and there was a smooth flow and clear connection of content covered in the individual modules.
    - The iterative design process requires us to obtain insights and feedback from external stakeholders including SMEs in disability (e.g., personnel in the disability services office who could provide insights and connect us with reviewers), IT accessibility, the target audience of the modules, and project sponsors (university and grant agency) to ensure the quality and accessibility of the modules via usability testing; module reviewing; and the feasibility of storing, hosting, and delivering the final product.
- Flexibility in the design process. Design is not a linear progression. It is a process filled with surprises and failures. Therefore, a design team needs to be adaptive and responsive to challenges. Built-in flexibility and iterative processes are critical for the success of the final product.
- Time management for deliverables. The design process might take more time than planned, especially when the design team is facing scarce resources. Good time and project management strategies can maximize the design team's productivity, maintain team morale with constant progress, and deliver the project on time.
- Rapid prototyping. The preparation of the project took us much longer than we expected. Months after we embarked on the project, we still lingered over the information gathering and ideation stages due to the design team's lack of expertise in the subject matter and selected technology tool. A rapid prototyping approach could have helped the design team jumpstart the design process by getting into design earlier and obtaining design insights through early iterations that wouldn't be achieved otherwise. While acknowledging the importance of gathering information and conducting analyses (e.g., learner analysis, contextual analysis) the designers must carefully evaluate their situations (e.g., resources, timeline) to determine how long the upfront preparation and analysis will take.

Discussion and Implications

We encountered numerous challenges during the design process. To name a few, we had limited knowledge of accessibility and the authoring tool; there were limited resources (e.g., funding, people) available for a project with a defined scope; there was a lack of SMEs to assist us in understanding the scope and enormous number of different types of disabilities to consider; cultural shock experienced by two of the designers who had limited exposure to American culture and disabilities; accents of the designer that might potentially lead to accessibility issues regarding the video/audio; and lack of guidance on selecting the best methods to help others understand accessible design for our development of the training modules. On the one hand, as designers we knew how to educate ourselves on the subject matter as well as master using the authoring tools to ensure the logic and accuracy of the presented content. We had to ensure the accessibility of the modules in spite of some technical constraints of the tools at the time of developing the modules. For example, even though Storyline generally complied with WCAG, the tool was still not fully accessible (e.g., certain interactivities and multiple-level menus were not fully compatible with screen reader software). As pointed out by our external evaluators who reviewed our products, the tool was not intuitive for navigation. In making sure of the accessibility of these three modules, we simplified the on-screen elements and rearranged the layout so that the order these elements were processed by screen reader software aligned with our intended design.

While understanding the principles for designing for accessibility is not a significant focus in most instructional design programs, the potential impact of additional accessibility training through authentic projects is substantial. Instructional designers train people, collaborate with others (e.g., instructors, clients, or SMEs), produce instructional content, and are often asked to lead large teams of developers and designers. Future instructional design students will benefit from having a clear awareness of disability issues as well as the legal requirements and knowledge about and skills in accessible design evidence-based practices to ensure the accessibility of e-learning and an inclusive online learning environment. There has been a paucity of research in studying evidence-based practices in accessible design, or design cases in delineating the design process to ensure accessibility in online education. This study can draw more attention to the importance of accessible design in online education and research. Furthermore, we hope the description of the design practice provides guidance for those who might have similar goals and encounter similar challenges to those that we experienced.

Conclusion

Instructional design graduates often lack the knowledge and awareness of accessibility in approaching their design projects, mainly due to the lack of accessibility training in the existing curriculum. It is especially important to make sure the content is accessible to the widest possible population of learners, as evidenced by the online transition during the Pandemic. The design case presented in this article included the development of three self-paced e-learning modules to train instructional design students on accessible design. Our recursive design process report provides implications for designers in approaching design projects amid multiple internal and external challenges. We call for more attention to research on accessible design to provide evidence-based practice and guidelines for design practice.

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Accessibility Within Professional Development: Two Promising Practices

Christa Miller[1]

Abstract

This article describes two practices employed to close the knowledge gap around accessibility at a postsecondary institution. Practice One integrated accessibility training within existing professional development requirements. Practice Two used a multi-session accessibility training addressing knowledge gaps identified by training registration data and accessibility reports from the learning management system. For practice One, Accessible Technologies worked collaboratively with instructional designers and learning technologists to make accessibility concepts a natural part of training on tools and online teaching. For practice Two, the team created a certification grant program to prepare people for the International Association of Accessibility Professionals certification exams. Practice One resulted in an increase in internal accessibility skills and the availability of intermediate and advanced courses on accessibility. Practice Two resulted in more than 100 individuals with internationally recognized accessibility certification(s). The implication for disability resource offices is to consider how integration with existing training might increase the reach of accessibility training. Additionally, disability resource offices may want to consider the benefits of using existing training materials or programs.

Keywords: accessible learning, accessible educational materials, accessibility certification, faculty development, postsecondary education

Depending on the institution, instructors may include full-time tenured or tenure-track faculty, full-time teaching faculty, adjunct teaching faculty, graduate instructors of record, or graduate teaching assistants (hereafter, instructors). The extent to which instructors have access to either formal or self-directed pedagogical training varies widely across institutions, but many start teaching without any pedagogical training (Kálmán et al., 2020; Knight & Trowler, 2000).

Simultaneously, the ADA generation of disabled students have entered post-secondary education (Forber-Pratt & Zape, 2017; Perry, 2015). These students grew up with Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990, and the Individuals with Disabilities Education Act (ADA, 1990; IDEA, 2004; Rehab Act, 1973). Many have gone to college and increasingly graduate school with high expectations regarding equitable access to educational programs. However, many instructors are not prepared to teach in ways that specifically support disabled students (Carey-Pace, 2021; Hansen et al., 2017; Hansen & Dawson, 2020). A logical step to close the gap between instructors' skills on accessible and inclusive teaching is to embed it into existing training requirements.

Furthermore, the need for training is a consistent theme of the Department of Education Office of Civil Rights (OCR) settlements (Dept. of Ed. Office of Civil Rights, 2022). The literature and OCR agreements together suggest that both availability and incentive for accessibility training are necessary to make lasting change. The challenge is to reach instructors where they are, provide flexible training options, and overcome pre-existing beliefs (Hansen et al., 2017; Hansen & Dawson, 2020; Murray et al., 2011). This article describes two professional development (PD) practices on accessibility that disability resource offices (DROs) and other collaborators should consider for their campuses.

[1] *Virginia Tech*

Summary of Relevant Literature

Two prevailing strategies for training instructors on inclusive practices that support disabled students reported in the literature are those related to the following:

1. Digital accessibility (Bong & Chen, 2021; Chen, 2021; Crossland et al., 2018; Gallego & Busch, 2017; Kearney-Volpe et al., 2019; Lazar, 2021; Nover, 2021; Sieben-Schneider & Hamilton-Brodie, 2016)
2. Universal design (UD), including Universal Design for Learning (UDL; Davies et al., 2013; Hakel, 2022; Hutson & Downs, 2015; Langley-Turnbaugh et al., 2013; Olivier & Potvin, 2021; Tobin & Behling, 2018; Wilson & Ellis, 2014) and Universal Design of/for Instruction (UDI; Burgstahler & Moore, 2015; Harrisson, 2006; Hartsoe & Barclay, 2017; Park et al., 2017; Roberts et al., 2015; Scott et al., 2003).

Table 1 summarizes some common methods and outcomes of UDL-based training reported in the literature. Results suggest that training instructors on UDL favors the multi-session approach over the standalone workshop model. Pre-post surveys indicated that participants tended to make instructional changes and perceived positive changes in student outcomes (Hutson & Downs, 2015; Langley-Turnbaugh et al., 2013; Olivier & Potvin, 2021). Several studies highlighted that students do notice these changes (e.g., Davies et al., 2013; Langley-Turnbaugh et al., 2013). Remaining gaps in the literature include determining the longer-term impact of training and its outcomes regarding objective measures of student success (e.g., grades, retention, degree completion) (Hakel, 2022; Wilson & Ellis, 2014).

UDI is a UD-inspired methodology for improving course accessibility and inclusion for disabled students. In Roberts et. al.'s (2015) literature review on UDI in postsecondary education, numerous peer-reviewed studies indicated that PD on UD principles has potential for improving student outcomes for disabled and non-disabled students. Table 2 shows additional studies and outcomes of UDI-based training. While much has been learned about the impact of UDI-based training, some identified gaps include earlier training interventions in undergraduate or graduate programs (Hartsoe & Barclay, 2017; Kearney-Volpe et al., 2019) and more multi-session training options (Park et al., 2017).

Digital *accessibility* focuses on the technical aspects of inclusive education (e.g., formatting headings, providing alternative text for images, captioning videos). In a recent and extensive survey of the literature, Bong and Chen (2021) found 16 studies focused on digital accessibility training for instructors in higher education from peer reviewed publications. These studies indicated that it is common practice for the training to be provided by an accessibility subject matter expert. The training audience size ranged from 3 to 15,223 participants depending on the format of the training (in-person versus online). The participants' university role varied across the studies, but largely included: administrators, related academic support staff, graphic designers, instructional designers, and teaching faculty. The literature shows that (a) the topics addressed in the training varied in breadth (e.g.., disability awareness, laws and regulations, assistive technologies, creating accessible content, UDL/UDI) as well as depth (e.g., Web Content Accessibility Guidelines), (b) an accepted instrument for evaluating the outcomes of such training does not yet exist, and (c) there is little objective data on digital accessibility training outcomes.

The literature also indicated that common motivations for accessibility training are legal complaints (Sieben-Schneider & Hamilton-Brodie, 2016) and identifying and addressing knowledge gaps of instructors (Gallego & Busch, 2017). The disruptive force of legal complaints pales in comparison to the impact of the COVID-19 pandemic on accessibility training. The pandemic catalyzed the growth of many campuses' digital accessibility efforts and the availability of training (Bong & Chen, 2021; Chen, 2021; Lazar, 2021; Nover, 2021).

This article describes two distinct practices for accessibility training that build on the best practices reported in current literature. Similar to many of the examples in the literature, the first practice was built on the one-time training paradigm. However, instead of the common stand-alone accessibility workshop model, it intentionally incorporated accessibility into PD classes on instructional design and academic technologies. The second practice was a more intensive multi-session program with a goal of long-term impact. It differed from most of the studies in the literature in that it incorporated professional certification. Since the training was open to a broader audience (non-instructors), it had the added benefit of influencing those who support instructors in their course development and execution.

Participant Demographics

The practices took place primarily at the Virginia Tech Blacksburg campus (VT). Participants in Practice One were volunteers obtained through the Professional Development Network and campus marketing notices. The computer refresh program requires 12-

Table 1

Descriptions of Relevant Literature on UDL Based Training for Instructors and Related Outcomes

Objective	Participants	Training Method	Outcomes	Reference
To determine the effectiveness of UDL training on instructors and impact on student outcomes.	6 graduate student instructors. 3 received UDL training and 3 did not.	5, 1-hour discussion meetings covering assigned reading on UDL.	Students surveyed before and after training. UDL group reported a significant increase in multiple means of representation, percentage of engagement level, and percentage of summarizing key points by the instructors.	(Davies et al., 2013)
To modify instruction to meet the needs of a growing enrollment of disabled students.	Multi-phase faculty cohort of 16 participants	Phase 1: 3 seminars, one from disability services, one from an accessibility expert, and a specialist on Asperger's. Phase 2: UDL redesign workshop from Center for Applied Special Teaching.	Faculty received pre- and post-surveys. Students received post- survey. All participants made changes to their course. 62% felt UDL benefited student outcomes. 64% of instructors provided information in multiple formats going forward.	(Langley-Turnbaugh et al., 2013)
To develop faculty knowledge and skills on supporting diverse learners with an emphasis on disabled students.	Tenure and tenure-track faculty in a faculty learning community	Alternating sessions on content and development	Pre- and post- surveys indicated participants' ability to implement UDL concepts increased, and participants perceived that the UDL-informed changes improved student learning.	(Hutson & Downs, 2015)
To increase awareness of the needs of diverse learners, promote the use of UDL and develop a foundation for future faculty development.	15 individuals who were a mix of part-time and full-time instructors at a community college	3 session training on UDL with a pre and post survey	Pre- and post- surveys showed an increase in use of UDL principles. Participants reported changing instructional methods and student learning activities. 46% reported that the training caused self-reflection and 69% reported making changes based on the training.	(Olivier & Potvin, 2021)
To improve learning outcomes for diverse students	Tenure or tenure track instructors	1 to 4-hour seminars, day-long workshops, semester-long course(s). Post survey.	Feedback from instructors on their long-term retention of the content ranged from nothing to accessibility minutiae	(Hakel, 2022)

Table 2

Summary of Relevant Literature on UDI Based Training for Instructors and Related Outcomes

Objective	Participants	Methods	Outcomes	Reference
To show how DROs can serve as UDI consultants.		Recommended a dynamic course design model to provide formal or informal PD.		(Harrisson, 2006)
To determine the impact of UDI training on the GPA of disabled students.	6 instructors attended a 1–3-hour UDI training	UDI trained instructors were matched with untrained instructors teaching similar subjects at a similar level. Analysis of student GPA pre- and post-training.	Comparing GPAs for 126 classes (264 disabled students and 3066 without disabilities) results showed a significantly improved GPA for students taking courses with UDI trained instructors.	(Burgstahler & Moore, 2015)
To determine patterns and themes in the variation of faculty's UDI implementation.	16 instructors trained, 4 participants in follow-up study.	3-day training covering UDI and teaching disabled students.	Variations in implementation tend to relate to perceiving UDI as ongoing effort, use of self-reflection, and internalizing the social model of disability	(Park et al., 2017)
To determine the relationship between faculty's beliefs, knowledge and confidence using UDI	60 instructors who were tenured, tenure track and non-tenure track	Used the Inclusive Teaching Strategies Inventory (Lombardi et al., 2018) to survey participants	Results support the belief that UDI is a strategy instructors are using to make learning more inclusive.	(Hartsoe & Barclay, 2017)
To use seed grants to incentivize instructors to develop accessibility modules in technology related courses.	12 instructors who applied for and received the Teach Access grant.	Pre- and post-surveys provided to the instructors and students.	400 or more students (undergraduate and graduate) received accessibility training. Pre to post results indicate a strong increase in student confidence in accessibility concepts particularly the Americans with Disabilities Act and Web Content Accessibility Guidelines.	(Kearney-Volpe et al., 2019)

hours of PD on a 4-year cycle from courses in the Professional Development Network course catalog. Beyond the approximately 2,400 eligible full-time teaching instructors who are required to participate to earn a new computer, an additional 3,000 individuals (administrative faculty, university staff and graduate students) of other ranks are eligible to participate without the incentive. The Professional Development Network's annual needs assessment survey indicated wide variability in the disciplines represented, level of technical ability, and familiarity with U.S. disability laws and accessibility standards. Demographics such as age, sex, gender, race, and disability were not collected as part of the application and registration processes for either PD practice.

Participants in Practice Two–international certification–self-selected through an application process. The pilot group of 16 individuals were not current instructors. They were a mixture of administrative professional faculty and staff from key areas of the university. Of the 138 total participants in Practice Two, 27% were from Information Technology, 8% were from the University Libraries, and 12% were from Disability Resources.

Depiction of Problem

Given the size and decentralized structure of VT, the issue of what instructors need to know about accessibility has historically fallen on a small group of subject matter experts in Accessible Technologies. The partner office, Services for Students with Disabilities, supports student accommodation requests and training on associated legal requirements; the Office of Equity and Accessibility serves the same role for employees. Accessible Technologies falls under the Division of Information Technology and is within Technology-enhanced Learning and Online Strategies (TLOS). One of TLOS's functions is to provide PD courses to increase instructors' technology skills. As a group within TLOS, Accessible Technologies is responsible for implementing technology and digital solutions to support accommodations and institutional universal design efforts and provide related training.

Training offered by Services for Students with Disabilities and the Office of Equity and Accessibility have traditionally focused on disability law and the reasonableness of accommodations. This left Accessible Technologies to provide training on assistive technologies and "how" to create accessible content. When the office was established in 1998, PD on accessibility took the form of one-time guest lectures to undergraduate and graduate courses through collaboration with individual instructors. Later, optional one-time PD courses for instructors were offered through the Professional Development Network.

In hopes of increasing PD enrollment in accessibility courses, Accessible Technologies analyzed available enrollment data from 2004 to 2017. The data revealed that the reach of accessibility training was quite small. Over this 13-year period, Accessible Technologies offered 58 unique courses and only 117 unique individuals participated. Just under one-third of participants (28%) attended at least two courses, 10% attended at least four courses and 9% attended at least six courses. However, the total number of participants was only 2% of eligible participants. Also, over this time frame no GTAs participated in any of the training. Given the length of time the data covered and the natural roll-off of people retiring or changing institutions, the reach was likely smaller than 2%.

When exploring the participant subcategory of administrative/professional faculty and staff, Accessible Technologies further discovered that participants often did not have the authority to make widespread digital accessibility changes. Many participants in this subcategory shared that their interest came from being asked to take on roles related to website management with limited prior knowledge on basic web design. After the training, these individuals had the knowledge and skills to make accessibility changes but no authority or widespread influence to do so. All in all, the courses did not have an impact on systemic barriers such as the inaccessible webpage theme produced by the institution or inaccessible course materials in the learning management system.

At the same time, Accessible Technologies gathered information on the skills of TLOS employees related to accessibility. The instructional design team was of particular interest due to their impact on direct instruction. At that point, the instructional design team was heavily focused on an internal grant program to certify instructors for online teaching and evaluate redesigned online courses against the Quality Matters rubric. Only courses that passed the rubric were eligible to receive a financial grant for their participation. The conversations revealed that the instructional design team was only passingly familiar with accessible instruction. Their skill set was limited to creating captions and transcripts for videos. Based on this information gathering, Accessible Technologies determined that not only was there very little incentive and participation in accessibility PD, but also that few people within the university were subject matter experts capable of providing accessibility PD. The lack of impact and skilled trainers led Accessible Technologies to consider ways to increase accessibility skills internally and re-evaluate the methods used for teaching accessible through PD.

Description of Practices

The first practice to address the lack of long-term impact was assisted by a department goal to transition from stand-alone, one-time training to a clearly branded, integrated curriculum on technology-enhanced teaching. For example, instead of stand-alone classes on online teaching and accessibility, the courses were revised so that concepts from online teaching were embedded into accessibility training and vice versa. The integrated training was a collaborative effort among 19 employees whose roles included specialists in professional development, instructional design, online learning, accessibility, and learning technologies. These individuals participated in the TLOS Curriculum Working Group. Their charge was to collaboratively redesign 16 workshops covering the learning management system (Canvas), the content management system (Adobe Experience Manager), teaching online, and accessibility. A key goal of this effort was to design the courses such that a train-the-trainer approach could be used for introductory courses. This allowed new student employees to take on the role of trainer for most introductory courses, and it freed the specialists to increase the availability of intermediate and advanced training in their areas of expertise (e.g., accessibility, online learning, etc.).

To address the lack of internal accessibility knowledge a second practice, international accessibility certification, was explored. Based on the low impact of in-house PD on accessibility, Accessible Technologies explored third-party accessibility training that could be purchased to meet VT's needs. A key element in the search process was to provide training to individuals with both the responsibility and authority to address systemic barriers, particularly related to web accessibility. Ultimately, this approach led to the development of a grant program to incentivize completion of the International Association of Accessibility Professionals (IAAP) certification exams.

Practice One: Integrated Accessibility Training

TLOS's Curriculum Development Committee was a multidisciplinary team. The core team of six individuals reviewed the existing classes. They collaborated to formulate a new structure based on the skill sets of the trainers and the PD needs of stakeholders. The result was a series of Level I courses designed to be taught by anyone on the training team and require minimum depth of knowledge on the part of the trainer. Level I classes included a detailed facilitators guide, pre-created slide deck, handouts, and email communication templates. Before the new classes were taught, they were evaluated by the core committee on the following: clear script for direct instruction, clear directions for guided practice, clear directions for individual practice, opportunities for reflections, and how the reviewer's unit could contribute. This format of development and evaluation allowed the TLOS staff to hand off the Level I training duties to graduate assistants and allowed TLOS staff to invest additional time and resources into the development of the Level II training in their areas of expertise.

The Level II training was designed by the staff with the most subject matter expertise on the topic. For example, the Accessible Technologies staff created a collection of courses related to creating accessible educational materials and supporting assistive technologies. Members of the curriculum committee were given the opportunity to review the Level II courses and provide feedback. This level of cross-pollination in training was the first of its kind in the department. The committee chair summarized the impact of this work best when he said, "The funny thing about that time was that accessibility was going from *we need to do it* to *how can we do it*." (I. Griffin, personal communication, February 28, 2022). At a departmental level, this collaborative process increased awareness of the need for intentional and strategic training on accessibility.

Practice Two: International Accessibility Certification

In tandem with efforts around PD curriculum development, Accessible Technologies was motivated to find possible third-party training options based on the gaps identified in the past PD training analysis. Financial support was unexpectedly supplied through the Division of IT strategic planning cycle in 2018 when senior leadership decided to place an emphasis on accessibility. As part of the operational plan, Accessible Technologies was asked to explore existing, well-established methods to provide PD. This led to the formal creation of the Accessibility Professionals Certification Grant.

Accessible Technologies discovered that the International Association of Accessibility Professionals had two certification programs relevant to increase accessibility skills for individuals with responsibility and authority over (1) direct instruction and (2) web content. The breadth of content covered in the body of knowledge for the Certified Professional in Accessibility Core Competencies (CPACC) and the depth of the body of knowledge for the Web Accessibility Specialist (WAS) credentials seemed like an excellent fit for improving campus culture and increasing support for digital accessibility. The IT operational plan stipulated a budget to cover membership to the International Association of Accessibility Professionals, cost of the exams and cost for the relevant training material from Deque University. The institutional support also allowed Accessible Technologies to expand the offering to participants previously excluded from training offered solely through the Professional Development Network. This included campus communicators, graduate students, library staff, and others.

Sixteen individuals participated in the first cohort during the pilot year of 2018-2019. They were a mix of web developers, designers, and library staff who were already invested in accessibility. Using the preparation materials from Deque University, each participant completed sections of the self-paced material on a weekly basis. Then the cohort met for weekly discussion to review the material. The meetings included a mix of face-to-face and virtual attendees. All told the participants took a little over a year to prepare and sit for the CPACC and WAS exams. Based on the favorable results of the pilot cohort, Accessible Technologies decided to run two cohorts each semester. One cohort prepared for the CPACC exam and one the WAS exam. Over the course of the program, this changed slightly to 2 CPACC study cohorts and 1 WAS cohort per academic year.

During the summer of 2020, Accessible Technologies reviewed participant feedback related to the study materials and the value of the exam. One theme of the feedback was low satisfaction with the Deque study material for CPACC preparation. According to comments, participants were interested in content that was more engaging and less generalized. To that end, new preparation materials were developed during Summer 2020.

Accessible Technologies decided to use the UDL framework and the engagement pillar in particular to shape the overall materials (CAST, 2018). The course materials were ultimately housed in Canvas using pages, modules, discussion boards, and integration with the Kaltura video management system. One of the key changes was the creation of introductory summary videos to complement the reading provided in the CPACC Body of Knowledge (Principle 3: Options for Comprehension). The "flipped class" style videos were short 7-10-minute videos that summarized key concepts, provided examples, and explored exceptions to the concepts. The second change was the use of multimodal, first-person supplemental material organized into three formats: videos, audio files (podcasts), and reading (Principle 1: Options for Perception). Participants were instructed to spend 30-60 minutes in self-study per week in addition to watching the summary video and reading the body of knowledge (Principle 7: Options for Recruiting Interest). Another change was the addition of weekly self-reflection prompts to solidify learning (Principle 9: Options for Self-regulation). Lastly, small group engagement activities were designed to increase mastery of concepts during the weekly discussion groups (Principle 8: Options for Sustaining Effort and Persistence).

In implementation, the cohort met weekly for 13 weeks. Week 1 was an orientation kick-off meeting. Weeks 2-11 were discussion sessions and Weeks 12 and 13 were exam preparation reviews. The content weeks were divided into 10 modules each covering a section of the CPACC body of knowledge. The weekly discussion sessions included a 10-15-minute review of practice quiz questions followed by 30-40 minutes of small group activities, and ended with a 5-10 minute recap of the key takeaways.

Evaluation of Observed Outcomes

Practice One Outcomes

Through the collaborative curriculum development work, Accessible Technologies found that VT instructional designers lacked skills beyond creating closed captions and transcripts. There were a few people who had knowledge on document accessibility, but it was largely limited to adding alternative text for images. There were also few to no skills around PDF accessibility or deeper web accessibility concepts. Perhaps the most noticeable outcome of the collaboration was a gradual closing of the internal accessibility skill gap through their participation in the certification program.

After the pilot cohort of the Accessibility Professionals Certification Grant, several TLOS instructional designers from the curriculum development committee applied to participate in the next cohort. Gradually, each semester 1-2 additional instructional designers joined a cohort, including full-time instructional designers and graduate assistants. Many of these individuals were working on graduate degrees in instructional design and technology from VT. In subsequent calls for applications, Accessible Technologies noticed an increase in the number of graduate student applicants from the instructional design and technology program who were not employees of TLOS. This might be an indication of the growing desirability of instructional designers trained in accessibility.

The efforts around curriculum development provided the opportunity not only to integrate accessibility in courses such as Canvas Basics, but also redesign some courses to reflect best practices for UDL. In Fall 2018, the redesigned courses had 2,168 participants and Spring 2019 had 489 participants. The combined changes make it challenging to determine how faculty skills changed over time, though. Since the Level I courses were typically taught by TLOS graduate assistants using the facilitator's guide, it is also challenging to determine the impact of the accessibility content in the basic courses. Another confounding variable is that many of the redesigned courses for Canvas transitioned to a self-paced online course after Spring 2019 because TLOS had concluded its rollout of the Canvas LMS.

While not as many instructors participated in the Level II courses as the Level I courses above, there were some interesting takeaways from the (re)designed courses. From Fall of 2019 to Spring 2022, Accessible Technologies gave 34 unique course offerings related to accessibility (accessible documents, assistive technology, web accessibility, and PDF accessibility). Some courses were offered more than once per semester amounting to 92 unique opportunities for participation over a 3-year period. This was a positive increase in the number of courses and the diversity of the topics offered. The number of unique attendees jumped to 527 in this time frame to 9% of eligible participants. Within those, 136 individuals participated in 2-3 courses, 31 participated in 4-5 courses, and 4 participated 6 or more times. In general, this is an overall positive trend in enrollment and persistence in accessibility related courses. Some of this upward trend may be attributed to additional campus efforts around PD technology improvements, marketing around accessibility course offerings, and an increase in institutional support.

One area of strong growth for Level II courses was in enrollment in PDF accessibility training. This Level II course, prior to the redesign, consistently had low enrollment. From Spring 2016 to Summer 2018, there were 4 offerings of PDF accessibility. The average enrollment in these courses was 7 individuals. The highly technical nature of PDF accessibility and the amount of prerequisite knowledge meant that few participants were able to remediate even basic tags by the end of the session.

Once again leveraging the UDL framework, Accessible Technologies identified engagement and action and expression as key areas for improvement based on participant feedback (CAST, 2018). Just a few of the intentional improvements included the following: a check-your-knowledge quiz with discussion (Principle 3: Options for Comprehension), demonstrations using participant materials (Principle 7: Options for Recruiting Interest), a kinesthetic activity on identifying document structures (Principle 4: Options for Physical Action), and live remediation of documents provided by participants (Principle 6: Options for Executive Functions). The redesigned course was offered 11 times from Fall 2019 to Spring 2022. The average enrollment for the redesigned course almost doubled with 13 participants on average.

Since the training included instructors and VT staff, finding adequate ways to determine impact is a challenge. One measure to consider though is the institutional data available from the Anthology Ally tool integration with Canvas. Having acquired the tool for pilot testing in January 2019, Accessible Technologies reviewed the institutional accessibility score data for the prior academic year. The goal was to use the data to identify gaps in the PD offerings and potential areas of focus for awareness campaigns. The institutional report from 2017-2018 academic year, prior to introducing Ally, showed 15,056 course shells and 1,367,420 individual documents in Canvas. The reports, highlighted in Table 3, showed that the most severe violation was *Image Only PDF Documents* (approximately 10% of all PDFs in the system). The report also showed the most frequent error was inaccessible PDF documents. A tremendous amount of effort around PDF accessibility tools and training was prioritized in direct connection to this data. The institutional report for 2020-2021 and 2021-2022 show an interesting shift detailed in Table 4.

In general, there is a downward trend of scanned, image-only PDF documents. This is remarkable considering the number of PDFs in the LMS during the 2021-2022 academic year totaled 905,094, a nearly 40% increase from 2017-2018. The increase in the amount of content does not appear to have negatively affected the level of accessibility in those dimensions.

With the impact of the COVID-19 pandemic, it is even more remarkable to see a downward trend in the number of scanned, image-only PDF documents. The previously established integrated approach of including accessibility in Level I PD was carried forward during the rapid transition to remote learning. PD courses related to the rapid transition to virtual teaching included information about how to use Ally to improve the accessibility of course materials and how to access VT's institutional captioning services.

Practice Two Outcomes

As mentioned earlier, the Accessibility Professionals Certification Grant program was established during the same period as the integrated and redesigned PD courses. The short-term result of the Accessibility Professionals Certification Grant program was sustained funding from the Division of Information Technology to support the cost of membership, exam fees, and one retake per individual. The long-term effect was a growing number of accessibility professionals with core competencies.

Applicants to the CPACC grant were asked to self-evaluate their prior knowledge of the domain areas using a 5-point Likert scale: 1 Fundamental Awareness (basic knowledge), 2 Novice (limited ex-

Table 3

Top Ranked Severe Issue and Major Issue From Institutional Reports From Ally

Year	Severe Issues		Major Issues	
2017-2018	Scanned PDF: 15.7%	Encrypted PDF: 0.06%	Untagged PDF: 56.4%	Contrast: 35.2%
2018-2019	Scanned PDF: 15.2%	Malformed Doc: 0.07%	Contrast: 36.2%	Untagged PDF: 55.9%

Table 4

Top Ranked Severe Issue and Major Issue From Institutional Reports From Ally

Year	Severe Issues		Major Issues	
2020-2021	Scanned PDF: 12.4%	Malformed Doc: 0.12%	Untagged PDF: 57.9%	Contrast: 34.0%
2021-2022	Scanned PDF: 11.4%	Malformed Doc: 0.09%	Untagged PDF: 59.0%	Contrast: 35.0%

perience), 3 Intermediate (practical application), 4 Advanced (applied theory), and 5 Expert (recognized authority). Table 5 shows that in most categories at least one-third of applicants felt they had some practical knowledge of how to implement accessibility. Familiarity with accommodations was the domain with the largest number of expert ratings (6% of applicants), the majority of whom were disability resource office professionals. The weakest areas of prior knowledge were in organizational governance and UDL. Organizational governance had the highest rating of applicants with only basic knowledge (34%), and UDL had the fewest number of applicants with expert knowledge (2%).

From 2018 to 2022, about 160 VT individuals participated in the grant program. Of those 102 individuals earned the core competencies CPACC certification, 16 individuals earned the WAS, and 11 individuals earned both and are Certified Professional in Web Accessibility. The end-of-course evaluations and pass rates indicate that the cohort study method generally supports the likelihood of passing the certification exam. The pass rate is currently 92% for the CPACC certification and 50% for the WAS certification. Additionally, since not all individuals pass the certification exam or wish to take it, a VT micro credential (badge) is now offered. Currently, 78 individuals have the A11y Core badge for completing the CPACC preparation, and 27 individuals have the A11y Dev Core badge for completing the WAS preparation. Only the pass rate for VT participants was tracked over time, and it has remained fairly high. Table 6 details the participation and the certification rate.

Over the last three years, several key shifts have occurred in the program. Based on the pass rate of the WAS exam, Accessible Technologies decided to recommend participants complete the CPACC certification prior to attempting the WAS certification. The pass rate also suggested that the WAS certification was more appropriate for developers rather than content designers. Many participants who were content designers did not pass or opted not to sit for the exam. The Pandemic also caused several shifts to the program. One shift was that the hybrid discussion meeting format became a synchronous all-virtual format. Moving to a fully online format allowed VT to expand participation in the program to other disability and accessibility professionals in Virginia.

To determine the value of continuing to leverage international certification, a post exam survey was conducted. Of the total examinees, 54 completed the post-exam survey. The consensus from both CPACC and WAS examinees was that the weekly meetings

Table 5

Self-Reported Prior Knowledge From CPACC Application

Domain Area	Level of Prior Knowledge	Percentage
Theoretical models of disability	1 - Fundamental Awareness	37%
Assistive technologies and adaptive strategies used by people with disabilities	2 - Novice	34%
Academic and workplace accommodations	3 - Intermediate	38%
Accessibility in information and communications technologies	3 - Intermediate	35%
Accessibility in the physical world	3 - Intermediate	33%
Universal Design for Learning	3 - Intermediate	29%
Usability and user experience design	3 - Intermediate	36%
Laws and policies regarding the rights of people with disabilities	3 - Intermediate	33%
Accessibility standards and regulations	3 - Intermediate	38%
Organizational governance and management strategies	1 - Fundamental Awareness	34%

Table 6

Accessibility Professionals Certification Grant Participation and Exam Pass Rate

Semester	CPACC Participants	CPACC Examinees	CPACC Pass Rate	WAS Participants	WAS Examinees	WAS Pass Rate
Fall 2018	16	16	**94%**	n/a	n/a	**n/a**
Fall 2019	15	14	**86%**	16	14	**57%**
Spring 2020	14	12	**100%**	8	6	**50%**
Fall 2020	20	16	**94%**	7	6	**33%**
Spring 2021	20	18	**89%**	5	4	**50%**
Fall 2021	23	18	**89%**	5	n/a	**n/a**
Spring 2022	19	17	**94%**	n/a	4	**25%**
TOTAL	127	111	**92%**	41	34	**47%**

and supplemental materials were of the most value in preparing for the exam. They also rarely reported feeling confident that they had passed, rating their confidence on having done well at "slightly" to "moderately" on a 4-point Likert scale. Perhaps most telling, however, is that 83% of examinees report that preparing for certification made them better prepared to address issues related to accessibility in their job either to a "very great degree" (57%) or "somewhat" (26%). Only 16% reported that preparing for certification did not make them better prepared to address accessibility in their jobs. Lastly, those who completed the preparation cohort and sat for the CPACC exam also generally passed in spite of how they felt directly after the exam.

Implications and Transferability

Collaboration and leveraging disruptive forces (such as strategic planning cycles, leadership goals, and the pandemic) were key factors in VT's approach to accessibility training. The number of accessibility allies grew by including accessibility in existing training on teaching and learning, which affected both the trainers and learners. This change was particularly noticeable in VT's instructional design team. As team members became more fluent in accessibility, their training gradually influenced their work with individual faculty. They began to include document accessibility as part of their one-on-one consultations with faculty and to use Ally to evaluate the accessibility of online courses.

However, others wishing to use a similar practice may need to generate leadership buy-in first. The integrated effort was initiated by a goal from leadership around PD. This focus created natural accountability for the curriculum committee that might not already exist at another institution.

A key finding from Practice Two is instructors are the least likely to have the available time to commit to an in-depth certification program when they are actively teaching. However, the process of re-evaluating current practices and creating the grant program had the unexpected benefit of reaching groups of people previously missed by the traditional PD approach, namely graduate students, web developers, and application developers. Their success ended up impacting inaccessibility outside the classroom. Furthermore, the enrollment of a strong contingent of disability resource professionals is an indication that there is a desire in the field for accessibility PD that goes beyond accommodations and legal standards.

In summary, without external pressures, it is difficult to transition from grassroots efforts to self-sustaining initiatives. Other groups looking to try similar strategies should look for opportunities to take advantage of existing structures, such as required PD, department goals, and strategic planning cycles to insert accessibility. In the process, DROs should keep in mind that success does not need to come solely from resources within a single department or college. There are numerous pre-existing training programs at various price points that can support colleges' goals around accessibility skill development for faculty and staff.

Conclusion

Providing flexible training options that meets instructors where they are is a way to address the accessibility PD challenge. Practice One, integrating with existing PD, may offer the most availability and reach the largest number of people with basic accessibility concepts. The additional advantage of the train-the-trainer model is that it may increase capacity for accessibility training. Subject matter experts may then have time to train on additional topics and address specific gaps.

In the practice at VT, this was achieved through internal collaboration. Even though the collaborators fell under the same larger organization (Information Technology), the principle of using campus partnerships can still benefit others. Others may find that possible collaborators are the institution's talent development, center for teaching and learning, or academic technologies, just to name a few. Depending on the availability of accessibility subject matter experts, the additional benefit of making intermediate to advanced training available may not be immediately possible. Offloading the training or acquiring third party training may be especially helpful to DROs given the caseload sizes and staffing challenges of many offices.

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Accessibility for All: Introducing IT Accessibility in Postsecondary Computer Science Programs for K-12 Teachers

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Abstract

While more universities are including IT accessibility in their computer science programs for undergraduate and graduate students, there is little accessibility training available for K-12 teachers. We created an intervention through which postsecondary students had opportunities to experience five computer games with a simulated impairment (color-blindness, auditory impairments, physical disabilities, blindness, or low-vision); first they played the game that was inaccessibly designed and then they played a version that was accessibly designed. The activity ended with a discussion of accessible design techniques. We tested the intervention with 18 teachers who were students in a university web development course that was part of their computer science training. Results show that teachers were very receptive to including accessibility topics in their future classrooms and thought the intervention was an effective method for teaching high school, middle school, and elementary school students about accessible design.

Keywords: accessibility, empathy, computing education, K-12 teacher training, computer games

Introduction

There are over 1 billion people living with disabilities in the world (World Health Organization, 2011), yet many computer interfaces are inaccessible (WebAIM, n.d.). Applying web accessibility guidelines ensures that "websites, tools, and technologies are designed and developed so that people with disabilities can use them" (W3C, n.d.). Web accessibility not only helps those with disabilities but can lead to better experiences for anyone (Schmutz et al., 2016).

To address inaccessible design issues, accessibility topics have been integrated into some university-level computer science (CS) and engineering programs (Carter & Fourney, 2007; Keates, 2015; Kurniawan et al., 2010; Martin-Escalona et al., 2013; Wald, 2008), and in particular some are seamlessly integrated in web design courses (Harrison, 2005; Rosmaita, 2006; Wang, 2012) in which students are already learning about design. However, to the best of our knowledge there is a lack of accessibility modules implemented at the university level for pre-service or in-service teachers.

In the United States, in 2016, President Obama created the CS for All initiative with a goal that all K-12 students will learn CS (Smith, 2016). Therefore, more opportunities to learn CS topics were offered to K-12 students (Chen et al., 2017), and some teachers were trained through professional development workshops (Pollock et al., 2017). In addition, university-level CS courses were developed for future teachers (Adler & Beck, 2020) and current teachers (Joshi et al., 2019). We argue that in addition to coding and computational thinking, the CS for All movement should promote the inclusion of accessibility topics in the CS curriculum offered to K-12 teachers as well. Such efforts have the potential to foster a better understanding of accessibility barriers and solutions for students in K-12 education.

Including accessibility topics in courses often includes activities which raise awareness of accessibility challenges and promote empathy for people with disabilities (Putnam et al., 2015). One method for inspiring empathy while teaching about accessibility is

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through simulations (El-Glaly et al., 2020; Keates & Looms, 2014) through which students interact with software simulating a disability.

However, disability simulations must be carefully formulated. Some uses of simulations have been criticized because they do not improve attitudes towards people with disabilities (Nario-Redmond et al., 2017) and fail to address coping strategies that people with disabilities have developed and the long-term effects of facing social and physical barriers (French, 1992). In addition, while simulations may promote sensitivity to the limitations people with disabilities face, they often do not share accessible design practices and how to apply universal design (UD) principles (Burgstahler & Doe, 2004).

We introduce disability simulation games at the university level for K-12 CS teacher training that not only simulate inaccessible design for people with disabilities, but also provides tips and suggestions for good designs for all. In particular, they are geared toward motivating the application of the basic principles of universal design for designing for all regardless of a person's ability or other factors (Connell et al., 1997). They also highlight the specific Universal Design for Learning (UDL) principles for presenting content in different ways so it is usable by more people (CAST, n.d.). Our simulations, which are presented as engaging and competitive games, demand no prior CS or HTML knowledge and can therefore be used to train K-12 teachers and students.

Depiction of the Problem

A lack of inclusion of accessibility training in K-12 education leads to students learning to program without thinking about the needs of their target users, furthering the development of software that is inaccessible for people with disabilities that excludes them from its use. To remedy the lack of accessibility in K-12 classrooms, we begin with inclusion of accessibility in CS teacher training in postsecondary education. We tested disability simulation games, which were effective in motivating students towards accessibility in CS undergraduate courses (Kletenik and Adler, 2022), in a university web development course taken by K-12 teachers who teach or plan to teach CS.

This work is novel with respect to introducing accessibility topics and training into teacher education. Through the inclusion of accessibility topics in teacher training, teachers will be able to integrate some of these concepts in their own K-12 classrooms through age-appropriate activities, such as computer games and simulations. This advancement will empower students to develop empathy for people with disabilities and to begin to take steps towards making software more accessible to everyone.

Our research questions are as follows:

1. Does participation in an intervention that includes disability simulation games increase empathy towards people with disabilities and knowledge of accessible design with respect to IT?
2. Will K-12 teachers consider including interventions that use simulation games in their future CS classrooms?
3. What changes would need to be made to these college-level activities to make them fitting for K-12 classrooms?
4. Is the inclusion of IT accessibility topics appropriate for elementary, middle, and/or high school students?
5. How do participants feel and perform when simulating disabilities both with and without accessibility options?

Setting and Participants Demographics

Eighteen teachers (14 female and 4 male) were enrolled in a web development course at Northeastern Illinois University that was offered remotely over Zoom. These teachers (eight elementary, eight middle school, and two high school) were a cohort taking 18 credit hours of study in CS, which count toward the state endorsement to teach CS. Ten (55%) were White, four were Black/African American, three were Hispanic/Latino, and one was Asian. Fifteen of the teachers taught various STEM (science, technology, engineering and mathematics) related courses, one was in special education, one taught English Language Arts (ELA), and one was a Diverse Learner Teacher. Twelve of the teachers (67%) currently included CS topics in their classrooms. Sixteen (89%) reported knowing someone with a disability. All participants completed each activity on their own computers within a 1 hour and 15-minute class session.

Description of Practice

We created five accessibility games simulating the following disabilities: color blindness, auditory impairments, physical/motor impairments, blindness, and low/blurred vision. Each game has 4 rounds: (1) Game mode with no simulated disability, (2) Simulation mode, in which the player plays with a simulated disability, (3) Game+accessibility mode, with no simulated disability and the game is accessible, and (4) Simulation+accessibility mode, where the player plays with a simulated disability and the game is accessible. Our games are free to the public and can be accessed at gooddesignforall.com.

The games feature balls of red, green, and yellow that move across the screen. Players are told to "pop" a red or green ball. If they succeed, they get a point; if not, the computer gets the point and the player loses a point. After a ball is clicked, another color is chosen and gameplay continues until the time limit of 30 seconds per round is reached.

Table 1 shows what happens in simulation mode (Rounds 2 and 4) and with the addition of accessibility features (Rounds 3 and 4). The purpose of Round 1 is to allow the user to try out the game before entering simulation mode. Round 3 was included to show participants how designs would look with accessibility features for someone without that disability, and to counter the misconception that accessibility features reduce usability for people without disabilities, since players can observe that the game was just as fun to play when it is accessible.

Evaluation Measures and Outcomes

We created pre- and post-surveys asking questions relating to participants' attitudes about stereotypes towards people with disabilities, whether the teachers felt the intervention would be helpful for teaching IT accessibility in K-12, whether they would use the games in their courses, and any modifications they deemed necessary to make it appropriate for the K-12 level. We also collected in-game metrics denoting performance and sentiment to measure the impact of disability simulations on the players. Performance was measured as a binary value where 1 indicates that they won the round. After each round, participants were prompted to select one predefined sentiment that reflected their feelings about that round. We measured this too as a binary value of positive vs. negative (e.g., "fun" is positive while "frustrating" is negative).

After the participants gave informed consent, the pre-game survey was loaded, followed by the five games, and lastly, a post-game survey. At the end of each of the five games, participants were brought to a tips page which displayed information on creating accessible content for people with that disability, thus enabling reflection on the experience and teaching about designing for people with that disability. Further, after completing the activity and post-survey, we followed up the activity with a short lecture and discussion on Web accessibility to reinforce the concept to the teachers, which we encouraged they impart to their students, on how to create websites that are usable for people with disabilities.

To address our first research question and examine whether disability simulation games increase empathy towards people with disabilities and knowledge of accessible design with respect to IT, we considered the responses to the pre- and post-survey questions regarding stereotypical attitudes towards people with disabilities. The questions, depicted in Table 2, were asked on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). These questions were adapted from a survey about stereotypes of elderly people and technology (Carmichael et al., 2007) and used previously in evaluating our simulation games on college

Table 1

Games and Rounds

	Game Mode	Simulation Mode	Game + Accessibility Mode	Simulation + Accessibility Mode
Colorblind	Play the ball popping game	Cannot distinguish colors of balls	Letter written in each ball (e.g., R for Red)	Simulates colorblindness. Letter in each ball too
Auditory	Color to pop is *heard* instead of on screen.	Cannot hear the color to pop	Words (e.g., Pop Red) are written on the screen	Simulates deafness. Words (e.g., Pop Red) are written on the screen
Physical	Play the game	Mouse becomes shaky	Keyboard navigation included	Mouse is shaking. Keryboard navigation is available
Visual	Play the game	Cannot see the game. Black screen	Keyboard navigation with audio announcing the color of the selected ball	Simulates blindness. Keyboard navigation with audio is available
Low Vision	Play the game	Blurred vision	Can magnify the screen to remove bluriness	Blurry screen. Can magnify

Table 2

Pre- and Post-Attitude Questions

Attitude Towards People with Disabilities
Most current interfaces are easy for most people to use.
People with disabilities are not interested in new technology.
If a person with disabilities has difficulty with technology, there will usually be someone around who can help.
Most developers don't need to worry about providing technology suitable for use by people with disabilities.

students (Kletenik and Adler, 2022). We compared pre- to post-survey results using a two-tailed Wilcoxon signed-rank test and found statistically significant changes in the pre- to post-responses for the attitude questions. The pre-median of the average attitude response decreased (indicating greater disagreement with negative attitudes) from 2 to 1.75, $p = 0.005$, with a large effect size ($r = .66$); therefore, we note statistically significant changes with a large effect size in improving the attitude of participants towards people with disabilities.

Student comments that support this increased awareness of accessibility issues and knowledge of how IT can be made more accessible to people with disabilities include the following:

- "I think this game gives insight into situations that many know about. This allows others to know and empathize about their concerns and need to be heard."
- "This does a great job of putting you in the shoes of someone with a disability. Once that happens it give[s] some ideas for solutions but also opens the door for new and more innovative solutions from our students."

To address our second research question, and examine whether K-12 teachers will consider using activities that include these types of games in their future CS classrooms, we examined survey responses that showed that 16 participants (89%) agreed or strongly agreed that if they were to teach CS topics they would likely use a game as part of their curriculum for teaching about accessibility.

In terms of these games, 16 participants (89%) agreed or strongly agreed that they would use them in their classroom. In addition, a high percentage of teachers agreed or strongly agreed that these games would be useful for teaching accessibility in high school ($n = 17$, 94%), middle school ($n = 17$, 94%), and elementary school ($n = 15$, 83%). Supporting comments included the following:

- "Students as young as K can understand that students with certain impairments may need additional resources and accommodations for successful computer learning."

We also asked participants what changes we would need to make to these college-level accessibility games to make it fitting for K-12 classrooms (see our third research question). While participants seemed to find the games suitable for K-12, their concerns were primarily in terms of our instructions before each round. Participants suggested that we make it easier for children to absorb the instructions, since they may gloss over the reading. Some responses included the following:

- "There are a lot of instructions and [they] are very wordy. [L]ittle children may skip the reading and not get all the instructions."
- "Everything was pretty clear except students will need to have the ability for directions to be read to them…"
- "YES. I realized that the instructions come in bulletin form. Nevertheless, I missed the instruction about what color needed to be popped under the timer."

To address our fourth research question, and examine whether the inclusion of accessibility topics was appropriate for K-12 students, we looked at answers to survey questions and found that a high percentage of teachers agreed or strongly agreed that teachers who teach CS should include accessibility topics in high school ($n = 17$, 94%), middle school ($n = 16$, 89%), and even elementary school ($n = 16$, 89%). Teachers were overwhelmingly positive about including accessibility topics at all levels.

In order to examine our fifth and final research question, how performance and sentiment were impacted when simulating disabilities both with and without accessibility options, we looked at the number of wins and positive emotions from Rounds 2, 3, and 4. Round 1 was removed from analysis since it was used primarily as a practice round and was allowed to be skipped in later games. Two participants were removed from the auditory game analysis due to technical difficulties with audio.

We used the sentiment chosen by the user in each round to ascertain whether participants had more negative emotions in Round 2 (simulation mode) than Rounds 3 and 4. A Cochran's Q test showed there were significant differences for emotions for all the games ($p < .0001$); follow-up pairwise McNemar tests showed that this difference was because emotions reported on second rounds were significantly more negative than in Rounds 3 and 4 ($p < .05$).

In terms of performance, we similarly compared participants' scores in Rounds 2-4 and found significant differences in performance for all but the physical game ($p < .0001$), with Round 2 having significantly lower scores than Rounds 3 and 4 ($p < .05$). Note that similar to Kletenik and Adler (2022), participants were still able to win Round 2 of the physical game (with the shaky mouse), and therefore there were no significant differences in percentage of wins, though reported sentiment was lower for that round. In the case of Visual, performance in Round 4 (where the game was still hidden by a black screen) was also significantly lower than Round 3. Despite accessibility options, participants struggled with not being able to see at all.

Implications and Transferability

The goal of our IT accessibility exercise is for K-12 teachers who teach (or will teach) CS classes to learn the importance of incorporating accessibility content in their own classrooms and give ideas for accessible design for students even as early as K-12. We found that participants were overwhelmingly positive in their support of including accessibility, and of using games, and particularly these games, when teaching K-12 about accessibility. A limitation of the evaluation is our small sample size. Future work is needed to test this intervention with more K-12 teachers and directly with students in K-12 classrooms to examine whether accessibility simulation games can be effective with students as early as elementary school. Our results suggest that while the games may be suitable for K-12, the directions should be modified to make them more age appropriate, perhaps by re-wording them and offering a read-aloud option.

While our results show promise for including accessibility in CS teacher training, activities that include accessibility simulations can also be considered in other education programs. For example, one teacher wrote: "It would ALSO be a great game to teach disability in courses training special education teachers." We envision expanding this work into other departments, thereby increasing accessibility awareness at all levels.

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Creating Inclusive Learning Opportunities in Higher Education: A Universal Design Toolkit (Book Review)

Burgstahler, S.E. (2020). *Creating Inclusive Learning Opportunities in Higher Education: A Universal Design Toolkit.* Harvard Education Press. pp. 227. (softcover). ISBN: 978-1-68253-540-0.

Reviewed by Margo Izzo[1]

Sheryl Burgstahler's latest book, *Creating Inclusive Learning Opportunities in Higher Education: A Universal Design Toolkit* (2020) is an essential resource for every professional within higher education who is committed to diversity, inclusion, and supporting those with disabilities[2]. Dr. Burgstahler provides stories, practical examples, and first-person accounts of how to make institutions more accessible and inclusive. Notably, *Creating Inclusive Learning Opportunities in Higher Education* offers guidance not just about creating supportive learning environments for college students with disabilities but other minority students more broadly. Dr. Burgstahler states, "Infusing universal design into all aspects of higher education is an important step toward destigmatizing disability and ensuring equity for all groups" (p. 35). By providing practical suggestions and examples for integrating universal design principles across the campus, *Creating Inclusive Learning Opportunities in Higher Education* can help administrators, faculty, and disability service providers to create inclusive learning environments across college campuses.

In the first chapter, Dr. Burgstahler provides an historical perspective on diversity, disability, and civil rights. This chapter is especially relevant for those seeking to understand how disability should fit into higher education institutions' diversity plans. As institutions update and revise their diversity plans, Dr. Burgstahler highlights that students with disabilities are the largest diverse group of students, with approximately 10% of today's college students identifying as students with disabilities. Many of these students will request reasonable accommodations, claims Dr. Burgstahler, who goes on to note that if reasonable accommodations are not provided, then the institution is at risk of violating the student's civil rights. Thus, incorporating universal design principles and practices into core functions to assure that all websites, registration and business processes are accessible is critical not just for students, but for the institution and its actors as well.

To ensure the widespread accessibility she argues for, Dr. Burgstahler challenges faculty and staff to implement the principles of universal design across all facets of higher education with a focus on the teaching and learning process. Dr. Burgstahler provides a Framework for Universal Design in Higher Education (UDHE) that integrates principles from universal design of instruction, universal design for learning, and universal design of information technology. The goal of UDHE is to create an inclusive campus, which is one where the entire campus is accessible and usable for all faculty, staff, students, and visitors. Administrators and faculty can use the UDHE lens to evaluate every aspect of higher education by considering three characteristics: accessibility, usability, and inclusivity. The UDHE framework can be further customized for a specific school and used to guide diversity, equity, and inclusion initiatives. Throughout Chapter 2, Dr. Burgstahler offers multiple ways to access, engage with, and transform the higher education environment, ranging from making physical spaces welcoming and accessible to creating digital learning and assistive technology programs that meet the needs of all users. Faculty are encouraged to develop UDHE syllabi by incorporating teaching and assessments practices that minimize the need for academic accommodations.

Chapters 3-8 apply the UDHE framework to physical spaces (Chapter 3), technology (Chapter 4), teaching and learning activities (Chapter 5), teaching and learning services (Chapter 6), teaching about universal design (Chapter 7), and a model for an inclu-

[2] This book review was accepted through regular editorial process independent of the development of this special issue. It was originally requested during Dr. Wessel's editorship, and Drs. Wells and Kimball accepted it for publication. They then saw an opportunity for it to speak to the content of this special issue, and placed it here purposefully. The special issue editor and the author of the reviewed book, Dr. Sheryl Burgstahler, played no role in the solicitation, acceptance, or publication of this book review.

[1] *The Ohio State University*

sive campus (Chapter 8). Each chapter shares several features that assist readers in quickly finding the resources they need:

- Learning objectives that serve as advance organizers for key content of the chapter
- Figures and tables that summarize key points and provide multiple examples of UD practices
- "Did You Know?" text boxes that highlight interesting facts
- Illustrations, simulations, images, and interactive graphics that reinforce key points
- My Go-To Resources that provide additional websites about topics discussed in the chapter so the reader can gain additional examples, when needed.

One particularly useful feature is the "Take Action" summaries at the end of each chapter that provides opportunities for the reader to "Reflect, Learn, and Apply" the principles and practices presented in the chapter. The "Take Action" summaries are highly useful to guide professional development activities on diversity, inclusion, and disability. These professional development activities are likely most effective when delivered by administrators or faculty at department meetings as a series of activities to encourage faculty to implement some of the universal design suggestions with coaching and mentoring from their colleagues.

Dr. Burgstahler draws upon her decades of experience as a national leader in creating inclusive learning environments for students with disabilities to develop her latest text on UDHE. Every chapter provides facts, stories, and actionable steps that make it clear that Burgstahler believes that using a universal design lens improves education and society for everyone. At the same time, she notes that incorporating universal design into the structure of higher education is challenging. However, Dr. Burgstahler does not provide adequate research-based evidence that specific UDHE practices increase achievement and outcomes for students with and without disabilities. And in many instances, the book lacks adequate details to replicate many of the UDHE strategies suggested. Given that most academics pride themselves on using research-based evidence to guide their teaching, more research on UDHE must be presented to offset the time and cost of creating inclusive learning environments within higher education.

In summary, Dr. Burgstahler provides a practical toolkit for higher education administrators and faculty so they can implement a UDHE framework that creates inclusive college campuses. Readers are encouraged to "Take Action" by reflecting, learning, and applying new concepts. Throughout this toolkit, Burgstahler provides numerous practical examples and useful strategies for administrators, faculty, and disability professionals who strive to make their college campus more inclusive, diverse, and universally designed.

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About the Author

Margo Izzo received her B.A. degree in psychology from D'Youville College and Ph.D. from The Ohio State University. Her experience included working as a Program Director at The Ohio State University Nisonger Center where she directed federal grants to improve academic and transition outcomes for students with disabilities. She assisted develop Ohio's Statewide Consortia to expand postsecondary programs for students with intellectual disabilities. She wrote the book: *Empowering Students with Hidden Disabilities: A Path to Pride and Success with LeDerick Horne* and continues to consult on topics related to the transition to college and careers for students with disabilities.

JPED Author Guidelines

Purpose

The purpose of the *Journal of Postsecondary Education and Disability* (JPED) is to publish research and contemporary best practices related to disabled college students , college and university disability services offices, disability educators, and disability studies as a field within and lens for the study of higher education institutions. The sponsoring organization for the JPED is the Association on Higher Education and Disability (AHEAD), the primary source of disability related expertise on accessibility, legislation, rights, and any other disability-related information as it pertains to higher education. Consistent with the overall goals of AHEAD, each JPED article includes practical *implications for disability services educators* in colleges and universities.

Review Process

The JPED is peer-reviewed and uses a masked-in-both-directions review process. Although our reviewers take care to provide developmental feedback, it is essential that prospective authors follow the guidance and formatting instructions in this document carefully. The editorial process is not typically able to address major issues of conceptualization or craft in a way that leads to eventual publication.

Manuscript Topics and Types

Published manuscripts will advance JPED's purpose as detailed above (i.e., research, best practices, implications for disability services educators).

Research Articles

Manuscripts demonstrate scholarly excellence using one of the types of articles described in the *Publication Manual of the American Psychological Association* (7th edition, American Psychological Association [APA], 2020) sections 1.1-1.8 These include quantitative, qualitative, mixed methods, replication, meta-analyses, literature review, theoretical, and methodological articles. ***Inclusive of all manuscript elements (including title page, references, tables, and appendices) research articles cannot exceed 35 pages and typically are between 25-30 pages.***

Practice Briefs

Manuscripts describe innovative programs, services, or contemporary best practices that support disabled college students or disability services, and are organized using the following first-heading levels (APA 2.27):

- **Summary of Relevant Literature:** provide a succinct summary of the most relevant and contemporary literature that provides context for what is already known about the practice/program.
- **Setting and/or Participants Demographics:** provide enough information about the implementation context for the practice described for the reader to make an informed assessment regarding similarity to their own practice environment-- using a pseudonym or compositing as needed to provide anonymity for participants / institutions involved;
- **Depiction of the Problem:** provide a statement of the problem being addressed.
- **Description of Practice:** briefly describe the intended outcome for the innovative practice/program and how it has been implemented to date. Tables and figures may enhance specific details.
- **Evaluation of Observed Outcomes:** summarize formative and/or summative data used to evaluate the efficacy of your practice/program; support claims with evaluation data.
- **Implications and Transferability:** discuss what has been learned and how this practice/program could be enhanced. Be realistic about any challenges encountered and how others seeking to replicate the practice elsewhere might experience them. Offer suggestions about what could be done differently in the future to achieve better outcomes. Provide a clear description of how and why other disability service educators should consider adapting your practice/program.

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- An evaluation of the resource's strengths, elaborating on the author/creator's objectives and how well those objectives were achieved.
- Recommendations about the audiences that might find the resource useful, why, and how you would suggest the resource be used. Please be sure to address its potential contribution to the field. For any gaps in the resource's content, rather than framing as weaknesses, consider offering suggestions about other works or perspectives that could be used in tandem with this resource. In other words, of what conversations in our field could this resource be an important part?

Inclusive of the text of the review itself, media reviews should typically be between 750-1250 words. Media review submissions should also be accompanied by a complete APA reference for the resource reviewed as well as references for any additional citations in the text of the review.

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All manuscripts must be prepared according to the standards of the APA publication manual (7th edition). Authors submitting manuscripts to the JPED will be well-served to thoroughly understand Section 12 of the APA manual where the publication process is described as preparing for publication, understanding the editorial publication process, manuscript preparation, copyright and permission guidelines, and during and after publication.

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- Submit *one* complete Word document (.doc or .docx) that contains all manuscript components (i.e., title page, abstract, body, references, tables/figures).
- Provide a separate cover letter (APA 12.11) asking that the manuscript be considered for publication and providing any other information that would be useful to the editors.
- Manuscripts should have one-inch margins in 12-point Times New Roman font. Double space the abstract, body, and references; single space the title page and tables/figures.
- The title (APA 2.4) should not exceed 12 words.
- Place the abstract (maximum 250 words, APA 2.9) on page two (following the title page). Include three to five keywords (APA 2.10) below the abstract (does not apply to book reviews).
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- Regarding language related to disability, authors must determine the type of wording that is best for their given study - typically person-first or identity-first language. (See the "AHEAD Statement on Language" for details about these options and for additional resources on the topic.) We encourage authors to be explicit about their choices in the manuscript, informing readers about the rationale for their choice of language. When research or program participants are disabled and it is possible to determine their preferences, the preferred language of those individuals should be prioritized ahead of researcher or practitioner decisions. Additionally, aligned with the AHEAD statement in terms of outdated language use, we discourage "the use of outmoded euphemisms such as 'special needs,' 'physically or mentally challenged,' differently- or alternatively-abled, etc." unless there is an explicit reason, such as referring to past practices or terminology to learn something valuable from it for current practice.
- Use APA Section 8, Works Credited in Text, related to general guidelines for citation, works requiring special approaches to citation, in-text citations, and paraphrases and quotations. All citations must be referenced, and all references must be cited; avoid undercitation and overcitation (APA 8.1). Double-space and block quotations of 40 words or more (APA 8.27).
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- Tables and/or figures, following references, are in black and white only, and must conform to APA standards in APA Section 7. Follow examples related to table lines. Align numbers in tables to the single digit or the decimal. If tables and/or figures are submitted in image format (JPEG, PDF, etc.), an editable format must also be submitted along with a text description of the information depicted in the table/figure. This will be provided as an alternate format in the electronic version of the JPED, making tables/figures accessible for screen readers.
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- Do not include footnotes, instead, incorporate footnote narratives into the manuscript.
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- Before submission, ensure that the manuscript is ready by using strategies, examples, and checklists provided by APA:
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    - Strategies to improve your writing (APA 4.25-4.30).
    - Tables checklist (APA 7.20).
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    - In-text citation styles (Table 8.1).
    - Examples of direct quotations in the text (Table 8.2).
    - Reference examples (section 10 and 11).
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