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Disability, ICT and eLearning Platforms: Faculty-Facing Embedded Work Tools in Learning Management Systems

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ABSTRACT
This paper contributes to the current discussion in the field of human-computer interaction design (HCI) on the accessibility and design of eLearning tools embedded in the online platforms for higher education. Presenting the preliminary results of a longitudinal study of the accessibility of the faculty-facing pages of Canvas learning management system, it aims at drawing the attention of designers, developers, and manufacturers to the barriers erected by the ableist LMS designs for disabled faculty. The paper asks for improvements in design processes by embracing participatory design methods and by paying attention to the recommendations included in this paper.

Author Keywords
Accessibility of learning management systems (LMS); accessibility of faculty-facing Canvas pages; accessibility problems in SpeedGrader; design of accessible e-platforms; empirical studies in HCI; human-computer interaction design (HCI); interaction techniques; participatory design; sensory substitution.

ACM Classification Keywords
• **Human-centered computing~Empirical studies in accessibility** • *Human-centered computing~HCI design and evaluation methods* • Applied computing~Learning management systems

INTRODUCTION
This paper discusses the preliminary findings of a longitudinal study of the accessibility of Canvas LMS for users with visual disabilities. The study distinguishes itself from other research on the accessibility of learning management systems (LMS) in its focus on the faculty-facing interface of Canvas. It also stands out in comparison with other studies since it provides some problematic data on the accessibility of an eLearning platform that is assumed to be accessible on the faculty side simply because its learner-facing web pages are found accessible by most students. The testing data included in this article should interest designers, information technology administrators, and manufacturers of learning management systems since the accessibility problems flagged in this study create major barriers for blind faculty in performing their online teaching without sighted support. The designers of learning management systems and the software engineers and developers implementing the designs might find the recommendations of this report useful for understanding the barriers blind university faculty face when building content for their courses and how they could work on the integrity of the faculty-facing interface of their learning tools.

The author has the experience of specific demands on a faculty with a visual disability in designing an online course on Canvas, Catalyst, and Blackboard, delivering content to students with diverse needs, and maintaining consistent interactional activity with students using integrated, as well as, externally located tools. This paper alternatively employs two identity markers for users with disabilities—disabled users, and users with disabilities. Both of these markers are in use within the disability community, and the disability organizations in the United States also use them according to their institutional choices. For users with visual impairments, again two markers have been used—blind user, and user with visual disabilities. The largest organization of the blind in the United States employs "blind" in most of its communications.

This paper emphasizes that the questions of disability and access are a central piece in the professional code of the Association for Computing Machinery (ACM). The revised ACM Code of Ethics and Professional Conduct is laudable in its inclusion of disability in Section 1.4 Be fair and take action not to discriminate. The code directly speaks to the questions of access to computing technology for disabled people in its edicts that 1) "Computing professionals should foster fair participation of all people, including those of underrepresented groups"; 2) "take action to avoid creating systems or technologies that disenfranchise or oppress people"; and 3) "Failure to design for inclusiveness and accessibility may constitute unfair discrimination" [3].

LITERATURE REVIEW
Researchers from divergent fields have extensively studied the questions of access to e-learning for students with disabilities during the past two decades [1,4,6,9,12,15,19,21,22,24,26,27,33,37,40]. This scholarship has particularly explored the accessibility issues

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pertaining to instructors' responsibility in making their course content barrier-free for disabled students—tagging of PDF files; captioning audio-visual materials; Adding alternative text to images and other visual content in PowerPoint slides; choosing student-facing online tools, such as, clickers, discussion boards, chat bots, and WIKIs accessible; and to some extent, making their course structure, curriculum, pedagogy, syllabi, and the style of delivery inclusive of diverse human bodies with a variety of learning styles, employing different adaptive technologies, and reaching the course from divergent points of access. On the technology side, researchers have studied the design of eLearning platforms and learning management systems from the perspective of disabled students. The faculty-facing interface of learning management systems in general is under-researched [2,7,8,23]. My extensive search of published literature did not bring up any articles or chapters discussing the use of learning management systems by faculty with disabilities with some exceptions [28,41].

BACKGROUND

In autumn 2012, the Canvas pilot group at my university gathered feedback on the viability of this learning management system from those constituencies that would be directly affected by the change if we moved to Canvas from Catalyst—our home-grown e-learning system--and Blackboard, both in use in various units at that time. I was the only faculty member with expert knowledge of screen readers and braille displays on this pilot who tested the various tools included in the Canvas LMS employing JAWS-for-Windows screen reader and shared my findings with the pilot group. Despite major accessibility barriers for screen reader users, the university adopted this LMS at the end of that academic year. After the adoption of this LMS, the first testing report on the ePortfolio tool of this LMS was published in 2013 and that tool was withdrawn soon after [28]. Since then, I have collected testing data on various Canvas pages and tools on an ongoing basis and some of these results have been shared with our internal technical staff in charge of the LMS. One of the challenging aspects of working with the LMS products is the constant updates these systems go through without specific advisories on the accessibility aspects of the changes. This researcher's experience shows that these updates do not always improve the accessibility of the LMS for screen reader users on the faculty-facing pages, and they can even disturb the existing accessible pages due to the focus on other priorities for nondisabled users. With a very small user-base for these faculty-facing pages, the labor of obtaining access is high and many times these accessibility concerns remain under-reported even when a problem is detected. The sociologists of technology discuss the process of product improvement implementation that falls on the user side experience long after a software product has been released for the market because these users are the only available repository of the experience-based contextual knowledge essential for a successful implementation of the product goals [10]. Unfortunately, in the matters of accessibility, only some of the producers of adaptive technology presently maintain such channels to learn about the product life after it is in the users' hands.

STUDY DESIGN

A learning management system is an independent platform for staging a set of instructional, assessment and storage tools embedded throughout its pages or frames and for organizing learning materials, creating digital learning spaces for interactions, offering delivery of synchronist and asynchronist class sessions, and administering exams, quizzes, and other assessments.

Data collection

The data was collected by a blind faculty in tandem with a sighted expert user. When Canvas interactions posed problems to the screen reader, the same function was executed by the sighted user with and without a screen reader to understand the behavior of the Canvas page under examination.

Research questions

This self-designed faculty user study asked these four basic questions:

1. Is the faculty interface accessible to a blind user?

2. If this interface has some accessibility issues, what are they?

3. How is the instructor using this interface with partial accessibility?

4. How does the instructor provide for the support to make up for the interface problems?

OVERVIEW OF THE PRELIMINARY FINDINGS

The faculty-facing interface of Canvas for the 2019 new gradebook is supposed to be accessible for screen reader users; however, its usability requires careful testing. The soon to be retired Canvas Gradebook had serious problems for screen reader users.

The most difficult and lasting accessibility problem with Canvas is its automatic rolling in of updates with no control for the institution to delay the changes to be applied until their integrity is determined as far as access for screen reader and other adaptive device users is concerned. These updates are frequent and are always a mixed bag for adaptive devices. The contextual problems listed below are doubly aggravated when the automated applied updates change Canvas interface behavior, including the placement of buttons, web page features within a particular tool, such as, SpeedGrader, or the web page for adding a new assignment, and the feedback provided to the screen reader user about the visual elements and notifications after the user takes an action. Making an assessment of the accessibility of the LMS itself becomes a challenge in such an ever-shifting web environment. In such an environment, even making a good

faith effort at testing the accessibility of the interface with a blind tester does not help individual users [11, 35].

Key Issues Confronted on the Faculty-Facing Canvas Interface

Canvas has accessibility issues in several design areas. Particularly challenging are the issues related to inconsistent page layout and a lack of a reliable structure to signal various elements on the page. These issues are present in most pages whether it is a template for creating a new assignment, or SpeedGrader tool.

Issues relating page layout and structure

1. The layout of Canvas web pages is confusing unless the user can draw on the visual cues; otherwise, the page is a heap of links, text entry boxes and other fields, and long segments of content on the entry pages related to multiple courses, assignments, and even Inbox messages—none of which can provide help to orient the user on the page.

2. While grading, on the quiz screen the user can move from one student's quiz to another and read the quiz content; Canvas does not allow the entry of individual quiz question grades. JAWS can see the field as the user hears the typical JAWS dip sound for a text entry in a form field, but Canvas does not register the response. Neither the space bar, nor the enter key seem to make a difference. Further, during grading quizzes, after finishing the grading of one quiz when instructor goes back to Course Home to start the grading of another quiz, Canvas starts reading the page from the top instead of landing on the next quiz.

3. The more critical issues relate to pain points where the LMS technology begins to get in the way of the faculty user's actual work of teaching a class synchronistically, building a quiz, or grading an assignment. For example, a faculty with a visual disability goes to Canvas LMS to get some teacherly tasks accomplished like other faculty. If the LMS page layout or screen design requires dedicated attention just to interact with the user interface, the faculty can't keep their focus on the academic task at hand. Let me give you a more specific example: a blind faculty member is grading a quiz for her class on Canvas' SpeedGrader. If she has to constantly figure out where she is in the information environment; that is, her location on the page, it begins to cognitively interfere with the actual task of grading. Instead of giving full attention to the information in the student answer, the instructor ends up dividing her attention between the extra chore of keeping track of her location and the answer itself. When the page is not only poorly designed but also crowded, this academic task becomes a secondary item in the cognitive process because the instructor needs to spend most of their attention on staying in the required spot.

Lack of helpful guidance for blind instructors

1. The LMS is rich with many options for nondisabled users which becomes a problem when the screen reader does not have many shortcuts to jump over these options.

2. Canvas pages can vary from one teaching activity to another, but the system does not offer an overview of the page. For providing a page overview for the fixed features of the page, the application of ARIA roles could be one possible candidate. Another option is the use of the longdesc attribute.

3. The system often does not confirm whether or not the blind instructor has been successful in the action taken.

4. This feedback is also hard to get about what students will see on their end although the link to the student view Canvas page itself is accessible.

5. The SpeedGrader page's comment boxes do not alert the instructor that the student has entered content in those boxes.

6. Canvas does not always provide notifications to alert the disabled users about the updated content in different areas of a web page. Such notifications are possible if Canvas would employ ARIA roles-based notifications that could be displayed to the screen reader once new content is displayed in another portion of the web page.

Poorly executed or missing access for certain Canvas tools

1. The Canvas has controls for reversing major changes on a page for nondisabled faculty but the process for recovering pages using a screen reader is mysterious because the instructions for recovery are not accessibly available.

2. The grade entry and comment fields on the SpeedGrader page are not easy to navigate with a screen reader and many times the cursor jumps over beyond these fields without a notification.

3. Email notifications about student interactions with the course page do not provide meaningful information to make the screen reader user aware of the specific action taken by the student.

4. The Canvas inbox displays messages from all the courses in one place, requiring the blind instructor to sift through the whole inbox to locate a particular student message.

5. If one chooses the skip link, the text starts flowing but the system reads some general directions for how to organize one's home page. Since this text is not visible to the sighted readers, it might be a long description from an ARIA role. The screen freezes once this long description is over and the system announces Application Mode On. At this point, the only key that allows the user to move to another link is the tab key, but one has to choose one of the links and go to that page to get out of the Application Mode.

6. At times, the system simply has some coding glitches due to a lack of attention to detail. When grading Quizzes, often the questions are read twice by Canvas. Visibly, both the text for the questions and answers appears identical and no special graphics seem responsible for this repetition.

7. Similarly, while grading assignments, even when the student has not submitted an assignment, a Canvas message states that it was "Submitted on time".

8. Canvas dictates application specific keyboard commands for screen reader users which is not only a violation of the WCAG 2.1 standards but are also responsible for additional cognitive load for the blind user who has to remember all the screen reader and Windows commands, recall the general page layout they are visiting, and mentally know the details of the content they are trying to interact with for attaining their work goals.

SUMMARY OF ACCESSIBILITY ISSUES EXPERIENCED ON STUDENT-FACING CANVAS PAGES

While this paper's focus is on faculty-facing Canvas pages, students with disabilities have reported several similar issues in their user experience. As for the faculty interface, the student-facing pages also do not have a consistent structure throughout the course sites. Likewise, Canvas does not enforce even a level of liminal access for the content created by the instructor or mined from third-party resources for student use. Consequently, instructors lacking knowledge of accessibility issues for disabled students, or instructors unwilling to put forth the effort essential for making the content accessible can continue to force disabled students to use inaccessible resources in their courses. More often, such omissions close off learning opportunities for students with disabilities who are already facing numerous other barriers on university campuses and digital environments.

RECOMMENDATIONS

This section presents a set of suggestions for addressing the accessibility and usability problems discussed in the previous two sections.

Problems requiring immediate attention

As provisional fixes, the designers and developers of this system could make several of the changes discussed below without a major upgrade of Canvas.

1. Remove all keyboard commands unique to the Canvas pages and replace them with Windows keyboard commands. Employing self-styled keyboard commands for the users of adaptive technology is equal to asking blind users to use a different method of access which is not only a violation of the WCAG 2.1 and Section 508 Standards but also can become the cause of a number of unrelated problems—confusion between the website specific keyboard commands and the commands used by the screen reader, the time invested memorizing a separate set of commands, and the negative effects of the resulting information overload on the instructor task at hand. Readers unfamiliar with the functioning of major screen readers like JAWS might note that the screen reader commands have been rationalized with those of the Microsoft Windows.

2. Add "skip navigation" links to help blind users jump to the first interactive element on all the faculty-facing pages

3. Add headings for quicker navigation that follow the WCAG 2.1 standards

Changes requiring a revision of page structure throughout Canvas

For addressing the accessibility problems of this LMS in the long run, participatory redesign with Canvas instructors well-versed in screen reader use is a good option because a blind screen reader user without online teaching experience can't understand the contextual problems faced in day-to-day teaching on an LMS of this nature with many complex features [29]. These features are at the moment not usable without sighted help or significant investment of time to fumble with them due to their poor accessibility.

1. Build a mechanism for the user to know which particular tool or activity they are on, right at the top of the pages

2. Create ARIA roles throughout the website for communicating information about page refreshes and notifications appearing in other parts of a page.

3. Use a consistent structure for all Canvas tools so that the regular user can instinctively navigate Canvas pages.

4. Improve the quality of editors embedded in Canvas pages, even if they are third-party tools.

5. Introduce individualized inboxes for each course during an active semester. Also introduce additional folders for sorting out student messages received in the inbox.

This study started with four questions about the accessibility and usability of Canvas for faculty members with visual disabilities. The answer to the first question is a straight "NO". The whole Canvas website has structural problems that make it a marginally accessible system. The second question is addressed in the three sets of issues outlined above. A blind instructor using Canvas for teaching a class independently is nowhere near the state of accessibility essential for working without sighted support. The answer to question four is more complicated, since each institution of higher education offers different levels of support to their disabled faculty. Speaking generically, few universities today offer sighted readers to their blind faculty. The common assumption among academic administrators is that the web is accessible, and a screen reader is sufficient for supporting a blind faculty. Since Disability Services do not support disabled faculty on most campuses, the responsibility of correcting this incorrect assumption falls to the disabled faculty. Many disabled faculty manage such support through family and financial resources in such situations.

CLOSING THOUGHTS

Researchers have begun to consider participatory design as an inclusive strategy for co-designing side-by-side with users with disabilities as partners [5,31]. The methodological design of these participations needs strengthening so that these relationships are not simply restricted to the extraction of information about disabled users' lifestyles and

technology usage. Instead, these relationships require a professional parity because the vast research literature in disability studies field has established that people with disabilities possess certain valuable knowledge due to their bodily differences and the lived experiences acquired through these differences are a key to understanding how users with visuo-sensory disabilities interact with technology and troubleshoot themselves out of poorly designed and limitedly accessible LMS at this time. Professionals in digital design and development fields can learn much from these colleagues and employ their knowledge to their advantage to improve the quality of these systems both for disabled and nondisabled users. The design field itself has to include participation of disabled user experts in its key research and conference agenda as the activity at this level only can attract the attention required for this inclusion. Major efforts at historicizing design activity have overlooked this aspect altogether [17].

Philosopher Michael Polanyi informs us that our acts of perception, recognition, and meaning making are dependent on a plethora of clues— "some at the edge of our vision, others inside our body"—that in the first place help us perceive [32]. Polanyi further explains that we transpose "bodily experiences into the perception of things outside" and this process assists us in transposing "meaningless experiences into their meaning at a distance from us". This process is also applicable to human use of tools, probes, and devices. For instance, we translate this tacit knowledge into the practical use of tools during the learning process whose coordination by our mind often becomes seamless unless when we fumble in the handling of a mouse click, or the stroke of a hammer due to some distraction [14]. Thus, when we click on a link to open a web page, several bodily processes are coordinating our process of first opening the link and then perceiving what appears before us on the web page. Additional bodily processes that include our focal and peripheral vision come into play to make sense once the details of the page sit in front of us. But none of these would make sense without our previous user experience of these details—the overall structure of the website and its pages, the distinct design of individual pages, if any, the specific layout of a home page, the navigation menus and related objects, and of course then all the objects that form the content of the site; however, we seldom attend to these processes and their details with our conscious mind unless we were engaged in the process of designing and developing these web pages with an active awareness of what specific outcome we would like users to experience from our coded product on the other end of the page. All the professionals engaged in the production of different aspects of this user experience actively contribute to this process and thus the design coherence for a web page is attained. Thus, when a nondisabled student, or faculty, land on a Canvas page, all the technical hands behind the design and structure of the LMS, as well as, the professionals involved in the production of these pages visible to the users' eyes, through their own tacit and explicit knowledge of human perception, locomotion, and coordination have built myriads of clues into these pages to contextually situate the users, point them to specific actional objects, draw their attention to alerts and warnings, and even prompt to act in case the user is still hesitant to disturb the peace of the page. However, we have not yet begun to engage in this sort of active process of experience design in learning management systems when imagining the users with sensory disabilities. There is no coherence on the pages for the ear navigating with a screen reader, or with a braille display, because the access to the page content is provided on a contingent basis by retrofitting the existing design prosthetically. We rarely have close friends or colleagues with sensory disabilities to obtain a feel for their day-to-day experience with web browsing and we have not yet made a concerted effort to bring colleagues with sensory disabilities into design work of this nature. Our approaches are instead more reactive than constructive. We limit our efforts to putting out the accessibility fires we have been made aware of by examples from the industry, or our own professional experiences than view our design work as that of constructing accessible and usable UX. The most critical aspect of this exclusionary approach is that we are missing on the possibilities of employing the tacit and conscious knowledges that the disabled bodies acquire through the experiences of difference. Since all the research of the past half a century in tacit knowledge theory, and its correlate in the gestalt psychology, tells us that eyes and ears alone do not help us see or hear—for an example, our skin is another organ vital to our visual sense making by our mind [30]—our designs neglect the affordances of the bodily difference at a cost both to the disabled and nondisabled users. Likewise, the LMS design have yet not begun to explore the application of haptic technologies that are otherwise becoming ubiquitous in hand-held devices—howsoever basic their employment might be at this time [20,13,18,25,34,38,39,42,43]. A direct result of this omission is that our learning management systems are inaccessible to the visually disabled and placid to the seeing eye and the hearing ear because they are so dependent on the two senses, neither of which are by far the most sensitive or subtle [36]. Consequently, in the current state, the disabled LMS users are primarily dependent on their memory and the small number of screen reader keystrokes to navigate in a web landscape with few nonvisual contextual clues.

The designers of the various eLearning platforms have been preoccupied with what disabled students and faculty cannot do and have tried to supply band-aid solutions to help them cope with what these designers consider these users' defects or deficits. Similarly, the narratives of efficiency, technological expertise, and innovative infrastructure often dominate our research discourse even where the question of inclusion is the central issue [16]. If we would try to learn about the alternative abilities these users possess, and make a good faith effort to learn from the expert users of adaptive technologies, they might succeed in unwrapping the band-

aids they have applied to these systems over these two decades and arrive at a design that is structurally coherent, inclusive of different modalities of a variety of users and takes into consideration the interaction patterns of users interfacing with different access technologies.

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