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Arab Online Courses and the Disabled: An Automated and User-Testing Approach

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ABSTRACT

There is a significant increase in the adoption of Learning Management Systems (LMSs) by higher education institutions worldwide and Saudi universities in particular. These pedagogical tools empower teaching and learning by providing access to online learning materials. However, all university students, including students with disabilities, encounter countless instances of inaccessibility that negatively impact their learning experience. In order to offer equal access to all students, it is of paramount importance to enhance the accessibility of LMSs and remove such barriers. The purpose of this case study is to evaluate an online course in the LMS Blackboard (Bb) using an automated and end-user evaluation approach. First, automated testing was carried out by Ally software. Second, end-user testing was conducted using a think-aloud protocol to understand the actual learning experiences. Data from the think-aloud protocol was examined to extract accessibility issues. The findings from the automated testing indicate that the online course is highly accessible in terms of the course materials. However, students were challenged by several accessibility obstacles that surfaced during the think-aloud Bb tasks. To the best of our knowledge, this is the first study that incorporates Bb Ally as an automated checker to test an online course for disabled Saudi students.

KEYWORDS

Think-aloud protocol, Ally software, Blackboard, Web content accessibility guidelines (WCAG 2.1), World Wide Web Consortium (W3C), Blind and visually impaired (BVI) students

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1. Introduction

Learning technologies have progressively been adopted in several contexts in higher education. One example of a fundamental technology integrated into every educational system is the LMS (Aljuhney and Murray, 2015; De Smet *et al.*, 2012). The percentage of American universities and colleges that rely on LMS course delivery has vastly increased to more than 90% (Arroway *et al.*, 2010). In Saudi Arabia, 87% of higher education universities have employed LMSs as a pedagogical tool for both teachers and students (Aljuhney and Murray, 2015; Aldiab *et al.*, 2019). Most LMSs consist of several tools and features, such as content previewing tools, communication tools, and student assessment tools. These learning websites and systems should guarantee equal access to all students. The LMS reported as the most utilized in higher education institutions, with a significant growth in student usage, is Bb (White, 2017).

Bb is an LMS mainly used to facilitate the learning process for both faculty and students. The primary features of Bb include access to online materials, such as course content, lectures, syllabi, assignments, and assessments, and the ability to attend online sessions using the virtual classroom tool. Thus, students have to enroll in generous training programs in their institution in order to enhance the information and communication technology (ICT) and technological skills needed to use the platform effectively.

Although the Bb system has shown benefits for university students in a number of institutions (Alokluk, 2018; Alkarani and AlThobaity, 2020; Chen *et al.*, 2020), Blind and visually impaired (BVI) students usually experience accessibility challenges when completing online tasks on websites and LMSs like Bb. This is evident in research indicating that university websites and LMSs are usually deprived of the accessibility and usability needed for their users to succeed (Babu *et al.*, 2010; Ristovska *et al.*, 2021). Despite the importance of this area of research, there is a clear scarcity in literature investigating Bb accessibility for BVI students in Saudi higher education. Therefore, every effort should be made for LMSs to be accessible and useful to all students, including BVI students.

Accessibility has been a crucial element of successful online learning environments. Accessible systems allow learners to easily access their functionalities (Goodhue, 1986). For learners with disabilities, accessibility is considered a technological element that enables the use of assistive technologies, such as screen readers, speech recognition software, magnifiers, or adaptable keyboards, in order to interact with the interface and its content. Literature has highlighted the important role of ICT skills in supporting the successful education and learning of students with disabilities (Pacheco *et al.*, 2017). ICT skills, along with knowledge of the W3C, prepare students with disabilities for a promising future in the digital world. W3C develops the WCAG 2.1, which are recognized and followed by users around the world (W3C, 2018). A significant goal of W3C is to allow every human being to access the web despite software or culture (W3C, 2018).

Although comparing LMSs against the WCAG assists designers in achieving accessible systems, compliance with the standards does not secure holistic and efficient accessibility, especially for BVI users (Clark, 2006). For a learning environment to be inclusive for all learners, course materials must be accessible to all students (Sapp, 2009). One promising tool that supports institutions in providing an inclusive learning environment for all students, including students with disabilities, is "Blackboard Ally." Accessibility of online materials has always been a time- and finance-consuming challenge, and Ally is one of the products that helps to reduce the burden on designers and instructors (Bastedo and Swenson, 2020). Ally is vastly useful for faculty as it focuses on a significant issue, i.e., course content, in which the tool gives guidance on how to correct accessibility issues as they appear in online course content. In addition, the tool makes materials compatible with mobile phones and tablets, as well as with assistive

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technologies. As for students, downloading "alternative formats" of files is one of the most useful features of Ally that supports all students, including disabled students, and their various preferences (Blackboard Ally, 2018). One study has explored the utilization of Ally by faculty members and students at Jazan University (Almufarreh *et al.*, 2021). The study suggested that Ally could maximize students' progress and learning achievements. However, to the best of our knowledge, there is no research that evaluates Bb accessibility by utilizing the Blackboard Ally tool in an online course designed specifically for BVI students.

There are some studies that have addressed the accessibility of the Bb system in Saudi Arabia (Alturki *et al.*, 2016; Alotaibi, 2015; Alnfiai and Alhakami, 2021). However, very little is known about accessibility issues encountered by Saudi BVI students, in particular, in Bb course content in Saudi higher education. One study evaluated the web accessibility of Bb at King Saud University from a faculty point of view (Alturki *et al.*, 2016), and it employed a questionnaire to assess usability, the designed interface, navigation, and level of content accessibility. The research suggested that Bb is reasonably usable and accessible when it comes to accessing course materials. In addition, Alotaibi (2015) evaluated the accessibility and usability of Bb against W3C guidelines using a group of automated evaluation tools, manual evaluation, and reporting of disabled students' experiences using survey data. The results indicated that the system employed by Taif University did not achieve accessibility and usability guidelines. When it comes to visually impaired students in Taif University, recent evidence emerged suggesting that there are accessibility issues in Bb, which include disturbed navigation, incompatibility with some assistive technologies, missing definition of visuals, and inaccessible PDF files (Alnfiai and Alhakami, 2021). In fact, Alnfiai and Alhakami (2021) emphasized the critical and significant need for universities to improve accessibility of websites and LMSs for disabled students. Thus, this paper addresses this gap by focusing on accessibility issues in a designed Bb course, in which course content accessibility is examined through the actual use of BVI students at King Abdulaziz University (KAU).

Despite some useful studies with multiple methods that investigated web accessibility issues experienced by disabled learners (Babu *et al.*, 2010; Babu and Singh, 2013; Alotaibi, 2015; Alnfiai and Alhakami, 2021), none of these studies employed both Bb Ally and think-aloud protocol to observe the experience of BVI students at a Saudi university and evaluated accessibility of the online Bb course designed specifically for them. Accessibility could be considered a subjective construct, as what is accessible for one learner does not mean it is accessible for another. Thus, the application of think-aloud protocol is promising in supporting educators and designers in uncovering accessibility issues that would otherwise not be known.

To this end, and with a focus on course content, this study aims to evaluate the accessibility of a Bb online course designed and used by a sample of BVI students using two evaluation methods. First, the automated testing tool, Ally, is employed to uncover the accessibility level of the course materials. To the best of our knowledge, this is the first study that incorporates Bb Ally as an automated checker to test an online course for the use of disabled Saudi students. Moreover, such groups of students need assistance in their university life, including accessible content and easy-to-use learning materials. This way, students embrace using Bb and enhance their self-learning skills (Chen *et al.*, 2012; El-Senousy and Alquda, 2017). Second, students' testing was carried out using think-aloud protocol in order to understand their actual learning experiences and how the accessibility issues surfaced in order to understand their online learning needs and inform accessibility and usability research.

2. Methodology

This mixed method case study was conducted at KAU during the 2020 fall semester. The methodology of this research evaluates the accessibility of LMSs based on literature recommendations (Moreno *et al.*, 2012). Since the use of automated testing software tools alone does not allow for the detection of all accessibility barriers, this study employs a combination of automated and student testing in order to guarantee the identification of most accessibility problems and, in turn, applying a more fruitful accessibility solution. For the purpose of this study, an online Bb demo course was implemented. There are three types of accessibility testing methods that derive the best results (Abou-Zahra, 2008). This study employs two methods: 1) Automated evaluation through the Ally tool and 2) Student evaluation accomplished by think-aloud protocol during students' use of the online demo course. These methods are detailed as follows:

2.1. Automated Evaluation: Ally Software:

This method is carried out by automatic software checkers, without the need for human intervention. This study contributes to the body of literature by employing one of the new software tools that helps to improve inclusive learning in Bb courses. Ally integrates with the institution's LMS and provides an accessibility feedback report, mainly identifying accessibility issues within the course content. Ally produces a course accessibility score, which represents the average accessibility score across all files and content. Ally checks each course item against the WCAG 2.1 at level AA standards and produces a score based on the severity of the issue (Blackboard Ally, 2018). The software knows where certain accessibility issues are located, i.e., in which content/documents, and recommends a solution. The accessibility report generated from the Ally tool will be used for an automated accessibility evaluation of the course.

2.2. Student Evaluation:

This evaluation phase was accomplished by four blind and one visually impaired undergraduate students (N=5). Participants were recruited purposefully by collaborating with the Special Needs Center at KAU. The center provided the research team with the contact information of students who are blind or visually impaired and who have basic background knowledge of using the Bb LMS. The invitation included a 100 SR Jarir Bookstore coupon as an incentive for each participant. Table 1 summarizes the participants' demographic information.

Table 1: Students' Demographics

	Participant Pseudonym	Disability Level	Bb Usage	PC or Mobile	Screen Reader/ Magnifier Usage
1	Sara	Blind	Advanced	Both	Advanced
2	Salma	Blind	Advanced	Both	Advanced
3	Samia	Blind	Basic	Mobile	Intermediate
4	Asma	Blind	Basic	Mobile	Voice-Over
5	Maria	Visually Impaired	Basic	Mobile	Magnifier (up to 400%)

2.3. Think-Aloud Procedure:

Participants completed a list of tasks based on the online demo course at lab workstations in the Deanship of E-Learning and Distance Education at KAU. Each workstation had a desktop computer running a Windows 10 operating system, a wired internet connection, a mouse, a NonVisual Desktop Access (NVDA) screen reader, and Google Chrome as a browser. First, each student (and their assistant, if applicable) was welcomed by two members of the research team and was asked to sit down at a desk. One researcher was responsible for conducting the think-aloud protocol, and the second researcher observed and wrote down comments. A researcher explained the think-aloud procedure and described how to verbalize thoughts while thinking. After the explanation, students practiced think-aloud in a sample exercise in order to familiarize themselves with verbalizing their thoughts. The researchers then explained the information sheet and the consent form to the participant.

When the student started to tackle each task given, the researcher watched, observed, and wrote students' comments in the list of the task sheet. The researcher probed students if they were silent for more than 10 seconds. In addition, the researchers made sure to remind students who infrequently verbalized to "keep talking." However, the researchers remained silent while students were thinking aloud to prevent any interruption of their trains of thought (Ericsson and Simon, 1993). When the student completed a task, the researcher made sure to ask questions related to incidents that occurred during the think-aloud process, such as "What was confusing in this task?" or "What helped you or made this task easy?" Each session with a participant lasted between one and two hours.

2.4. Data Analysis:

Observation of the think-aloud protocol produced a written tabulated transcript for each student. Three indicators of the accessibility of the course were examined: *critical moments (cm), pleasure moments (pm), and completion time (ct).* A member of the research team reviewed the five transcripts to gain an overall sense of the data and to focus on places that needed closer examination. Next, each participant's file was additionally revised in order to tag the applicable parts for the indicators and to assign the list of observations for each part. Two researchers reached an agreement regarding the identification of sentences in each unit task that could be coded as cm, pm, or ct. Then, a second researcher reviewed the analysis, and the coded parts were organized according to the applied codes to ensure consistency. The cm count was used to identify the Bb tasks/tools that were the most accessible and the least accessible. The mean of the ct for each Bb tool/task was considered in the reported results. In order to calculate the mean task completion, ct=sum of ct for the task/total number of students.

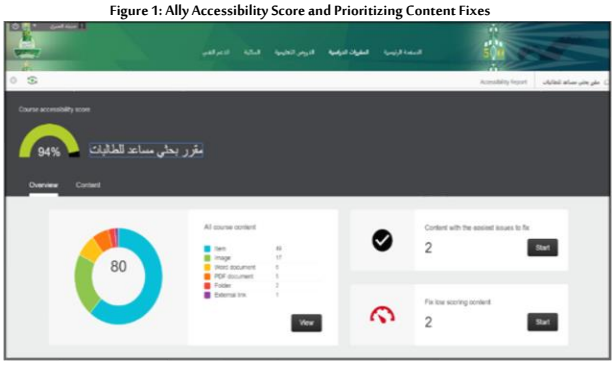
3. Results

This section demonstrates the findings of the research from the automated and end-user evaluations as well as the resulting accessibility barriers associated with the online course unit.

3.1. Automated Evaluation Results: Ally Software:

As shown in Figure 1, the overall accessibility score of the demo course content on Bb was 94%. This means that the demo course had high accessibility in terms of the course content and learning materials and that the success criteria, WCAG 2.1 AA standards, were achieved. The course accessibility report also provided support in terms of solving the issues that arose and could be fixed by the course instructor or instructional designer.

Figure 1: Ally Accessibility Score and Prioritizing Content Fixes



Ally indicated four accessibility problems in the demo course used in this study. One issue resulted from the supported course logo added to the "Start" page of the demo course, which was missing a description. The software allows the instructor or the instructional designer to fix the issue by instantly writing a description or by choosing the option to make the image decorative, as indicated in Figure 2. Another issue resulted from a Word document titled "Communication Skills Test Questions Form," which did not have headings. A third issue appeared with a scanned PDF file, and to solve this issue, the Ally interface permitted the instructor to upload or replace the file with a text-based electronic version, such as a text-based PDF, Word, or PowerPoint file, which is more accessible and usable than a scanned version. The final problem from the Ally evaluation was from a PDF file that was untagged, and this could be solved by using an editable source document, such as a Word or PowerPoint file, after creating the necessary tags.

Figure 2: Ally Example of an Accessibility Issue

3.2. Student Evaluation Results:

Accessibility issues are discussed in terms of think-aloud protocol themes that emerged according to three main types of Bb tools: Bb content previewing tools, Bb interactive tools, and Bb assessment tools. Identification of cm, pm, and ct are discussed for each Bb tool result.

3.2.1. Accessibility of Bb Content Previewing Tool-Based Tasks

This section discusses the themes that emerged while students accessed and viewed the following different types of files.

3.2.1.1. Glossary: Insufficient Color Contrast

Accessing the Glossary and reading the terminologies included in the course was the least critical task students accomplished in this study. As shown in Figure 3 [A], the frequency of all pm encountered during this task was (pm=5), while the total frequency of cm was only (cm=1), and the mean ct of the task was merely (ct=1.4 minutes), as indicated in Figure 3 [B]. All blind participants (Sara, Salma, and Samia) used the screen reader to access this tool, navigate it, and easily read the content, without any negative incidents. When the Glossary opened, Sara announced, *"That's super easy!*" However, the visually impaired participant, Maria, was challenged by needing to increase the magnification up to 400% on the desktop PC used in the study. Maria complained that there was insufficient contrast between text and the background color of the Bb Glossary page, which hindered her ability to fully read and understand the content of the page.

3.2.1.2. PDF Files: Inaccessible Hyperlink Inside the File

Opening PDF files received a higher frequency of pm across all tasks (pm=10), while cm had a low frequency (cm=3), and the mean ct did not exceed 2.5 minutes for any participant (ct=2.2). This may be due to employing Bb Ally for automated evaluation, which reduced problematic incidents and increased students' feelings of satisfaction during PDF tasks. They were easily achieved by all participants, as the PDF files were automatically opened after downloading using the Google Chrome browser. The only problem some participants announced was that the screen reader did not read and open the

hyperlink while reading the file. As for the visually impaired participant, Maria, the hyperlink included in the PDF file was not clickable using the keyboard; therefore, she had to use the mouse to open the link.

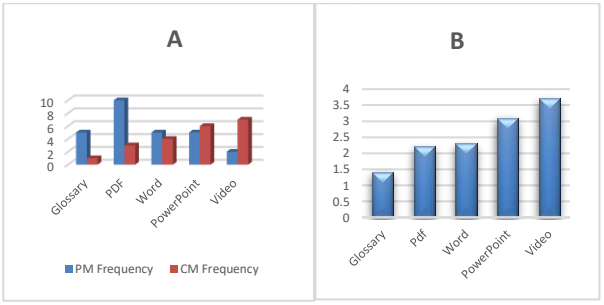
3.2.1.3. Word and PowerPoint Files: Inaccessible Protected Mode Files

As shown in Figure 3 [A], the total frequency of pm for both tasks was 10 moments, while the cm ranged between four and six incidents. The mean ct of tasks involving Word and PowerPoint files were ct=2.3 and 3.1, respectively. While the majority of students verbalized positive comments about accessing these files, Sara and Samia struggled with opening the files after the download, as these files opened in a protected mode and, in turn, the reader could not access the enable button or read the content of the files. Samia said, "It's strange! Because when I use the Bb mobile version, the reader is always able to open these files directly (Word and PowerPoint) and can read the content, captions attached to images, and tables inside the document without any problems." While observing students during the PowerPoint file tasks, the reader did not read the slide content unless the user placed the mouse cursor inside the slide area. In addition, students verbalized that PowerPoint files uploaded by their instructors usually contain countless images that do not contain alternative text or descriptions. Maria stated that the insufficient color contrast hindered reading, even with 400% magnification. Such negative encounters led students to have a low preference for using PowerPoint slides and a high preference for using Word documents.

3.2.1.4. Video: Inaccessible Play Button:

Accessing and playing the video task raised the most frequent critical incidents (cm=7), the least pm (pm=2), and the highest ct (ct=3.7) compared to the other Bb content previewing tool-based tasks, as shown in Figures 3 [A] and [B]. Students' efficiency in completing this task varied according to their experience with using the Bb system. Advanced students (Sara and Salma) spent less than two minutes, while the rest of the participants needed more time to successfully complete the task. The extended time some students needed was due to the reader software not accessing or starting the play button of the video. Sara and Salma, however, were able to use shortcut keys and play the video themselves. Sara explained, "*Firefox browser works way better with the reader; I wouldn't need to use extra effort to play this video*!" As for Maria, she succeeded in playing the video but stated that the page had low readability and insufficient color contrast due to the use of green text on a gray background. It should be noted that students generally did not seem to be used to playing videos within Bb. This may be indicative of faculty's lack of including video files within Bb learning materials.

Figure 3: Accessibility of Bb Content Previewing Tool-Based Tasks, [A] Frequency of PM & CM, [B] Mean of CT (Min.)



3.2.2. Accessibility of Bb Interactive Tool-Based Tasks

This section discusses the tasks that students accomplished using Bb tools that offered communication and discussion in the online course.

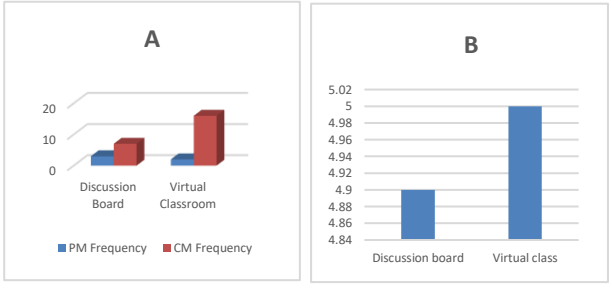
3.2.2.1. Virtual Classroom: Inaccessible Classroom, Whiteboard, and Chat Box:

As shown in Figure 4 [A], the highest number of cm (cm=16) and the least pm (pm=2) occurred while students attempted to complete this task, and the average time was one of the highest across all tool-based tasks (ct=5), as indicated in Figure 4 [B]. All students experienced frustration, as the screen reader did not read the entire content of the whiteboard. Despite participants' efforts while listening to the lecturer, it seemed that the reader did not "see" the collaborate tool or any of the content uploaded to the whiteboard. Participants then attempted to locate the chat in the Bb virtual classroom without success. Samia declared, *"I have tried this before, and I knew I wouldn't be able to get anything out of it."* According to Samia, the reader software works perfectly with the virtual classroom when using an iOS operating system (e.g., Mac computers). Maria had a less negative experience compared to her blind counterparts. Although she was able to access the virtual classroom, the inadequate color contrast and the inability to magnify the virtual classroom made it difficult for her to read the slide content on the whiteboard. Maria was hardly able to read the main title of the active slide (which was written in a large font size). However, the remaining text on the slide was unreadable to her. Another cm occurred when Maria attempted to write and send a message through the chat box of the virtual classroom. She asked, "*Was the sentence I typed already sent? The font is too small; I can't see very well...*" Clearly, this occurred due to the small chat box font size in the tool.

3.2.2.2. Discussion Board: Inaccessible Forum Title Links and Text Editor

Although this tool-based task had fewer cm (cm=3) compared to the virtual classroom, only (pm=3) pm were recorded by participants, and they spent almost the exact same time they spent on completing virtual classroom tasks (ct=4.9), as indicated in Figures 4 [A] and [B]. All participants agreed that this tool had some of the easiest and most manageable tasks, even though it was the first attempt for two of them. However, some blind students felt dissonance encountering difficulties in accessing the discussion board's main page, which contained all the forum topics in the course. Although the reader worked well on each internal page of each specific forum, the reader could not navigate through the forum topics on the forum's main page or inform users if the cursor reached the forum link. Another accessibility issue appeared when some students were challenged writing in the text editor, as the reader took a long time to read all the options in the toolbar (e.g., bold, italic, underline). Salma suggested creating a direct link to the forum, so the reader can read the forum page perfectly starting from the link "create thread."

Figure 4: Accessibility of Bb Interactive Tool-Based Tasks, [A] Frequency of PM & CM, [B] Mean of CT (Min.)



3.2.3. Accessibility of Bb Assessment Tool-Based Tasks

This section discusses the tasks that students accomplished using Bb assessment tools.

3.2.3.1. Assignment: Difficulty Locating Text Field

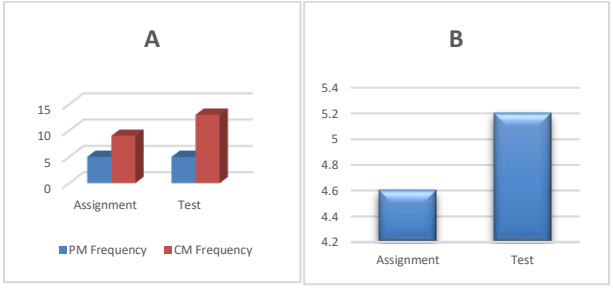
As shown in Figures 5 [A] and [B], the frequency was (pm=5), while

the cm reached (cm=9). Students were asked to write a response to an assignment question, as well as attach a file and submit it. For the majority of participants, the accessibility issues revolved around finding the text editor and writing the response, as the reader took a long time to read the toolbar options before it reached the text editor. The majority of students took a long time trying to locate the text editor or locate the file to be attached, without success. It seemed that students were not accustomed to using this tool in their courses. Maria, the visually impaired participant, almost failed to achieve this task due to the challenge of navigating while the page was magnified to 400%. She had difficulty locating the cursor in the text editor to write a response. However, Maria was satisfied with the color contrast, and she was able to read the content.

3.2.3.2. Test: Inaccessible Pop-Up Confirmation Window

Compared to the assignment task, the cm reached (cm=13), it was the second most difficult task among the list of tasks, and it had the highest mean time (ct=5.2), as indicated in Figures 5 [A] and [B]. The critical incident that reoccurred was that the screen reader did not read the confirmation message that appeared as a pop-up window after clicking the "submit" button. Students were not able to understand the goal of the window nor decide what to do. They felt trapped in the pop-up window. It appeared that this problem was the most disappointing of all that the BVI participants encountered. They needed assistance to continue. The default setting of the reader did not include the pop-up message in the page content, and only advanced participants figured out a way to change these settings. Further, the majority of participants mistook the "save answers" button with the submit button on the test page. As declared by Salma, this mistake led her to lose some points in an actual exam for clicking submit without saving the answers first. For Maria, the insufficient color contrast and the magnification used made it difficult to read the content of the page and locate the test questions and the submit button.

Figure 5: Accessibility of Bb Assessment Tool-Based Tasks, [A] Frequency of PM and CM, [B] Mean of CT (Min.)



4. Discussion

This study aimed to evaluate an online course in the Bb LMS using two unique evaluation methods in one of the major Saudi universities, KAU. The evaluation approach included an automated testing of the online course using Bb Ally and an end-user evaluation using think-aloud protocol to shed light on the accessibility issues that surfaced from their interaction with the course content and features. According to the study results, although the automated checker of the online course, Bb Ally, revealed a high percentage of accessibility to course content and files, BVI students indicated a number of inaccessible moments while accomplishing basic tasks in a Bb course, such as playing a video file, opening Word and PowerPoint course materials, attending and participating in a virtual classroom, and solving questions on a test in the platform. The majority of BVI students considered these tasks difficult to accomplish without human help due to their incompatibility with an NVDA screen reader.

This research's findings contribute to the findings of previous research examining web and LMSs. Although the majority of previous research mentioned similar accessibility issues (Alturki *et al.*, 2016; Alotaibi, 2015; Alnfiai and Alhakami, 2021), some accessibility issues in previous research did not surface as problematic in this paper. For instance, in Alnfiai and Alhakami's study (2021), missing alternative text (Alt) for pictures and videos and inaccessible PDF files appeared as major inaccessibility issues for students, even though the authors used an automated checker before student usage. This points out the effectiveness of Bb Ally as an automated checker, as the tool solved many visual elements missing Alt and suggested converting PDF files into tagged PDF files before students use the course. Therefore, there is a need for faculty members in all courses to raise the awareness and significance of activating Bb Ally in order to produce more accessible online courses (Almufarreh *et al.*, 2021).

The findings of this study raise considerable implications for e-learning, instructors, and all students in higher education institutions. Most specifically, BVI students went through difficult situations due to inaccessible features in the Bb e-learning system. Automated evaluation using Ally indicated that the designed course had high accessibility in terms of the course materials. Think-aloud protocol can be considered an effective method to help uncover hidden critical incidents and, in turn, create more accessible environments, where all students can learn efficiently. Students provided a useful record of accessibility issues that would not have been possible to uncover without end-user testing using think-aloud protocol. Students found it difficult to access and play a video using the screen reader, and the Word and PowerPoint files took more time for students to access due to issues related to their inexperience using desktop Bb with the screen reader. These results align with previous research in terms of incompatibility of assistive technology with the platform (Alnfiai and Alhakami, 2021). Therefore, higher education institutions should offer special training for BVI students on using their preferred screen reader with Bb in order to gain all the benefits of the course content.

The virtual classroom and test were the Bb task-based tools that most challenged students with accessibility barriers. The interaction of the screen reader with these tasks was the most problematic. The themes that emerged in this study align with previous studies' errors (Babu and Singh, 2013; Alnfiai and Alhakami, 2021), such as the inability of the reader to read pop-up windows and difficulty reading the text editor, as well as the inability to participate in the virtual classroom using the chat window. These results signal e-learning developers to take these obstacles into consideration and enhance the accessibility of Bb to support BVI students in becoming independent students.

It could be argued that some accessibility barriers that surfaced may be due to students' lack of training in using the Bb system, or the screen reader used by the students. Moreover, there is a widely held belief that the JAWS reader provides the best Bb experience when using Windows and that it works more effectively than NVDA (Pauls, 2015). Another possible explanation for some accessibility issues that students raised (such as the visually impaired student's struggle with following the cursor with a 400% screen magnification) is students' inclinations to use the mobile version of Bb. The majority of students preferred to use their phones in all their learning tasks, including accessing the LMS. In general, the findings of this study highlight that most online learning platforms employed by higher education institutions suffer from accessibility issues that deny equal access to students with disabilities. They also indicate the urgent need to increase awareness among faculty members of higher education institutions of activating the Bb Ally tool to fix as many accessibility issues as possible before students use the online course. Finally, it is of paramount importance for institutions to offer appropriate training to students with disabilities to enhance their ICT skills in order to

succeed in the digital era (Pacheco *et al.*, 2017).

5. Conclusion

This study followed a two-method evaluation process in order to validate an online demo course presented in the institutional Bb LMS. It is vastly evident that the combination of the Ally software report and students' evaluations is significantly helpful for the identification of some of the fundamental accessibility problems present in Bb. Particularly, the use of Bb Ally eliminates some major accessibility barriers in online course content; therefore, it is recommended that higher education institutions make the Ally tool available to all instructors and students, especially those faculty who teach special needs. This supports the universal aim of providing equal access to all students, including disabled students. Developers of online systems should take these accessibility concerns into consideration and find solutions to the inaccessible features identified by the disabled. Universities should also arrange periodic training sessions and workshops for Bb in order to enhance students' ICT skills and support them in becoming independent learners. In addition, some lessons learned from students with advanced level ICT skills suggest that all students should be trained in using keyboard shortcuts in order to eliminate some Bb barriers. As for BVI students, it is expected that a good grasp of screen reader navigation commands would be sufficient to successfully use most Bb tools without major problems. Thus, it is recommended that future studies replicate this research using the mobile version of Bb. The findings of this research could be applied to online platforms in other universities with the aim of improving the accessibility of digital content and interfaces.

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References

Abou-Zahra, S. (2008). Web accessibility evaluation. In: S. Harper, Y. Yesilada (eds.) *Web Accessibility: A Foundation for Research*. London, the UK: Springer.

Aldiab, A., Chowdhury, H., Kootsookos, A., Alam, F. and Allhibi, H. (2019). Utilization of learning management systems (LMSs) in higher education system: A case review for Saudi Arabia. *Energy Procedia*, **160**(n/a), 731–7.

Aljuhney, Y. and Murray, L. (2015). A comparison of the utilization of e-learning management systems in the Republic of Ireland and Kingdom of Saudi Arabia: A case study. *International Journal on Recent and Innovation Trends in Computing and Communication*, **4**(2), 1–12.

Alkarani, A. and AlThobaity, A. (2020). Medical staff members' experiences with Blackboard at Taif University, Saudi Arabia. *Journal of Multidisciplinary Healthcare*, **13**(n/a), 1629–34.

Almufarreh, A., Arshad, M. and Mohammed, S. (2021). An efficient utilization of Blackboard ally in higher education institution. *Intelligent Automation & Soft Computing*, **29**(1), 73–87.

Alnfiai, M. and Alhakami, W. (2021). The accessibility of Taif University Blackboard for visually impaired students. *International Journal of Computer Science and Network Security*, **21**(6), 258–68.

Alokluk, J. (2018). The effectiveness of Blackboard system, uses and limitations in information management. *Intelligent Information Management,* **10**(6), 133–49. DOI:10.4236/iim.2018.106012.

Alotaibi, S.J. (2015). Evaluating the Blackboard system based on web accessibility and usability guidelines. *International Journal of Digital Society*, **6**(4), 1094–101.

Alturki, U., Aldraiweesh, A. and Kinshuk, Dr. (2016). Evaluating the usability and accessibility of LMS"Blackboard" at King Saud University. *Contemporary Issues in Education Research*, **9**(1), 33–44.

Arroway, P., Davenport, E., Xu, G. and Updegrove, D. (2010). *Educause Core Data Service Fiscal Year 2009 Summary Report.* Available at: https://library.educause.edu/resources/2009/10/educause-core-data-service-fiscal-year-2008-summary-report (accessed on 02/12/2020)

Babu, R. and Singh, R. (2013). Accessibility and usability of social media: Convergence between blind users and design standards. In: *The 19th Americas Conference on Information Systems*, Chicago, USA, 15-17/08/2013.

Babu, R., Singh, R. and Ganesh, J. (2010). Understanding blind users' web accessibility and usability problems. *AIS Transactions on Human Computer Interaction*, **2**(3), 78–91.

Bastedo, K. and Swenson, N. (2020). General accessibility guidelines for online course content creation. In: S.L. Gronseth and E.M. Dalton (eds.) *Universal Access through Inclusive Instructional Design: International Perspectives on UDL*. New York: Routledge.

Blackboard Ally (2018). *Blackboard Ally help*. Available at: https://help.Bb.com/Ally/Ally_for_LMS/Instructor (accessed on 2020/12/02)

Chen, J., Dobinson, T. and Kent, S. (2020). Students' perspectives on the impact of Blackboard collaborate on Open University Australia (OUA) online learning. *Journal of Educators Online*, **17**(1), n/a.

Chen, S., Gao, F., Lau, K.O. and Wang, Y. (2012). Design an innovative pe learning package through Blackboard to enhance students self-learning and generic skills. *The Global Journal of Health and Physical Education Pedagogy*, **1**(2), 143–58.

Clark, J. (2006). *To Hell with WCAG 2.* Available at: http://alistapart.com/articles/tohellwithwcag2. (accessed on 02/12/2020).

De Smet, C., Bourgonjon, J., De Wever, B., Schellens, T. and Valcke, M. (2012). Researching instructional use and the technology acceptation of learning management systems by secondary school teachers. *Computers & Education*, **58**(2), 688–96.

El-Senousy, H. and Alquda, J. (2017). The effect of flipped classroom strategy using Blackboard mash-up tools in enhancing achievement and self–regulated learning skills of university students. *World Journal on Educational Technology*, **9**(3), 144–57.

Ericsson, K.A. and Simon, H.A. (1993). *Protocol Analysis: Verbal Reports as Data*. Cambridge, Mass: MIT Press.

Goodhue, D.L. (1986). Is attitudes: Towards theoretical definition and measurement clarity. In: *Proceedings of the Seventh International Conference on Information Systems*, San Diego, 14-17/12/1986.

Moreno, L., Iglesias, A., Calvo, R., Delgado, S. and Zaragoza, L. (2012). Disability standards and guidelines for learning management systems: Evaluating accessibility. In: R. Babo and A. Azevedo (eds.) *Higher Education Institutions and Learning Management Systems: Adoption and Standardization*. Hershey, PA: Information Science Reference.

Pacheco, E., Yoong, P. and Lips, M. (2017). The role of icts in students with vision impairments' transition to university. In: *The International Conference on Information Resources Management*, Santiago, Chile, 17-19/05/2017.

Pauls, J. (2015). *The Blackboard Online Coursework and Learning Environment: Accessibility Reports from Two College Students and One Instructor*. Available at: https://www.afb.org/aw/16/7/15442 (accessed on 27/04/2021)

Ristovska, A., Canevska, O., Tasevska, A., Bruziene, R., Orechova, M., Paiva dias, G., Brito, E. and Haubro, H. (2021). Accessible learning management systems: Students' experiences and insights. *Prizren Social Science Journal*, **5**(2), 1–13. DOI: 10.32936/pssj.v5i2.224.

Sapp, W. (2009). Universal design: Online educational media for students with disabilities. *Journal of Visual Impairment & Blindness*, **103**(8), 495–500.

White, D. (2017). *Blackboard Delivers Worldwide Growth*. Available at: https://press.blackboard.com/2017-01-27-Blackboard-Delivers-Worldwide-Growth (accessed on 07/10/2021).

W3C Web Accessibility Initiative. (2018). *Web Content Accessibility Guidelines (WCAG) Overview*. Available at: www.w3.org/WAI/standards-guidelines/wcag/ (accessed on 27/04/2021).