

# The Accessibility of Taif University Blackboard for Visually Impaired Students

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## Summary

Online learning systems are becoming an effective educational medium for many universities. The accessibility of online learning system in universities means that every student, including the visually impaired, is able use all the site's services. This research focuses on investigating the accessibility of online learning systems for visually impaired users. The paper purpose is to understand the perception of visually impaired undergraduate students towards Blackboard's accessibility and to make recommendations for a new Blackboard design with accessible features that support their needs. Impact of a new Blackboard design with accessible features on visually impaired students, using Taif University students as a case study is evaluated in this paper, as it is similar to most learning systems used by Saudi universities. A study on Taif University's utilization of Blackboard was conducted using mixed method approaches (an automatic tool and a user study). In the first phase, Taif's use of Blackboard was evaluated by the web accessibility tool called AChecker. In the second phase, we conducted a user study to verify previously discovered accessibility challenges to fully assess them according to the accessibility and usability guidelines. In this study, the accessibility of Taif University's Blackboard was evaluated by thirteen visually impaired undergraduate students. The results of the study show that Blackboard has accessibility issues, which are confusing navigation, incompatibility with assistive technologies, untitled pages or parts, unclear identification for visual elements, and inaccessible PDF files. This paper also introduces a set of recommendations that aim to improve the accessibility of Blackboard and other educational websites developed for this population. It also highlights the serious need for universities to enhance web accessibility for online learning systems for students with disabilities.

**Key words:** *Accessibility; Website; Blind Students; Blackboard; Visually Impaired People; Screen Reader; Navigation; Assistive Technology.*

## 1. Introduction

The internet has simplified many mundane tasks, including some of the following: bill payments, meetings and communication, news consumption, and education. Internet technology has significantly affected education for two decades, and the manner in which information is presented in webpages has grown in importance in the education field over the last two decades. Many

universities have utilized Blackboard's learning management system, becoming an effective educational medium for many. However, as easy as the internet has made life for most, visually impaired people face challenges completing tasks online in the form of accessibility barriers while browsing websites' pages. Accessibility guidelines highlight the importance of allowing all users with different disabilities to have equal access to web pages by providing intelligible pages that allow access to all online resources. The key definition of Accessibility by the International Organization for Standardization (ISO) is that "the ability of a product, service, environment or equipment to be used by a large range of people with very different capabilities" [1]. There are various resources that are used to meet the definition of accessibility and provide guidelines for delivering Web accessibility criteria, particularly the World Wide Web Consortium (W3C), the International Organization for Standardization (ISO) and the US Federal Government through Section 508 [2]. These guidelines are more important when it comes to providing education materials and lessons to people with disabilities online [3]. It is critical for the visually impaired to have equal access to information in order to become self-sufficient and productive adults [4].

Website accessibility features for people with no or low vision have been greatly enhanced in recent years, particularly in the form of screen reader software that allows visually impaired individuals to use computers and mobile phones in order to access the internet. In Saudi Arabia, visually impaired university students usually print the course material in braille, which is expensive and often not very effective, as it is very time consuming for writers to code all the course material in braille. In this paper, we analyzed the usability and accessibility of the Taif University's Blackboard for visually impaired people. All Saudi universities like King Saud University, King Khaled University and other Arab universities all utilize similar blackboard systems to the one at Taif university. Determining the usability and accessibility issues that visually impaired students have faced while using the Blackboard system can inform developers to build a new

learning tool that may better serve visually impaired students accessing various learning platforms online.

We decided to examine these accessibility issues because they are problems that affect a significant portion of the Saudi Arabian population. According to the Ebsar Foundation for the rehabilitation of the visually impaired in Saudi Arabia, there are nearly one million blind or partly blind people in Saudi Arabia, with 75% being totally blind and 25% having low vision [5]. Thus, it is essential to evaluate existing websites for higher education to make sure they are accessible for this often-underserved population.

Blackboard is a web-based educational management system that is built to improve both teaching methods for faculty and learning for students. In 2007, 70% of universities used Blackboard sites in the world [6]. In 2010, 91% of 4,800 American universities had Blackboard websites [7]. In 2017, White (2017) reported on the dramatic growth in the number of Blackboard websites and the equally high growth of students who used the system [8]. Blackboard is primarily used to enable students to access online course materials—such as the course syllabus, lectures, daily assignments, and quizzes and exams—that are uploaded by faculty [9]. To provide an effective teaching and learning platform, the course materials can be provided in different formats, including the following: PowerPoint, Adobe Captivate, video, audio, graphs, and animation. The flexibility of Blackboard allows all learning styles to be accommodated. Providing this information allows students to review the course material based on their own schedule. In addition to just being a mere “drop box” of assignments, Blackboard gives faculty flexibility, as it allows them to grade and provide feedback of submitted assignments for each student [10]. The virtual classroom tool allows students and faculty to communicate in a real time video chat room, and there is also a discussion tool where students and faculty can discuss some topics related to their course and exchange knowledge efficiently.

However, as beneficial as the Blackboard system has proved to be for university students and faculty alike around the world, accessing Blackboard is a challenging task for visually impaired students. Moreover, a review of the literature has revealed that few articles have examined visually impaired students’ accessibility to university websites. Therefore, the purpose of this study was to evaluate the accessibility of the blackboard learning system for visually impaired students, determine the accessibility barriers from a visually impaired user’s perspective, and answer the following research questions with consideration of wider implications across universities:

1. What are the accessibility barriers recognized by students with no or low vision in the Taif University Blackboard website?

2. Which parts from the Blackboard website do visually impaired people find inaccessible?

3. And what are the usability problems that prevent the screen reader from accessing the Blackboard content?

Thus, first, we conducted an automatic evaluation to identify Blackboard accessibility issues using Achecker. Second, we conducted a user study with thirteen visually impaired students and providing some recommendations for improvements both in Taif University’s system and for universities globally.

The paper begins by presenting theoretical background of the problem, along with a literature review. The paper then offers a description of the study design and methodology, a presentation of the results, an overview of discussions, and finishes with recommendations and the conclusion in the final section.

## 2. Related Work

Web accessibility is a concept that concerns the extent through which materials on web are easy to access by people with disabilities [11]. Dinc (2017) writes that the World Wide Web Consortium’s (W3C) Web Accessibility Initiative (WAI) offers the best definition: “Web accessibility means that people with disabilities can use the web [12]. More specifically, Web accessibility means that people with disabilities can perceive, understand, navigate and interact with the web while at the same time they can contribute to the web.”

Numerous papers discuss the accessibility of universities’ websites [13-17]. Kurt, (2011) conducted an evaluation of ten Turkish universities’ pages to measure their accessibility levels [18]. The study indicated that none of the evaluated universities’ sites are error free, and the author provided some recommendations for developers to redesign sites to achieve an acceptable web accessibility level.

In 2008, Harper and DeWaters conducted a study where they evaluated 12 universities’ websites in terms of rate of accessibility following the standardization criteria, finding that only one university website meets all the W3C guidelines [11]. İşeri et al. (2017) examined the accessibility level of 38 Cypriot university websites using the web accessibility evaluation tools, which are TAW, WAVE, and EIII Page Checker [19]. They also assessed the accessibility measures to verify whether the website meets the W3C criteria for accessibility and found that none of the websites satisfy the criteria. Similarly, other researchers investigated the accessibility of university websites in different countries, discovering that those websites also failed to meet the web accessibility criteria [20-26]. Acosta-Vargas et al. evaluated 20 university websites from throughout the world [27]. They found that most of the evaluated university websites do not comply with web accessibility standards and are not accessible to a

large number of students.

Few articles have examined the accessibility of universities' websites by visually impaired students. Espadinha et al. investigated the accessibility of all public Portuguese universities' homepages, focusing on the assistive services that are provided for students with disabilities [3]. Websites built for visually impaired students in Jordan were explored by Abu Shawar [28]. Abu Shawar compared the websites in Jordan to selected ones in England and Arabic universities, finding that the university websites in Jordan and the other Arab countries suffer from more accessibility issues than university websites in Britain [28]. This might be because of the UK applies a law of web accessibility based on the Equality Act 2010 (EQA) when implementing web sites where it forces the importance of making the web content for everyone [28]. This indicates the importance of applying similar policies and laws for both educational and non-educational web sites in Arab countries to meet web accessibility principles.

In a recent study conducted by Menzi- Çetin et al. (2017), the usability of a Turkish university website by six students with visual impairment was evaluated [29]. The study showed that visually impaired students could not complete the tasks given by investigators, including opening the university website, opening the participants' department pages, opening the registrar's page, and logging in to the library page. The study indicates a need to improve university websites to meet visually impaired users' abilities. Doing so will help a large number of people with disabilities to be more independent. As stated by the United Nations report, "there are around 1 Billion persons with disabilities which is 15% of the world population", therefore improving the accessibility of blackboard will enhance allow students with disabilities to have equal access and to reach their goals [29]. As a result, students with disabilities will experience significant positive changes in their university lives and become more independent. Another potential benefit of tracing the accessibility of university systems is to meet the main aim of international accessibility observatories like European Internet Accessibility Observatory (EIAO). In addition, improving the accessibility of online learning systems for visually impaired students and other students with disabilities is expected to minimize attrition percentages [30]. If students with disabilities feel that universities care and support their learning, enrolment and retention is more likely to improve. To meet these objectives, universities and educational institutes should first improve their learning system to meet a high level of web accessibility.

Similarly, Hassouna et al. (2017) conducted an evaluation study with 16 visually impaired users for several Palestinian universities' websites [31]. The main objective of the study was to specify the visually impaired students' requirements in order to create accessible

university websites. The study highlighted that most universities' websites suffer from significant accessibility issues that prevent visually impaired users from having easy access to their institutions' sites. The study also emphasized the importance of making the homepage accessible, given that it is the main point of entry to reach other site pages.

This research discusses the results of the evaluation study of the accessibility of Taif University's Blackboard. It also aims to highlight the accessibility issues and inform developers about them in order to rebuild similar sites to meet the criteria for website accessibility. The research objectives are predominantly aimed at investigating the Taif university Blackboard accessibility using AChecker evaluation tool, and to determine accessibility issues related to Blackboard by conducting a user study [32]. Most importantly, however, the objective is to provide recommendations that increase the website accessibility in ways that can also be applied in a wider context.

### 3. Methodology

Blackboard is one of many web-based systems used by most universities as a medium between teachers and students. These systems allow students to attend their classes virtually, take tests, upload assignments, download course content, and see their grades.

Although Blackboard is a convenient and effective teaching and learning tool, it has its limitations, especially in regard to visually impaired students, therefore, it is necessary to perform a complete accessibility evaluation to identify accessibility barriers that prevent visually impaired users from having complete access to Blackboard services.

We used mixed methods to assess the accessibility of Taif University's Blackboard system including automatic evaluation and user study. First, an automatic accessibility evaluation using is performed; after that, a user study of thirteen visually impaired students is conducted to confirm each previously highlighted accessibility challenges and present possible recommendations to overcome these challenges. The guidelines that are most often used are WCAG 2.0, and several automated tools that are used to assess web pages. In this research, first AChecker, the automatic tool, was used to recognize accessibility issues. However, it is unlike investigating the web site accessibility by the target. Next, we evaluated and provided recommendations for increasing accessibility awareness to developers and designers of similar web pages.

Second, we conducted a user study with thirteen visually impaired students as our research path is based on the premise that an evaluation of accessibility and usability is not complete if it does not use real users to interact with the website. Thus, we chose to conduct review sessions

with visually impaired users.

Although the automatic evaluation is not complete, it is necessary to conduct a study with users who have an experience with Taif University's Blackboard. The design of the user study was based on a qualitative approach that facilitated the following research questions:

1. What are the accessibility barriers recognized by students with no or low vision in the Taif University Blackboard website?
2. Which parts from the Blackboard website do visually impaired people find inaccessible?
3. And what are the usability problems that prevent the screen reader from accessing the Blackboard content?

The study did not collect information that led to identify participants. It also was approved by Taif University.

### 3.1 Automatic Accessibility Evaluation

In this first evaluation stage, the automatic evaluation method was used to assess the accessibility of Blackboard pages. We used AChecker, which is an automatic tool used to assess HTML content in order to detect accessibility barriers and to ensure the web content is accessible for everyone by evaluating compliance with different accessibility guidelines, involving Barrierefreie Informations technik-Verordnung (Barrier-Free Information Technology Regulation; Germany) (BITV) 1.0 (level 2), Section 508, Stanca Act, WCAG 1.0, and WCAG 2.0 [32]. It evaluates a page of the entered URL or uploaded page at a time and provides a descriptive report of the exist accessibility problems.

The automatic accessibility evaluation was based on the W3C accessibility guidelines via AChecker, which is a set of automatic accessibility tools that are used to evaluate the accessibility of web pages. Even though the automatic tool has a strong ability to determine the accessibility errors by comparing the uploaded page with the various options of international accessibility guidelines, there is a serious need to conduct a user study that evaluates the accessibility of Blackboard and verifies the automatic tool's results.

All Blackboard pages were evaluated by the automatic tool by uploading the web page through the AChecker website. Similarly, visually impaired participants were asked about the accessibility challenges of each page to determine undefined accessibility barriers and verify those detected through a face-to-face interview where participants were asked to answer questions related to each blackboard page and they are free to express themselves.

We evaluated all Taif University Blackboard pages to improve the evidence-based evaluation. Examining the whole pages of Blackboard helps to gain a broader view of the accessibility level of the entire Blackboard Web site. Figure 1 shows the examined content web page using AChecker.



Figure 1: The examined web page using AChecker

#### 3.1.1 Automatic tool

The AChecker detects the accessibility barriers based on the Web Content Accessibility Guidelines (WCAG), Version 2.0 [32]. The most critical problems are detected by the automatic tools and presented in this section, which are:

- Guideline 1.4 (Distinguishable): Criteria 1.4.1 “Use of Color”
  - This failure occurs when using color to represent information, for example, this failure happens in the Blackboard when users upload a file, such as an assignment, and the page shows a black color indicating the file has been uploaded successfully. However, it does not display an audio message that states “the file has been uploaded successfully.”
- Guideline 2.4 (Navigable): Criteria 2.4.2 “Page Titled”
  - Each document section in the page should start with a title and be written in a heading tag (H1, H2, H3). Unfortunately, all these pages in Blackboard have some sections without meaningful titles because the developers do not change the default title. The result is that, the screen reader can not recognize the web page structure due to some sections having no title, as most of the pages use the default titles.
- Guideline 3.1 (Readable): “Language of Page” and “Language of Parts”
  - Declaring every webpage's and part's language is a very important grammatical step, as it helps screen readers to identify the assigned language and pronounce texts based on the defined language.
- Guideline 1.3 (Adaptable): Info and Relationships
  - It is very important to determine programmatically the structure of information and its relationship between website elements, visually and aurally.
- Guideline 2.1 (Keyboard Accessible): Keyboard

- All functionality of the section is operable through a keyboard. The key objective of the success criterion “keyboard accessible” is to allow users to keyboard to execute all available functions on an interface. This guideline is helpful for visually impaired users who cannot track a pointer or use a mouse, as they find that it is more accessible to use the keyboard to control all their actions on webpages.
- Guideline 2.4 (Navigable): Bypass Blocks
- This error occurs in Blackboard because blocks have no title that reflect the purpose of the content. Then the screen readers cannot recognize the content of a block.

**3.2 User study**

In our study, we followed Hassenzahl & Tractinsky’s definition of UX theoretical Framework of user experience to guide our evaluation process of Taif University’s Blackboard [33]. This framework was selected to analyze the website’s performance as well as allowing the researchers to understand users’ behaviors while using the system. The subjects in this study are visually impaired undergraduate students.

Before embarking on the study, a pilot study was undertaken to ascertain problems associated with any of the measurements and data collection methods. The pilot study facilitated the discovery of reliability and the validity of instruments used in measurement, after which the sampled population could be used in data collection. Questionnaires with open ended questions were administered to thirteen participants using a standard interview method, after which responses were given and verified.

**3.2.1 Data collection**

The semi-structured interview was used in the data collection to determine the accessibility problems have faced by visually impaired students when using Blackboard. Thirteen visually impaired students were recruited for the study from Taif University’s Accessibility Center. Participants are currently users to Taif University Blackboard. The characteristics of each participant are presented in Table 1. Visually impaired students were interviewed from first of April until the end of November 2020. The age of the students ranged from 24 to 32-years-old. All of the students were totally blind and used screen reader service to interact with the digital world. In total, the research sample consisted of thirteen visually impaired students from some of the following majors: law, English, History, and religion.

**3.2.2 Questionnaire design**

The interview questions included closed and open-ended questions relating to tasks on Blackboard. Participants were encouraged to share their experiences and opinions through the interviews. The interview

questions contain which type of platform and screen reader users use to browse the blackboard; the tasks they complete on Blackboard, the accessibility services users have used to browse Blackboard, difficulties faced while using Taif University blackboard; the main difficulties that users have faced while registering or login to Taif University website; the main difficulties that faced while downloading course material, whether users have asked for help while using the website, Blackboard navigation, the strengths and limitations of Blackboard, problems faced while completing an exam on Blackboard or uploading homework and accessing announcements from the blackboard direct to student email.

**Table 1:** Participants’ demographic data

Participants’ number	Age	Vision status	Education	University level
P1	27	Totally blind	English	Master
P2	25		Law	Bachelor
P3	27		English	Bachelor
P4	24		History	Bachelor
P5	26		Religion	Bachelor
P6	25		Religion	Bachelor
P7	29		English	Bachelor
P8	24		Religion	Bachelor
P9	23		Religion	Bachelor
P10	32		English	Master
P11	27		Religion	Bachelor
P12	29		Law	Bachelor
P13	24		Law	Bachelor

**3.2.3 Analysis and results**

After data was collected by the interview method, the sampled results from the participants were analyzed and general conclusions were drawn. The interview questions are therefore related to all the tasks that students can do when using university Blackboard and included closed and open-ended questions. Participants were encouraged to share their experience and opinion through the interviews.

**3.2.4 User study results**

**3.2.4.1 Accessibility and barriers**

There were several barriers and technical problems identified for visually impaired students who use Taif University’s Blackboard. For instance, most designers were found to build websites without following accessibility guidelines or taking into account visually impaired students, or students with other disabilities, forcing those students to use other ways to meet their needs, including hiring an assistant or asking a teacher to

contact them through other media. As a result of these barriers, visually impaired students lose their independence, and the quality of their education is reduced.

#### 3.2.4.2 Items that facilitate web accessibility

Responses from P1, P3, P7 and P10 indicated that the Blackboard website was rarely used, as both respondents were English majors, and their professors would send the course materials to them through email. Other participants used the website daily with the support of others. Partially blind students used zoom feature to enlarge the text on the Blackboard, and blind students used a voiceover to read out the content of the website.

Results showed that all participants used iPhone devices to open the Blackboard website, with none of the participants using desktop devices to access the Blackboard site. P2 reported that "iPhone is easy to use and it is capable through the help of voiceover." However, respondent (P3) indicated that it was not easy to browse the blackboard with the support of screen reader.

Participants also commented on the preference for touchscreen devices to browse Taif University's Blackboard over desktop devices. They indicated that using the touchscreen is easier than using keyboards to browse the web pages. Moreover, Other participants said they are more familiar with touchscreen devices than desktop; thus, it is easier for them to use.

#### 3.2.4.3 Desktop barriers

Participants mentioned three primary barriers that prevent them from using desktop computers: screen reader failure, screen reader cost, and unfamiliarity with desktop keyboards. For instance, P3 stated that "I do not use the computer because I am only familiar with iPhone interface." Similarly, P6 also reported that "The desktop accessibility is lower than touchscreen accessibility."

Visually impaired users also reported that the screen reader is very difficult to use on desktop devices. Economics also played a role in students' choices of preferred devices, as participants mentioned the cost of buying a screen reader on desktop is not affordable. P5 stated that "I did not use a desktop because I am a student and I cannot afford buying the screen reader and a computer device." Fortunately, voiceover comes free in smartphone devices as an accessibility feature. P13 reported that "Apple company provides an efficient VoiceOver service thus I always use touchscreen apple devices."

#### 3.2.4.4 Inaccessible parts

The study results also showed that because navigating Taif University's Blackboard is not easy for visually impaired people for several reasons, they often have to seek help to browse certain pages. Respondent P2 stated that

"Sometimes, I ask my sisters to open the discussion room and then I can contribute with other students." As it is very difficult to move between the Blackboard pages and to navigate the home page, not all participants can locate their desired page independently. P10 said "The tasks that I can do on blackboard was very limited. I was only able to download course materials. I never was able to do an online test or respond in a discussion room by myself." In addition, P13 stated that "I cannot reach some of Blackboard parts as no shortcuts are available to allow me access the content".

None of the participants were satisfied with Taif University's Blackboard website, disclosing that not all the pages are accessible or compatible with voiceover service. As P3 stated, "My overall impression about Taif University's Blackboard was negative because I was not able to do any task on it". As the website is not accessible it prevents blind students from doing basic tasks to complete their course requirements. Participants also reported that several tasks that they were not able to perform when using Blackboard website like sighted students. Another problem in the discussion page is that voiceover service interferes with other sounds that come from teachers when explaining or other students when responding.

Most participants revealed difficulty in downloading course materials from the Blackboard site. For instance, P3 stated that "I always ask my friend or the professor to send the content to my personal email instead of downloading it from the Blackboard." Other participants highlighted that some types of documents were not readable by VoiceOver. P11 stated that "Downloading materials in form of images or PDF were inaccessible as the VoiceOver service cannot access the pdf file and read its content." Similarly, P3 mentioned that "I cannot read file in form of images or pdf. I have access to only a text or Word file." All of these problems seem to indicate that the type of files uploaded to Blackboard should be text or Word document accessible by the voiceover service. Participants also noted that they had problems opening the course assignments, P7 stating, for instance, that "it was not easy to download the assignments."

The contact page on Blackboard was also inaccessible. P5 reported her experience by saying, "I cannot contact course teacher through Blackboard. I cannot access the teacher's information including email and schedule because the VoiceOver does not read it and I could not locate the position of this page."

All participants indicated that virtual course rooms on Blackboard were also inaccessible, rendering it unusable for all vision impaired students. In cases where it is mandatory to participate with the respective teacher, visually impaired students hired an assistant. However, hiring an assistant is very expensive, as P9 stated: "I was studying Culture course and I hired a person who asked

me too much money to complete the course requirements on the Blackboard. I attended the online course with the assistant because I could not open the virtual classes with VoiceOver service. Hired persons usually exploit me financially as I have to depend on them to complete the course tasks.”

### 3.2.4.4 Screen reader and blackboard problems

Five of the participants identified difficulties participating in Blackboard discussion rooms as a major accessibility problem. P2 and p12 reported the problem of typing the response through chat in the discussion room. As found by previous research, visually impaired people spend a significant amount of time typing short messages [39][40][41][42][43][44][45][46]. P2 stated that “Sometimes, I ask my sister to open the discussion room and then I can contribute with other students. I cannot contribute quickly on the discussion chat as other students are faster than me and the professor changes the topic of discussion question before I have the chance to respond. As I need time to hear the VoiceOver reading the question and time to type in my response.” In a similar vein, some participants noted difficulties navigating to the discussion page, as P3 reported: “I have never use it and I do not know where the discussion icon is located on the Blackboard site.”

Because of these issues, most participants tend to hire an assistant to help them complete course requirements. Participant 2 stated that “I asked a person who I hired to help me when I am doing a discussion because it is very hard to participate on the discussion by myself.” P6 agreed with P2, noting, “Once I hear the question with the support of VoiceOver and start writing my respond, my classmates finished their participations, and the professor begins another discussion. Thus, it is very important for me to hire an assistance for online classes. And interference usually occurs when the professor speaks during the lecture and Voiceover is on.” P10 also reported that “I found it very noisy and annoying when I was writing with the support of VoiceOver and other students sending their replies. I could not concentrate and complete the task and my response on time. I usually lose participation marks when I do not have someone to do it for me.”

Participant 6 stated that “In the online test, I always need to hire assistants to put my answer as the test time is equal for normal and impaired people, so I cannot depend on technology while sitting the exam as I am concerned about time. Sometimes, the Blackboard is frozen, and I have to ask for help to open the exam page and read out the questions.” P2 reported that “For the online text, the hired person reads out the question and I tell her the answer and she writes it on the test form. I could not take the risk and trying to write the exam with the support of VoiceOver as I usually have two chances to do an online test. Thus, I always ask for help when I am doing online

test.”

P1, P3, P7 and P10 tend to take exams orally, with P3 stating that “I always perform the exam verbally or orally, face to face with the professor. I found it easier for me and felt more confident. Most of my friends do not use Blackboard unless they have a sighted person who can assist them.”

All participants check their exam grades with their professors through email, not on Blackboard, which means the grade announcements on Blackboard are not accessible for them. On the other side, all participants mentioned that it was easy to upload their assignment, but they cannot download course materials like assignments. P2 reported that “I can upload my homework. If the professor upload question in the Blackboard, I cannot find its location and I cannot download it.”

Other Taif University Blackboard limitations are addressed by participants. P9 and P3 stated that it is not completely compatible with voiceover or other accessibility tools and that the Blackboard is limited ways as many things are presented visually and cannot be read by VoiceOver.

Participants agreed that the primary benefit of the Blackboard website is the easy access to course materials and requirements it offers. P12 said, “All online lectures are recorded and kept online for the students. They can access it any time they like.”

Participants suggest that the Blackboard developers fix the previous mentioned problems and improve accessibility of the system. P8 also suggested improving the website by making it more accessible with the VoiceOver service. She stated that “It is very good if they develop a page compatible with VoiceOver that allow visually impaired students to do the exam easily.” In addition, participants suggested that they be enabled to participate in a discussion session aurally/orally without the need to type. P6 stated that “As I have a visual impairment, it is very important to allow me to participate verbally.”

## 4. Recommendations

These recommendations are summarized as follows and can be applied to any system providing website content in two languages. While these recommendations were developed after evaluating Taif University’s Blackboard system, they are general recommendations that can be applied to any system.

- Set the primary language by meta tag as described in Guideline 3.1.1 in Readable principle. As Taif University’s Blackboard uses Arabic and English, the language must be set for each content to allow screen readers to determine the language of each content.
- Add headers to each part and page in the Blackboard that assist in the organization of the page structure. By doing so, visually impaired students will easily find the

wanted content with the support of a screen reader.

- Avoid using any color to provide information, for example “click the blue button” and should not rely on color alone for charts and graphs’ information.
- Set a meaningful page title and ensure the title addresses the purpose of the page and uses pages titles in the site map.
- A clear and meaningful label and caption for each graph, in the form of a button or a shape, has been added on the web page.
- Provide an effective structure for the site by setting a clear title or heading for all content, passages links, and table columns.
- Make all web functionality accessible through a keyboard. Visually impaired people cannot locate or see the mouse pointer on a screen; therefore, developers must provide alternative an approach to operate all the website functionalities.
- Make the link description clear and understandable. To be navigable, which indicates that developers must make the purpose of the link and its destination clear in the content.
- Follow consistent navigation and identification mechanisms. Using consistent mechanisms allowing users to navigate from one page to another by following the same order in each page, and using consistent labels allowing users understand the purpose of each element in the context.
- Prevent interference of screen readers with other aural content, such as virtual classes or auditory content in the webpage. This criterion prevents confusion for visually impaired users.

These recommendations are not limited to Taif University’s Blackboard; they can be applied to different types of websites and applications that visually impaired users need for enhanced accessibility and they can be used as a guideline for how best to display information digitally.

In general, Blackboard needs to be more accessible for all types of browsers and screen readers using any type of device. Since visually impaired users interact with Blackboard site with the support of their screen reader, we need to make Blackboard compatible with screen readers to avoid facing any technical issues especially for novice users.

Most of the recommendations and improvements introduced in this article can be easily addressed and implemented if developers focus on this effort as most of the work is related to the importance of selecting appropriate graphics, charts, labels, and the organization of the site into a clear layout [34]. Developers must consider that visually impaired people have different vision abilities and preferences, thus they use different assistive technologies and browsers [34].

One of the main accessibility issues encountered by visually impaired users is the difficulty of typing long

responses quickly, thus they find participation in chat during virtual classes or in the discussion page is a very difficult task. Notice that due to the complexity to type a text on the chat page or discussion page on Blackboard, visually impaired students become more stressed, due to an increased cognitive load and the complexity of the page layout, leaving them force to rely on sighted assistance to help them complete the required tasks.

The overall user opinion of Blackboard was negative, as all of the participants were limited on the website without the assistance from sighted users. Thus, this study indicates a serious need to make Blackboard more accessible for visually impaired people by addressing the forementioned recommendations. It also highlights the importance of take these recommendations in consideration when designing learning systems to allow students with disabilities feel that universities care and support their learning and enrolment.

## 5. Discussion

Based on the study and finding the following points have been determined. Basic tasks such as downloading course materials, writing exams online, uploading assignments, and participating in virtual classes were not accessible for all visually impaired students. All these tasks are considered very difficult for students to perform due to accessibility barriers, including incompatibility with the voiceover. Another major barrier to accessibility is that all the information presented visually, and not labeled or titled correctly, cannot be easily read by the screen reader service.

In addition, all participants explained common problems they faced when trying to do a particular task on Blackboard. They were not able to navigate correctly to the desired page. Often, this issue occurs due to the mislabeling of page headers, the use of small touchscreen devices, and the illogical order of tasks. Importantly, none of Blackboard’s pages follow the accessibility guidelines and do not meet visually impaired students’ needs. Other problems encountered included difficulties taking online tests and contributing to discussion rooms. Given that visually impaired students cannot perform this task independently, they tend to hire educated assistants to input their answers to exam questions, which negatively affects the learning and assessment processes.

Overall, the study indicates that the complexity of Blackboard interactions causes frustration and a high level of cognitive load. The main causes of frustration in Blackboard are the following: unorganized page layout, incompatibility with assistive technologies like screen readers, untitled or unlabeled pages, graphs and other elements, no text explanation for visual elements, unclear links, inaccessible PDF, ambiguous site maps, and inaccessibility for keyboard users.

Thus, e-learning system developers should take into



consideration the above-mentioned recommendations for better accomplishing web accessibility and overcoming the defined accessibility issues. This study also can assist developers in improving the accessibility of blackboard sites for any university students with disabilities, therefore making them more independent.

The overall findings of this work are reflective of previous works investigating the accessibility of universities' web sites. Most previous studies indicated similar results of low web accessibility levels. For instances, Ringlaben et al. investigate the accessibility of special education homepage in the USA and indicated that 97% of homepages did not meet the minimal accessibility requirements [35]. Similarly, Nir and Rimmerman found that the examined Web pages of Israeli institutions are inaccessible to visually impaired students [36]. Research conducted by Wijayaratne and Singh found that the analyzed home pages of Asian universities suffer from serious accessibility issues [37]. İşeri et al. also examined Cyprus Island's higher education institutions' websites and found that most were not accessible [38]. In general, the findings highlight that most online learning systems for universities suffer from accessibility problems that prevent students with disabilities having equal access. It also indicates the serious need for improvement in order to meet the maximum level of accessibility requirements for allowing students with disability to practice their learning processes easily.

## 6. Research limitation and future work

This research contributes to previous research that have been carried out on web accessibility by visually impaired and disabled students. Moreover, this article has successfully examined the use of the Blackboard website through highlighting the importance of improving the accessibility of university Blackboard to provide equal access to information for all university students. Therefore, there is a need to increase the awareness for teachers to make sure the course materials are accessible to all students with different abilities. On the practical level, the article has successfully identified accessibility barriers and inaccessible parts and problems in Blackboard that students undergo during their daily routine.

An intensive training program must be designed especially for those visually impaired undergraduate students who use Blackboard. Specialized IT support is also necessary for students who have visual disabilities. We can see that advanced technologies like screen readers can be better integrated in Blackboard to facilitate the learning of visually impaired students. This integration can assist those students to complete most of the work. These technologies must be improved according to accessibility guidelines in order to serve these students well.

Research was limited in the essence that it was conducted with only thirteen participants, which are a

small sample size even though it is common to have few subjects from this sample in most evaluation study, thus the result cannot be generalizable to all university students. However, the conducted user study has provided a comprehensive understanding of blind students' perception regarding its' accessibility of Blackboard. It is recommended that Future work needs to consider building accessible pages for visually impaired students in universities worldwide. Furthermore, there is a need to train students at the beginning of first year to make sure that they know how they can locate course materials and other important pages related to their courses. Furthermore, it is recommended to use larger sample sizes and combine both qualitative and quantitative research design to give a clearer overview of web accessibility and its related problems. There is also a need to run another study to evaluate the accessibility of smartphone devices.

## 7. Conclusions

In this paper, we conducted an automatic evaluation and a user study to determine the accessibility issues with the Taif University Blackboard. Lack of accessibility prevents visually impaired students from benefiting from the Blackboard website services and acts as a barrier to equal access to quality education.

Although this study was conducted with thirteen participants, it is still extremely important for three reasons. The first reason is that this study identifies several accessibility barriers that exist in the Taif University Blackboard and its findings have indicated that Saudi universities' systems are still not providing full accessibility to visually impaired students. This study also addressed the importance of improving the accessibility features of Blackboard to guarantee equal access for all students with or without disability. Second, this study identifies serious concerns about the quality of visually impaired students' education where they depend completely on others to do assessments and other tasks. Third, this study serves to increase the awareness of teachers and web developers about the importance of providing accessible interfaces to enable students with disabilities to gain the full benefits of the course sources. The results of this study can be applied to other universities web educational sites for enhancing the accessibility of websites and systems.

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