



Teachers Perspectives on Transition to Online Teaching Deaf and Hard-of-Hearing Students during the COVID-19 Pandemic: A Case Study

Wajdi Aljedaani
wajdialjedaani@my.unt.edu
University of North Texas
Denton, Texas, USA

Mohamed Wiem Mkaouer
mwmvse@rit.edu
Rochester Institute of Technology
Rochester, New York, USA

Mona Aljedaani
mona.m.aljedaani@hotmail.com
King Abdulaziz University
Jeddah, Saudi Arabia

Stephanie Ludi
Stephanie.Ludi@unt.edu
University of North Texas
Denton, Texas, USA

Abstract

Education has faced various challenges due to the COVID-19 pandemic. These challenges were even more dramatic for deaf and hard-of-hearing students as they transitioned to the online setting. This paper aims to explore the teachers' perspectives on transitioning to educating computer science deaf students at a technical college in the Kingdom of Saudi Arabia (KSA). Therefore, the paper presents the results of 10 surveys and 5 interviews with faculty to identify the main obstacles that teachers have faced during the transition. This study outcomes reveal several challenges related to poor accessibility of learning tools, issues with the online availability of materials, no updates on the teaching pedagogy to accommodate the new settings and communication problems between teachers and students. Our study outlines important takeaways to provide deaf and hard-of-hearing students with a better learning experience.

CCS Concepts

• **Human-centered computing** → **Accessibility**; • **Social and professional topics** → **Computing education**.

Keywords

Education, E-Learning, Deaf and Hard of Hearing, Accessibility, Saudi Arabia, COVID-19.

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1 Introduction

Education has been heavily impacted by the Coronavirus (COVID-19) pandemic. According to Yazcayir and Gurgur [34], the public health measures that have been implemented by many countries, such as social distancing, quarantines, and school closures, have led to the introduction of various challenges related to learning and course adjustments. As noted by Sutton [30], students with neuro-developmental, physical, learning, and cognitive disabilities have been particularly adversely affected by the pandemic. Furthermore, a study by Zhang et al. [37] found that deaf students raised more concerns during and after the transition to online education, especially with the inaccessibility of educational technologies that were quickly adopted by various institutions. Hence, there has been an urgent need to expose all challenges that deaf students are facing.

The goal of this study is to extract all the difficulties that teachers of deaf students have faced during their transition to the online setting because of the COVID-19 pandemic. Previous studies, such as Stelitano et al. [29] in the United States, found that the teachers were less confident in meeting disabled students' learning needs, while Alqurshi [11] in Saudi Arabia found that there were challenges in interactions between teachers and their students, challenges with creating alternative assessment methods, and lack of guidance in the new learning system. In the context of deaf education, Madhesh [20] in Saudi Arabia found that deaf students in Saudi Arabia were fully excluded due to the current pandemic, where the focus population was middle-school teachers. In addition, Alawajee [2] investigated the use of sign language as a motivation for e-learning among students in a Saudi University, while Krashennnikova and Kirsanova [18] established that distance English learning for deaf students in a Russian university had been disrupted by the COVID-19 pandemic. However, none of the previous studies have explored the challenges faced by teachers of deaf students in a technical college, specifically within Saudi Arabia. Such a gap in the literature is the motivation for this study, which seeks to address the identified unexplored areas.

This study focuses on deaf students and how their education has been disrupted during the COVID-19 pandemic. The current study fills a gap in the literature by exploring the perspectives of Computer Science (CS) teachers of deaf students in a technical college in KSA, which offers CS undergraduate courses. Hence, the

context of this case study is unique and will provide crucial insights into how to improve deaf education in KSA. The research question that will guide this study is as follows:

What are the challenges and concerns CS teachers of deaf and hard-of-hearing students face during the transition to online education?

Given that the transition to online learning was abrupt, many CS teachers were unprepared for such a change, which has greatly affected how they teach deaf students. The challenge is even more significant in technical institutions, such as the Technical and Vocational Training Corporation (TVTC), where CS teachers are used to being in proximity to their students when explaining complex concepts in a hands-on fashion. Hence, our study addresses an existing gap in the literature by making crucial recommendations for resolving the challenges faced by CS teachers of deaf students during the pandemic.

The remainder of the paper is organized as: Section 2 presents a thorough understanding of the underlying study domain. Previous studies related to the current domain are discussed in Section 3 and the approach of the study is elaborated in Section 4. The study results and findings are provided in Section 5 that are further discussed in Section 6. Section 7 provides certain limitations of our study, and Section 8 concludes the study with possible future work.

2 Background

In this section, the case study of TVTC college is explained as well as the deaf learning in the institution. Furthermore, the pre-pandemic learning procedures are given, and the use of Learning System Management (LMS).

2.1 Case Study Selected

The Saudi Arabia Technical and Vocational Training Corporation (TVTC) is a higher learning institution that offers vocational education and training. The college has offered tertiary education for the last four decades and oversees various vocational training centers, technical colleges, and secondary institutions. TVTC also regulates the operations of more than 1,000 private tertiary education colleges, which makes it an influential player in skills development in Saudi Arabia [33].

2.2 Deaf education in Technical and Vocational Training Corporation (TVTC)

The TVTC offers two majors which are computer science and business. In this study, we only focus on the computer science major. It is important to state that deaf students have their own special classrooms, with appropriate setups allowing interpretation and captioning services. It is noted that deaf students prefer not to learn in inclusive classrooms because they are not treated similarly to others [23]. Furthermore, in deaf education, most of the CS teachers are trained in special education and sign language. For teachers who are not conversant with sign language, students must get an interpreter from the department. Presently, only three interpreters are available, who also assist students during spoken seminars.

2.3 Pre-pandemic learning process

Before the COVID-19 pandemic, teachers handling CS courses had a Dropbox for submitting homework and assignments or projects,

except for two fundamental computer courses, which students take in the first semester of college. It is important to note that CS teachers were not conversant with online learning functionalities. For example, most did not know how to mark exams, upload students' grades, or take attendance on Blackboard. Instead, they used another website for doing such functions, named Rayat¹ [32], which was designed for taking attendance, grading, accessing students' listing, and retrieving course information, even though such functions can be conveniently done in the Blackboard system.

2.4 Learning Management System (LMS)

Many institutions of higher learning are using Learning Management Systems (LMS) in order to facilitate online learning, enable interactions, and assist tutors in evaluating students' achievement [4]. The most common LMS application in Saudi Arabia is Blackboard, followed by Moodle and D2L [3]. Although TVTC college was using the Doroob system since 2016, it slowly began adopting Blackboard before COVID-19. Blackboard was fully implemented in TVTC college when the pandemic hit because there was a need to shift to online learning.

Blackboard Learn It is a fully configurable online learning platform that enables users to enroll and administer online courses [25]. Students and teachers can communicate via different tools such as discussion boards, video conferencing, assignments, tests, etc. Students can participate remotely and actively in class using Blackboard Learns' mobile applications and accessibility features. Moreover, blackboard learning showed promising benefits at the time of the COVID-19 pandemic when the world transitioned to online learning [1].

3 Related Work

Several studies have explored the experiences of teachers of deaf and hard-of-hearing students during COVID-19 [6, 7]. For example, Lynn et al. [19] in the USA explored the successes and challenges that teachers faced when teaching chemistry to deaf colleges. According to the study's findings, it is essential to employ strategies such as synchronous instructions, real-time modeling of solutions, laboratory demonstrations, and simultaneous text chat sessions when deaf students are to be included in the student population. On the contrary, the impact of forced change on the social and emotional conduct of deaf students must be addressed. Smith and Colton [28] created a YouTube channel to provide deaf students, their teachers, and parents with signed and captioned instructional videos which explain various educational activities. The study results reported positive feedback from teachers and deaf students around the USA. An et al. [12] demonstrated that USA instructors had a high degree of self-confidence and were able to transition to online learning swiftly. In other countries, Fuente [15] in the Philippines investigated the experiences of college teachers with deaf students, using a sample of 43 teachers. From the teachers' narratives, four themes—inspiring, opportunity, creative/innovative, and challenging—were established. In Greece, Mantzikos and Lappa [21] explored teachers' difficulties and barriers when handling deaf students during COVID-19. The authors advocated for enhanced teacher in-service training to ensure a smooth transition

¹A portal enables students/trainees to obtain many services such as the tracking training record and the attendance and grades, etc.

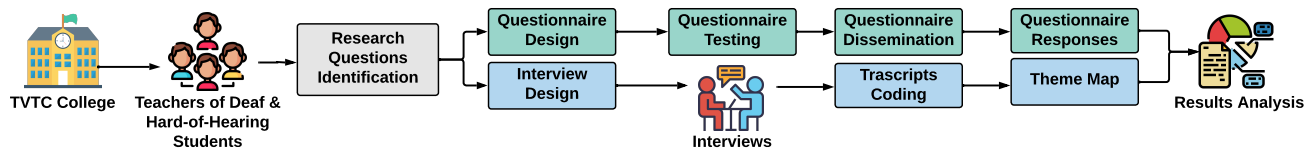


Figure 1: Overview Approach of Our Study.

to online learning. Another study by Madhesh [20] in Saudi Arabia explored the exclusion of deaf students in Saudi education from the perspective of middle school teachers. The authors placed a strong emphasis on redrafting disability-related policies to better serve the requirements of the deaf and other impaired student populations. From the mentioned studies, it is evident that Saudi Arabia has not received much focus from previous researchers. In addition, no Saudi study has sought CS teachers' experiences at the technical college level, which offers a crucial gap that is explored in this paper.

Other studies have explored teachers' experiences when teaching students with various forms of disability in the current pandemic. For example, Huff et al. [17], and Tigwell et al. [31] from the USA investigated the experiences of teachers handling visually impaired students and teaching American Sign Language, respectively. Another study by Dey et al. [16] in India focused on visual impairment and looked at the related programs that had been created for both teachers and students. In Brazil, Pacheco et al. [24] explored the challenges of teaching human anatomy subjects to students with intellectual disabilities. Furthermore, three review articles by Rasheed et al. [26], Smith [27], and Zaid et al. [35] focused on special education and addressed the challenges faced in blended learning, teaching students with disabilities and deafness, respectively. From Saudi Arabia, Alawajee [2] addressed the effects of the COVID-19 pandemic on the training of university teachers on Students' Sign Language, with the primary focus being the hearing loss path. Our review of existing literature found an article by Krashenninnikova and Kirsanova [18] in Russia to be closely related to this study because it explored the experiences of online learning by deaf students in a technical university. From the review, we established that there was no study in Saudi Arabia focusing on the college CS teachers' perspectives in teaching deaf students, which is the objective of this study.

Our analysis of related work indicated that Saudi Arabia had not been adequately covered in deaf and hard-of-hearing studies. We found one study by Madhesh [20] that was done in Middle School, and another by Alawajee [2] that took the perspective of students. The apparent neglect of Saudi Arabia and CS teachers' perspective is the motivation for doing the current study. Our research is also unique because we focus on teaching in a technical college in Saudi Arabia, given that teaching CS courses to students with disabilities is more challenging compared to teaching students without disabilities. To the best of the researcher's knowledge, no previous studies have focused on the aspects that we have just mentioned.

4 Study Design

In this section, we present the approach of our study. We discuss the interview and survey approaches that we used for the study. We explain the data collection approaches and provide details of the participants who took part in the study. Figure 1 presents an overview of our study.

We began this study by creating the interview and survey guides using insights from available literature [13, 36]. The survey and interview questions were refined through a pilot study with one teacher who was randomly sampled. Thereafter, we conducted the interviews and administered the survey, which was later analyzed using thematic analysis. We deemed it appropriate to combine qualitative and quantitative data by using both case study and survey respectively. We used a case study research design to enable us to explore the experiences of CS teachers in their own environment at the TVTC college. The reason for using the survey was to get diverse views from the CS teachers since COVID-19 is currently a global problem. We actualized the survey technique using interviews and surveys. Regarding the research design, our study was both exploratory and descriptive so that we could effectively identify the experiences of CS teachers during the pandemic. Then, we used the essentialist/realist thematic analysis because we wanted to utilize the deductive approach to make sense of the data. We also used the case study analysis guidelines provided by Braun and Clarke [14]. The qualitative data in our study were analyzed using deductive thematic analysis.

4.1 Data Collection

We began data collection by conducting interviews to get an overview of the teaching experiences of CS teachers at TVTC college. Then, using our findings from the interviews, we conducted a survey to establish the accuracy of the interview data using a larger sample size. We were convinced that the survey would help us to conduct an in-depth examination of the research questions. An overview of the demographics of the CS teachers who participated in the interviews and survey is given in Table 1.

4.2 Interviews

We used a semi-structured interview guide to give opportunities to respondents to give their views as opposed to answering structured questions. The validity of the interviews was ensured using investigator triangulation. Our interview guide had 19 questions, and the interviews were conducted through the Zoom platform in the Arabic language. The set of questions that were asked in the interviews is given in Table 2. We used a voluntary sampling method, where the number of interviewed was 5 out of 10 CS teachers. To encourage the interviewees to participate in the study, we

Table 1: Demographic information of the interview participants.

Participant	Age	Major	Year of Teaching Experience	Sign Language Yes/No	Received Training on LMS Yes/No	Prefer Teaching Online Yes/No
P1	38	Computer Science	13	Yes	No	No
P2	41	Computer Science	16	Yes	No	No
P3	47	Computer Science	15	No	Yes	No
P4	29	Computer Engineering	4	No	Yes	No
P5	44	Computer Science	17	Yes	No	No

Table 2: Presents the set of interviews questions.

First Background and Demographics	Fourth Challenges and Concerns
Years of age, major, years of teaching experience	What were your distractions while you were teaching online?
Do you speak sign language?	What were your most challenges during online teaching?
Second Generic Views	How was your teaching environment at home?
How would you describe your experience in teaching online?	How did you communicate with your students?
What type of device did you use for online teaching?	Were you able to access the class materials via Blackboard?
How did you teach classes that needed hardware equipment?	Have you ever encounter any barrier or issue communicating with your students or department?
Based on your experience in online teaching, what do you prefer now?	Did all videos support the subtitles?
Third E-learning Tool	Have you given all the course materials as pre-pandemic?
What is your perspective on Blackboard platform?	Fifth Teachers recommendations
Did you use any other e-learning tools? why?	What do you feel are the benefits of online courses, such as those provided during Covid?
Did you train on Blackboard? if not, did the department shared with you resources?	What are the things that you would like to change in online teaching?

provided them with a \$25 prepaid gift card. After the interviews, we transcribed the audio data, and then the three authors translated the Arabic interview scripts into the English Language. Afterward, the translated scripts were, thereafter, checked by each of the three authors separately to ensure their accuracy. We then analyzed them using thematic analysis, which involved reading the scripts, generating codes, and creating a theme map. In transcript coding, the researchers assessed the scripts, identified emerging codes from the data, created a list of codes, and revised them to have a final set of codes. To deduce themes, the researcher identified patterns of responses, which were categorized and constantly reviewed to give a theme map.

4.3 Survey

We designed the survey using the insights we gained from the interviews, and also by assessing the research questions of our study. We created the survey in order to confirm the earlier interview questions with a larger sample, which would help us get more information about our study.

Our questionnaire was organized into four sections and generated a total of 50 questions. After the refinement of the questions between the authors, we reduced the number of questions to 17. The survey had 13 multi-choice questions and 4 open-ended questions. The questionnaire was semi-structured, with both open-ended and closed-ended questions, allowing the respondents to express their views and explain them without restriction. We also made some questions to be optional so that participants are not forced to answer in case they do not want to. We created the questionnaire in the teachers' native language, using Google forms, to make the

collection then the dissemination of information easier [22]. The survey questions are presented for both English and native language in Appendix 3. Once the survey was ready, we conveniently sampled 10 participants interested in participating in the study. These participants were all volunteers.

4.4 Privacy and Data protection

We ensured the confidentiality of the participant's information by storing it on a password-secured laptop. Furthermore, we sought informed consent from every participant before the study. Finally, we anonymized the data to conceal the respondents' identities.

5 Study Results

In this section, we provide the results of this study. The results are based on the research question that we generated in this study, which looked at the challenges of CS teachers of deaf students.

What are the challenges and concerns CS teachers of deaf and hard-of-hearing students face during the transition to online education?

The research question that we wanted to answer in the study focused on the challenges and concerns that CS teachers of deaf students are having during the current pandemic. The responses are illustrated in Figure 2. From the responses, the most significant problem faced by CS teachers was internet connectivity at home (81%), followed by lack of access to tools of teaching (63.6%). Other challenges were associated with communication, internet speed, and the impact on career, among others. It was evident that CS teachers at TVTC college were facing serious challenges with

Select the top three most significant challenges you face while teaching from home?

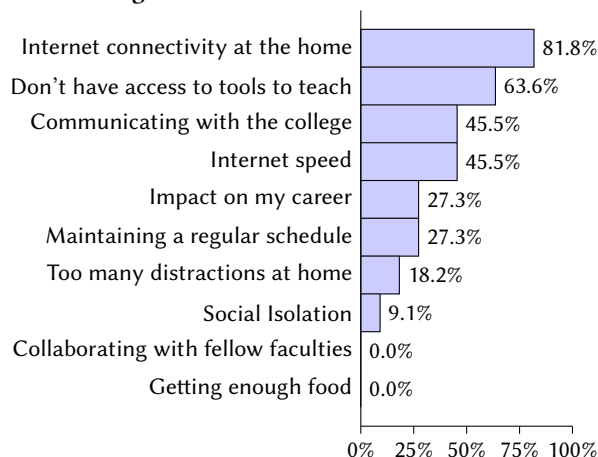


Figure 2: Presents the most challenges teachers faced.

teaching deaf students during the pandemic that needed to be addressed.

We were interested in identifying the challenges that faced CS teachers in relation to the accessibility of the blackboard platform. Our results are presented in Figure 3.

Challenge 1. Lack of support during the transition.

From the results we have presented in Figure 3, 90% of the respondents indicated that it was not easy to access and navigate the Blackboard platform. Participant (P3) said:

"It happened suddenly, where every university and college in Saudi Arabia use the Blackboard. It was hard to access the website, the page froze, or suddenly get an unavailable message page." (P3)

In addition, 80% of the CS teachers did not know how to create large text portions that students could easily read, and 90% did not understand how to design course materials that could be accessed remotely by deaf students. It was also established that 70% of the CS teachers could not access all the contents of their classes on Blackboard, while another 70% did not add captions or explanations of figures and tables if they were added.

Challenge 2. Lack of familiarity with Blackboard accessibility.

Accessibility was a challenge among many CS teachers and students, which can be attributed to a lack of familiarity with online teaching, especially the Blackboard platform. For instance, the participant (P5) stated:

"Before the pandemic, we never used any electronic platform besides taking attendance. We have no idea how to create digital documentation and materials accessible to deaf students. I contacted the college administration to ask if there are guidelines that can help us; unfortunately, Blackboard does not provide support for non-English versions." (P5)

Indeed, CS teachers were not trained to use Blackboard, and it seems that even the college administration was unable to arrange for necessary instructional resources. Another interesting challenge that teachers complained about was the video sessions on the blackboard. The default video sessions of blackboard only show for students aside from the teacher's shared screen. The fact of only seeing students were extremely annoying to the teachers because they would not be able to see and react to any deaf student trying to ask questions through sign language. Many deaf students complained about feeling left behind and ignored due to the non-responsiveness of the teachers. Therefore, to overcome this challenge, teachers switched to using WhatsApp groups as an alternative solution for video sessions with students. The usage of WhatsApp forced students to dispose of smartphones, and phone numbers that they needed to publicly share, which presented another privacy issue for some students.

Challenge 3. Irreproducibility of classroom settings.

The availability and usage of learning materials are crucial in the teaching process. We asked the CS teachers two questions relating to learning materials, and their responses are given in Figure 4.

Approximately 90% of the respondents felt that the amount of teaching content they gave during the pandemic was not the same as pre-pandemic. In this context, the participant (P3) commented:

"The content provided through in-person sessions cannot be given online as is. Online teaching takes up more time, and I was only able to cover no more than 40% of what I had prepared. I was facing much more questions, and timely communication was the hardest with students." (P3)

Regarding the method of content delivery, 43.62% of CS teachers used documentation, 42.66% used live streaming, and 13.72% used pre-recorded videos. However, the CS teachers felt that not all these methods were evenly effective with students. Participant (P2) quoted:

"As a technical college, most of the courses rely on practical hands-on activities such as computer assembly and diagnosis. Thus, online teaching cannot reproduce the classroom needed settings." (P2)

Challenge 4. Network outages.

It is crucial to indicate that many CS teachers and students did not dispose of reliable internet connection at their homes, which added another burden for live video sessions, being bandwidth demanding by nature. Many deaf students experienced session logouts and shaky videos, preventing them from continually following their teachers' gestures, and therefore. Teachers mentioned that they were constantly interrupted by students who lost access for a few minutes, asking them to repeat again what they have missed. Teachers also pointed out that many deaf students are attending their sessions using their cell phones to access materials that were initially set up to be accessed using computers. Many students were asking for software solutions to open proprietary formats, such as Microsoft office, etc. Such software systems are typically available in classroom machines.

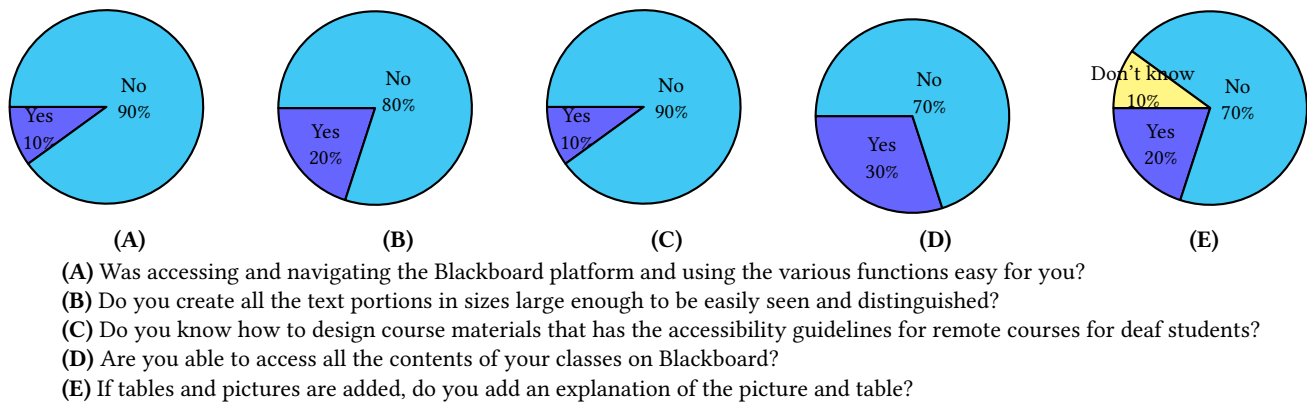


Figure 3: Responses to questions regarding to accessibility aspect.

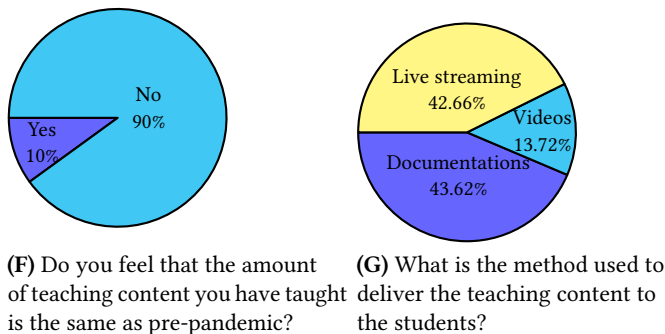


Figure 4: Learning material.

of students answering at the same time. Also, students cannot see each other's gestures as easily as they used to in the classroom. Teachers felt that students gradually lost their engagement with the class questions. It is also important to state that communication was sometimes hampered by weak connections or even the absence of an interpreter, which would make professors cancel some classes. Participant (P1) said:

"Sometimes students experience cut-offs due to limited internet bandwidth from the teacher's side. The interpreter does not know what to do with the students. I experienced once that the interpreter did not show up, so I had to cancel the class because I do not know how to sign." (P1)

Therefore, amidst communication challenges, classroom participation was also a challenge in online teaching to deaf students.

What is the most suitable e-learning platforms for you?

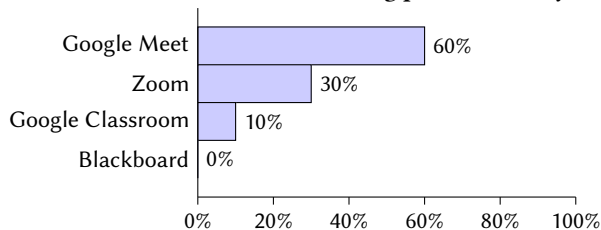


Figure 5: Presents the most suitable e-learning platforms teachers experienced.

Challenge 5. Problems with communication & class interaction.

One of the key challenges faced by CS teachers was communication and class interaction. When a question is being asked to the whole classroom, students typically start answering through gestures, which allows them to incidentally learn from each other and allows the teacher to have a sense of the general agreement in the classroom, and reflect on their answers. Teachers complain that, in the online setting, they can only focus on a limited number

Challenge 6. E-learning tools limitations.

We wanted to identify which platforms CS teachers found most suitable when teaching deaf students. Our results are given in Figure 5.

While 60% of the respondents found Google Meet to be the most suitable, 30% and 10% found Zoom and Google Classroom to be most suitable, respectively. Unfortunately, none of the respondents considered Blackboard to be suitable, and we requested them to explain the situation. Participant (P1) said:

"The Blackboard was not user-friendly. It was hard to get familiar with its functionalities without any tutorials or workshops on using it. In order to find the icon to create exams, I have to go through multiple pages and steps until finding it." (P1)

Another CS teacher pointed to the challenges in creating tests on Blackboard and (P2) said that :

"I tried to create tests in Blackboard, and I faced many difficulties, unlike other platforms that are easy to use the basic actions that the CS teacher needs. Also, if I want to do a simple function, it requires many steps, making the process more complex." (P2)

It is crucial to state that Blackboard has a limitation on the number of cameras that can be used simultaneously, which was a problem for CS teachers because deaf students need to see the sign language in the camera. Participant (P4) said that:

“I used Blackboard for a very short period because Blackboard allows only four cameras to be shared, and there are ten students in the class. Blackboard does not assist me in teaching people with special needs like deaf, where I need to see all students. We must switch to other platforms such as Zoom or Google Meet to help us share a large number of cameras.” (P4)

Given that communication through Blackboard was difficult, some CS teachers used social media, such as WhatsApp and Telegram. During exams, the CS teachers sent emails to students, who answered within a given period and sent back their responses through emails. Furthermore, students who had concerns communicated to their teachers through WhatsApp. Unfortunately, even when Blackboard was functioning, effective learning was often interrupted. For instance, the participant (P4) said:

“Students lack focus during class, and I tried to check up if everything was okay. They do not answer because they are talking to another student. Students will be between the teacher and interpreter, and chat with their classmates.” (P4)

Such feedback is vital in determining how online learning should be structured for deaf people.

6 Discussion

In this section, we provide key takeaways that we consider critical in dealing with the challenges facing CS teachers of deaf students during the COVID-19 pandemic. Our findings echo the outcomes of previous studies conducted in different countries [12, 15, 19–21, 28]. Similarly, the Saudi Arabian teachers’ transition to e-learning for the teaching of deaf students was not without its difficulties.

Takeaway 1. Transitioning of CS teaching and learning methods. Although TVTC college introduced Blackboard to facilitate virtual learning during the pandemic; CS teachers were not conversant with it because they lacked training and experience. Therefore, the CS teachers could not do even simple tasks with Blackboard, such as preparing tests for students. In addition, we found that CS teachers were unable to cope with the challenges of teaching deaf students through online means. Therefore, TVTC college requested that deaf students return to the institution to attend face-to-face when other students were safely learning from home. The situation at TVTC college is different from other learning institutions that cater to students without disabilities, and it is important to ensure the seamless transition of learning methods to cater to the needs of deaf students.

Takeaway 2. Support for sign language. Most deaf students in Saudi Arabia do not have exposure to Saudi Arabian Sign Language (SASL) because they are born to hearing families. Many students find themselves heavily practicing sign language only on campus. Such cultural aspect also affects the work of CS teachers. For example, the lack of an established deaf culture within families prevents

most CS teachers from being conversant with SASL, hampering their ability to educate deaf students without the need for immediate and direct support.

Takeaway 3. Need to improve communication on online platforms. We noted that communication and class interaction was challenging for many CS teachers. We recommend that software developers of sites, such as Blackboard or Zoom, create a flashing feature where CS teachers click on a section of their screen, and the selected student’s camera flashes with a specific color. Given that raising hands has been found ineffective, flashing on the screen can help the student know that s/he has been selected to answer a question.

Takeaway 4. Support and facilitation for CS teachers. This study established that CS teachers faced many challenges during the pandemic and received very little support from the college administration or relevant bodies. We recommend that CS teachers be provided with the necessary facilities, technology, and materials that will facilitate them to deliver virtual content to deaf students. It is also vital to ensure the availability of adequate translators so that lessons do not have to be postponed if one translator is absent.

Takeaway 5. Train CS teachers on online learning methods. We have established that CS teachers are neither familiar with online learning nor learning platforms such as Blackboard. We recommend that CS teachers be trained on the transition to online learning and how to use the various available learning platforms. Colleges can organize tutorials, training, and workshops to empower CS teachers with information to provide effective virtual learning.

Takeaway 6. Simplify LMS systems. We found that CS teachers were facing difficulties, especially with Blackboard, in navigating through the system and even accessing teaching materials. Some complained that they were unable to create tests using the platforms, while others complained that there were many complex steps involved in doing straightforward tasks. It is important to simplify LMS systems so that CS teachers can customize and benefit from all the system’s functionalities.

Takeaway 7. Overcome e-learning limitations. CS Teachers complained that some e-learning platforms had limitations that hampered their teaching efforts. For example, Blackboard offered only four cameras, which was not practical because deaf students and their teachers needed to see each other during the learning process. In addition, e-learning platforms need to provide teachers with the ability to provide subtitles in other languages, such as Arabic. Overcoming such limitations will greatly improve virtual teaching for teachers of deaf students.

Takeaway 8. Impact on emotional behavior. The CS teachers claimed that the deaf students’ social and emotional behaviors were negatively impacted by the forced shift in the learning environment. Their poor performance may be brought on by their inability to address their mental health. It is essential that researchers should investigate potential solutions for resolving the social, emotional,

and educational problems that need to be addressed. Teachers must integrate those practices into their teaching methods to give these students a sense of peace and improved psychological outcomes.

Takeaway 9. Modifying LMS for Deaf Students. The CS teachers also commented that one of the reasons deaf students were not able to transition to e-learning was multiple navigation windows. A video was displayed in one window, a sign language interpreter in another, captions in a third, and a whiteboard in a fourth window. Moreover, it lacked simultaneous transmission of content. This provided a significant issue for both teachers and students, as deaf students were clueless about the topic when teachers were addressing it. It is vital to upgrade LMS to transmit all of the similar content simultaneously so that teachers, as well as deaf students, can easily navigate through windows.

7 Threats to Validity

Surveys in educational research are always challenged with the generalizability of their findings. While the number of participants is representative of the teaching code of the college and sufficient for our case study, but we cannot verify whether our findings are generalizable across other institutions. Also, survey questions were asked in the teachers mother-tongue language to guarantee that teachers can adequately express themselves. Their answers were then translated. Such translation may not be perfect. Yet, the authors who performed the translation were familiar with both languages.

Further, our study was only confined to the difficulties of CS teachers, meaning that other scholars may look at the challenges faced by the administration of colleges or universities in offering online education to their students.

Another threat refers to the objectiveness of the questions. Our focus on revealing challenges may have biased our interviewees toward providing only negative aspects of their experience. To mitigate this limitation, we have examined all questions prior to performing any surveys. A pilot study has been also performed to refine the wording of the questions.

8 Conclusion and Future Work

The work of CS teachers of deaf students has significantly been affected by the COVID-19 pandemic. In this study, we explored the challenges that have been faced by CS teachers at TVTC college in Saudi Arabia. We wanted to know how CS teachers have been affected by the transition to online learning because of the COVID-19 pandemic.

Due to the closure of physical classes, online learning using several devices in synchronous (live) and asynchronous (pre-recorded) environments has become an alternative learning method. However, this alternative learning method becomes challenging to deaf students due to the limited resources and accessibility to online learning. In summary, we found that: (1) Blackboard as well as the course material are not easily accessible to deaf students; (2) deaf students find that learning is extremely stressful during the pandemic; (3) Google Meet is the preferable e-learning tool; (4) communication between deaf students and teachers is ineffective, which impacts the learning outcomes; (5) a lack of support in terms of the provided interpreters hinder the learning process; (6) technology is not always enhanced for people who are deaf or hard of hearing; (7)

students who were deaf or hard of hearing had difficulty managing their time due to different types of distractions.

Future researchers may investigate the challenges CS teachers face with students with disabilities other than deafness during the COVID-19 pandemic or even conduct a similar study in non-technical college students. We also plan on analyzing user reviews, bug reports, and social media related to deaf users [5, 8–10], to reveal more challenges in their learning management systems.

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Appendix

Table 3: Survey questions.

English Language	Native Language (Arabic)
First: Background and Demographics	(أولاً) المعلومات الأساسية
Q1: What are your total years of teaching experience? <input type="radio"/> 1 - 3 years <input type="radio"/> 3 - 6 years <input type="radio"/> 6 - 9 years <input type="radio"/> 9 - 12 years <input type="radio"/> More than 12 years	ما هي سنوات خبرتك في التدريس ؟ <input type="radio"/> ١ - ٣ سنوات <input type="radio"/> ٣ - ٦ سنوات <input type="radio"/> ٦ - ٩ سنوات <input type="radio"/> ٩ - ١١ سنوات <input type="radio"/> أكثر من ١٢ عامًا
Q2: Based on your experience in online teaching, what do you prefer now? <input type="radio"/> Online teaching <input type="radio"/> Face-to-Face <input type="radio"/> Blended	بناء على تجربتك في التدريس عن بُعد، ماذا تفضل الآن؟ <input type="radio"/> التدريب عن بعد <input type="radio"/> حضوري في الكلية <input type="radio"/> التدريب المدمج
Second: Challenges, Concerns& Experience	(ثانياً) التحديات والمخاوف والخبرة
Q3: What are the top three most significant challenges you face while teaching from home? <input type="radio"/> Maintaining a regular schedule <input type="radio"/> Communicating with the college <input type="radio"/> Internet connectivity at the home <input type="radio"/> Collaborating with fellow faculties <input type="radio"/> Do not have access to tools to teach <input type="radio"/> Too many distractions at home <input type="radio"/> Getting enough food <input type="radio"/> Social Isolation <input type="radio"/> Impact on my career <input type="radio"/> Internet speed <input type="radio"/> Other	ما هي أهم ثلاث تحديات تواجهها أثناء التدريس من المنزل؟ <input type="radio"/> التواصل مع الكلية والإدارة <input type="radio"/> الحفاظ على جدول منتظم <input type="radio"/> التعاون مع زملائي التدريس <input type="radio"/> جودة اتصال الإنترنت في المنزل <input type="radio"/> الكثير من المهيات في المنزل <input type="radio"/> لا يمكنني الوصول إلى جميع الأدوات بالبلدك بورد <input type="radio"/> الانعزال الاجتماعي <input type="radio"/> عدم الحصول على ما يكفي من الطعام <input type="radio"/> آخرى <input type="radio"/> توفر الإنترنت <input type="radio"/> قلق من تأثير فيروس على حياتي المهنية
Q4: Was accessing and navigating the Blackboard platform and using the various functions easy for you? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> I do not know	هل كان الوصول إلى نظام منصة البلاك بورد الأساسي والتنقل فيه واستخدام الوظائف المختلفة أمراً سهلاً بالنسبة لك؟ <input type="radio"/> نعم <input type="radio"/> لا <input type="radio"/> لا أعرف
Q5: Do you create all the text portions in sizes large enough to be easily seen and distinguished? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> I do not know	هل تنشأ جميع النصوص بأحجام كبيرة بما يكفي لرؤيتها وتمييزها بسهولة؟ <input type="radio"/> نعم <input type="radio"/> لا <input type="radio"/> لا أعرف
Q6: Do you know how to design course materials that has the accessibility guidelines for remote courses for deaf students? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> I do not know	هل تعرف كيفية تصميم المواد التعليمية التي تحتوي على إرشادات إمكانية الوصول للطلاب الصم؟ <input type="radio"/> نعم <input type="radio"/> لا <input type="radio"/> لا أعرف
Q7: Are you able to access all the contents of your classes on Blackboard? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> I do not know	هل يمكنك الوصول إلى جميع محتويات دروسك على منصة البلاك بورد؟ <input type="radio"/> نعم <input type="radio"/> لا <input type="radio"/> لا أعرف
Q8: If tables and pictures are added, do you add an explanation of the picture and table? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> I do not know	في حال إضافة جداول والصور، هل تقوم بإضافة شرح للصورة والجداول؟ <input type="radio"/> نعم <input type="radio"/> لا <input type="radio"/> لا أعرف
Q9: Do you feel that the amount of teaching content you have taught is the same as pre-pandemic? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> I do not know	هل تشعر أن مقدار المحتوى التدريسي الذي قمت بتدريسه عن بُعد هو نفس مقدار ما قبل فترة حجر فيروس كورونا ؟ <input type="radio"/> نعم <input type="radio"/> لا <input type="radio"/> لا أعرف
Q10: What is the method used to deliver the teaching content to the students? <input type="radio"/> Documentations <input type="radio"/> Videos <input type="radio"/> Live streaming <input type="radio"/> Others	ما هي الطريقة المستخدمة لتقديم محتوى التدريس للطلاب؟ <input type="radio"/> المستندات <input type="radio"/> مقاطع الفيديو <input type="radio"/> بث المباشر <input type="radio"/> أخرى
Q11: I receive help from department in a timely manner in my online teaching courses. <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> I do not know	ألتقى المساعدة من الإدارة في الوقت المناسب خلال التدريس عن بُعد ؟ <input type="radio"/> نعم <input type="radio"/> لا <input type="radio"/> لا أعرف
Q12: Do you use any technologies, such as social media, video chat, etc. to help you in your communication with your students? If so, which ones? <input type="radio"/> Video chat e.g., Zoom <input type="radio"/> Text messages e.g., WhatsApp <input type="radio"/> Voice call <input type="radio"/> Email <input type="radio"/> No communication	هل تستخدم أي تقنيات، مثل وسائل التواصل الاجتماعي، والردشة المرئية، وما إلى ذلك لمساعدتك في التواصل <input type="radio"/> تواصل بالفيديو مثل زووم <input type="radio"/> رسائل نصية مثل الواتساب <input type="radio"/> تواصل صوتي مثل الاتصال المباشر <input type="radio"/> الايميل <input type="radio"/> لا يوجد تواصل
Q13: What is the most suitable e-learning platforms for you? <input type="radio"/> Blackboard <input type="radio"/> Zoom <input type="radio"/> Google Meet <input type="radio"/> Google Classroom <input type="radio"/> Other	ما هو أفضل برامج ل لتدريس عن بعد بالنسبة لك ؟ <input type="radio"/> البلاك بورد <input type="radio"/> زووم <input type="radio"/> قوقل ميت <input type="radio"/> قوقل كلاس روم <input type="radio"/> أخرى
Third: Teachers Recommendations (Open-Ended Questions)	(ثالثاً) توصيات المعلمين (أسئلة مفتوحة)
Q14: Describe any improvements to online teaching courses that would make them more accessible, interesting, useful, etc.	أذكر بعض التحسينات على التدريس عن بُعد والتي من شأنها أن تجعله أكثر سهولة وإثارة للاهتمام ومفيدة ؟
Q15: What are the things that you do NOT like in online teaching?	ما هي الأشياء التي لا تعجبك في التدريس عن بُعد؟
Q16: What are the things that you like in online teaching?	ما هي الأشياء التي تعجبك في التدريس عن بُعد؟
Q17: What are the things that you would like to change in online teaching?	ما هي الأشياء التي ترغب في تغييرها في التدريس عن بُعد؟