Research article

Using online information technology for deaf students during COVID-19: A closer look from experience

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A B S T R A C T

The COVID-19 pandemic has interrupted the education of millions of students across the world. The purpose of this study was to investigate the perceptions regarding the technological instruction and accommodations provided to deaf students in online distance learning during the COVID-19 pandemic. This study was qualitative in nature and used anonymous, one-to-one semi-structured interviews. In June 2020, we interviewed a convenience sample of deaf students (n = 15) and their instructors (n = 3) and analysed the responses thematically. Upon achieving theme saturation, the thematic structure analysis was finalised. The results revealed five main themes related to deaf students' experience with online distance learning during COVID-19. The themes are as follows: course content delivered, technology used, delivery method, assessment tools used, and social interactions. Each theme is discussed and compared with the related literature to scientifically encapsulate its suggested dimensions.

The interviewed students described their experience of using online technology in both negative and positive terms. Instructors also provided their input to express their experiences during that time. Online distance learning was described as a difficult and challenging experience that lacked efficient communication channels and failed to address the needs of the deaf with respect to the communication medium. The typical course delivery methods were described as challenging, and the lack of social interaction was highlighted as a liability. At the same time, participants acknowledged some ancillary benefits of online distance learning especially that it enhanced their technology skills and their competences in adapting to a new environment.

1. Introduction

In 2020, the World Health Organisation (WHO) stated that 466 million people worldwide have disabling hearing loss, of which 432 million are adults, but only 30% of them are over the age of 65 (World Health Organisation [WHO], 2020a). Some hearing loss is age-related; however, for individuals born with hearing loss or in whom hearing loss occurs prior to language development, the specific requirements for learning move from the auditory channel to the visual channel. A disabling hearing loss is defined as a 'hearing loss greater than 40 decibels (dB) in the better ear for adults' (WHO, 2020a, para. 2). Decibels denote the loudness or volume of a sound, whereas Hz denote its frequency (high or low pitch sounds). In the classroom, a student with such hearing loss would hear only the "j", "m", "d", "b", and "sh". Most vowel sounds are not heard. If there is noise in the classroom, the student will hear and understand even less (John Tracy Clinic, 2012). Thus, a student

with a disabling hearing loss is likely to need a sign language interpreter to understand the content and flow of a college class. All participants in this study had disabling hearing loss.

A disabling hearing loss typically results in delay or lack of spoken language acquisition. Depending on the situation at home, it often also delays the development of sign language, which is a visual-spatial language that does not quite match the native spoken language (Lugman and Mahmoud, 2020). In all sign languages, the whole body is used, including facial expressions (facial grammar), which is required for depth of understanding (Borgia et al., 2014). Since sign language does not match the grammar of spoken language, the acquisition of the written language becomes a challenge, which affects reading comprehension and writing (e.g., Mayer and Trezek, 2020; Metha et al., 2005; Wang et al., 2008). Educators of deaf students have struggled to raise the typical fourth grade reading level since 1916 (Pintner and Patterson, 1916) but are yet to successfully support the majority of deaf students in achieving reading

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comprehension to fifth grade or higher (González et al., 2019; Mayer and Trezek, 2020). Thus, deaf students typically significantly lag behind their hearing peers in background and/or domain knowledge such as skills, facts, or concepts that their hearing peers already know. Numerous studies reveal the connection between background knowledge and achievement (e.g. Dochy et al., 1999). Typically, deaf students do not catch up with their hearing peers academically and enter college and universities underprepared and with wide gaps in knowledge, facing challenges in reading and writing and potential paucity of the skills requisite to succeeding in a postsecondary setting. According to the World Federation of the Deaf, 80% of deaf students are uneducated or semi-educated (Hashim et al., 2018). Recent statistics reveal that 51% of deaf students enrol in college, but only 18% actually graduate with a bachelor's degree (Johnson et al., 2020).

For those deaf students who do make the move to postsecondary colleges and universities, the transition may be problematic. Deafness is a low incidence disability (less than 5% of the school population) (Noble, 2010). Colleges and universities are not typically prepared for supporting deaf students; so, their specific needs are not well understood (Kaba and Ellala, 2019). The lack of understanding is not for want of intent; it is simply a lack of experience on the part of the Student Services department and the professors. According to the National Deaf Center, the majority of the deaf students polled considered "online learning harder than traditional learning" (NDC, 2020a,b,c,d,e). Distance learning has posed numerous problems for deaf students, mainly in the area of communication. Deaf students who rely on sign language for learning also rely on a sign language interpreter for understanding coursework presented through online distance learning. It is erroneous to assume that online classes are accessible to deaf students just because the interpreter is on the screen (Moreno et al., 2012).

It is important, when working with deaf students, to keep in mind that the following issues may interfere with learning (Lucker et al., 2012)):

a) Language, vocabulary, and literacy delays
b) Gaps in background and domain knowledge
c) Inadequate knowledge and use of learning strategies
d) Social skill deficits
e) Reliance on assistive technology.

There are important differences that, when not addressed, put deaf students at an additional and significant disadvantage. For example, inclusion design for deaf learners is often developed as a "workaround", with the assumption being that deaf students are like hearing students, except that they cannot hear. That historically simplistic misunderstanding leaves postsecondary instructors with the illusion that if the content is delivered in an alternative manner, all will be well (Borgia et al., 2014).

2. Background

2.1. Assistive technology and accommodations

Deaf students in postsecondary courses rely on both assistive technology and accommodations in order to access content and the instructor. Assistive technology may include both hardware and software and depends on the needs of the student. Examples of assistive technology often include assistive listening devices or captioned videos. Accommodations include qualified sign language interpreters and, often, skilled note-takers (NDC, 2020a,b,c,d,e). Deaf students rely on sign language interpreters and assistive technology to access the instructor and course content. Deaf students benefit greatly from highly qualified and trained interpreters. Qualified sign language interpreters typically hold a bachelor's or master's degree in interpretation, in addition to passing a rigorous licensing exam consisting of a test of ethics, as well as a receptive and expressive interpreting test. Licensing tests are common in the European Union and the United States.

The profession of interpreting is in its infancy in the Middle East. Currently, there are no training programs for interpreters in the UAE, although there is a "license for signing". In Jordan, however, a license is always required to work in the government or ministry (Trine, 2013), so the test may be more of a formality rather than a test of skill. As late as 2013, there was no interpreting training program in Jordan. According to Trine, Jordan was "way ahead" of its Arab neighbours, and the author cites numerous invitations for Jordanian interpreters to move to the UAE, among other places (2013, p. 56).

Deaf students benefit from assistive technology. Assistive technology for deaf students may include interpreters, note-takers or videotext displays (Guyer and Uzeta, 2009). In the United States, the provision of qualified interpreters and required assistive technology is mandated by several laws, as described in Guyer and Uzeta (2009). The requirements are similar in the European Union (European Parliament, 2018). Qualified interpreters and support from assistive technology, when incorporated appropriately, can provide close to equal access to the instructor and course content (Kent et al., 2018). When any part of this critical combination of support is missing or integrated poorly, deaf students suffer, and the instructor may be unaware of such challenges.

2.2. Challenges of learning and teaching during COVID-19

The world has faced obvious challenges in different sectors during the COVID-19 pandemic and in particular for the education sector. The quick adaptation to distance learning for all levels and courses has been a struggle for teachers and students (Reimers et al., 2020). That experience may have been even more intense and harder to adapt for students with disabilities (Lazzari and Baroni, 2020). Numerous working components must be included in a 'successful' online distance learning experience.

The physical equipment, the lack of institutional capacities and resources, the inability to digitize the learning physical resources, and the shortage of students access to digital devices have been the main technical challenges (Reimers et al., 2020; Lazzari and Baroni, 2020). A strikingly high number of schools and colleges have experienced other problems in terms of delivering alternative learning methods, creating content that ensures the inclusion of the majority of students, and providing clear instructions for students on how to cope and follow up. Toquero (2020) suggested that one of the main challenges has been to scale up the teachers' competencies to "acquire online-driven competencies in planning, implementing, and assessing the performance of their students" (Toquero, 2020). The numerous glitches or full on failures to deliver quality education was a stressor for teachers, parents and students.

Focusing on the social and emotional aspects, Fegert et al. (2020) explored the "anxiety, lack of peer contact and reduced opportunities for stress regulation" as the main challenges in the time of crises. There are different mental health problems related to the COVID-19 pandemic and its subsequent restrictions. Wright et al. (2020) stated that students with disabilities are "among the most vulnerable individuals" in crisis that may affect them and their families' emotional and mental health on the long run. In many publications, for example Toquero (2020), stressed that mental health topics should now be added and integrated into the classes and curriculum. In addition, online mental health services were recommended to help students and their families during crisis (Toquero, 2020).

2.3. Context of the study

This study was carried out in the United Arab Emirates (UAE). The UAE is a relatively new country that comprises seven emirates. Approximately one million Emirati Nationals living in the UAE, accounting for approximately 10% of the nation's nearly 10 million people (Abu Dhabi Government, 2020 UAE, 2020). Although there are no prevalence statistics for deaf and hard of hearing Emirati Nationals, the World Health Organization estimates that approximately 6.1% of individuals

worldwide live with a disabling hearing loss (Davis & Hoffman, 2020). Extrapolating from the WHO estimated prevalence indicates a deaf population of approximately 60,000 UAE Nationals who are supported and protected by laws, policies, and agreements in the UAE.

Founded in 1971, the UAE passed its first law to support and protect people with disabilities in 2006 (Abu Dhabi Government, 2020). The law stipulates equal access to all aspects of life including medical access, education, and employment. Inclusion is a critical aspect of the federal law and was emphasised when the UAE joined 183 other countries in signing the Incheon Agreement (UNESCO, 2015). There is clear intent to support, education and employ individuals with disabilities; however, the infrastructure in the UAE for serving individuals with disabilities is still in an early stage and, for the most part, inadequate. There is a strong desire for inclusive schools (e.g. Abu Dhabi Government, 2020 Federal Law No. 29, 2006; (Inclusive education, 2021; UAECD, 2011) although yet it takes time to train teachers and create a trained, inclusive communities in schools. By 2011, the UAE had established ten inclusive schools and, by the year 2013, the goal was to have 100 K-12 schools designed for inclusive education (UAECD, 2001), out of the 673 public schools at the time. The emphasis on the development of inclusive practices and model schools was in the K-12 sector. In 2013, Gaad and Almotairi reviewed the inclusion of students with learning difficulties at the postsecondary level. They found untrained professors who "relied so much on students themselves to 'teach' them how to teach" (Gaad & Almotairi, 2013, p. 289). There are more efficient and supportive measures that can be provided to instructors so that courses can support students to reach their full potential at the postsecondary level, particularly in the UAE where there is a keen desire to do so.

In the UAE, the term "People of Determination" has replaced the term "people or individuals with disabilities". To serve the needs of postsecondary level deaf and hard of hearing students in the Abu Dhabi region of the United Arab Emirates (UAE), Al Ain University partnered with the Ministry of Education and Zayed Higher Organization for People of Determination. Al Ain University offers deaf students the opportunity to study undergraduate majors in the College of Education under two programs – the Special Education program and Sociology program. The first graduating cohort of deaf students was in 2016. Currently, 38 deaf students are being served at two campuses: Abu Dhabi and Al Ain (the two campuses are a little more than an hour's drive apart).

Prior to the Coronavirus pandemic, Al Ain University planned to accommodate its deaf students in one room throughout the day. They are not included in typical classes with hearing students. The decision to place them all in one room was made at an administrative level. They probably thought it would be easier for the deaf students and the interpreter. Additionally, according to different studies (Oleszkiewicz, 2021), deafness is more difficult to overcome in the social context than other disabilities such as blindness. This results in more negative convictions about the social exchange balance, most likely due to the feeling of isolation and the stigma. In general, though, the university has received no complaints on this arrangement from deaf students or other stakeholders.

In response to the COVID-19 pandemic in 2020, the university, like nearly all other universities, quickly shifted classes from a face-to-face format to a distance-learning format. The rapid move to a distance learning format affected instructors, especially those teaching the deaf student population. There was little preparation time for instructors and even less for students. The quick migration to distance learning was problematic for many universities too (Pappas et al., 2018). Therefore, the perceptions regarding the technological instruction and accommodations provided to deaf students in online distance learning during the COVID-19 pandemic were investigated through the following research questions:

1. From the perspective of deaf university students, how did online distance learning affect their learning experience during the COVID-19 pandemic?

2. From the perspective of deaf university students, what are the benefits of using online distance learning during the COVID-19 pandemic?
3. From the perspective of deaf university students, what are the challenges of using online distance learning during the COVID-19 pandemic?
4. From the perspective of the instructors, how did they perceive their preparation to teach the deaf in general and their preparation to teach the group online?
5. From the perspective of the instructors, how did they perceive deaf students' success during online distance learning using technology?

3. Methods

3.1. Population and sample

Al Ain University delivers courses to deaf students in the College of Education under two programs: Special Education program and Sociology program. There is a strong desire and intention to provide the required human and technical support. The target population for this research consisted of the 38 deaf students who were enrolled in undergraduate courses in the College of Education at Al Ain University during the summer term in the 2019–2020 academic year. These students identified themselves as having a hearing loss, with requirements of specific support to continue their studies.

Having gained approval from the Institutional Review Board/ research ethics committee at Al Ain University, the first author talked with the two instructors of the courses and gained access to the participants. This study began with a convenience sample of 38 potential deaf student participants and 5 instructors attending/teaching deaf students at the university in the summer of 2020 during the COVID-19 pandemic. All deaf students registered in Al Ain University (n = 38) during summer term 2019–2020 were contacted through e-mail and/or directly at the end of one of the online classes in which they were registered. Of the 38 students, five male and ten female students (n = 15, 39.4%) agreed to participate through in-person interviews on MS Teams through an Arabic Sign Language interpreter. Although there were more potential participants, it was clear from the data that consensus among the issues emerged at a high level. In his study of deaf adults and their experiences in school, there was a strong 'shared experience' among 15 deaf adults who participated (Smith, 2013). Like Strauss and Corbin (1990), this sample satisfied the aims of this research study as it was intended to represent a snapshot of the experiences of deaf students in distance learning courses in the Middle East. This cohort of students is the *only* group of deaf students attending a postsecondary institution in the UAE. Fifteen participants is approximately 39.4% of the cohort. The range of ages and gender of the participants matched well with non-participant group. Typically, classes of deaf students are kept to a maximum of approximately 20 students, as true at Gallaudet University (Gallaudet University, 2021).

The students communicated with the first author through email. The first author requested the opportunity to interview the five instructors working with the students during the COVID-19 pandemic. All five instructors teaching the deaf students during this period were male. Three instructors agreed to participate in this study and reflected on their observation of students participating in their classes.

3.2. Tools

In this study, we generated two semi-structured interviews for the students and the instructors. The semi-structured interviews were self-developed by the second author. Questions were based on a literature review related to the challenges facing deaf students in postsecondary settings (e.g. Alsadoon and Turkestani, 2020; Lang, 2002; McKeown and McKeown, 2019). Through this review, questions were chosen that best fit the region, culture, and the deaf students in this specific setting.

Below are the semi-structured interview questions for students:

1. Describe the changes you faced when the University switched to distance learning.
2. What changes helped you learn?
3. What changes made it more difficult to learn?
4. Describe what would be included in the best and most effective distance learning environment for you.
5. What quick changes could your professor/university make that would help you the most?
6. For an online class to be perfect for you, what would you include and what would you eliminate?
7. What else would you like us to know?

Below are the semi-structured interview questions for instructors:

1. Describe your preparation for teaching deaf students in a face-to-face model and for online distance learning.
2. How do you think deaf students perceive their online distance learning experience?

3.3. Procedure

3.3.1. Preparation

After receiving the approval from the Institutional Review Board/ research ethics committee at Al Ain University, a pilot study was conducted with two deaf students who volunteered to review the semi-structured interview questions for clarity, accuracy, and ease of translation from spoken to signed Arabic. Written/spoken Arabic does not have a one-to-one correspondence with Arabic sign language. The grammar in Arabic sign language, and one sign, may hold multiple meanings; so, students looked for phrasing that would allow for clarity in both written and signed format. Students who participated in the pilot study provided useful feedback to ensure that both the interpreter and deaf participants were more likely to understand the questions. In preparation for the semi-structured interviews, the deaf students from the pilot study explained how to successfully hold a conversation between the deaf student, the interpreter, and the first author. For example, it is common for hearing individuals to look at the interpreter who is talking rather than the deaf person. Students advised the first author to look at the deaf person and simply listen to the interpreter. The research questions were revised based on feedback from the pilot study.

The first author, with one of the instructors, decided on a specific day for the interviews. The interpreter was subsequently informed that class time would be reallocated to the semi-structured interviews. He was provided a copy of the questions and prepared himself for this task.

To prepare for the students' interviews, the first author met the potential student participants during one of their classes. The meeting was conducted via MS Teams. He reviewed the purpose of the research, the main questions for the semi-structured interviews, and sought informed consent. This was all communicated to them through the sign language interpreter. The following measures were undertaken to prepare the students and ensure optimal data collection:

- To familiarise students with the research process and questions, a group discussion with deaf students (through the sign language interpreter) was organised in the class using MS Teams. Participants were assigned time to read through the questions and encouraged to make notes and seek clarification if needed. All students' questions were answered.
- The meaning of informed consent was explained to the students. Next, they were provided with informed consent materials. A discussion was held to clarify questions related to consent. Students were informed that the study would begin the next day. If they wanted to participate, they were requested to send their consent forms to the first author and log on to class. Participants self-selected an interview slot during the class period. The first author, the student, and the sign language interpreter participated in each interview.

- Fifteen students returned their consent forms. Students who did not provide consent forms were not a part of the team discussion. The discussion was recorded using MS Teams by the first author for validation and verification purposes.

Figure 1 illustrates the procedure that the research team followed in the interviews.

3.3.2. Data collection and analysis

Fifteen of the 38 potential student participants volunteered for the study and were interviewed. There were nine respondents from the Special Education program (60%) and six from the Sociology program (40%). Data were collected through semi-structured interviews using MS Teams, each lasting approximately 30 min.

The first part of this study investigated how online distance learning affected the learning experience of the deaf participants; the benefits and the challenges of using online distance learning during the COVID-19 pandemic. The second part of this study investigated instructors'
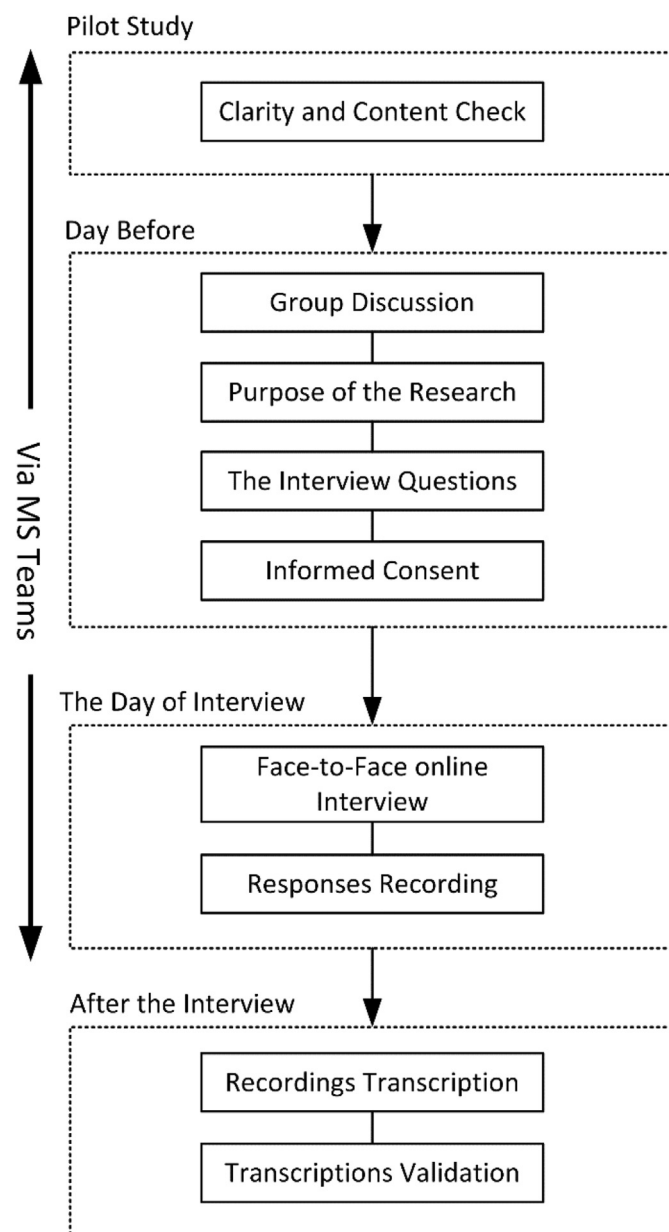

Figure 1. The procedure that the research team followed in the interviews.

preparation on how learning through distance learning technology affected the deaf students.

Student participants were assigned pseudonyms and an "M" or "F" to denote gender. Prior to data analysis, the semi-structured interviews were translated from spoken Arabic to written Arabic. Next, the transcripts were translated from written Arabic into written English. Student participants were assigned initials (S), and a number (1–15). Three male instructors participated. They were assigned an initial (I) and a number (1–3). The anonymised transcripts were distributed to the second and third authors. From this point, the research team was able to begin data analysis.

For the first part, we conducted a content analysis to retrieve textual data and information from interviewees. According to Basit (2003) the decision to use manual or electronic coding depends on the size of the sample and the time available for the researcher. Despite using electronic coding makes the process relatively smooth; however, it may distracts researches by focusing on using the software itself rather than the data. Therefore, for analysing small-scale datasets it is recommended to use manual coding (Lichtman, 2012; Saldaña, 2013). Since this "qualitative research does not deal with large datasets", it does not involve a lot of time for analysis (Basit, 2003); as a result, manual coding has been used in this research. The aim of the analysis was to fully report interviewees' comments and identify common themes. To analyse the contents, a thematic analysis approach from Vaismoradi et al. (2016) was adopted (see Table 1). Two of the authors participated simultaneously in each phase of the process.

The research team then began the *initialisation phase.* The English transcripts were read numerous times, and meaningful units were highlighted and coded using reflective notes. The salient themes were identified by each author, and through discussions, the team recognised that five themes fit the student responses. The team moved into the *construction phase.* Student statements were classified and compared. Researchers 1 and 3 reviewed the Arabic transcripts once again to ensure the translation into English was correct. Data were labelled. Translations were reviewed and matching determined. The team then started defining and describing. During the *Reflection phase,* the team related the themes to established knowledge. This included a return to the literature on how deaf students function in postsecondary settings. By the end of this phase, the data were stabilised. In the *Finalisation phase,* the team read and reread the revisions and included the existing knowledge related to deaf students in postsecondary settings. Minor adjustments were made. Finally, during the rectification phase, broad themes were finalised and connected with related established knowledge. The themes were reevaluated and discussed at length by the researchers until agreement was reached.

3.4. Reliability and validity

Reliability and validity were considered carefully during the research process. First, for the purpose of reliability, the analysis was carried out in parallel by all authors independently (investigator triangulation) and the constructed themes were compared and modified until an agreement was reached. The parallel analysis of data was done for reasons of reliability, which made it possible to explore differences and similarities between the respondents' statements (Kvale and Brinkmann, 2009). Therefore, data were discussed by the research team to refine, challenge, and elaborate on the developing thematic structure. To facilitate the process, criteria of internal homogeneity and external heterogeneity were used (Braun and Clarke, 2006); that is, data cannot fall between two categories, or fit into more than one category. Research meetings were held regularly throughout the data analysis process. Discrepancies were resolved through reference to specific data examples. The intercoder agreement percentage reached 80%. Disagreements included issues related to information technology as a separate theme or as an umbrella for the other themes. Through discussion, the team decided to include information technology as a separate theme. Eventually, 100%

agreement was reached. As themes were established, the interview transcripts were revisited and read once more.

Second, for validity purposes, validity checks included confirming and clarifying the transcripts with student participants. An Arabic sign language interpreter was the medium of communication between the researcher and interviewees. To make sure that the interpreter's statement aligned with the student's statement, the Arabic transcriptions were returned to the students for validation purposes. Students were given the opportunity to read the transcripts to confirm their accuracy or revise the transcripts to reflect the meaning of their statements. For each participant, the first author sent their transcript by email and sought a reply with written feedback if needed. Thus, the participants were able to check that the transcripts represented the interview accurately. They were able to add and clarify their statements. This active process provided high face validity to the transcripts, as described by Tong et al. (2007), which ensured an accurate reflection of the students' actual statements. All participants responded and all amendments were accordingly made. At that point, interview transcripts were translated into English.

4. Results and discussion

Five themes emerged from this research on deaf students' perceptions of online distance learning during the COVID-19 pandemic. An interesting caveat should be shared here. Deaf students in postsecondary school, in general, tend to be in regular and intense contact with one another through technology, typically with the intention of clarifying course information and gathering new information and knowledge (Sweet et al., 2019). Since deaf students are unable to listen in order to learn, the academic, assistive technology and accommodation needs of deaf students in postsecondary education are similar (e.g. Laurent Clerc National Deaf Education Center, 2013; National Deaf Center, 2020a,b,c,d,e; WHO, 2020b). Therefore, it is not surprising that deaf students' responses to questions tend to evoke similar responses, regardless of gender. This study was no different. The challenges were the same and, hence, the message that was conveyed was the same as well. We have provided quotes that reflect the perceptions of this rather single-minded group of deaf students. The themes included Course Content, Technology, Delivery Approach, Assessment Methods, and Social Interaction. These themes report challenges that were faced by students during the COVID-19 pandemic(see Table 2).

4.1. Course content

Content delivery and expectations are factors that determine deaf students' success in education using online distance learning. In the context of this study, students focused on the challenges from two main aspects of the course content: the volume and format of the content. According to McKeown and McKeown (2019), when it comes to online course structure for students (including deaf students), some universities

Table 1. Phases and stages of theme development in qualitative content and thematic analysis (Vaismoradi et al., 2016).

Phases	Stages of each phase
Initialisation	1. Reading transcripts and highlighting meaning units;
	2. Coding and looking for abstractions in participants' accounts;
	3. Writing reflective notes.
Construction	1. Classifying; comparing;
	2. Labelling; translating & transliterating;
	3. Defining & describing.
Rectification	1. Immersion and distancing;
	2. Relating themes to established knowledge;
	3. Stabilising.
Finalisation	1. Developing the story line.

expect the instructors to design their online courses' content, whilst others utilise instructional design teams and then consult with student disability services to recognise the need for and provide appropriate accommodations.

At Al Ain University, it is the instructor's responsibility to create the course content and format of material for deaf students. The courses are designed for the typical hearing student, according to assumptions made on the level of accessibility needed to help them participate fully in the course. This involves resources such as Word documents, videos, PDF files, or any other resources. Similar to instructors in other universities, instructors in Al Ain University may not be aware of the needs of this group of students (Edmonds, 2014; Mike & Harrington, 2013).

According to the survey in this research, most of the students suggested that the number of slides was overwhelming. For example, S1 said, "The discussion approach was missing because of the large volume of content the instructor needs to deliver [sic]." The perception was that the LMS lacks resources and, if found, they were very difficult to access. The content within the slides was too heavily based on reading. S2 stated, "We felt the need for different types of content like images and not just focusing on text [sic]." In addition to this, S1 clarified that "using texts only is not helpful for deaf students [sic]".

These difficulties students faced, in general, were a result of assumptions made by instructors who had received little training on how to teach students with hearing impairment and so were not fully aware of their accessibility needs. To illustrate, some instructors replaced text with images, assuming that would help their students, rather than combining text and graphics to support one another, which was a fortunate happenstance because that strategy can be more helpful to deaf students (Fajardo et al., 2006). At the same time, such addition of graphics was not uniformly integrated into classroom instruction in other courses. A more challenging barrier to accessing content was access to the internet.

For the deaf students, both course content and instructional methods appeared to be the same as they were during classroom instruction prior to the pandemic. Nothing changed, and yet everything had changed. In the classroom, the instructor and the interpreter stood in the front of the room. The content was explained and there were easy discussions in that setting. When courses moved to the online distance learning format, students felt overwhelmed. The content that was on the screen was the same. The interpreter was on the screen but in a small box. The difference for the deaf students was that without being able to see the instructor the course content quickly appeared overwhelming and disjointed. They saw only the interpreter. In addition, class discussions were challenging because all comments were funnelled through the interpreter. There is an MS Teams fix that can re-size the space for the interpreter and add both the instructor and content. Content that is well organised and available for students prior to the class also provides opportunities for pre-reading.

Instructors can be proactive and provide course material with detailed instructions to both the deaf students and the interpreter. The interpreter should have access and be required to read the material to avoid misunderstandings. This recommendation aligns with the suggestions of Alsadoon and Turkestani (2020).

Instructors and course developers often believe what they do is sufficient to accommodate their deaf students' needs because the primary method of delivery for online courses is text or audio but, in reality, several other methods are available that they are not fully aware of. According to McKeown and McKeown (2019), while it varies from course to course, some of the main tools that instructors can use to help students with hearing impairments may include the following:

1) Lectures/video transcripts
2) Captioned videos

We recommend that instructors engage in different delivery approaches that can energise students, actively engage them, and reduce the burden of the online learning experience. However, it is essential to implement this method using the itemised steps given by (Kim and Chen (2016)), using asynchronous and synchronous technologies. Additional information and suggestions specific to postsecondary education can be found at nationaldeafcenter.org.

Although universities have regulations regarding class duration, the instructor can utilise different delivery approaches to reduce the burden of the online learning experience. Integrating a visual discussion session, video presentation, infographic content and pop-up polls within the lecture will give the opportunity to reach students diversely.

Another critical recommendation is to keep the instructor, interpreter, and students on screen or at least give the option for the student to keep any of them simultaneously on screen. This option will facilitate the communication channel between the instructor and the students and among the students themselves inside the online class.

4.1.1. Visual attention training for instructors

It is important to recognise that deaf students are visual learners and, because of their deafness, they attend to one visual input at a time. S7 said, "We can't focus on the interpreter while reading the slides. We need the instructor to give us at least 2–3 min to read a slide before we can watch the interpreter." In a study of visual attention, Thakur et al. (2019) found significantly slower processing speeds for deaf students than among their hearing counterparts.

Without training, instructors would not naturally know when to stop, wait for students to read the slides, and then watch as their eyes move back to the interpreter. It was impossible to see that during the online distance learning. Instructors will benefit from specific training in how deaf students learn and the components and strategies used in effective face-to-face and online distance learning classes.

At the same time, deaf students and perhaps the interpreters would benefit from instruction in self-advocacy. The recognition that a team effort is required can be accomplished and has the potential to boost self-confidence as well (NDA, 2020). This resource provides basic information and a full infographic (NDA, 2020).

4.1.2. Student feedback and interpreter training

In addition, typical accommodations for deaf students in post-secondary settings include a sign language interpreter; however, "the degree to which interpreters can capture a sufficient level of material can depend greatly on the context of the communication" (Cawthon et al., 2015, p. 11). In the UAE, there are no interpreter training schools. Interpreters are "imported" from countries like Jordan. They may have a "license" but mostly lack training. It is impossible to know how much the

Table 2. The main themes and codes from the research.

Codes	Themes
Slides	Course Content
Text	
Resources	
Notes	
Computers	Technology
Camera	
Internet	
Microphone	
MS Application	
Way of communication	Delivery Approach
Interpreter	
Instructor	
Focusing	
Exercises	Assessment Methods
Exams	
Physical appearance of the teacher	Social Interaction
Colleagues	

students understand through an untrained interpreter. The role of a sign language interpreter is to facilitate communication between the instructor and the students. That role includes being the 'voice' of the deaf student. That role also involves accountability as well as holding to a Code of Ethics. Without an interpreter training program, we highly recommend seeking student feedback related to their understanding of the interpreters' work during classes. To receive an honest feedback, another interpreter would be required, who will covey the students' opinion without any bias. We also recommend specific training for the instructors and the interpreters so they can work together synchronously and the attention of the deaf students is not divided. We also recommend the adoption of a deaf education teacher training program along with an interpreter training program for the UAE.

4.1.3. Alternative formats

Reading a screen is uninteresting, and even less so when deaf students' attention is divided. Kim and Chen (2016) recommend presenting content in different formats such as videos and images. Student responses could also differ. Using polls in MS Teams is an option. This simple strategy can support student engagement as well as provide instructors with a quick formative assessment. The instructor should allow for additional time for reading and responding.

4.2. Technology

Technology is the main enabler for online distance learning. However, for deaf students, there were technical barriers related to access and bandwidth in using their online program that is a necessity for distance learning (Slike et al., 2008). Moodle & MS Teams were the platform used for distance learning. In their study, Moreno et al. (2012) found that Moodle was only partially accessible and did not provide the needed support to the instructors who would be posting to ensure their students could access what they were supposed to do.

In this study, the students expressed the difficulties they faced in using new technologies, the learning management system, and the applications in this experience. One student (S15) said, "I was unsure about this new method of learning as I knew it requires certain IT skills which I don't have." In one way or another, all interviewees expressed gaps in computer skills and a high sense of the need for those skills in order to function successfully in a fully online class. Although all the students had completed a computer skills course in a previous semester, the foundation for online distance learning was not part of any of the IT syllabi. Deaf students faced challenges and barriers related to ease of access to the content.

Although the students complained about their inability to properly integrate the new technologies in classes at the time, most of the interviewees expressed their "happiness" because they will be better prepared to use technology in order to attend their classes. They believed the new skills will now help them in their future careers. According to S1, "I am happy because we are now [sic] better able to use computers and internet than before."

The major barrier to understanding content included the speed of the internet at their end and the speed of the internet at the interpreter's end. When the internet speed was slow, sign language from the students to the interpreter was slow, disjointed, and often misunderstood. Student (S2) said, "I face a [sic] problem with the internet in my house and because of interruptions I lose a lot." Similar to this problem, participants complained about the quality of the camera and internet available for one of the interpreters. When high-quality video is not used or available, the message can be distorted; this distracted them and made it difficult to understand everything their lecturer wanted them to understand.

Students' prior expectations about their ability and knowledge of using technology affected their perception of this experience. Many of them found the transition from a traditional class to online distance class

challenging. Although the instructors had training in MS Teams, the students did not have explicit visual instructions from the IT department. Their knowledge of and use of MS Teams was a result of using the platform, not shaped by formal instruction, which resulted in an awkward start.

In addition to the lack of training for students, there was little thought given to how the interpreter would fit into the functionality of the class. There was no reference point for the university in the swift migration from classroom to online distance learning and the use of the interpreter. In this case, the interpreter used a personal computer on a personal internet connection. Faculty were given the option to teach from their personal offices and all equipment was provided. Since the interpreter used personal equipment and personal internet, problems were encountered. The image of the interpreter frequently froze or, sometimes, the pace of the interpreting slowed due to the internet speed. This affected student comprehension of the material. Similar challenges were found in Alsadoon and Turkestani's (2020) study of deaf students and online instruction in Saudi Arabia. Heavy traffic affected bandwidth, which compounded access challenges for instructors and deaf students (Alsadoon and Turkestani, 2020).

We recommend that interpreters either be requested to work with the instructor on campus in a separate room or be provided with a high-quality laptop with a built-in camera and high-speed internet. We also recommend that instructors and interpreters practice with the relevant technology prior to class to better ensure a smooth delivery of content. Finally, we recommend training on the organisation of the MS Teams screen so that the interpreter's area is large enough to see without eye strain.

Some training courses will help both instructors and students to use technology more efficiently by utilising online tools and hacks. Although the participants previously took the course of computer skills, these hacks did not provide enough support to use MS Teams. Ideally, some explicit instruction and self-paced practice may bolster student confidence in their ability to learn using the MS Teams or any other platform used for instruction.

4.3. Delivery approach

Effective and targeted online instructional delivery for students who are deaf supports the achievement of the students. Sufficient communication and delivery methods are vital in the education of deaf students. Comprehension is minimised when the students have to look at the slide and the interpreter at the same time. Simple devices like building in pauses allow students to assimilate the content, recognising that there are times in a course when deaf students must choose to either watch the interpreter or read a slide, which typically results in loss of a part of the information (Foster and Long, 1999). Instructors, when possible, can provide both synchronous and asynchronous content. Taped content with an interpreter can be accessed at the convenience of the student and can be reviewed when points are missed. Simply posting a summary of the class content can also support learning according to the National Disability Authority (NDA, 2020).

It has been found that even regarding the methods delivered by universities, their success in the course was impacted by their disability (Roberts et al., 2011). For example, Mike and Harrington (2013) described a case, wherein the delivery and communication methods were altered to accommodate a student with a hearing impairment, yet the student still struggled in understanding and gaining from the said course. Although this could be seen as a 'failure', it may actually be a call to action. How can universities, instructors, interpreters, and students develop strategies that promote academic achievement in spite of unique circumstances?

The deaf students attending Al Ain University took English and Islamic Culture courses in March 2020, when instruction was delivered in a

face-to-face model. During week nine of the semester, the university moved to a fully distanced learning platform that included Moodle for course instructions and MS Teams for course delivery. Using MS Teams, hearing students were able to see their instructor on the screen and communicate with them directly. However, with deaf students, only the interpreter was on the screen. The instructor could not see the students and vice versa. The only person visible to the deaf students was the interpreter. According to the literature (deGroot, 2015; Winstone, 1995), highly skilled interpreters familiar with the content can help students to achieve better scores than their peers who are less skilled interpreters.

When MS Teams is used in course delivery, there are nine screens available for view. Nevertheless, the instructor was not visible on the screen. Instead, they could only see the interpreter on screen. This presented an enormous barrier for the deaf students. They could not see their instructor. The only person on the screen was the interpreter, who was shown in the MS Teams small box, as was the material text. S2 stated, "indirect communication with our teacher has caused some lack of understanding, which negatively affected my learning [sic]." Another student (S9) stated, "talking to the interpreter and not being able to see the instructor on the screen gave us the feeling that he doesn't exist and therefore this discouraged us from asking some questions we wanted to ask [sic]." S8 said, "It is a big challenge. It is frustrating because we feel our questions are not addressed properly by the interpreter, and the time it takes to repeat the question again online makes it longer than usual, which is frustrating for us and stops us from asking any more questions [sic]." This is an example of an issue that should be addressed with deaf students. They did not advocate for themselves. They did not communicate their frustration with the instructors. Students and the interpreter could have mentioned the "big challenge". To our knowledge, no one mentioned it. Self-advocacy is considered one component of potential success in individuals who are deaf (Smith, 2013).

Another dimension is that the delivery approach of the course remained the same, as if the course were still occurring in the classroom. As an example, class duration was one of the factors students complained about. While course time in other local postsecondary courses was reduced by one third, the length of online class time at the university remained the same. S12 stated, "The class duration is too long and therefore we feel very tired trying to focus. It is not enough that we see the interpreter, as we need to see the instructor also using the white board." Similarly, S7 said, "We can't focus on the interpreter while reading the slides. We need the instructor to give us at least 2–3 min to read the slide, before we can watch the interpreter." This presented a challenge to visual attention. First, the students only saw the interpreter in a small square. The instructor was not on screen. Visual attention, at times, was demanded in two places at the same time – on the PPT and on the interpreter. Visual attention is fluid and deaf students are likely to perform worse than their hearing peers when attention gets divided (Thakur et al., 2019).

Although class time remained the same, students recognised some advantages in online distance learning in terms of time, cost and new experiences gained on the computer. According to S1, "I am happy because now we don't need to travel, which saves us time, effort and money [sic]."

When comparing online and traditional class delivery approaches and methodologies, the first complaint is the lack of a physical classroom and presence of the teacher. In general, immediate feedback and communication between instructor and students are considered critical for the learning experience (Kim & Chen, 2016). In online class delivery, the communication and language are missing, which tremendously affects the course accessibility (McKeown and McKeown, 2019) and the learning experience as a whole. This challenge of the physical separation from the instructor was addressed by McKeown and McKeown (2019) as being a potential barrier for deaf students.

In this study, both students and instructors noted this problem. The students wanted to see the instructor and the instructor wanted to see the students. Instead, the content showed up on the screen inside the little box, with the interpreter. Alsadoon and Turkestani (2020) noted that instructors, in particular, missed seeing the faces of the deaf students in order to recognise whether they had understood a specific concept. To accommodate the deaf students, the instructor, the interpreter, and the content together, we recommend devising a strategy that splits the MS Teams screen into fourths. In their study, Bosh-Baliarda et al. (2020) suggest a left-hand side position as being the most favourable for comprehension of sign language when the screen is split. This is an area where deaf students should be a part of the design team, particularly since reading in Arabic begins on the right. There may be unrecognised preferences. The publication *Making Online Learning Accessible for Deaf Students: A Guide to Disability Servers* (NDA, 2020) is an easy place to begin the process.

4.4. Assessment methods

Proper management is considered a key factor that leads to academic success for deaf students (Lynn et al., 2017). Assessments are part of this management. During the COVID-19 pandemic, assessments distributed among deaf students, including assignments, quizzes, and exams, became problematic in two important areas: (1) the type and structure of the assessment tools and (2) the lack of direct communication during the assessment event.

During an assessment event, in their typical classroom, students raise their hands with questions. A very challenging issue for the deaf students was the unavailability of direct communication with the instructor during the exam. During classroom quizzes or exams, the interpreter is available for face-to-face communication. There is the time involved, but the student can see both the interpreter and the teacher/instructor. The online distance learning format presented challenges because the students could only see the interpreter on the small screen and they perceived that the communication process took longer (see Figure 2).

According to S6, "Exams are too long and have too many questions, which are not easy to finish as we need to type using the keyboard (slow typing) [sic]." Similarly, S8 said, "assignments given to us are too long and there are too many instructions we need to follow. Not being able to contact the instructor directly affected the quality of our answers." Using the same types of questions in online learning as in traditional classes resulted in student dissatisfaction. Also, students felt a similar assessment structure as in the traditional classes in terms of the length and type negatively affected their achievement. There were two issues: First, there was a lack of basic IT skills in terms of keyboard typing to answer long questions. Second, the length of the assessments caused stress for the students, as they felt unable to cope. Accommodations for testing with deaf students quite often include additional time (NDC, 2020a,b,c,d,e). Additional time seems like an equitable accommodation since the reading levels of deaf students tend to be lower than those of their peers (e.g. Mayer and Trezek, 2020; Metha et al., 2005; Wang et al., 2008).

The deaf participants noted a few challenges with the assessment. They noted that the assessments remained the same, even though the format of the classes had changed. In the classroom, they could ask questions. In the online distance learning setting, they could not. This was frustrating for them. Another challenge for deaf students was writing/typing. Similar to the challenges found in the study by Alsadoon and Turkestani (2020), student writing was often difficult to read. Keyboard fluency was lacking for most of the students so that more time was required to type the questions. Students may have known the answers, but typing skills may have affected assessment grades. Cawthon and Wurtz (2008) suggest alternative assessment strategies, such as providing a menu or a portfolio that can serve as a comprehensive body of evidence that the student does understand the content. Alternative assessments also align with the tenets of Universal Design (NDA, 2020).

It is known that the inability to comprehend a given concept in class can cause academic difficulty for deaf students (Lynn et al., 2017), especially when they lack background knowledge (e.g. Dochy et al., 1999). Deaf students have different communication preferences and
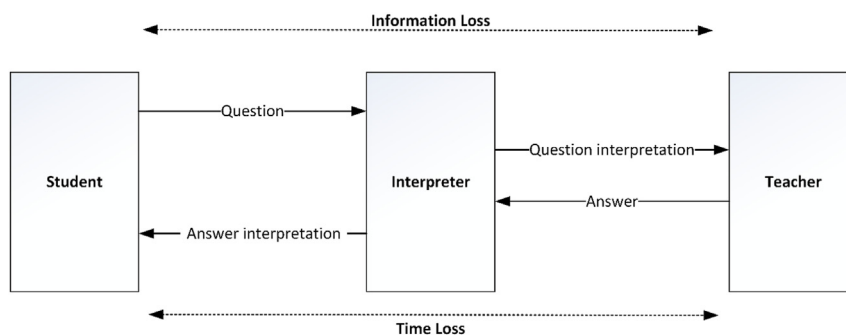
Figure 2. The flow of information between the instructor and the students during an exam, with the information and time losses.

diverse tactics to conduct academic work (Lynn et al., 2020). In our case, the type and structure of the offered assessment methods did not change with the migration to online distance learning. The difficulties the students faced previously during the face-to-face mode were handled by face-to-face interaction and by trying to bridge the gap physically. In the new forced learning shift, leveraging online communication and assessment tools was much harder. The challenge increased through having the same type and numbers of assessment methods, and the absence of physical social communication to bridge the differences and difficulties.

Instructors can divide an exam and deliver it over two days. This strategy provides students with the opportunity to show their learning and at the same time reduces stress. Cawthon (2006) suggested allowing the sign language interpreter to sign parts of the test that are written, particularly if the required reading is substantial. A major disadvantage, however, is the competence of the interpreter. Videotaping the interpretation of the reading material and verifying it with a second sign language interpreter can ensure more reliability.

Although focusing mainly on bilingual English instruction, the suggestions by Holcomb and Lawyer (2019) could work in classes other than English also. One assessment option may include a pre-post test method when appropriate. In this manner, the instructor can assess the current knowledge of students, engage in instruction, and provide a post-test.

4.5. Social interaction

Social interaction was identified as a theme in this study. Participants expressed their sadness at not being able to socialise with each other; for instance, S4 said, "at the beginning of the pandemic, we as a group asked the university to give us the opportunity to come to classes rather than using online distance learning, as coming to university is one of the few opportunities we get to socialise." However, due to the strict health regulations during the pandemic, this request was not approved.

The university setting provided numerous opportunities to socialise with both deaf and hearing peers, although this socialisation is not always possible. To communicate effectively, the deaf students either enlist the help of a sign language interpreter or hearing students who have learned some Arabic Sign Language. In typical hearing universities and in life, deafness can be isolating (Oleszkiewicz, 2021). S6 and S9 looked at this matter from another perspective. When they were receiving classes before the COVID-19 pandemic they felt isolated from their hearing peers since their classes were scheduled in one room. We are unsure why this decision was made. It was administrative in nature. According to S6, "I am proud of what I am and understand my reality of not being able to hear as the others. However, isolating us from the others brings sadness to me as we are treated as strangers." Therefore, according to S6 and S9, they felt happier receiving learning online, as their identity loss has stopped. They believe being deaf is not a big problem as they can manage it efficiently. Their perception of deafness may not be shared among the group members. However, isolation

among deaf students can be reduced through scheduling classes that include both deaf and hearing students. This, however, is an administrative decision, although it could be ameliorated by self-advocacy on the part of the deaf students.

Students in this study missed the social interaction with each other. The deaf students asked for a special dispensation so they could go to the university during the pandemic because it was one of the only times when they could socialise. The students also preferred the classroom model for their learning. Social interaction is an important part of education, and even more so when deaf individuals are isolated within a family who may have no signing members. During the COVID-19 pandemic, it is more than likely that the university will not be the centre of social interaction for any student. Students themselves will have to navigate this challenge.

Physical social interaction has proven to be a means of straightforward collaboration, to share knowledge and experiences, and to be self-giving (Oleszkiewicz, 2021). However, the absence of audition cues can negatively affect the students' interaction in a typical mixed social environment (Oleszkiewicz, 2021) and hinder socially meaningful data being obtained while retaining the preferred social interactions (deGroot et al., 2015). In general, deafness is related to reduce social participation (Oleszkiewicz, 2021).

In fact, little is known about the quality of relationships for deaf students around the world (Oleszkiewicz, 2021), and there is even less awareness in the developing countries. The main challenge in the research case was that the students did not have "the resistant and navigational capital" (Johnson et al., 2020); that is, the ability to express the type and amount of assistance and adjustments necessary to succeed in distance learning classes. That may be caused by the lack of trust deaf students have in others compared to their peers (Oleszkiewicz, 2021). Unlike hearing students, the information coming from the interpreter is expected to be accurate. Without trained interpreters, the information may be inaccurate and result in poorer academic achievement for deaf students. Trust is critical.

Although it may seem uncomfortable, the easiest way to find out what deaf students need is to ask them. Providing students with the opportunity to direct the class both empowers students and sets up a successful platform for learning. The National Deaf Center (2020a,b,c,d,e) suggests that instructors connect with the deaf students, clarify assignments, provide transcripts if possible, and develop a turn-taking procedure so one person talks/signs at a time. This reduces visual distractions. Finally, be prepared for technical issues (NDA, 2020).

There can be no "one-size-fits-all" solution to all challenges and for all students; however, some techniques will help to support the unique needs of deaf students. Informal chat and more substantive peer-to-peer contact prior to class should be included in classes with deaf students (Lynn et al., 2020). Actually, this will promote learning during class and will enhance communication with their peers, the teacher and the interpreter. This exercise offers deaf students the chance to communicate

with their friends, an integral source of social encouragement, to express their experiences and to bridge the gap of technological platforms.

Schedule classes differently than normal classes so students "take screen breaks." Screen fatigue is real, especially if the text size is small on the laptop screen or mobile phone (Lin et al., 2013). Learning through listening is easy. Learning through sign language requires the coordination of both eyes and brain processing power. In addition, the interpreter is only in 2D on a screen. Deaf students (and interpreters) benefit greatly from breaks at least every hour (NDA, 2020).

Request a note-taker for the class. Typical accommodations for deaf students include the sign language interpreter, but almost always include a hearing, paid note-taker. Deaf students cannot attend to two visual stimuli at the same time. Providing a paid note-taker will reduce the stress on students, and if reviewed by the instructor, notes provide an accurate review of the class content.

4.6. Instructors' perceptions

Five instructors were invited to participate in this study. All five were male. Three instructors agreed and were interviewed regarding their perception of teaching deaf students using online distance learning during COVID-19.

The instructors were asked about their preparation to teach the deaf students in their classes. They expressed that no teacher preparation training has adequately prepared them to teach deaf students. According to I1, "During my teaching experience, this is my first time teaching deaf students. I found this experience rewarding, as I had to revise my methods of teaching to cope with their needs, which has helped me acquire new experience." In terms of training, despite responding that they understood the implications hearing loss has for deaf students' learning, all participants indicated their lack of experience of how to deal with deaf students and understand their specific needs. They felt unprepared to teach deaf students.

Despite feeling unprepared, one instructor sought to match his instruction to the needs of the students. I2 stated: "I found teaching English as a foreign language to deaf students very difficult. I used images from the internet to link with words, but I cannot always easily find the correct ones. I taught English 1 to the same group before in class, and it was a challenge to teach them comprehension, but with online distance learning I found it even more difficult." According to the same instructor, he sought to learn new techniques that he found very helpful in teaching deaf students a foreign language, such as using colours to deal with the structure of the sentence. This instructor was fortunate to have taught the group prior to the pandemic and during the pandemic. Instructors in this semester teach the deaf students only once since they teach general university courses (i.e. Islamic culture and English). Thus, their experience in dealing with them and developing an understanding of their needs will remain limited.

Instructors uniformly agreed that they see deaf students as capable learners. They believe that deaf students are academically capable and will make good progress compared with their hearing peers if they get the support they need. Furthermore, respondents also expressed their happiness to cooperate with an interpreter using MS Teams.

Similar to the response of the deaf students, all three instructors felt the challenge of not being able to deal directly with deaf students during class. The class content was on the screen. The interpreter was on the screen but the instructors never were. Although MS Teams helped them as a technology tool to facilitate their work, the physical element was missing, which made it worse than in the face-to-face model. When using MS Teams, the instructors had to depend completely on the interpreter's ability to deliver information for both parties.

Instructors noted that they asked the deaf students for feedback numerous times. None of the deaf students shared feedback with the instructors. When the first researcher shared deaf students' feedback with the instructors who participated in this research, two of them were surprised about the students' complaints, especially since they consistently asked students for feedback. None of the deaf students had shared such feedback with them.

5. Conclusion

Deaf people have been called "the forgotten victims of the pandemic" (Shin, 2020). Students at the postsecondary level, their instructors, and their interpreters shifted from classroom learning to online distance learning in a very short time. In this study, we engaged in semi-structured interviews with 15 deaf students at a university in the UAE. We also interviewed three of the five instructors assigned. Students found online distance learning a challenge. They missed seeing their instructor on the screen. Furthermore, using a sign language interpreter was awkward. The results of this study revealed some areas where changes can be implemented so that instructors can more effectively accommodate deaf students in the online distance learning environment. It also revealed areas where university infrastructure can support the needs of the stakeholders. More knowledge about the online distance education process and the people involved will enable instructors to re-design courses and coursework taking into account the needs of the deaf population. This knowledge will not be lost when classes resume in brick and mortar classrooms. In fact, the process of transitioning back to face-to-face classes should be seamless.

The costs of the COVID-19 pandemic for education are substantial both in money and in loss of time and loss of educational opportunities. No one was prepared for the rapid shift to online distance learning. As colleges and universities move forward, we suggest the following:

- Training for all instructors on the effects of deafness on learning, effective strategies for teaching visual learners, and on classroom needs of deaf students
- Training for instructors with the interpreter
- Formal training for the students from IT with an interpreter on the use of the LMS and the delivery system prior to the first class
- Engaging deaf students in planning how the class will run (e.g. turn-taking, time for reading the screen, "screen breaks", etc.)
- Working with the IT team to manage the screen so that instructors, students, the interpreter, and the content can all be seen simultaneously'
- Considering the assessments and how they may be adapted to online distance learning
- Providing high-quality equipment for the sign language interpreters

6. Limitations and future research

The size and convenience sample remain a limitation. Another limitation is the required use of the sign language interpreter. Uncertainty surrounds the responses from participants whose first language is not English (Barirball and While, 1994). Although this limitation was somewhat mitigated through email clarifications with the student participants, it cannot be entirely ignored.

Nowadays, there is a growing in the research regards adding innovation IT solutions to support students with special needs. Therefore, more focused for deaf students is required regarding online learning. These technologies could be unique platform offers new kind of support for meeting special requirements to reach full participation of deaf students. Future research should highlight the new design of interactive technologies including participatory design and the possibility transformative potential of those designs to tangible computing.

Moreover, the possibility of using animation for deaf students should be considered as it has become an important research question (Marco et al., 2013; Baglama et al., 2018). That requires examining and discussing the role of animation as a tool to enhance online learning for special needs in general and deaf students in particular.

Declarations

Author contribution statement

Abdallah A. Alshawabkeh: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

M. Lynn Woolsey, Faten F. Kharbat: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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