AlShawabkeh, A., Kharbat, F., Daabes, A. A., & Woolsey, M. L. (2023). Technology-based Learning and the Digital Divide for Deaf/Hearing Students During Covid-19: Academic Justice Lens in Higher Education. *Educational Technology & Society*, *26*(4), 136-149. https://doi.org/10.30191/ETS.202310_26(4).0010

Technology-based Learning and the Digital Divide for Deaf/Hearing Students During Covid-19: Academic Justice Lens in Higher Education

Abdallah AlShawabkeh[1], Faten Kharbat[2*], Ajayeb Abu Daabes[3] and M Lynn Woolsey[4]
[1]College of Business, Al Ain University, UAE // [2]College of Engineering, Al Ain University, UAE // [3]College of Business, Liwa College of Technology, UAE // [4]Campbell County Public Schools TN, USA //
abdallah.alshawabkeh@aau.ac.ae // faten.kharbat@aau.ac.ae // ajayeb.daabes@ect.ac.ae //
drmarylynnwoolsey@gmail.com
[*]Corresponding author

ABSTRACT: This longitudinal mixed method study investigated the education experiences among 38 Deaf/Hard of Hearing (DHH) students, 44 of their hearing peers, and three lecturers in two programs at a postsecondary institution in Abu Dhabi, UAE. Longitudinal data were collected at three points in time, summer 2020, winter 2021, and spring 2021. To investigate the differences between the two groups, GPA marks and responses to designed questionnaires for the different moments were collected from students. Repeated-measures ANOVA, the fixed effect regression approach, and one-way ANOVA were used to analyze the quantitative data. Qualitative data were collected through semi-structured interviews and personal communication with the students and the lecturers. Interviews were conducted with the addition of a sign language interpreter familiar to the DHH students. Results revealed a significant distinct digital divide between the two groups in academic achievement, degree of adaptation, and general perceptions of their education. The results of this study suggest that DHH students in postsecondary settings may be at risk of underachieving in the distance learning study mode. As a result, higher education institutions, universities, and curriculum designers need to take steps to improve the environment of distance learning platforms considering the diversity of students' needs. This will ensure that students with hearing loss have equal access to lectures, course content, and their peers. Promoting equity and justice in the learning environment aims to bridge the knowledge gap and prepare DHH students for their future careers.

Keywords: Longitudinal study, Digital divide, Covid-19 crisis, Academic justice, Deaf/Hard of hearing students

1. Introduction

Simply defined, the digital divide is the "gulf" between the people who have what they need to access the internet and those who do not have what they need to access the internet. It may have been simpler in the 1990s when the term digital divide began to take hold (DeMartino & Weiser, 2021; Dijk, 2005). In the notion of "have what they need," there is an inherent grouping and/or individualizing of the digital divide. Do groups and individuals have the competency to effectively use the technology (Wu et al., 2018)? How do sociodemographic and socioeconomic indicators such as age, income, gender, education, and disability status affect an individual or group's place in the digital divide (Goodall & Ward, 2010; Jones et al., 2009; Rice & Haythornthwatte, 2006)?

Additionally, inherent to the digital divide, are educational justice (Corcoran et al., 2021; Xiao, 2021), equity (Gorski, 2005; Williams et al., 2021), inclusion (Long & Kowalske, 2022; Shaw, 2021), and social justice, which is a process as well as a goal (Xiao, 2021). The goal is to empower all groups in society to have full and equal involvement that is mutually tailored to fulfill their needs (Shin, 2020). The process promotes equity-mindedness by critically reflecting on how to overcome systemic injustices and pave the path to social justice (Leithwood et al., 2019). Addressing these issues is one of the answers to closing the digital divide (The National Association for Multicultural Education, 2020) During the Covid-19 pandemic, a spotlight was cast on the digital divide on many fronts. This paper addresses the effects of the digital divide in terms of access to distance learning by deaf and hard of hearing students attending virtual classes at a university.

All students had access to the internet. The university education was free for all students. Age, income, and gender do not appear to play a part in the digital divide in this study. Components of the digital divide that challenge deaf and hard-of-hearing students include the competency to use technology, equity, inclusion, and educational and social justice. The competency to use the technology is relevant to the professors and to the individuals in information technology who designed the platform for instruction. All students had the right to continue their education during the pandemic. Not all students can succeed with equity.

Literature focused on DHH students during the pandemic is limited. As evidence, in SciVal (Scopus), statistics show that only 15 studies were conducted between 2018 and 2022 at the time of writing this study addressing "deaf," "higher education," and "Covid-19" jointly; none of them was longitudinal (SciVal, 2022).

This study addresses the issue of appraising the educational experience and the academic achievement of DHH and hearing students through the lens of components of the digital divide that affected university students with hearing loss. It also, demonstrates the perceptions of students and lecturers when implementing the distance learning model of education during the Covid-19 pandemic by answering the following questions:

- Did Covid-19 affect academic achievement for DHH and hearing students equally over time?
  If yes,
- Did both groups adapt at the same rate during the pandemic?
- Did digital equality contribute to the perception of equity amongst both groups over time?

This study provides rich knowledge and information about technology-based learning by using longitudinal quantitative and qualitative approaches to enhance and deepen the understanding of different perspectives and experiences over an extended period and change.

1.1. Context of the study

The United Arab Emirates (UAE), also called the Emirates, is an ambitious young country located at the eastern end of the Arabian Peninsula. There is a priority to ensure Emirati citizens with disabilities have rights and are protected and afforded equal opportunities in all areas of life (UAE, 2021). According to the World Health Organization, approximately 11 percent of the UAE population has a disability (WHO, 2020). Federal Law protects Emirati citizens with disabilities (also called People of Determination) No. (29), 2006. They may not be discriminated against in any way. For example, the law provides for "equal care, rights, and opportunities in education, health care, training, and rehabilitation" (UAE, 2020). The UAE also guarantees, "the right to request, receive and communicate information on an equal footing with others" (UAE, 2020, sec. 7). The law was passed in 2006. Nevertheless, executing this 16-year-old law for students who are DHH remains a challenge, particularly in higher education.

Higher education institutions are considered integral to the UAE learning management system. DHH undergraduate students' bachelor's degree enrollment depends on various factors, including high school grades and performance on standardized tests. Students enter with a range of communication styles/preferences, academic backgrounds, cognition abilities, and digital literacy. These qualities often play a crucial role in their success and response to online education (Lynn et al., 2020). Sign language is unlike most other languages; it has no written component, and so DHH students have the extra challenge of learning the language without its written component to boost their learning process.

The courses offered for DHH students are limited to two specific programs. The programs take eight semesters plus an internship semester to be completed. The programs aspire to actively prepare special education teachers and socially qualified cadres acquainted with knowledge, science, and modern technology. DHH students in the UAE, depending on the severity of their hearing loss, learn written Arabic and written English. Their preferred mode of communication is a mixture of Arabic Sign Language with some features of the developing Emirati Sign Language and American Sign Language. In the university setting, they take classes with a sign language interpreter who is typically familiar with these signed languages.

A Moodle-based LMS was established in the university early in 2013 to be used by all students and all faculty. The university provided consistent training for new students and faculty every semester. However, the LMS was only used to support students during the semester before the pandemic. All classes were provided face-to-face with no exceptions. During the Covid-f19 pandemic, in the middle of the second semester of the academic year 2019/2020, UAE education institutions migrated from face-to-face to complete distance learning in response to instructions from the Ministry of Education. Relying on distance learning during Covid-19 was the only method that could reach the students in the UAE. The use of distance learning may have unexpectedly exacerbated the challenges of "technical infrastructure, competencies, and pedagogies for distance learning" (Marinoni et al., 2020, p. 2) facing students in the world, in general, and DHH students in particular.

2. Material and methods

2.1. Participants

The target population for this research consisted of all the students admitted before the pandemic in the academic year 2018/2019 in two programs at one of the UAE universities, where 38 DHH students and 44 hearing students registered in the same programs taking the same courses at the same pointed semesters.

2.2. Methods and data collection

This 12-month longitudinal study investigated the digital divide between two groups of students (DHH and hearing students) across three measures times. Data collection began at the beginning of the Covid-19 pandemic during the summer semester (June 2020) (T1). A short time after the learning process was "stable" and a new academic year started (January 2021) (T2), and a third time at the end of the academic year where the teaching remained online but the exams were on campus (June 2021) (T3). To represent a starting point reference, we chose December 2018 (T0) to track the changes in student performance during these times. Table 1 shows the details for each instrument used during each moment and highlights the main respondents for each instrument along with specific data at each time.

Table 1. Data collection instruments over time

Instrument	Time	Respondents	Studied moments and respondents' numbers
GPA Marks	T0, T1, T2, T3	DHH students	(38: 21 Male, 17 Female) (T0), (T1), (T2), (T3)
		Hearing Students	(44: 19 Male, 25 Female) (T0), (T1), (T2), (T3)
Interviews	T1, T3	DHH students	(15) (T1)
		Hearing Students	(10) (T1)
		Lecturers	3 (T1), 3 (T3)
Questionnaires	T2, T3	DHH students	20 (T2), 31 (T3)
		Hearing Students	28 (T2), 38 (T3)

Three main data collection activities were undertaken: the calculated grade point average (GPA) marks, questionnaires, and in-depth interviews with both students and lecturers. Student GPAs were extracted from the registration system for each moment. The interviews were designed to probe the emerging pandemic issues in-depth detail. Thereafter, the questionnaire was constructed to provide a comprehensive overview of students' perception of their experiences with distance learning, with a particular focus on pedagogy and student learning. Figure 1 below demonstrates the data collection process within the study.

3. Data analysis and results

The section started by analyzing the GPA marks of DHH and hearing over four semesters. This was followed by analyzing the designed interviews and questionnaires at three different moments in time for students and lecturers. SPSS V27 package was used to analyze quantitative data. To explore the divide between the two groups of students in the different moments, repeated-measures ANOVA, the fixed effect regression approach, and one-way ANOVA were used. A significance level of $p < .05$ was used throughout the study. Manual analysis was employed to analyze the qualitative data, with the data being classified and line coded about emerging themes.

3.1. GPA grades analysis

Table 2 shows the descriptive results for the GPA of DHH and hearing over four semesters. Results show decreasing in GPA means for DHH students. Conversely, the GPA scores for hearing students showed an increase over all time points.

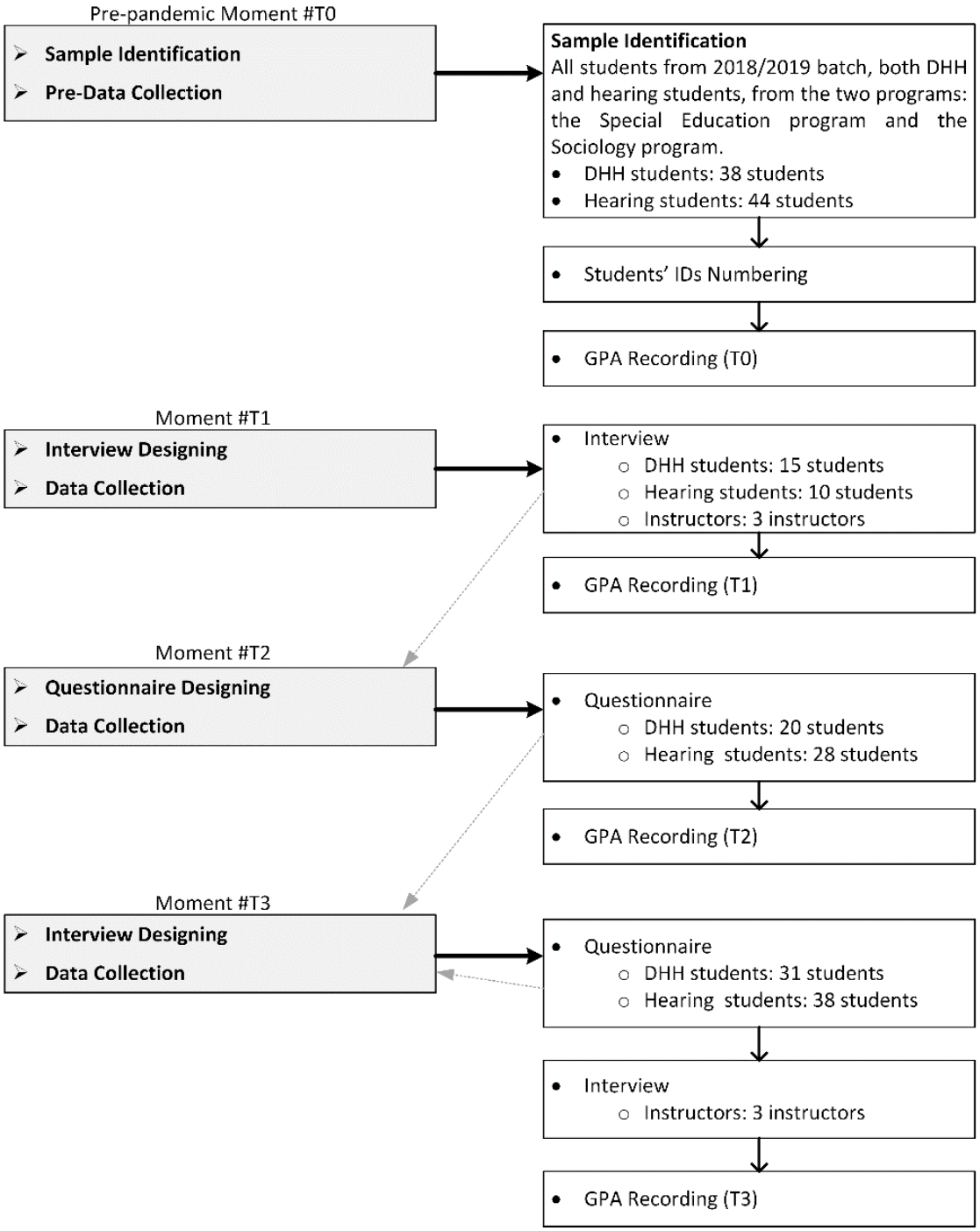
One-way repeated measures of ANOVA showed that there were significant differences in the GPA means between the DHH students over time $F(4,320) = 10.706$, $p < .001$.The partial $\eta^2 = .118$ revealed a medium toward large effect. The Wilks' lambda was calculated to be.626 with an associated level of statistical significance of $p < .001$, leading to a conclusion that there was a strongly significant difference between the GPAs of DHH and hearing students over the time of the pandemic. There was a statistically significant

difference in the academic performance between DHH and hearing students during the three semesters, $F(4,77) = 11.489$, $p < .001$.

Table 2. Descriptive statistics for the GPA over the different semesters

	Hearing status	Mean	Standard deviation	*N*
T0	Hearing	2.07	.79	44
	DHH	2.73	.45	38
T1	Hearing	2.18	.80	44
	DHH	2.68	.45	38
T2	Hearing	2.38	.74	44
	DHH	2.63	.43	38
T3	Hearing	2.56	.48	44
	DHH	2.66	.42	38

Figure 1. Data collection moments



The fixed effect regression approach was applied for DHH and hearing students separately. The R-square change indicated the increment in *R*-square as a result of adding in the time-varying predictors. It showed that adding in the time-varying predictors for the hearing students added an additional 6.1% of the total variation to students' GPA marks, with $F(4,172) = 10.350$, $p < .001$. The *F*-test indicated that the variation accounted for was significant, $F(47,172) = 1.914$, $p < .001$. While only 0.6% was added addition to the DHH students' GPA marks, with $F(4,148) = 2.734$, $p = .031$. The *F*-test indicated that the variation accounted for was significant, $F(41,148) = 40.981$, $p < .001$.

To investigate the direction of the above significance, hierarchical regression was used for hearing students, T2 ($b = 0.309$, $SE = 0.089$, $p = .001$) and T3 ($b = 0.486$, $SE = .089$, $p = < .001$). Both were positive and significant variables in the model. T1 emerged as positive but non-significant ($b = 0.111$, $SE = 0.089$, $p = .218$). In contrast, for DHH students, T2 ($b = -0.098$, $SE = .032$, $p = .003$) was a negative and significant variable in the model. T1 and T3 emerged as a negative but non-significant ($b = -0.044$, $SE = .032$, $p = .171$) (b = -0.061, $SE = .032$, $p = .062$), respectively variable in the model.

3.2. Interviews and questionnaires

The interviews for students were conducted in the first moment (T1) (as shown in Figure 1), while the questionnaires were consequently conducted in the second and third moments. Regarding the instructors, they were interviewed in the first and third moments. Table 3 shows the descriptive of the qualitative instruments used in this study along with their reliability results.

Table 3. A Description of the interviews and questionnaires respondent numbers

Instrument	Respondents	T1	T2	T3
Interview	DHH student	15 (5 male,10 female) (n = 15, 39.4%)		
	Hearing students	10 (4 male, 6 female) (n = 10, 22.7%)		
	Lecturers	3 (3 male) (n = 3, 60%)		3 (3 male) (n = 3,60%)
Questionnaire	DHH students		20 (8 male, 12 female) (n = 20, 52.6%)	31(20 male, 11 female) (n = 31,70.5%)
	Hearing students		28 (10 male, 18 female) (n = 28,63.6%)	38 (17 male, 21 female) (n = 38,86.3%)
Questionnaire's Reliability			Cronbach's Alpha =.902	Cronbach's Alpha =.916

3.2.1. Reliability and validity

Reliability and validity were considered carefully during the research process for both the interviews and questionnaires. First, for the interviews' reliability, internal homogeneity and external heterogeneity were used (Braun & Clarke, 2006). Several meetings took place to go through the analysis process. Any discrepancies found were resolved with specific data examples. The intercoder agreement through the analysis process reached 80%. Through several meetings of data analysis discussions, 100% agreement was reached, resulting in well-established themes (see section 3.2.2). For the validity purpose, to confirm and clarify the transcripts, transcripts were sent by email to all students and required written feedback.

Second, the reliability measure was tested using Cronbach's alpha for the questionnaires. According to the results of this test, Cronbach's Alpha =.902 and.916 for the first and second questionnaires, respectively. To validate the questionnaire, two steps were followed. First, two experts in technology and special education were asked to review the questionnaire to evaluate how well the questions effectively captured the objectives of this study. That step resulted in a few changes that were reflected in the questionnaire used in the second step. Thereafter, a pilot study was conducted before distributing the main questionnaire. A small sample of students from both groups (n = 10) was contacted to go through the questionnaire which resulted in removing or editing some of the questions.

3.2.2. Interviews analysis

This section shows the details of the thematic analysis of the students' interviews along with the results from the lecturers' interviews.

Students' interviews

The initial data collection began by designing and conducting an interview with DHH students, hearing students, and lecturers. Data were collected through a semi-structured interview format where the questions were prepared as a result of the related literature review; e.g., Alsadoon & Turkestani, 2020; McKeown & McKeown, 2019; Vos et al., 2015.

Below are the semi-structured interview questions for students:

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

For the first moment (T1) in June 2020, of the 38 DHH students, five male and ten female students (n = 15, 39.4%) agreed to participate through in-person interviews on MS Teams. An Arabic Sign Language interpreter was present in the conference call to facilitate communication. Of the 44 hearing students, six female and four male students (n = 10, 22.7%) agreed to participate through in-person interviews on MS Teams. For ease of communication, the DHH students were interviewed at different times than the hearing students.

A content analysis was applied. A thematic analysis approach from Vaismoradi et al. (2013) was used. Two authors participated simultaneously in the analysis. The analysis resulted in five themes: course content, technology, delivery approach, assessment methods, and social interaction. In these themes, students described the challenges they faced during the Covid-19 pandemic.

A. Course contents

Both groups of students stated the number of slides per lecture was overwhelming. According to one of the hearing students, *"The material is too large and intimidating."* Students noted frustration with the text-based resources which were not suitable for the DHH students without support: *"We felt the need for different types of content like images and not just focusing on text. In addition to this, using texts only is not helpful for deaf students."* The DHH students raised another important issue *"the discussion approach was missing because of the large volume of content the instructor needs to deliver [sic]."*

B. Delivery approach

Both groups emphasized changes regarding online delivery. One hearing student said: *"Nothing changed in the teaching style, and yet everything had changed in our teaching environment.*" Moreover, DHH students complained about the online delivery approach using video conferencing. Compared with the physical classroom, the instructor's presence was missing on the screen. This is an important distinction and difference between the delivery mode for the hearing students and the DHH students. According to the DHH students, when video conferencing was used in course delivery, they only saw the interpreter. They could not see the instructor, which was a key communicative barrier for them. This is important to explain. Typically, when using a program like MS Teams, there are spaces for the faces of people. In this case, the screens were set to show only the interpreter. The lecturer was not able to be seen. One DHH student said, *"Indirect communication with our teacher has caused some lack of understanding, which negatively affected my learning."* Another student 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."*

C. Technology

The DHH students expressed their concerns about gaps in their IT skills. Although they had completed a course in computer skills in the previous semester, they felt overwhelmed. *"I was unsure about this new method of learning as I knew it requires certain IT skills which I don't have."* Having said this, some DHH students appreciated the opportunity to learn new technology. One DHH student stated, *"I am happy because we are now [sic] better able to use computers and internet than before."* Hearing students were more confident in using the new technology required. A common concern was the poor quality of learning opportunities if they did not have access to high-quality, smart devices.

D. Assessment methods

Both groups shared similar concerns regarding assessments. Assessments did not change when classes migrated to distance learning. They still included assignments, quizzes, and exams. Hearing students reported problems handling the long quizzes and the assignments' instructions. One hearing student clarified, *"I am terrified by the long instructions associated with the assignments. We are not used to this."* A very challenging issue for the DHH students was the unavailability of direct communication with the lecturer, particularly during the exams. One DHH student explained, *"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."*

E. Social interaction

The DHH students shared grave concerns. DHH students conveyed their sadness at not being able to socialize with each other; for instance, "*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 socialize.*" Of course, their request was not permitted since the educational facilities were all shut down. Hearing students expressed similar difficulty in limited socialization but to a much lesser extent. One student stated, "*we missed our gatherings and our chats, but we used other means to communicate with our close colleagues*." DHH students reported that they have been lonely and isolated during COVID.

Lecturers' interviews

A. First moment (June 2020)

Lecturers' perceptions of online distance learning during Covid-19 were canvassed from three open questions asked during semi-structured interviews. They were asked to:

- Describe your preparation for teaching DHH students in the face-to-face model vs for online distance learning.
- Describe your perception of teaching DHH students in the face-to-face model vs for online distance learning.
- How do you think DHH students perceive their online distance learning experience vs hearing students?

Five lecturers were invited to participate in this study. Three lecturers agreed and were interviewed. In general, lecturers have rather negative experiences with teaching DHH students using distance learning. They reported that this was due to several challenges of using the new technology to align between students, interpreters, and course content. One instructor stated that: *"not only new technology but also a very huge challenge to manage between the content and the interpreter speed."*

At the same time, lecturers were positive about learning new techniques to help DHH students. One of the lecturers commented on the teaching strategies he used during the pandemic. "*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."*

Concerning the second question about their perception of teaching DHH students face-to-face compared with online distance learning, despite feeling unprepared, one of the instructors 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."

Finally, lecturers reported their concerns about their DHH students' abilities to cope with distance learning. They recognized the gaps in IT skills in the DHH students. According to one of the instructors, "*many times; during online classes; at least two or three students asked for IT help as they can't perform some activities requested from them*." The quality of their learning, according to the lecturers; was affected negatively.

B. Third moment (June 2021)

To provide a contextualized view of the issues that arose from the first and second questionnaires with students, another interview took place with lecturers who taught DHH and hearing students (at least two times between T1 and T3). The main questions were:

- What is the difference between the first and second-time experience of teaching DHH and hearing students using online distance learning tools during Covid-19; and
- What are their perceptions of the effect of online learning on lecture attendance and communication patterns of DHH students in comparison with their peers of hearing students?

The three lecturer participants described more confidence in teaching students (DHH and hearing) compared with the first time they used the system. According to one of the participants, *"compared with the first time, I have become more confident in using technology in teaching online classes, especially for hearing students*." Another instructor indicated his happiness in learning new techniques as a result of the feedback the authors shared with them from the first round of this study. According to the lecturer, the DHH students improved on their second learning experience with the lecturer compared with the first time. Additionally, two out of three lecturers indicated that fewer students reported difficulty using the technology the first time. It seems that their motivation and confidence in using digital tools have enhanced and empowered them to adapt to the current environment.

Although there were some bright spots in instruction, some lecturers relayed their concerns that hearing students were not attending lectures regularly compared with the DHH students. When lecturers talked to students about their lack of engagement, students said they felt the online attendance was optional compared to the face-to-face classes where students had to attend physically. Moreover, even with DHH students, lecturers were concerned that the quality of the student's learning could be reduced due to missing direct face-to-face communication with the instructor, and the opportunity to work as a group with their peers in class.

To conclude, two of the three lecturers agreed that online distance learning was more beneficial to hearing students compared to the DHH students who showed their lack of confidence in learning using online distance learning tools. According to one of the instructors, *"there was a mismatch between deaf and hearing students in their experience to achieving better results and motivation and support to learn.*"

3.2.3. The questionnaire analysis

The questionnaire for this study was developed based on the first interview's identified dimensions, which led to the development of the questionnaire which was based on the literature (Baber, 2022; Jacobson & Mackey, 2013; Resta & Laferrière, 2008; Woo et al., 2016). The questionnaire contained five themes and 13 related criteria as shown in Table 4. Respondents indicated their level of agreement with each of the 63 statements on a Likert scale from 1 to 7. Another three questions were added to the third moment's questionnaire to identify the students' general experience perception of using online distance learning during the pandemic.

Table 4. The factors and related criteria of the questionnaire

Themes	Criteria
Course content	Content quality
	Online material usage
Technology	Accessibility
	System quality
	Computer playfulness
	Computer self-efficacy
	Perceived ease of use

Delivery approach	Effectiveness
	Usability
Assessment methods	Exams
	Assignments
Social interaction	Lack of social
	Perception of social distance

A. DHH vs hearing students in the second moment (January 2021)

For the second moment (T2), in January of 2021, the 38 DHH students and 44 hearing undergraduate students were sent an email invitation, with a short description of the study, information about confidentiality, and a link to the questionnaire. Of the 82 respondents, 20 DHH students and 28 hearing students responded to the questions of the questionnaire.

The 20 DHH participants had average perceptions of content, technology, assessment, social interaction, and delivery approach of 4.64 (*SD* = 1.01), 4.78 (*SD* =.83), 4.89 (*SD* = 1.08), 5.12 (*SD* =.94), 4.79 (*SD* =.87), respectively. The 28 hearing students had average perceptions of content, technology, assessment, social interaction, and delivery approach of 6.01 (*SD* = .85), 6.34 (*SD* = .85), 6.17 (*SD* = .96), 6.09 (*SD* = .86), 5.78 (*SD* = 1.05), respectively. The general experience had an average of 5.45 (*SD* =.87) for DHH students and 6.45 (*SD* = 1.12) for hearing students.

The results for the one-way ANOVA test show that the effect of the health condition of students, therefore, was significant, $p \leq .001$, in every area (content, technology, assessment, social interaction, and delivery approach). ANOVA results show that was a significant difference between the perspectives of the two groups of students, $F(1,46) = 11.073$, $p = .002$.

B. DHH students vs hearing students in the third moment (June 2021)

For the third moment (T3), in June of 2021, the students were sent an email invitation, with a short description of the study, information about confidentiality, and a link to the questionnaire. Of the 82 respondents, 31 DHH students and 38 hearing students responded to the questions of the questionnaire.

The results for the one-way ANOVA test between the two groups of students in the second moment showed that the 31 participants the DHH students had average perceptions of content, technology, assessment, social interaction, and delivery approach of 4.21 (*SD* = .74), 4.51 (*SD* = .88), 4.74 (*SD* = 1.19), 4.80 (*SD* = 1.09), 4.10 (*SD* = .73), respectively. The 38 hearing students had average perceptions of content, technology, assessment, social interaction, and delivery approach of 5.92 (*SD* = 1.08), 6.11 (*SD* = 1.13), 5.90 (*SD* = 1.44), 6.04 (*SD* = 1.13), and 5.41 (*SD* = 1.51), respectively. The general experience had an average of 4.60 (*SD* = .94) for DHH students and 5.66 (*SD* = 1.98) for hearing students.

The effect of the hearing status of students was significant, $p \leq .001$, in every area (content, technology, assessment, social interaction, and delivery approach). The ANOVA results show that was a significant difference between the perspectives of the two groups of students, $F(1,67) = 7.477$, $p = .008$.

C. Comparison of questionnaire analysis between the two moments for each group

One-way ANOVA results show that there was a significant difference between the perspectives of the DHH students only in the delivery approach dimension perception; T2: Mean = 4.79 (*SD* = .87), T3: Mean = 4.10 (*SD* = .73), $F(1,49) = 9.112$, $p = .004$. However, one-way ANOVA results show that there was no significant difference between the perspectives of the hearing in any of their perceptions.

It is interesting to note that DHH students were more positive in the second moment than in the third moment despite the accumulated knowledge they were supposed to have during the time between the two questionnaires. Generally speaking, DHH students were less satisfied than the hearing students and they also were less satisfied with time.

4. Discussion

This one-year longitudinal study investigated the experiences of DHH and hearing students and three of their lecturers regarding distance learning during the Covid-19 lockdowns. Exploration of the digital divide in higher education is an important predictor to students' success (Azubuike et al., 2021; Sabeghi et al., 2021; Song et al., 2021). Overall, the results in this study indicate differences between DHH and hearing students in regard to the changes in their GPAs and perceptions of the distance learning experience. The following points of discussion will go through the three main questions of this study one by one.

4.1. Research Question 1: Did COVID-19 affect the academic achievement of DHH students and hearing students equally over time?

To answer this question, the GPA analysis over approximately a year was conducted to show if both groups were equally affected. Results showed that academic achievement was affected for both groups; however, the effect was not in the same direction nor were they at the same level. The academic achievement of the DHH students was significantly better than the hearing students before the pandemic. This contradicts the literature where Shaw (2021) suggested that "disabled students … tend to have worse post-degree outcomes presents a social justice issue" (p. 13). In the current study case, DHH students tend to have better results and outcomes regarding their GPAs. DHH students did not have concerns regarding their health conditions, nor did they report facing any negative stigma within their on-campus learning environment. However, results show a significant variation in the means of the students' GPAs per semester considering both groups of students. The GPAs of the hearing students increased over time while the GPAs of the DHH students dropped for the first two moments but showed a rebound by the third moment. This phenomenon could be a result of student development of familiarity and confidence with the platform and instructional model. These results highlight a gap in performance between the two categories of students. DHH students' learning seemed to be more negatively affected by the pandemic; their GPAs decreased significantly in T1 and decreased even further in T2, with a total variation of 0.6%. However, the GPA for the hearing students increased significantly during the interval of Covid-19 with a total positive variation of 6.1%, implying that they had advantages throughout distance learning. These results are not surprising, considering the challenges and confusion of distance learning amongst DHH students during this period. This difference was picked up previously (Lambert & Czerniewicz, 2020) for DHH and hearing students with different social backgrounds, GPAs, course grades, and genders. Recognizing that digital inequality can reinforce social inequities, it is necessary to investigate how such imbalances perpetuate the inability to compete academically (Moldavan et al., 2021).

4.2. Research Question 2: Did both groups adapt at the same rate during the pandemic?

The simple answer is no, they did not adapt at the same rate. However, none of the students failed. The DHH students began the experience of distance learning feeling unsure about the technology. The inability to see the lecturer was reported as a major barrier. Although the hearing students showed higher academic achievement and more positive perceptions toward distance learning, in the third moment, they considered online instruction to be optional. It was in the third moment that the DHH students' GPAs rose but insignificantly. Studies using DHH students as participants revealed practice with technology and an increase in experience support their academic successes (e.g., McKeown & McKeown, 2019). Studies have found links between students' attitudes and their general adaptation in, and outside of the classroom (Wang & Holcombe, 2010; Wu et al., 2018). It is possible that part of the difference in adaptation between the two groups is associated with how students viewed themselves and their universities, which may be reflected in their social environment and the time they invest in their studies. This may be derived from the sense of self-confidence and engagement in constructive academic relationships (Høigaard et al., 2015).

The DHH students formally requested in-person classes even when the university shuttered. By nature, students using sign language are limited in easy communication by the number of people who can effectively sign with them. DHH students who use sign language are already at risk for loneliness, isolation, and challenges in mental health (Bott & Saunders, 2021; Tigwell et al., 2020). In addition, studies have found links between students' attitudes and their general adaptation in, and outside of the classroom (Wang & Holcombe, 2010; Wu et al., 2018). DHH students' GPA could be a proxy measure for their academic achievement. Their initial experience was associated with underachievement and low adaptation during distance learning intervals especially the first and second-time points with a significant reduction in GPA. Thus, early attempts by students to adapt could have affected their experiences and attitudes, as well as academic achievement. This result is in line with the

contention that early life experiences have a significant impact on university students' future development and early perceptions of students toward the campus climate and university examination performance are associated with later GPA (Sakız et al., 2021).

It seems that DHH students and their lecturers reported the lack of DHH students' technological abilities, missing face-to-face communication, and the challenge of social distancing. This is considered a major barrier within their physical environment. The difference in adaptation while using online learning contradicts Lambert and Czerniewicz (2020) who found using online courses succeeded to enhance the educational experience and equity. However, the current study echoed the findings of Tigwell et al. (2020), which showed that the Covid-19 pandemic presented physical, social, and emotional challenges for students with disabilities. In conclusion, referring to the social model of disabilities, limitations were imposed on DHH students affecting their adaptability during the pandemic.

4.3. Research Question 3: Did digital equality contribute to the perception of equity amongst both groups over time?

The Covid-19 pandemic exposed the digital divide between the two groups of students. There are longstanding digital inequities that may have exacerbated other inequities, especially those related to disabilities as highlighted by (Gao & Hayes, 2021). In this study, it has been shown that the perception of DHH students declined over time while the hearing students had no significant changes. The impact of the pandemic has been multiplied by online education, highlighting even more the negative impact of a digital divide in higher education. As stated by Sabeghi (2021, p. 2): "online education has created a gap in the gap, worsening the negative impacts." The reality is that the platforms designed for distance learning were not designed for easy access for students who relied on sign language, particularly for synchronous courses. Since the environment in this case study did not consider the concept of diversity, according to the social model of disability the environment imposed limitations on the DHH students due to the physical and social barriers; therefore, there is a high possibility that students would not get what they need and they might face many barriers that could affect their study.

Another major dimension is the lecturers involved in teaching the students. Teaching at the postsecondary level is challenging and the availability and value of lecturers should not be underestimated. According to Diez et al. (2015), lecturers play a pivotal role in student learning which can be supported or hindered by them. When postsecondary institutions migrated to distance learning, it occurred quickly and without the requisite training. Many lecturers reported feeling overwhelmed and underprepared to teach remotely (DeMartino & Weiser, 2021). The quick move out of face-to-face instruction resulted in no time to learn those strategies which was the source of challenges for lecturers (Marinoni et al., 2020). Researching teaching strategies particularly effective for students enrolled in courses that are based on a distance learning model is a recommendation. This can, perhaps, reduce the digital divide.

In addition to planning for distance learning, lecturers can greatly improve lessons through planning by using the Universal Design for Learning (UDL) framework. Based on more than 1000 research studies on effective practice (CAST, 2022b), all strategies begin with access and equity. Briefly, UDL is comprised of three pillars. Using UDL, lecturers can ensure planning designed to emphasize equity through designing lessons that "provide multiple means of engagement; provide multiple means of representation; [and] provide multiple means of action and expression" (CAST, 2022a, para. 1). Social justice is based on equity, access, participation, and harmony (Crethar & Winterowd, 2012). The lessons planned using UDL are equity-based, research-based, and have a focus on social justice.

5. Conclusion and implications

This study was conducted over three points of time during the Covid-19 pandemic to examine the educational experiences of Deaf and Hard of Hearing (DHH) students in relation to their hearing student peers through a social justice lens for more than a one-time slot. These semesters represent the beginning, middle, and end of the student's experience during the pandemic, with the early year before the pandemic serving as a reference point (the "Zero time point"). The study found that there was a significant difference between the two groups in terms of educational outcomes, even though they were using the same program design, course design, delivery mode, assessment tools, and technology. The results of the study suggest that the priority for DHH students is not inclusion and equality per se, but rather a more equitable learning environment.

These findings have implications for postsecondary education, as they suggest that DHH students are at risk of underachieving in this setting. Higher education institutions, universities, and curriculum designers should therefore work to improve distance learning platforms so that students with hearing loss can have equitable access to lecturers, course content, and their peers. Universities should also develop strategies to reduce inequities and adapt their educational systems to meet the needs of, more broadly, all students with disabilities. To achieve this, it will be necessary to engage in a continuous process of collaboration between DHH students, deaf parents, deaf teachers, sign language interpreters, universities, and Higher Education Institutions to construct equitable learning environments. Equity and justice in the learning environment are the targets to manage the knowledge gap and prepare DHH students for their future careers.

The Covid-19 pandemic presented a unique opportunity to consider how the needs of postsecondary students who were used to face-to-face classes could be met through distance learning. DHH students who use sign language were particularly affected. Based on both the quantitative and qualitative data, the following recommendations are made:

- Provide specific instruction to lecturers on the very specific needs of DHH students in the classroom, accommodations and how to prepare for instruction (Alsadoon & Turkestani, 2020; McKeown & McKeown, 2019). This activity, when conducted properly, can address the challenges noted in the abundance of course content, the overwhelming assessment process, and the frustrations with the delivery of the assessments.
- Consult with the DHH students, the lecturers, and the IT department to ensure students can see the interpreter and the lecturer on the screen. The collaboration of some student representatives and the IT department can help to eliminate frustrations related to the technology.
- Incorporate Universal Design for Learning. Planning lessons using this platform can increase equity to achieve a higher level of social justice.

References

Alsadoon, E., & Turkestani, M. (2020). Virtual classrooms for hearing-impaired students during the COVID-19 pandemic. *Romanian Journal for Multidimensional Education, 12*, 1–8.

Azubuike, O. B., Adegboye, O., & Quadri, H. (2021). Who gets to learn in a pandemic? Exploring the digital divide in remote learning during the COVID-19 pandemic in Nigeria. *International Journal of Educational Research Open, 2*, 100022. https://doi.org/10.1016/j.ijedro.2020.100022

Baber, H. (2022). Social interaction and effectiveness of the online learning – A Moderating role of maintaining social distance during the pandemic COVID-19. *Asian Education and Development Studies, 11*(1), 159–171. https://doi.org/10.1108/AEDS-09-2020-0209/FULL/XML

Bott, A., & Saunders, G. (2021). A Scoping review of studies investigating hearing loss, social isolation and/or loneliness in adults. *International Journal of Audiology, 60*(S2), 30–46. https://doi.org/10.1080/14992027.2021.1915506/SUPPL_FILE/IIJA_A_1915506_SM3242.PDF

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

CAST. (2022a). *UDL guidelines*. https://udlguidelines.cast.org

CAST. (2022b). *Universal design for learning.* https://udlguidelines.cast.org/?utm_source=castsite&lutm_medium=web&utm_campaign=none&utm_content=aboutudl

Corcoran, T., Whitburn, B., & Knight, E. (2021). Inherent requirements in higher education: Locating You in Us. *Perspectives: Policy and Practice in Higher Education, 26*(2), 69–75. https://doi.org/10.1080/13603108.2021.1986166

Crethar, H. C., & Winterowd, C. L. (2012). Values and social justice in counseling. *Counseling and Values, 57*(1), 3–9. https://doi.org/10.1002/J.2161-007X.2012.00001.X

DeMartino, L., & Weiser, G. S. (2021). Striving for equity in pandemic times: The Administrator's role in the shift to online education in K-12 and higher education spaces. In *Handbook of Research on Inequities in Online Education During Global Crises* (pp. 199–223). https://doi.org/10.4018/978-1-7998-6533-9.ch011

Dijk, J. Van. (2005). *The deepening divide: Inequality in the information society*. Sage Publication.

Gao, N., & Hayes, J. (2021). The digital divide in education. *Public Policy Institute of California*. https://www.ppic.org/publication/the-digital-divide-in-education/.

Goodall, K. T., & Ward, P. R. (2010). Older migrants finding what they need to know for everyday living Lareen Newman Tapping into Serenity. *Quality in Primary Care, 18*, 27–32. https://www.researchgate.net/publication/276921318

Gorski, P. (2005). Education equity and the digital divide. *AACE Journal*, *13*(1), 3–45.

Høigaard, R., Kovač, V. B. Ø., Cecilie, N., & Haugen, T. (2015). Academic self-efficacy mediates the effects of school psychological climate on academic achievement. *School Psychology Quarterly*, *30*(1), 64–74.

Jacobson, T. E., & Mackey, T. P. (2013). Proposing a metaliteracy model to redefine information literacy. *Communications in Information Literacy*, *7*(2), 84–91.

Jones, S., Johnson-Yale, C., Millermaier, S., & Pérez, F. S. (2009). U.S. College students' internet use: Race, gender and digital divides. *Journal of Computer-Mediated Communication*, *14*(2), 244–264. https://doi.org/10.1111/J.1083-6101.2009.01439.X

Lambert, S., & Czerniewicz, L. (2020). Approaches to open education and social justice research. *Journal of Interactive Media in Education*, *2020*(1), 1–6. https://doi.org/10.5334/jime.584

Leithwood, K., Harris, A., & Hopkins, D. (2019). Seven strong claims about successful school leadership revisited. Https://Doi.Org/10.1080/13632434.2019.1596077, 40(1), 5–22. https://doi.org/10.1080/13632434.2019.1596077

Long, M. R., & Kowalske, G. M. (2022). Understanding STEM Instructors' Experiences with and Perceptions of Deaf and Hard-of-Hearing Students: The First Step toward Increasing Access and Inclusivity. *Journal of Chemical Education*, *99*(1), 274–282. https://doi.org/10.1021/acs.jchemed.1c00409

Lynn, M. A., Templeton, D. C., Ross, A. D., Gehret, A. U., Bida, M., Sanger, T. J., & Pagano, T. (2020). Successes and challenges in teaching chemistry to deaf and hard-of-hearing students in the time of COVID-19. *Journal of Chemical Education*, *97*(9), 3322–3326. https://doi.org/10.1021/acs.jchemed.0c00602

Marinoni, G., Land, H. V., & Jensen, T. (2020). The Impact of Covid-19 on higher education around the world. *IAU Global Survey Report*, 23. https://www.uniss.it/sites/default/files/news/iau_covid19_and_he_survey_report_final_may_2020.pdf

McKeown, C., & McKeown, J. (2019). Accessibility in online courses: Understanding the deaf learner. *TechTrends*, *63*(5), 506–513. https://doi.org/10.1007/s11528-019-00385-3

Moldavan, A. M., Capraro, R. M., & Capraro, M. M. (2021). Navigating (and disrupting) the digital divide: Urban teachers' perspectives on secondary mathematics instruction during COVID-19. *Urban Review*, *54*, 277–302. https://doi.org/10.1007/s11256-021-00611-4

Díez, A., Gavira, R., & Molina, V. M. (2015). Students with disabilities in higher education: A Biographical-narrative approach to the role of lecturers. *Higher Education Research & Development*, *34(*1), 147–159. https://doi.org/10.1080/07294360.2014.934329

The National Association for Multicultural Education (NAME). (2020). *Definitions of multicultural education - national association for multicultural education*. https://www.nameorg.org/definitions_of_multicultural_e.php

Resta, P., & Laferrière, T. (2008). Issues and challenges related to digital equity. In *International Handbook of Information Technology in Primary and Secondary Education* (pp. 765–778). https://doi.org/10.1007/978-0-387-73315-9_44

Rice, R. E., & Haythornthwatte, C. (2006). Perspectives on internet use: Access, involvement and interaction. In *Handbook of New Media* (pp. 92–113). https://www.hoepli.it/editore/hoepli_file/download_pub/978-88-203-3344-7_Chapter4.pdf

Sabeghi, H., Rezvani, M., Bahrami, M., & Kavi, E. (2021). Exposure of medical education system to digital divide due to COVID-19. *Journal of Medical Education*, *20*(2), 8–10. https://doi.org/10.5812/jme.114569

Sakız, H., Özdaş, F., Göksu, İ., & Ekinci, A. (2021). A Longitudinal analysis of academic achievement and its correlates in higher education. *SAGE Open*, *11*(1). https://doi.org/10.1177/21582440211003085

SciVal. (2022). *SciVal - Home*. https://www.scival.com/home?dgcid=ScopusHeader

Shaw, A. (2021). Inclusion of disabled Higher Education students: Why are we not there yet? *International Journal of Inclusive Education*. https://doi.org/10.1080/13603116.2021.1968514

Shin, H. (2020). Technological innovation in public education in the era of COVID-19: Focusing on distance education policy in South Korea. *Asian Journal of Innovation and Policy*, *9*(2), 207–222. https://doi.org/10.7545/ajip.2020.9.2.207

Song, S. J., Tan, K. H., & Awang, M. M. (2021). Generic digital equity model in education: Mobile-assisted personalized learning (MAPL) through e-modules. *Sustainability (Switzerland)*, *13*(19). https://doi.org/10.3390/su131911115

Tigwell, G. W., Peiris, R. L., Watson, S., Garavuso, G. M., & Miller, H. (2020). Student and teacher perspectives of learning ASL in an online setting. *Proceedings of ASSETS 2020 - 22nd International ACM SIGACCESS Conference on Computers and Accessibility* (pp. 1–7). https://doi.org/10.1145/3373625.3417298

United Arab Emirates Government (UAE). (2020). *Federal Law (No.) 29 of 2006: Concerning the rights of people of determination*. https://www.tamm.abudhabi/en/aspects-of-life/peopleofdetermination/peopleofdeterminationrights/LawsandRegulations/federal-law-no-29-of-2006-concerning-the-rights-of-people-of-determination

United Arab Emirates Government (UAE). (2021). *Protecting the rights of people of determination (persons with disabilities) - The Official Portal of the UAE Government*. https://u.ae/en/about-the-uae/human-rights-in-the-uae/protecting-the-rights-of-people-of-determination

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences, 15*(3), 398–405. https://doi.org/10.1111/nhs.12048

Vos, T., Barber, R. M., Bell, B., Bertozzi-Villa, A., Biryukov, S., Bolliger, I., Charlson, F., Davis, A., Degenhardt, L., Dicker, D., Duan, L., Erskine, H., Feigin, V. L., Ferrari, A. J., Fitzmaurice, C., Fleming, T., Graetz, N., Guinovart, C., Haagsma, J., … Murray, C. J. L. (2015). Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990-2013: A Systematic analysis for the Global Burden of Disease Study 2013. *The Lancet, 386*(9995), 743–800. https://doi.org/10.1016/S0140-6736(15)60692-4

Wang, M. Te, & Holcombe, R. (2010). Adolescents' perceptions of school environment, engagement, and academic achievement in middle school. *American Educational Research Journal, 47*(3), 633–662. https://doi.org/10.3102/0002831209361209

World Health Organization (WHO). (2020). *Listings of WHO's response to COVID-19*. https://www.who.int/news/item/29-06-2020-covidtimeline

Williams, T. K., McIntosh, R. W., & Russell, W. B. (2021). Equity in distance education during COVID-19. *Research in Social Sciences and Technology, 6*(1), 1–24. https://doi.org/10.46303/ressat.2021.1

Woo, K., Gosper, M., McNeill, M., Preston, G., Green, D., & Phillips, R. (2016). Web-based lecture technologies: Blurring the boundaries between face-to-face and distance learning. *Research in Learning Technology, 16*(2), 81–93. https://doi.org/10.1080/09687760802315895

Wu, T. F., Chen, C. M., Lo, H. S., Yeh, Y. M., & Chen, M. C. (2018). Factors related to ICT competencies for students with learning disabilities. *Educational Technology & Society, 21*(4), 76–88.

Xiao, J. (2021). Decoding new normal in education for the post-COVID-19 world: Beyond the digital solution. *Asian Journal of Distance Education, 16*(1), 2021. http://asianjde.com/ojs/index.php/AsianJDE/article/view/558/341