MODERATING ROLE OF HEARING STATUS ON THE RELATIONSHIP BETWEEN TECHNOLOGICAL FACTORS AND THE ACADEMIC ACHIEVEMENT OF DEAF AND HARD OF HEARING STUDENTS IN SAUDI UNIVERSITIES

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Issues related to academic achievement of deaf and hard of hearing students (DHH) in higher education has led to the need for a deep understanding of support factors related to academic achievement among these students, including technological factors and hearing status. Therefore, the purpose of this study is threefold: 1) to validate the psychometric properties of the technological factors measure, 2) to examine the relationship between technological factors and academic achievement of DHH students, and 3) to test the moderating role of students' hearing status on the relationship between technological factors and student academic achievement. Using a quantitative survey approach, data were collected from 298 DHH students in Saudi universities. The study employed co-variance-based SEM by using AMOS in order to achieve the objectives. First, confirmatory factor analysis (CFA) was employed to test the psychometric properties of the technological factors. Second, a full-fledged SEM was conducted to test the relationship between the technological factors and academic achievement. Finally, to examine the moderating role of hearing status on the relationship between technological factors and academic achievement of DHH students, a multi-group analysis (MGA) was applied. The results confirmed that the multidimensional hypothesised model of technological factors was empirically valid and reliable. The results also revealed a statistically significant relationship between technological factors and academic achievement. The results also showed no moderating role of the hearing status on the relationship between technological factors and achievement. Finally, this study has a potential positive impact on DHH students' higher education programmes, thus enhancing their academic performance.

Keywords: Hearing status, technological factors, academic achievement, deaf and hard of hearing

INTRODUCTION

Within the last few decades, The Kingdom of Saudi Arabia (KSA), like many other countries, has focused on the education of deaf and hard of hearing students (DHH) and made it a top priority (Al-Rayes, 2008; Hanafy, 2018). This was to ensure that there would be some form of educational equality. To this end, approval No. 7 / B / 9173 was issued to give DHH students the opportunity to complete their educations in higher education institutions in 2001. In response, the Ministry of Education (MOE) took the initiative to provide all educational resources and services that students needed (Al-Rayes, 2008). In addition, several Saudi universities established programmes through a comprehensive access system for DHH students that included procedures for support factors to meet their needs according to scientific foundations (Hanafy, 2018). Therefore, student access to various higher education programmes has improved since 2001 (Hanafy & Al-Saleh, 2018). This transformation in the education, training, and rehabilitation of DHH students is due to the approval of supportive legislation and laws, as well as continuous scientific and research efforts (Al-Rayes, 2008).

Some attempts were made to enrol DHH students in Saudi colleges and universities (Hanafy & Al-Saleh, 2018), but the enrollment of DHH students in higher education institutions remains limited in a few universities such as King Saud University (KSU) and Arab Open University (AOU) (Al-Ajlan, 2017). Thus, it is important to meet their needs to guarantee their entrance into Saudi universities through tests and interviews (Al-Rayes, 2008). Also, universities must provide support factors for DHH students that differ in nature from the services offered to hearing students (Bell & Swart, 2018; Hanafy, 2018). These support factors, especially technological factors, have become associated with higher education for DHH students (Salem, 2017), as well as hearing status and institutional readiness (Adkins, 2020). All of these factors may have a role in promoting success for DHH students, especially as academic achievement of DHH students is considered as the outcome of interactions between a number of complex factors (Marschark et al., 2015).

Technological Factors and Academic Achievement for DHH Students

Technological factors are services that facilitate DHH student learning through various different devices, along with multimedia, and online tools (Al-Hawi, 2015; Zirzow, 2019). Technological factors enable DHH students to fulfill the academic and non-academic requirements in universities (Kisanga, 2020). In the current study, technological factors refer to the technological devices provided to DHH students through the university's support service office, in addition to the technological usage by DHH students, the university's administrative and educational staff.

Technological devices include mobile phones, computers, Internet, amplification devices, FM hearing aids, light signal, microphone (Al-Hawi, 2015), smart board (Taiwo & Taiwo, 2020), and real-time captioning (Al-Salamah, 2020). As for the technological usage, it is a mixture of steps and implementations oriented to DHH students (Zirzow, 2019). It helps in the implementation of various projects and increases learning effectiveness (Murati & Ceka, 2017).

Use of technological devices in education is very important because it encourages changes to the concepts of education and teaching techniques (Murati & Ceka, 2017). The future teacher must not only be accomplished in choosing appropriate technological devices for students but also must be able to effectively use technology in the curriculum (Bates & Poole, 2003). Furthermore, teachers should monitor student responses while conducting technology-enhanced instruction to determine whether the educational activity is effective.

Therefore, technological factors should be focused on decreasing the access barriers, allowing DHH students to have more access to the auditory content (Peng & Daud, 2015). Moreover, disability support offices should ensure that technological factors meet DHH student needs in order to enhance their educational experience in a higher education environment (McNicholl et al., 2019). Technological factors are indispensable for DHH students because it helps them to access information related to tasks and to improve their achievement (McNicholl et al., 2019; Nordin et al., 2015).

Successful integration of technological factors in a class of DHH students relies on (a) the teacher's ability to support content delivery through educational technology, (b) teacher attitudes and biases toward educational technology, (c) the match between educational technology and student learning needs (Chong & Shaffe, 2015; Peng & Daud, 2015), and (d) teamwork associated with technology use (Lartz et al., 2008). Therefore, teachers play a key role in effective use of technological devices, which can help DHH students be more successful academically (Peng & Daud, 2015). According to Zirzow (2019), technological factors allow better access to the curriculum and help to increase vocabulary and literacy skills, all of which increase success for DHH students. In contrast, the inability to access information successfully can prevent DHH students from learning and hinder their graduation from university (Mwanyuma, 2016). Therefore, technological factors for DHH students aim at providing and improving access to auditory information presented (Al-Hawi, 2015).

PURPOSE OF THE STUDY

The purpose of this study is to examine the relationship between technological factors (e.g., technological devices and technological usage) and the academic achievements of DHH students in Saudi universities. Besides that, it was done to test the moderation effect of hearing status on the relationship between technological factors and academic achievement of DHH students in Saudi universities. The study also seeks to examine the underlying factors of the technological factors construct.

HYPOTHESES OF THE STUDY

Accordingly, this study seeks to address the following research hypotheses:

H1: The multidimensional measure of technological factors is valid and reliable.
H2: Technological factors are directly and significantly related to DHH students' academic achievement in Saudi universities.
H3: Students' hearing status plays a moderating role in the relationship between technological factors and DHH students' academic achievement in Saudi universities.

THEORETICAL FOUNDATION

A body of previous research has focused on technological factors in the higher education of DHH students (Lartz et al., 2008). These factors include computer-based applications, real-time captioning, C-Print systems, and whiteboards (Zirzow, 2019). Several studies have indicated that using these factors increased student achievement effectively because they captured important details of the lessons and helped students to participate in discussions (Al-Hawi, 2015; Al-Salamah, 2020; McNicholl et al., 2019; Salem, 2017; Taiwo & Taiwo, 2020).

Moreover, Lartz et al. (2008) investigated the obstacles and benefits of using technology from the perspectives of DHH students at a university. The findings showed that technology use helps the DHH students in inclusion by increasing access and supports, which creates a feeling of inclusion. Likewise, Crowe et al. (2017) indicated that technology use may improve access to information and learning, thus enhancing DHH students' academic achievement. Meanwhile, McNicholl et al. (2019) report that technology provides educational benefits to students with disabilities. They identified that inadequate devices and insufficient technology training were factors that could hinder effective technology use in higher education for students with disabilities.

In the KSA, Hanafy and Al-Aydy (2016) revealed that higher education programmes for DHH students faced many difficulties in providing support factors for them and showed that some of the students were dissatisfied with the provided technological services. Furthermore, Al-Hawi (2015) conducted a study to identify how common the use of Information and Communications Technology (ICT) was among KSU faculty members and support staff in Riyadh city. The results showed that the main obstacle was poor awareness of the importance ICT plays in teaching DHH students. The results also show that the most available and used technologies were the Intranet, computers, smart blackboards, and electronic mail systems.

Factors such as hearing status and institutional readiness also may predict academic success of DHH students (Adkins, 2020). Through research by Ohlenforst et al. (2017), it was indicated that the hearing status in some cases determines how effectively one can communicate, learn, and achieve academically. Moreover, Su et al. (2020), confirmed the existence of an independent association between hearing loss and academic achievement of DHH students in early years in Australia. In contrast, Tomblin et al. (2020) showed that some of the DHH students performed better academically than the hearing students. Therefore, this is a clear indication that the DHH students can make good progress with good services and effective teaching. In Saudi Arabia, Salem (2017) indicated that there were no statistically significant differences in using technology in the higher education programme at KSU in the KSA according to the degree of hearing loss.

Nonetheless, data on the effect of moderation effect of hearing status on the relationship between technological factors and academic achievement among DHH students in Saudi universities is still limited. After extensive literature analysis, no studies have been conducted to investigate the moderation effect of hearing status on technological factors in DHH students' academic achievement in the Saudi higher education context. As such, the importance of this study is based on its effective contributions to DHH students, higher education programmes, and the Ministry of Education (MOE) in the KSA. The results of this study may add to the body of knowledge and literature in this field in the KSA. In conclusion, there is justification for conducting a study on the role of providing and using technological devices in the academic success of DHH students in Saudi universities, in addition to investigating the moderation effects of hearing status in this relationship by looking at the current status of higher education programmes for DHH students.

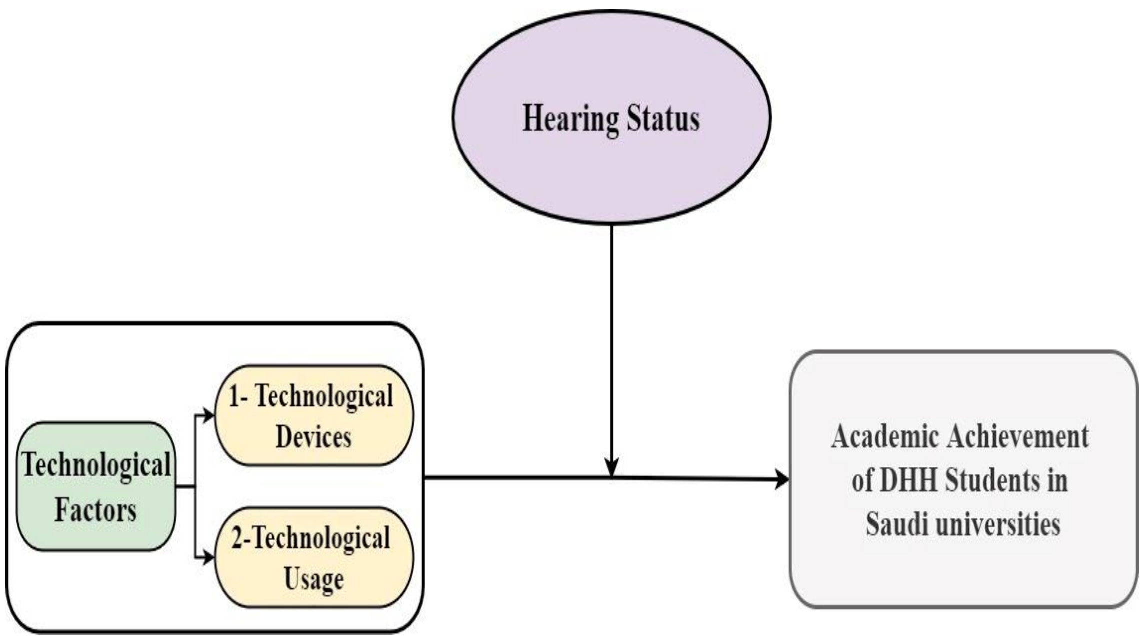
CONCEPTUAL FRAMEWORK

The conceptual framework of this study was based on the current version of the Human Activity Assistive Technology (HAAT) model by Cook and Miller Polgar (2008), which was itself an extension of Bailey’s (1996) human performance model. This model helps to understand the role of technology in improving an individual’s performance (Cook & Hussey, 2002). In the Special Education field, Giesbrecht (2013) examined and applied this model for occupational therapy research. According to Giesbrecht (2013), students with disabilities benefit from the HAAT model facilitating performance. This idea was further supported by Chong and Shaffe (2015), who state that learning for DHH students is easier through technology that helps them overcome any obstacles they encounter.

Furthermore, the conceptual framework of the current study is based on dependent and independent variables. The independent variable is technological factor (technological devices and technological usage), while the dependent variable is academic achievement, which was measured by the CGPA. Moreover, the researchers used hearing status as a moderator variable in the relationship between technological factors and academic achievement of DHH students in Saudi universities. In this study, the focus was on the hearing status of DHH students (deaf and hard of hearing students). Deaf students are those who have a hearing loss of 70 dB or more, while for the hard of hearing students are those whose hearing loss ranges from 35 to 65 dB (Moorse, 2008). The following Figure 1 shows the conceptual framework that clarified the relationship between the variables of this study.

Figure 1

Conceptual Framework of the Study



METHODOLOGY

Participants and Sampling Method

The data for this study were collected during the second semester of the 2019/2020 academic year from Saudi undergraduate DHH students in public and private universities. This includes those enrolled full-time, whether in the first, second, third, or fourth year of higher education. Information related to these programmes was obtained from the MOE in KSA; only two universities in the KSA offer undergraduate programmes for DHH students to obtain bachelor degrees; these are KSU and AOU. The total number of male and female DHH students in these two universities is 385. Due to the COVID-19 pandemic, all participants in the current study have switched to online learning. Therefore, the researchers cooperated with a deaf person who holds a Master's degree in deaf education to make videos using Saudi Sign Language for each item of the online questionnaire.

According to Krejcie and Morgan (1970), the sample size will be 191. Moreover, there is another method that can be used to determine the sample size, which is available online in the form of a sample size calculator (Raosoft, 2011). By using the Raosoft calculator, the researchers found that the sample size will be 298. Because of the objectives of this study and the nature of participants, the researchers decided to distribute questionnaires based on Raosoft calculator so that they can obtain adequate data and make appropriate generalisations.

In this research, the sampling technique employed to select the targeted participants was simple random sampling. After defining the population and deciding on the sample size, the researchers asked the administration office in both universities for lists of undergraduate DHH students during the 2019/2020 academic year (that included name, matric number, and mobile number). In these lists, each student was also assigned with a sequential number starting with 1, 2, 3, and so forth. After that, the researchers randomly selected the sample from these sequential numbers because the sampling frame used in this study is the random number method. After that, the questionnaire was given by mobile messages by the researchers to every student whose number was selected.

Instrument

The current study applied a quantitative research using a survey design consisting of a correlational study, and data were collected using a questionnaire divided into two main sections to specifically address the hypotheses proposed for this study. According to Creswell (2012), correlational design is used to measure the degree of relationship between two variables or more. The first section covered the student demographic information namely gender, university, year of study, hearing status, communication method, and actual CGPA. Students' actual CGPA was used to measure their academic achievement. Students were asked to write their current CGPA, which should be between 1 and 5, as the main grading system used by higher education institutions in the KSA is out of a 5.0 grading scale. As such, the maximum academic achievement presented in this study was 5.0 and the minimum was 2.15. The mean score of student academic achievement by using CGPA was 3.905 and the standard deviation was 0.5761.

The second section consisted of items covering the technological factors, which were divided into two domains: (D1) technological devices and (D2) technological usage. It contained 14 items. Domain (D1) was designed to measure the relationship between technological devices and academic achievement of DHH students in Saudi universities, and this domain contained 9 items. The second domain (D2) was designed to measure the relationship between technology usage and academic achievement of DHH students in Saudi universities, and this domain contained 5 items. All items were adapted from Lovejoy (2016), Stewart and Crane (2019), and McLennan et al. (2014). In addition, all items on the technological factors' questionnaire were measured using a five-point Likert scale, where (1) represented 'strongly disagree', and (5) was 'strongly agree'. These questionnaires were completed by the DHH undergraduate students in order to achieve this study objective. A total of 298 usable questionnaires were analysed using covariance-based structural equation modelling (SEM) via AMOS software (version 24).

Preliminary Data Analysis and Data Preparation

SPSS version 26 was utilised for data preparation prior to analysis, and AMOS 24.0 was used to determine the study model's fit as well as statistical analysis of the data obtained. To validate this study, the researchers took some important steps. First, the initial edition of the questionnaire was delivered to special education professionals, and their comments and observations were taken into account. Second, because the majority of the participants in this study were Arabic speakers, the original English questionnaire was translated into Arabic. In order to ensure the validity of employing this questionnaire in multiple languages, any errors in translating the questionnaire had to be avoided. According to Chua (2016), there are several directions about what language should be utilised when drafting questionnaire items.

One of the most important rules is to employ back translation to ensure that the language used is the same as in the participants' mother tongue. As a result, some efforts were taken to complete the questionnaire's back-translation process, including consulting with specialised translators with special education backgrounds. In terms of reliability, the overall Cronbach alpha for the variables was above .70, indicating a good level of dependability and emphasising the questionnaire's validity in achieving its goals. Furthermore, these findings demonstrated that the multiple correlation values for each questionnaire item reflected a reasonable standard of correlation.

RESULTS

Demographic Characteristics

The demographic characteristics of the DHH students in Saudi universities who took part in this study are presented in Table 1. The first characteristic is students' gender; as shown in the table, 53.4% of the participants were males while 46.6% were female.

Table 1

Summary of Demographic Information of Questionnaires Participants

Variable	Group	Percentage %
Gender:	Male	53.4
	Female	46.6
Institution studying in:	King Saud University (KSU)	56.0
	Arab Open University (AOU)	44.0
Year of study:	First year	26.5
	Second year	23.5
	Third year	24.5
	Fourth year	25.5
Hearing status:	Deaf	50.3
	Hard to hear	49.7
Communication Method:	Saudi sign language	8.1
	Oral method	18.8
	Sign language and oral method	73.2

Note: N = 298

Regarding the universities attended, 56% came from KSU while 44% came from AOU. With regard to year of study, results of the study revealed similar variation between the respondents from each group and there was no significant difference between the numbers of participants. Regarding the students' hearing status, almost the same number were in each group, with 50.3% deaf and 49.7% hard of hearing. Finally, sign language and oral method are the most common among the three methods of communication used by DHH students in Saudi universities.

SEM was used to evaluate the measurements of technological elements as well as to investigate the impact of technological factors (technological devices and technological usage) on the academic performance of DHH students in Saudi institutions using the AMOS (version 24) model-fitting program. Both the measurement and structural models were used by the researchers to verify the adequacy of this model. The covariance matrix produced from the data was used to estimate the postulated models. As a result, the estimating processes satisfied the underlying statistical distribution theory, giving defensible property estimates. Finally, to achieve the study's final goal, multigroup analysis was used to look at the moderating effect of students' hearing status.

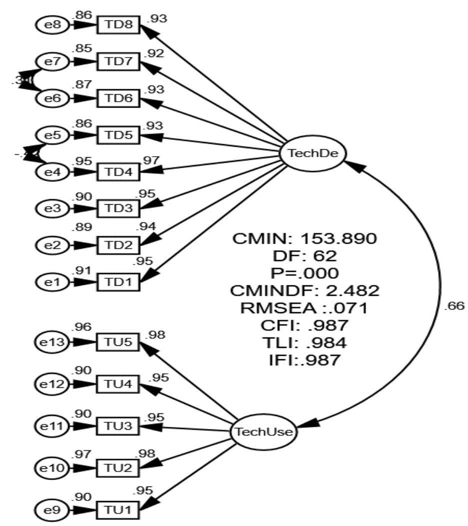
ANALYSIS PROCEDURES

Measurement Model of Technological Factors

The technological factors measurement model (which can be referred to as confirmatory factor analysis) was conducted to examine the construct validity and reliability of the model in two dimensions. This study used a series of indicators that had to be compared to the model fit results to ensure that it was accurate. Chi-square (χ^2), degrees of freedom (DF), comparative fit index (CFI), Tucker-Lewis index (TLI), and root-mean-square error of approximation (RMSEA) were the indices used. The chi-square (χ^2) value should have been .5, the RMSEA value should have been .08, and CFI and TLI should have been > .90 (Hair et al., 2013; Kline, 2016). For this reason, the measurement model for the model of the study was revised by using modification indices. Figure 2 shows that the CFA indicated an acceptable fit with χ^2 = 153.890, DF = 62, RMSEA = 0.071, CFI = 0.987, IFI = 0987, and TLI = 0.984.

Figure 2

Confirmatory Factor Analysis Results of Technological Factors



(TD) Technological Devices
(TU) Technological Usage

As a result, only one item, TD 9, was removed from the list since it did not match the requirements. Table 2 lists the items. This section discusses more evidence for the hypothesised model's validity and suitability as a measurement model for technical aspects. The measurement model's two types of construct validity, convergent construct validity and divergent construct validity, are discussed in this section. Examining all of the elements that reveal that all of the loadings were more than 0.70 was the first indicator of this stage. With an adequate sample size of participants, the factor loadings for the items are acceptable in this scenario (Byrne, 2013; Hair et al., 2014; Kline, 2015). As a result, all indicators in this study were related to their variables, and there was sufficient evidence of the measurement model's convergent construct validity. In terms of divergent construct validity, the correlation between the two dimensions was less than .85, as shown in Figure 2.

Table 2

Items of the Model

TD				TU			
Item Code	Loading	Covariance	Error	Item Code	Loading	Covariance	Error
TD 1	.954	0.91	e1	TU1	.951	0.90	e9

TD 2	.943	0.89	e2	TU2	.983	0.97	e10
TD 3	.952	0.91	e3	TU3	.947	0.90	e11
TD 4	.970	0.94	e4	TU4	.947	0.90	e12
TD 5	.917	0.84	e5	TU5	.980	0.96	e13
TD 6	.939	0.88	e6				
TD 7	.931	0.87	e7				
TD 8	.929	0.86	e8				

(TD) Technological Devices/ (TU) Technological Usage

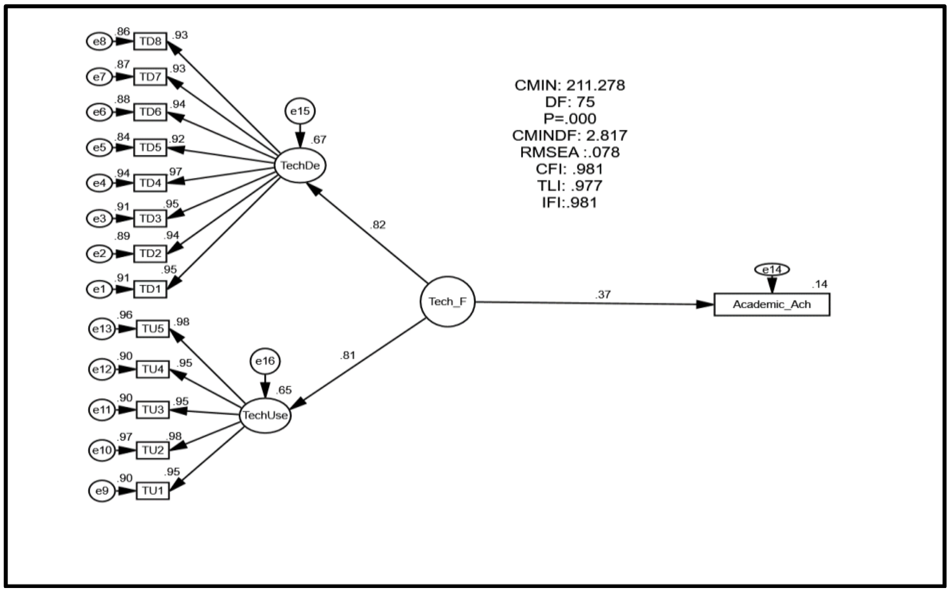
As a result, discriminant validity was shown to be valid, and both of these variables in this investigation supported discriminant validity (Hair et al., 2014). The findings showed that the study model was psychometrically valid in general.

Adequacy of the Hypothesised Structural Model

After establishing the study model's psychometric qualities, the structural model was used to investigate the impact of technological elements on student academic achievement (see Figure 3). The initial research hypothesis was addressed in this step. Following the successful construction of the measurement model as the structural model, this phase was deemed the second stage of AMOS analysis. This model's anticipated causal links were consistent with the data (normed chi-square = 2.817; RMSEA = .078; CFI =.981; TLI =.977 and IFI = .981). The fit indices for the technical influences on the student academic achievement model all met the recommended levels, indicating that the structural model was well-fitted. Furthermore, the study found that technological considerations accounted for 14% of their performance. The hypothesised model's parameter estimates were devoid of objectionable values with uncorrelated errors. The causal structure's route coefficients were statistically significant at the .01 level and displayed practical significance. The standardised path coefficient of technological elements on pupils' academic achievement, $\beta = 0.37$, was statistically significant (see Figure 3).

Figure 3

Structural Model of the Study



(TD) Technological Devices/ (TU) Technological Usage

Moderating Effect

The results of the moderation analysis are shown in Table 3, which support the study's third hypothesis about the moderating function of students' hearing status on the influence of technological elements on the academic achievements of DHH students at Saudi universities. Another chi-square value was obtained from the estimation of the constrained structural model for the effect of technological elements on student academic achievement, which was then compared to the baseline value for statistically significant differences. Finally, the limited model's change in CFIs and the value of the RMSEA were checked against the .001 and .05 cut-off scores, respectively (Byrne, 2013; Kline, 2015).

Table 3

Results of Gender-Invariant Analysis

Indices	Unconstrained	Constrained	Change	Decision
Chi-square	424.119	424.220	0.101	Groups are not different at the model level; however, they are different at the path level.
Degree of freedom	148	149	1	
CFI	0.965	0.965	0.000	
RMSEA	0.079	0.079	0.000	

The structural model's multi-group analysis test revealed no statistically significant differences in the chi-square value between students who are hard of hearing and those who are deaf. In other words, the association between the moderating influence of students' hearing status on the relationship between technical elements and the academic results of DHH students in Saudi universities worsened as the chi-square values increased from the unconstrained model to the confined model. Furthermore, neither the CFI nor the RMSEA changed.

DISCUSSION

The results from the measurement model have provided evidence for two-dimensional models for technological factors, thereby immensely expanding our understanding of their existence. Therefore, the present study offers empirical evidence that technological factor is a multidimensional construct. Furthermore, the results confirmed there is a positive correlation between the provision and use of technological factors and academic achievement of DHH students. This result supports our hypotheses that technological factors are a significant predictor of academic achievements of DHH students in Saudi universities. Accordingly, a change in technological factors resulted in enhanced academic achievement. It was determined that technological factors can also affect what students see as significant in their academic performance; they are likely to perform positively with better technology. This result is consistent with the results of previous studies revealing that technological factors helped DHH students greatly in accessing and retaining lecture information. These studies also indicated that technological services such as real time captioning, C-Print, and whiteboard helped these students to achieve academic success and raise their rate of participation and performance in colleges and universities (Al-Salamah, 2020; McNicholl et al., 2019; Stinson et al., 2017; Taiwo & Taiwo, 2020).

Stinson et al. (2017) found that the use of C-Print as a technological device in lectures had a positive impact on DHH students' academic achievement. This result supports the results of McNicholl et al. (2019), which confirmed the importance of technology in enhancing the educational benefits to students with disabilities including DHH students. Similarly, this finding was consistent with those of Taiwo and Taiwo (2020), who stated that using an interactive whiteboard effectively increased DHH students' achievement, facilitates learning, and helps them participate in discussions. This result is also consistent with the study of Al-Salamah (2020), which reviewed seven articles and studies between 1989 and 2019 on using captioning and its impact on DHH students' academic achievement in higher education. The results confirmed existence of a significant positive relationship between use of the real time captioning as a technological device and the DHH student achievement. In contrast, this finding was not supported by Kawas, Karalis, Wen, and Ladner (2016), who emphasised that a number of problems related to the use of real time captioning in university, such as limited control, and complex settings.

With respect to the moderation effect of hearing status on the relationship between technological factors and academic achievement of DHH students in Saudi universities, the results of the multi-group analysis test for the structural model revealed no statistically significant change in the chi-square value across the students who are hard of hearing and those who are deaf. In other words, there was no moderating effect of hearing status in this relationship. Specifically, the positive relationship between technological factors and academic achievement did not differ according to student hearing status. Thus, the degree of hearing loss did not affect the relationship between provision and use of technological devices and student achievement. A possible explanation for this result is that whatever the degree of hearing loss, it is possible to compensate through using various technological devices to access information for achieving academic success (Peng & Daud, 2016). This finding is consistent with those reported in Salem (2017) indicating that the hearing status for DHH students in universities was not a significant indicator of academic success, especially regarding technology use. Also, there are no differences in technology use at KSU according to the degree of hearing loss. In contrast, Adkins (2020) and Su et al. (2020) indicated that the degree and type of hearing loss is one of the factors that play a role in academic achievement of DHH students.

CONCLUSION

Based on the abovementioned discussion, it can be concluded that better utilisation of technology could lead to better academic achievement of DHH students in Saudi universities. In fact, this study aims at generating essential data in the field of technology and student achievement, as well as the effect of hearing status as a moderating factor between technology and academic achievement. Especially since previous studies have examined the impact of student hearing status in higher education from different angles in the Saudi context. Therefore, the results of this study can be considered as an important addition in the field of Saudi higher education for DHH students.

The academic success of DHH students is one of the most important aspects that must be studied and addressed in sufficient depth by researching the factors influencing higher education programs for DHH students (Hanafy & Al-Saleh, 2018). Therefore, it is important to investigate the factors influencing academic achievement of DHH students in higher education in order to overcome the difficulties they face. Accordingly, this study was prepared to examine the relationship between technological factors and the academic achievement of DHH students in Saudi universities, taking into account the moderating effect of hearing status in this relationship.

Researchers in the future could explore similar fields from different perspectives. This study was limited to the higher education sector, especially universities. Therefore, there is a need to study the same variables in colleges that offer diploma programmes, as well as in the context of the general education sector, to reach more general conclusions, especially as the model proposed in this study may apply to the entire education sector. Qualitative and quantitative research (mixed methods) can be conducted to provide stronger conclusions. Moreover, it would be possible to conduct a similar study for other categories of students with disabilities such as blind students and students with learning disabilities. Comparative studies are needed to compare higher education programmes for DHH students in Saudi universities with higher education programmes in other countries.

More studies are needed regarding the relationship between different types of support factors and their relationship to DHH student achievement in higher education. In addition, there is a need to explore other demographic variables such as gender to determine whether they affect the relationship between technological factors and the academic achievement of DHH students.

In summary, technological factors play a crucial role in the academic success of DHH students in higher education programmes in Saudi universities. Further research will provide valuable evidence in improving higher education programmes by examining the factors influencing academic success. Lastly, it is hoped that this study will inspire future researchers to search for more important factors that help to raise the academic achievement rate of DHH students in higher education.

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