Full text open access online (Since 2009)
© IJES 2022
PRINT: ISSN 0975-1122 ONLINE: ISSN 2456-6322
Int J Edu Sci, 39(1-3): 7-23 (2022)
DOI: 10.31901/24566322.2022/39.1-3.1254

Designing a Tool for Evaluating Employing Augmented Reality Technology to Distinguish between Similar Alphabets

Deyab A. Almaleki[1] and Atheer M. Alqarni[2]

[1]Department of Evaluation, Measurement and Research, College of Education, Umm Al-Qura University, Makkah, Saudi Arabia
[2]Department of Special Education, College of Education, Umm Al-Qura University, Makkah, Saudi Arabia
E-mail: [1]<damaleki@uqu.edu.sa>, [2]<Atteer1413@gmail.com>

KEYWORDS Evaluation. Method of Technology. Alphabets. Attitudes. Learning-Difficulties. Psychometric-Properties

ABSTRACT The study aimed to evaluate the attitudes of learning difficulties of teachers towards employing augmented reality technology in the formation of mental visualization to distinguish between similar alphabets. The study sample consisted of 153 teachers. Results identified that there is a positive attitude among teachers, as it creates a supportive environment to facilitate the learning process of people with learning difficulties, in addition to their desire to provide equipment and training programs that would help them employ Augmented Reality Technology in teaching people with learning disabilities. Furthermore, there are no statistically significant differences due to the variables of gender, academic qualification, years of experience and using Augmented Reality Technology. Moreover, there are statistically significant differences due to the variable of sub-specialty. However, teachers with other specializations associated with a diploma in learning difficulties have a more positive attitude than specialists in learning difficulties.

INTRODUCTION

The educational fields of the age are witnessing brilliance and unprecedented scientific progress, so keeping pace with it has become an urgent necessity, and a lofty mission that calls for the field of learning difficulties to break free from the restrictions of traditional methods in the world of education and to launch into the space of innovation and renewal to lead to a beneficial and enjoyable educational impact. As the field of learning difficulties is one of the largest fields of special education in terms of the number of students. In addition, the number of students who attend learning difficulties programs in the Kingdom of Saudi Arabia may reach 7 percent of those who belong to the primary stage (Freire and Ferreira 2020; Abriata 2022).

It is worth noting that the concept of learning difficulties met with many definitions, and the first definition that gained legal status was the definition that states that learning difficulties mean a disorder in one or more of the basic psychological (intellectual) treatments involved in understanding or using spoken or written language. This disorder may manifest as an improper ability to listen, think, speak, read, write, dictate, or perform mathematical operations. This means that learning difficulties become apparent when there is a difference between the expected performance of the student and his actual performance, and this difficulty is not due to environmental deprivation, family problems, or lack of educational opportunities (Plancher et al. 2020; Redondo et al. 2020; Sahin and Yilmaz 2020).

Considering these indicators, people with learning disabilities need modern educational programs and methods that develop their understanding and comprehension and help them retain the information for a long time. The traditional programs and methods of teaching are not always effective in providing them with many basic skills that they face difficulty in, namely: the difficulty of learning the letters of the alphabet and distinguishing between similar ones, as well as the difficulty of linking the sounds of speech with the corresponding letters. The use of modern strategies and techniques is one of the important methods in improving the performance of this category (Altinpulluk 2019; Carreon et al. 2020; Suppan et al. 2020; Toropova et al. 2021).

In the same context, augmented reality technology is considered one of the latest technolo-

Address for correspondence:
Deyab A. Almaleki
E-mail: damaleki@uqu.edu.sa

gies that allows the student the opportunity to watch, listen, practice, meditate and think. Thus, all his senses participate in the learning process, which leads to the consolidation and deepening of concepts and the development of motivation to learn. One of the visions that support mental perception in developing reading skills and reading comprehension is that it helped improve students' attitudes towards reading and also had a clear impact on developing their reading skills (Geroimenko 2020b; Almaleki 2021e; Almaleki and Alomrany 2021; Alrefaei et al. 2022a, 2022b).

Based on the data of the effectiveness of these two methods, the researchers decided to extrapolate the attitudes of teachers of learning difficulties towards employing augmented reality technology in the formation of mental perception and knowing its impact in the field of teaching letters and distinguishing between them for people with learning difficulties. It keeps pace with our technical progress, fulfill students with learning difficulties needs, and helps them to overcome difficulties, and then they understand what is being taught with passion and pleasure. Thus, the educational process becomes meaningful and purposeful.

Our modern age has witnessed a development that exceeded all expectations in all fields, especially improving the quality of learning and employing technology to satisfy the needs of learners. However, the category of learning difficulties is still in dire need to increase the effectiveness of learners and develop their skills and abilities by employing modern technologies appropriate to their requirements. It seems clear to us that one of the biggest challenges facing people with learning difficulties is the awareness of linguistic sounds and the link between the shape of the letter and its sound, the formation of words from a group of letters and distinguishing between letters that may have slight differences in their form, such as: Baa and Nun if they appear at the beginning of a word, and what came in this way. It is not only about their academic achievement, but also affects aspects of their social life. Moreover, the negative impact of low social skills for people with learning disabilities appears in the inability to form and maintain friendships with their peers (Gudoniene and Rutkauskiene 2019; Motejlek and Alpay 2019; Wotto 2020).

Through field practice in the field of teaching people with learning disabilities, the researchers sensed the extreme difficulty they face in distinguishing between similar alphabets and the inability to link the sound of the letter to its shape. Also, the clear gap in the lack of use of technical applications such as augmented reality, which help in the success of the educational process, and which update the method of teaching alphabets, as teaching them still depends heavily on traditional methods. However, the use of technologies serves the educational process by attracting students' attention, and providing an effective learning environment, which increases their motivation towards learning, and thus reduces the cognitive pressures caused by the method of memorization (Bloom et al. 2020; Almaleki 2021a; Almaleki et al. 2021b, 2021c)

In the same context and based on the foregoing, the mental visualization strategy adds an atmosphere of fun to the learning process, and the student has an active role in it, so his role turns from a receiver of knowledge to a producer of it. On the other hand, the augmented reality technology helped students focus attention and work effectively, which enabled them to memorize and retrieve information after a period of time. This gave rise to an urgent desire to investigate the attitudes of teachers of learning difficulties towards employing augmented reality technology in the formation of mental perception to distinguish between similar alphabets. This contributes in the future to employing this study in an educational application that aims to give people with learning disabilities the ability to distinguish between similar alphabets, develop their skills, and transfer its impact to the field of learning difficulties.

Augmented Reality

Technology is the hallmark of the times and the lifeblood that has enriched countless aspects. From this standpoint, the pioneers of education sought to take advantage of what it brought in motivating learners, and making the learning process more fun, interesting, and exciting, which allowed the augmented reality technology to make its way easily and easily to contribute to redefining learning and making it meaningful and meaningful. In the same context, the term augmented reality refers to the possibility of interactively merging real and imaginary objects in the real environment. There are many names for this technology, including: augmented reality, enhanced reality, and augmented environment. Perhaps it is appropriate to point out that augmented reality technology

must have many characteristics, the most prominent of which are: (a) It combines virtual information with real information, (b) to be interactive and allow the user to move smoothly between all types of information, (c) to used three-dimensional environment (Iwanaga et al. 2021; López-Belmonte et al. 2020; Luck et al. 2021; Sahin and Yilmaz 2020).

Virtual Reality (VR) and Augmented Reality (AR)

Nowadays, virtual reality technology that delivers computer graphics is becoming increasingly popular and indistinguishable from the real world, but these images in games, movies, and other computer-generated media are separate from our physical surroundings. However, augmented reality holds promise for creating direct, automatic, and actionable links between the real physical world and electronic information. Virtual Reality (VR) places the user inside a completely computer-generated environment, and Augmented Reality (AR) aims to present information recorded directly in the physical or real environment. Virtual reality is also an illusory and unreal embodiment of reality, or an alternative world that is formed in the computer, and a person can interact with it in the same way as he interacts with the real world. Augmented reality is a form of virtual reality, where users of augmented reality devices and applications continue to communicate with the real world around them while interacting with virtual objects, which made augmented reality completely different from virtual reality because it is designed to be a part of its users rather than transfer them to a different reality. The differences between augmented reality and virtual reality in Table 1 (Anderson 2019; Khan and Mian 2020; López-Belmonte et al. 2020; Luck et al. 2021).

Areas of Using Augmented Reality Technology in Education

Augmented reality technology has been used in several fields, most notably in the fields of design, tourism, education, art, architecture, medicine, and in robotics. As for education, it is used in: (1) educational augmented reality games, which are used by teachers to create interactive educational opportunities for students. This makes it easier for them to understand the concepts and information presented to them, (2) Providing opportunities for familiarity with historical and geographic sites that are difficult to access. This technique is embodied in the discovery of educational information, (3) The use of augmented reality glasses for training in some skills, such as aircraft maintenance (Almaleki 2021b, 2021c, 2021d, 2021e; Almaleki and Alomrany 2021; Abriata 2022).

Advantages of Augmented Reality Technology in Education

Augmented reality technology is one of the modern technologies that have proven useful in many studies in education. Considering this, it is appropriate to review some of these features: (a) Contribute to the provision of scientific material in proportion to the generation of technology, (b) It allows the learner to control the educational process, (c) Availability of new modes of education so that learning is more realistic, (d) It brings pleasure to the learning process, (e) It provides opportunities for new explorations, (f) It increases the efficiency of the teacher and his ability to present information in a simplified and accessible manner, (g) It motivates the learner to participate and interact because it combines knowledge and pleasure (Wardley et al. 2019b; Baragash et al. 2020; Ifijeh and Yusuf 2020).

Augmented Reality Technology and Distinguish Between Similar Alphabets

Considering these interesting indicators of integrating augmented reality technology in teaching Arabic language skills, many studies have proven the possibility of employing this technology in

Table 1: Differences between augmented reality and virtual reality

Augmented reality	*Virtual reality*
It merges physical objects with imaginary ones	Includes only virtual objects
Transfers the external environment to the inside of the digital device	Transfers the learner to the virtual environmentIsolates the learner from the real reality while using it
Brings fantasy to reality while using it	

learning the alphabet, reading, and writing skills. Therefore, augmented reality technology can increase students' motivation towards learning the Arabic language and leave a positive impact towards it. It is worth noting that it overcame the traditional methods in its ability to deliver information and allow the student to interact with it, in addition, it enhanced the retention of learning and the continuity of its practice in the absence of the teacher or in the event the student was outside the classroom (Altinpulluk 2019; Anderson 2019; Beck 2019; Marpa 2021; Turan and Atila 2021).

Cognitive Perception

The emergence of mental visualization goes back to the beginning of the cognitive revolution in the seventies and eighties of the twentieth century, which was characterized by its interest in developing mental abilities and skills. Based on this, the mental perception reappeared and became a subject of interest, as several studies have proven its effectiveness in several fields of knowledge because it is closely related to human cognitive functions. From another angle, mental visualization is referred to by several terms such as mental practice, visualization, mental training, mental rehearsal, and other terms. It is worth noting that mental perception was mentioned in the Stanford Encyclopedia of Philosophy, and it was defined as: seeing through the mind's eye, hearing the sounds that go on inside, and imagining internal feelings in the absence of an external stimulus. Mental visualization is one of the memory activation strategies, in which the learner practices mental operations that help him to facilitate the preservation of information in memory for a longer period, in addition to facilitating the retrieval of this previously stored information (Wardley et al. 2019b; Baragash et al. 2020; Ifijeh and Yusuf 2020; Altinpulluk 2019; Anderson 2019; Beck 2019; Marpa 2021; Turan and Atila 2021).

Activating the Role of Mental Visualization in Distinguishing between Alphabets

Perhaps it is appropriate to highlight some of importance, which serve as justifications for using mental visualization with people with learning difficulties. Activating the role of mental visualization with people with learning difficulties works to treat memory deficiencies, and to give the individual the ability to retain the concepts and information that he passes through in educational situations. In addition, it helped many people with learning disabilities to distinguish between words and sentences in the Arabic language, and its impact was evident on the spelling of letters in the English language and the distinction between their sounds, which is a motivator to investigate its impact on distinguishing between similar alphabets in the Arabic language. It is worth noting that it increases the learner's ability to retrieve what he has learned in case he needs it and improves his motivation to learn by linking his previous experience with the current experience, in addition to increasing his academic achievement level. This is reflected positively on his role in the learning process, improving his self-perception and increasing his belief in his abilities (Altinpulluk 2019; Anderson et al. 2020; Suppan et al. 2020).

Objectives

Based on the above, the study aimed to evaluate the attitudes of learning difficulties of Teachers towards employing augmented reality technology in the formation of mental visualization to distinguish between similar alphabets.

MATERIAL AND METHODS

The current study used the descriptive approach to obtain direct information from teachers of learning difficulties, in addition to its relevance to the objectives of the current study and its help in reaching the answers to the study presented.

Measure

A customized measurement tool was used to assess the attitudes of learning disabilities teachers towards employing augmented reality technology to form mental visualization to distinguish between similar alphabets for people with learning disabilities. The questionnaire was embodied in the main axes: (1): Teachers' attitudes towards using augmented reality technology in facilitating the education of people with learning difficulties, (2) Teachers' attitudes towards the use of augmented reality in the formation of mental perception to distinguish between similar letters for peo-

ple with learning difficulties and (3) Teachers' attitudes towards the obstacles of using augmented reality in creating mental perception to distinguish between similar letters for people with learning difficulties. The measuring tool was built as shown in Table 2.

Reliability

After applying the tool to a pilot sample of (140) teachers, Cronbach's alpha coefficient reliability for scale dimensions, as well as the overall reliability of the scale have been validated. Table 3 shows the reliability coefficients of the scale.

Based on the Cronbach's alpha coefficient reliability in Table 3, the scale has good reliability coefficients located in the period from (0.70-0.99), which makes it valid to achieve the objectives of the study.

Internal Validity

Using the pilot sample data, Pearson correlation coefficients were calculated to validate the correlation of the scale phrases with the dimensions to which they belong, to ensure the internal validity of the scale. Table 4 shows the results of the correlation coefficient.

Table 4 shows that the correlation coefficients of the phrases with their dependent dimensions are significant correlations at the level of significance (0.01), which indicates a high internal validity of the dimensions of the questionnaire.

Structural Validity (Factor Analysis)

The Shapiro-Wilk test was used to ascertain the moderation of data distribution in the four factors which constitute the scale of the attitudes of learning difficulties teachers towards employing augmented reality technology in creating mental perception to distinguish between similar alphabets, which was applied to the study sample. The probabilities of the test ranged between (0.62-0.31). The probability value of the moderation of the distribution in the factors is higher than the significance level (0.05), which indicates the moderation of the distribution, and the applicability of the condition for conducting the factorial analysis of the study model.

The determinant of the matrix was calculated to ensure that there is no linear dependence between the variables, or in other words, the presence of unreal high correlations between some variables. The value of the matrix determinant is (0.0002). This value indicates that there is no linear dependence between the variables.

Table 2: Shows the distribution of phrases on the dimensions of the questionnaire in its final form

The dimension	*Number of phrases*
The first dimension: Teachers' attitudes towards the use of augmented reality technology in facilitating the education of people with learning difficulties	15 phrases
The second dimension: Teachers' attitudes towards the use of augmented reality in the formation of mental perception to distinguish between similar letters for people with learning difficulties.	07 Phrases
The third dimension: Teachers' attitudes towards the obstacles of using augmented reality in creating mental perception to distinguish between similar letters for people with learning difficulties.	07 Phrases
Total	29 phrases

Table 3: Cronbach's alpha coefficient reliability for the dimensions of questionnaire and overall reliability

Dimensions	*Cronbach's alpha coefficient*
1 The first dimension: Teachers' attitudes towards the use of augmented reality technology in facilitating the education of people with learning difficulties	0.80
2 The second dimension: Teachers' attitudes towards the use of augmented reality in the formation of mental perception to distinguish between similar letters for people with learning difficulties.	0.82
3 The third dimension: Teachers' attitudes towards the obstacles of using augmented reality in creating mental perception to distinguish between similar letters for people with learning difficulties.	0.79
4 The total reliability of the questionnaire	0.84

Table 4: The correlation coefficients of the phrases of the questionnaire dimensions

Dimension	*Item*	*Correlation coefficient*	*Item Item*	*Correlation coefficient*
The first dimension: Teachers' attitudes towards	1	0.741**	8	0.710**
the use of augmented reality technology in	2	0.770**	9	0.715**
facilitating the education of people with learning	3	0.751**	10	0.699**
difficulties	4	0.571**	11	0.430**
	5	0.505**	12	0.440**
	6	0.692**	13	0.392**
	7	0.776**	14	0.792**
	-	-	15	0.720**
The second dimension: Teachers' attitudes towards	1	0.799**	5	0.758**
the use of augmented reality in the formation of	2	0.713**	6	0.758*
mental perception to distinguish between similar	3	0.791**	7	0.758**
letters for people with learning difficulties.	4	0.837**	-	-
The third dimension: Teachers' attitudes towards	1	0.696**	5	0.751**
the obstacles of using augmented reality in creating	2	0.609**	6	0.378**
mental perception to distinguish between similar	3	0.777**	7	0.656**
letters for people with learning difficulties.	4	0.765**	-	-

** Significant level at (0.01).

The Kaiser, Meyer, and Olkin (KMO) tests were used to ensure that the sample number was sufficient to perform the factor analysis of the model and the value was (0.66), which is higher than the borderline value (0.5). This indicates the sufficiency of the sample number to perform a factor analysis of the model. The Bartlett test was performed, and the result indicated that the probability value of the two matrices asymmetry was (0.001), which is a probability value less than (0.05), which indicates that the two matrices are different.

After applying the conditions of factor analysis, the factor validity of the questionnaire was verified by exploratory factor validity (EFA), using the principal components method, which is considered one of the most famous methods of calculating exploratory factor analysis. To extract the results of the analysis, the method of determining the factors (Fixed number of factors) predetermined by four factors was used. Table 5 shows the communalities values for the scale items.

It is clear from Table 5 that the communalities, which represent the proportion of each variable's variance can be explained by the factors. Communalities are between (0.328 - 0.860). The high prevalence of communalities is an indicator of the high stability of the item or phrase. It is clear item (17) is the item with the highest contribution, and item (5) is the less one.

The Component Matrix was also extracted using Varimax method, which assumes that the factors are independent of each other. It is the most widely used in psychological and educational sciences, to obtain an easier and clearer interpretation of the results. Table 6 shows the lambda values of the items on the factors.

Table 5: Communalities coefficients for the items of the scale

Item	*Commu-nalities*	*Item*	*Commu-nalities*	*Item*	*Commu-nalities*
1	0.782	11	0.685	21	0.630
2	0.432	12	0.338	22	0.669
3	0.450	13	0.373	23	0.606
4	0.528	14	0.375	24	0.349
5	0.328	15	0.796	25	0.495
6	0.539	16	0.805	26	0.517
7	0.705	17	0.825	27	0.647
8	0.590	18	0.783	28	0.587
9	0.441	19	0.794	29	0.720
10	0.495	20	0.860	-	-

It is clear from Table 6 that items (1-7) have the most saturated values on the third factor, items (8-15) have the highest saturation values on the second factor, items (16-22) have the highest saturation values under the first factor and finally the phrases (23-29) fall under the fourth factor. It is also evident from the table that all saturation values exceed the Kaiser criterion (0.3) to be acceptable saturation values for each of the statements.

In view of the results of the previous exploratory factor analysis, the expressions are divided into four dimensions as previously defined by the

Table 6: Component Matrix after using Varimax method

Item	*1st factor*	*2nd factor*	*3rd factor*	*4th factor*
1	-0.053	-0.081	0.788	-0.011
2	0.054	-0.041	0.814	-0.033
3	-0.020	-0.177	0.739	-0.167
4	0.065	-0.036	0.530	-0.251
5	0.035	-0.041	0.307	-0.313
6	0.054	0.168	0.679	0.157
7	0.053	0.028	0.778	0.193
8	0.172	0.739	-0.104	0.027
9	0.023	0.841	-0.089	-0.065
10	-0.021	0.825	0.003	-0.065
11	0.207	0.302	-0.242	0.192
12	-0.018	0.342	-0.093	0.074
13	0.101	-0.308	-0.131	0.231
14	0.024	0.887	0.076	0.056
15	-0.144	0.883	0.057	0.020
16	0.908	-0.027	0.014	-0.002
17	0.883	-0.028	-0.009	-0.055
18	0.882	-0.047	0.095	-0.070
19	0.923	0.059	0.040	-0.054
20	0.881	0.021	0.078	0.017
21	0.649	-0.018	-0.053	-0.090
22	0.426	-0.085	-0.279	0.337
23	-0.150	-0.039	-0.215	0.677
24	0.172	0.183	0.095	0.505
25	-0.155	-0.061	-0.090	0.710
26	-0.279	0.061	-0.126	0.780
27	-0.109	-0.148	0.065	0.743
28	0.182	-0.195	0.262	0.318
29	0.049	0.099	0.096	0.523

researchers based on previous studies and research literature. These factors were named according to Table 7.

Actual Sample

The study population consisted of teachers of learning difficulties in the Makkah region in the Kingdom of Saudi Arabia. They were randomly selected representing the current study population to achieve the desired research objectives. They were contacted in cooperation with the leaders of schools implementing the learning difficulties program in the primary stage. Table 8 shows the distribution of the sample members according to the study variables (gender, academic qualification, specialization, years of teaching experience, familiarity with the concept of augmented reality, the use of augmented reality technology during the teaching period).

RESULTS AND DISCUSSION

To answer the question ”What are the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in creating mental perception to distinguish between similar alphabets?”; Means (M) and standard deviations (SD) were used to prioritize the scale dimensions statements as shown in Tables 9-11: (the attitudes of teachers of learning difficulties towards using Augmented Reality Technology in facilitating the education of people with disabilities – The attitudes of teachers of learning difficulties towards using Augmented Reality in creating mental visualization to distinguish between similar alphabets for people with learning difficulties, and the attitudes of teachers of learning difficulties towards obstacles using Augmented Reality in creating mental perception to distinguish between similar alphabets for people with learning disabilities).

Table 9 shows that the statement (Augmented Reality Technology creates a supportive environment and increases the motivation of people with

Table 7: Distribution of scale expressions to the factors and their denominations

Factors	*Factor number*	*Items*	*Total items*
Attitudes of teachers who use augmented reality technology towards the use of augmented reality technology in facilitating the education of people with learning difficulties	3	1-7	7
Attitudes of teachers who use augmented reality technology towards the use of augmented reality technology in facilitating the education of people with learning difficulties	2	8-15	8
Teachers’ attitudes towards using augmented reality in creating mental visualization to distinguish between similar letters for people with learning difficulties	1	16-22	7
Teachers’ attitudes towards the obstacles of using augmented reality in creating mental perception to distinguish between similar letters for people with learning difficulties	4	23-29	7

Table 8: Distribution of the total sample members according to the study variables

Variables	*Variable levels*	*Frequency*	*Percentage*
Gender	Male teachers	58	37.9
	Female teachers	95	62.1
Qualification	Bachelor	114	74.5
	High diploma	10	6.5
	Master	27	17.6
	Ph.D.	2	1.3
Sub-specialization	Learning difficulties	107	69.9
	Another specialization coupled with a diploma in learning disabilities	46	30.1
Years of experience	From 1 year to less than 5 years	49	32.0
	From 5 years to less than 10 years	45	29.4
	More than 10 years	59	38.6
Familiarity with the concept of augmented reality	No.	10	6.5
	Somewhat	78	51.0
	Yes	65	42.5
The use of augmented reality technology during the teaching period	Yes	70	45.8
	No	83	54.2
	Total	153	100%

Table 9: Means and Standard Deviations of the sample responses arranged in descending order for each of the first-dimension statements among the users of Augmented Reality Technology

Items number	*Items*	*M*	*SD*	*Agreement level*	*Rank*
4	Augmented Reality Technology creates a supportive environment and increases the motivation of people with learning disabilities towards learning. Its impact is positively reflected on their satisfaction with individual education.	4.49	0.63	Strongly agree	1
2	Augmented Reality Technology is compatible with the characteristics of people with learning difficulties and their teaching methods and develops their self-learning skills.	4.30	0.69	Strongly agree	2
6	The Corona pandemic is an appropriate opportunity to activate the role of Augmented Reality Technology in teaching.	4.20	0.84	Agree	3
1	I plan to use Augmented Reality Technology in all the courses I study, because it is fun and very easy to use.	4.17	0.78	Agree	4
3	The use of Augmented Reality Technology in teaching people with learning difficulties is more efficient than traditional methods and reduces the teaching burden on teachers.	4.10	0.84	Agree	5
7	Augmented Reality Technology applications are a convenient and consistent solution with distance education.	4.07	0.87	Agree	6
5	The use of Augmented Reality applications as an educational program is financially costly and requires administrative and financial support from the school administration.	3.76	1.00	Agree	7
	Overall Mean Agreement Level for the Dimension	4.15	0.55	Agree	

learning disabilities towards learning. Its impact is positively reflected on their satisfaction with individual education) ranked first according to the responses of teachers of learning difficulties, where

the mean of their responses to this statement was (4.49), which falls within (strongly agree). This indicates that teachers have a positive attitude towards the role of Augmented Reality Technology in increasing motivation towards learning and satisfaction with individual learning. On the other hand, the statement (The use of Augmented Reality applications as an educational program is financially costly and requires administrative and financial support from the school administration) ranked seventh among the statements according to the responses of male and female teachers, with mean of (3.76) responses, which falls within (Agree). This indicates that teachers agree that the financial cost of technology is high, and this characteristic is negative for them. It is also clear from the table that the attitudes of teachers of learning difficulties who use Augmented Reality Technology towards its use in facilitating the education of people with learning difficulties in general was within the level (Agree), which mean of (4.15). This indicates the general positive attitude towards the use of technology in facilitating education for this category.

Second: Attitudes of teachers who are not using augmented reality technology:

Table 10 shows that the statement (The use of Augmented Reality applications as an educational program is financially costly and requires administrative and financial support from the school administration.) ranked first according to the responses of teachers of learning difficulties, where the mean of their responses to this statement was (4.16), which falls within (agree). This indicates that teachers see that the use of Augmented Reality applications as an educational program is financially costly, which contributes to reducing the positive attitude towards the use of Augmented Reality Technology. On the other hand, the statement (Implementing Augmented Reality applications wastes class time without achieving the desired goal and increases the teaching burden on teachers of learning difficulties.) ranked eighth according to the responses of teachers, as the mean

Table 10: Means and Standard Deviations of the sample responses arranged in descending order for each of dimension (1) statements among non-users of Augmented Reality Technology

Items number	*Items*	*M*	*SD*	*Agreement level*	*Rank*
5	The use of Augmented Reality applications as an educational program is financially costly and requires administrative and financial support from the school administration.	4.16	0.83	Agree	1
3	Augmented Reality Technology creates a supportive environment, increases the motivation of people with learning disabilities towards learning, and develops their self-learning skills.	4.06	0.69	Agree	2
1	I am keen to know enough information about Augmented Reality Technology and how to use it in teaching people with learning difficulties.	4.02	0.88	Agree	3
7	The Corona pandemic is an appropriate opportunity to activate the role of Augmented Reality Technology in teaching.	4.00	0.88	Agree	4
2	Augmented Reality Technology is flexible and appropriate for the skills of people with learning disabilities in Lughati “My Language” and “Mathematics” Courses.	3.92	0.83	Agree	5
8	Augmented Reality Technology applications are a convenient and consistent solution with e-education.	3.92	0.89	Agree	6
4	The use of traditional means in teaching people with learning difficulties is more efficient than Augmented Reality Technology.	3.01	0.99	Somewhat agree	7
6	Implementing Augmented Reality applications wastes class time without achieving the desired goal and increases the teaching burden on teachers of learning difficulties.	3.00	1.01	Somewhat agree	8
	Overall Mean Agreement Level for the Dimension	3.76	0.50	Agree	

of their responses reached (3.00), which falls within (Somewhat Agree). The table also shows that the attitudes of teachers of learning difficulties who do not use Augmented Reality Technology towards its use in facilitating the education of people with learning difficulties in general falls within the level (Agree), with average mean of (3.76). This indicates the general positive attitude towards the use of technology in facilitating education for this category.

Table 11 shows that the statement (The formation of mental perception to distinguish between similar alphabets using Augmented Reality Technology increases the student's desire to learn, and adds fun) ranked first according to the responses of teachers of learning difficulties, where the mean of their responses to this statement was (4.29), which falls within (strongly agree). This indicates that teachers have a positive attitude towards the role of Augmented Reality Technology in increasing the student's desire and creating an atmosphere of fun. On the other hand, the statement (Augmented Reality Technology is effective in achieving the mental perception of distinguishing between similar alphabets) ranked seventh according to the responses of the teachers, where the mean of their responses reached (2.92), which falls within (Somewhat Agree). This indicates that teachers agree to some extent that the Augmented Reality Technology is effective in achieving the mental perception of distinguishing between similar alphabets. This shows a positive attitude towards technology. The table also shows that teachers' attitudes towards using Augmented reality in creating mental perception to distinguish between similar letters for people with learning difficulties in general was within the level (Agree), with a mean of 3.90. This indicates the general positive attitude towards the use of technology in the formation of mental perception to distinguish between similar letters of this category.

Table 12 shows that the statement (The lack of training programs and the lack of equipment and technical means to activate the Augmented Reality Technology leads to difficulties in its implementation) ranked first rank according to the

Table 11: Means and Standard Deviations of the sample responses arranged in descending order for each of dimension (2) statements

Items number	*Items*	*M*	*SD*	*Agreement level*	*Rank*
2	The formation of mental perception to distinguish between similar alphabets using Augmented Reality Technology increases the student's desire to learn and adds fun.	4.29	0.70	Strongly agree	1
4	The use of Augmented Reality Technology contributes to enhancing mental image retention that enables the student to distinguish between similar alphabets and maintains the learning effect.	4.14	0.71	Agree	2
5	The student's interaction with Augmented Reality Technology motivates him to build a mental perception to distinguish between similar alphabets away from stimuli in the teaching environment.	4.08	0.73	Agree	3
3	The formation of mental perception to distinguish between similar alphabets using Augmented Reality Technology enables students with learning disabilities to shorten the time and effort in learning.	4.07	0.75	Agree	4
1	Employing Augmented Reality Technology helps the student to form a mental image that enables him to distinguish between similar alphabets easily.	4.05	0.71	Agree	5
6	In the absence of the perceptual - Augmented Reality; the student will retain the mental image previously acquired to distinguish between similar alphabets.	3.76	0.81	Agree	6
7	Augmented Reality Technology is effective in achieving the mental perception of distinguishing between similar alphabets.	2.92	1.21	Somewhat agree	7
	Overall Mean Agreement Level for the Dimension	3.90	0.57	Agree	

Table 12: Means and Standard Deviations of the sample responses are arranged in descending order for each of dimension 3 statements

Items number	*Items*	*M*	*SD*	*Agreement level*	*Rank*
6	The lack of training programs and the lack of equipment and technical means to activate the Augmented Reality Technology leads to difficulties in its implementation.	3.99	0.82	Agree	1
2	Insufficient class time hinders the use of Augmented Reality Technology, which negatively affects the learning process.	3.54	0.90	Agree	2
7	Implementation of Augmented Reality applications increases dispersion among people with learning difficulties and increases the teaching burden on teachers of learning difficulties.	3.30	1.01	Somewhat agree	3
5	Creating and designing cards of similar alphabets using Augmented Reality Technology increases the teaching burden on teachers of learning difficulties.	3.16	1.03	Somewhat agree	4
1	Traditional methods of teaching distinguishing between similar alphabets are more effective than Augmented Reality Technology.	2.85	1.04	Somewhat agree	5
3	There is a difficulty of applying Augmented Reality Technology to distinguish between similar alphabets for people with learning difficulties in the primary level.	2.66	1.00	Somewhat agree	6
4	The concern of students with learning disabilities about dealing with Augmented Reality Technology leads to obstacles in training them to use it.	2.58	1.06	Somewhat agree	7
	Overall Mean Agreement Level for the Dimension	3.15	0.65	Somewhat agree	

responses of teachers of learning difficulties, where the mean of their responses to this statement was (3.99), which falls within (Agree). This indicates that teachers believe in the importance of training and providing equipment in activating and implementing Augmented Reality Technology. On the other hand, the statement (The concern of students with learning disabilities about dealing with Augmented Reality Technology leads to obstacles in training them to use it) ranked seventh according to the responses of teachers, with a mean of (2.58), which falls within (Somewhat Agree). This indicates that teachers agree to some extent that the Augmented Reality Technology calls for providing training programs for people with learning difficulties that relate to the mechanism of using and employing technology in facilitating the learning process. The table also shows that teachers' attitudes towards the obstacles of using Augmented reality in creating a mental perception to distinguish between similar letters for people with learning difficulties in general was within the level (Somewhat Agree), with a mean of (3.15).

To answer the second question, which states: " Are there statistically significant differences at the level (0.05) or less in the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets due to the variables of (Gender, Educational Qualification, Sub-Specialty, Years of Experience, Familiarity with the Concept of Augmented reality, Use of Augmented Reality Technology during the Teaching Period)? " The t-test was employed for independent samples, in addition to One-Way ANOVA Test to find statistical differences between the responses of teachers of learning difficulties in the questionnaire axes due to the study variables according to the following:

Differences between the Responses of Teachers of Learning Difficulties According to the Gender Variable

Table 13 shows the results of the t-test for independent samples, to find statistically significant differences between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets, according to the gender variable (male, female).

Table 13: T-test for independent samples of teachers' responses according to the gender variable

Gender	*N*	*M*	*SD*	*T-value*	*df*	*P-value*
Male	58	3.4957	0.42726	0.726	151	0.469
Female	95	3.5518	0.48442			

Table 13 shows that there is no statistically significant differences at the level of (0.05) or less between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets due to the gender variable.

Differences between the Responses of Teachers of Learning Difficulties According to the Educational Qualification Variable

Table 14 shows the results of One-Way ANOVA Test, to find the significance of the differences between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets, according to the educational qualification variable (Bachelor, Higher Diploma, MA, PhD).

Table 14 shows that there are no statistically significant differences at the level of (0.05) or less between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets due to the educational qualification variable.

Differences between the Responses of Teachers of Learning Difficulties According to the Variable of Specialization

Table 15 shows the results of One-Way ANOVA test, to find the statistically significant differences between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets, according to the educational qualification variable (learning difficulties, another specialization).

Table 15 shows that there are statistically significant differences at the level (0.05) or less between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets due to the variable specialization. Teachers with other specializations associated with a learning disability diploma have a more positive attitude than specialists in learning difficulties.

Differences between the Responses of Teachers of Learning Difficulties According to the Years of Experience Variable

Table 16 shows the results of One-Way ANOVA test, to find the statistically significant differ-

Table 14: One-Way ANOVA Test for teachers' responses according to the educational qualification variable

Source	*Type III sum of squares*	*df*	*Mean square*	*F*	*P-value*
Between groups	0.098	3	0.033	0.150	0.929
Within groups	32.479	149	0.218		
Total	32.577	152	-		

Table 15: t-test of independent samples of teachers' responses according to the sub-specialty

Sub-specialization	*N*	*M*	*SD*	*t-value*	*df*	*P-value*
Learning difficulties	107	3.4786	0.42189	2.141	151	0.034*
Another specialization associated with a Diploma in Learning Disabilities	46	3.6513	0.53229			

* Statistically significant differences at the level (0.05).

ences between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets, according to the variable years of experience (from one year to less than 5 years, from 5 years to less than 10 years, more than 10 years).

Table 16 shows that there are no statistically significant differences at the level (0.05) or less between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets due to years of experience variable.

Differences between the Responses of Teachers of Learning Difficulties According to the Variable of Familiarity with the Concept of Augmented Reality

Table 17 shows the results of the One-Way ANOVA test, to find the statistically significant differences between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in creating mental perception to distinguish between similar alphabets, according to the variable of familiarity with the concept of Augmented reality (No, Somewhat, Yes).

Table 17 shows that there are no statistically significant differences at the level (0.05) or less between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets due to the variable of familiarity with the concept of Augmented reality.

Differences between the Responses of Teachers of Learning Difficulties According to the Variable of Using Augmented Reality Technology During the Teaching Period

Table 18 shows the results of the t-test for independent samples, to find the statistically significant differences between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets, according to the variable of using Augmented Reality Technology during the teaching period (Yes, No).

Table 18 shows that there are no statistically significant differences at the level (0.05) or less between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets due to the variable of using Augmented Reality Technology during the period Teaching.

Table 16: One-Way ANOVA Test for teachers' responses according to the years of experience

Source	*Type III sum of squares*	*df*	*Mean square*	*F*	*P-value*
Between groups	0.357	2	0.178	0.830	0.438
Within groups	32.220	150	0.215		
Total	32.577	152	-		

Table 17: One-Way ANOVA Test for teachers' responses according to the variable familiarity with the concept of Augmented reality

Source	*Type III sum of squares*	*df*	*Mean square*	*F*	*P-value*
Between groups	1.028	2	0.514	2.444	0.09
Within groups	31,549	150	0.21		
Total	32.577	152	-		

Table 18: T-test of independent samples of teachers' responses according to the variable of using Augmented Reality Technology

Use	*N*	*M*	*SD*	*T-value*	*df*	*P-value*
Yes	58	3.4957	0.42726	0.726	151	0.469
No	95	3.5518	0.48442			

This study aimed to design a tool for measuring and evaluating the attitudes of learning disabilities teachers towards employing Augmented Reality technology in creating mental visualization to distinguish between similar alphabets. This study derives its importance from the importance of employing strategies and techniques for the benefit of the student and its role in extrapolating the attitudes of teachers of learning difficulties towards the effectiveness of this technology, which leads in the future to the development of an educational method in the field of learning difficulties. It also benefits students with learning difficulties for whom traditional teaching methods have not worked. It may also contribute to allowing similar research on the use of augmented reality technology in the field of teaching students with special needs. This is consistent with the objectives of several previous studies (Geroimenko 2020b; Almaleki 2021e; Almaleki and Alomrany 2021; Alrefaei et al. 2022a, 2022b).

The limitedness of the currently reliable measurement and evaluation tools makes this study necessary to provide a distinguished base for measurement tools in the field of people with special needs. As well as, designing a measurement tool to assess the attitudes of teachers of learning difficulties towards the application of augmented reality technology in the formation of mental visualization, which will benefit in the future in providing an integrated educational application that enables teachers of learning difficulties to apply it with their students with learning difficulties, and build similar methods and programs that serve other study subjects such as mathematics and others. This study can contribute to the development of electronic curricula for learning difficulties based on the use of augmented reality technology in learning. This is consistent with the objectives of several previous studies (Wardley et al. 2019b; Baragash et al. 2020; Ifijeh and Yusuf 2020; Altinpulluk 2019; Anderson 2019; Beck 2019; Marpa 2021; Turan and Atila 2021).

CONCLUSION

Through this study and the previous research literature, the researchers suggest some points that are believed to be important to evaluate the attitudes of learning disabilities teachers towards employing Augmented Reality technology in creating mental visualization to distinguish between similar alphabets.

1. There is a positive attitude among teachers of learning difficulties towards employing Augmented Reality Technology, creating a mental perception to distinguish between similar alphabets, as it creates a supportive environment to facilitate the learning process of people with learning difficulties, in addition to their desire to provide equipment and training programs that would help them employ Augmented Reality Technology in teaching people with learning disabilities.
2. There are no statistically significant differences between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets due to:
   a. Gender variable (male and female)
   b. Educational qualification variable (Bachelor, Higher Diploma, MA, Ph. D.).
   c. Years of experience variable (from 1 year to less than 5 years, from 5 years to less than 10 years, more than 10 years)
   d. Variable of familiarity with the concept of Augmented reality (No, Somewhat, Yes).
   e. The variable of using Augmented Reality Technology during the teaching period (Yes, No).
3. There are statistically significant differences between the attitudes of teachers of learning difficulties towards employing Augmented Reality Technology in the formation of mental perception to distinguish between similar alphabets due to the variable of sub-specialty. However, teachers with other specializations associated with a diploma in learning difficulties have a more positive attitude than specialists in learning difficulties.

RECOMMENDATIONS

The researchers recommend the following main recommendations:

Drawing the attention of decision - makers in the development of an electronic platform for teach-

ers of learning difficulties and their students aims to provide training programs on the use of the mechanism of activation and recruitment of Augmented Reality Technology in facilitating the learning process, in addition to adding mental perception strategy to the school curriculum. Developing schools' guides aimed at increasing awareness of educational practitioners and families of people with learning difficulties in ways that activate mental perception strategy and how to apply them in the education of people with learning difficulties. Developing several applications based on the enhanced Reality Technology in various teaching skills for people with learning difficulties and dissemination for them among educational practitioners.

CONFLICT OF INTEREST DISCLOSURE STATEMENT

We do not have any interests that might be interpreted as influencing the research. Additionally, this manuscript has not been submitted to any other journal, nor is it under consideration for publication with any other entity.

ETHICAL CONDUCT STATEMENT

That Internal Review Board (IRB) approval for the use of human subjects was granted prior to conduct of the research and guidelines were adhered to throughout the research process.

REFERENCES

Abriata LA 2022. How technologies assisted science learning at home during the COVID-19 pandemic. *DNA and Cell Biology*, 41(1): 19–24.

Ahied M, Muharrami LK, Fikriyah A, Rosidi I 2020. Improving students' scientific literacy through distance learning with Augmented Reality-based multimedia amid the Covid-19 pandemic. *Jurnal Pendidikan IPA Indonesia*, 9(4): 499–511.

Almaleki D 2021a. Examinee characteristics and their impact on the psychometric properties of a multiple choice test according to the Item Response Theory (IRT). *Engineering, Technology and Applied Science Research*, 11(2): 6889–6901.

Almaleki D 2021b. Stability of the data-model fit over increasing levels of factorial invariance for different features of design in factor analysis. *Engineering, Technology and Applied Science Research*, 11(2): 6849–6856.

Almaleki D 2021c. The precision of the overall data-model fit for different design features in confirmatory factor analysis. *Engineering, Technology and Applied Science Research*, 11(1): 6766–6774.

Almaleki DA 2021a. Challenges experienced use of distance-learning by high school teachers' responses to students with depression. *International Journal of Computer Science and Network Security*, 21(5): 192–198. https://doi.org/10.22937/IJCSNS.2021.21.5.27

Almaleki DA 2021b. The psychometric properties of Distance-Digital Subjective Happiness Scale. *International Journal of Computer Science and Network Security*, 21(5): 211–216. https://doi.org/10.22937/IJCSNS.2021.21.5.29

Almaleki DA 2021c. Evaluate students' interaction and happiness in distance learning among students with learning-difficulties during Covid-19 pandemic. *International Journal of Computer Science and Network Security*, 21(11): 119–130. https://doi.org/10.22937/IJCSNS.2021.21.11.16

Almaleki DA 2021d. Accuracy of data-model fit using growing levels of invariance models. *International Journal of Computer Science and Network Security*, 21(12): 157–164. https://doi.org/10.22937/IJCSNS.2021.21.12.23

Almaleki DA 2021e. The psychometric properties of effectiveness scale in distance-digital. *International Journal of Computer Science and Network Security*, 21(12): 149–156. https://doi.org/10.22937/IJCSNS.2021.21.12.22

Almaleki DA, Alomrany AG 2021. The effect of methods of estimating the ability on the accuracy and items parameters according to 3PL Model. *International Journal of Computer Science and Network Security*, 21(7): 93–102. https://doi.org/10.22937/IJCSNS.2021.21.7.12

Almaleki DA, Alhajaji RA, Alharbi MA 2021a. Measuring students' interaction in distance learning through the electronic platform and its impact on their motivation to learn during Covid-19 crisis. *International Journal of Computer Science and Network Security*, 21(5): 98–112. https://doi.org/10.22937/IJCSNS.2021.21.5.16

Almaleki DA, Khayat WW, Yally TF, Al-hajjaji AA 2021b. The effectiveness of the use of distance-evaluation tools and methods among students with learning-difficulties from the teachers' point of view. *International Journal of Computer Science and Network Security*, 21(5): 243–255. https://doi.org/10.22937/IJCSNS.2021.21.5.34

Alrefaei AF, Almaleki D, Alshehrei F, Kadasah S, ALluqmani Z, Abdulaziz Alotaibi Alsulaimani A, Aljuhani A, Alruhaili A 2022a. Assessment of health awareness and knowledge toward SARS-CoV-2 and COVID-19 vaccines among residents of Makkah, Saudi Arabia. *Clinical Epidemiology and Global Health*, 13: 100935. https://doi.org/10.1016/j.cegh.2021.100935

Alrefaei AF, Hawsawi YM, Almaleki D, Alafif T, Alzahrani FA, Bakhrebah MA 2022b. Genetic data sharing and artificial intelligence in the era of personalized medicine based on a cross sectional analysis of the Saudi human genome program. *Scientific Reports*, 12(1): 1405. https://doi.org/10.1038/s41598-022-05296-7

Altinpulluk H 2019. Determining the trends of using augmented reality in education between 2006-2016. *Education and Information Technologies*, 24(2): 1089–1114.

Anderson A 2019. *Virtual Reality, Augmented Reality and Artificial Intelligence in Special Education: A Practical Guide to Supporting Students with Learning Differences*. UK: Routledge.

Baragash RS, Al-Samarraie H, Moody L, Zaqout F 2020. Augmented reality and functional skills acquisition among individuals with special needs: A meta-analysis of group design studies. *Journal of Special Education Technology*, 0162643420910413.

Beck D 2019. Augmented and virtual reality in education: Immersive learning research. *Journal of Educational Computing Research*, 57(7): 1619–1625.

Bloom DA, Reid JR, Cassady CI 2020. Education in the time of COVID-19. *Pediatric Radiology*, 50: 1055–1058.

Brezicha KF, Ikoma S, Park H, LeTendre GK 2020. The ownership perception gap: Exploring teacher job satisfaction and its relationship to teachers' and principals' perception of decision-making opportunities. *International Journal of Leadership in Education*, 23(4): 428–456.

Carreon A, Smith SJ, Rowland A 2020. Augmented Reality: Creating and implementing digital classroom supports. *Journal of Special Education Technology*, 35(2): 109–115.

Darmawan FA, Jainuddin J 2021. Augmented Reality-based Mathematics worksheet for online learning during Covid-19 pandemic. *Indonesian Journal of Educational Studies*, 23(2): 81–90.

Ferguson P, McKenzie M, Mercieca D, Mercieca DP, Sutherland L 2021. Primary Head Teachers' construction and re-negotiation of care in COVID-19 lockdown in Scotland. *Frontiers in Education*, 6: 88.

Freire T, Ferreira G 2020. Do I need to be positive to be happy? Considering the role of self-esteem, life satisfaction, and psychological distress in Portuguese adolescents' subjective happiness. *Psychological Reports*, 123(4): 1064–1082.

Geroimenko V 2020a. *Augmented Reality in Education*. Germany: Springer.

Geroimenko V 2020b. *Augmented Reality in Education*. Germany: Springer.

Godoy Jr CH 2021. Augmented reality for education: A review. *ArXiv Preprint ArXiv,* 2109.02386.

Gudoniene D, Rutkauskiene D 2019. Virtual and augmented reality in education. *Baltic Journal of Modern Computing*, 7(2): 293–300.

He L, Yang N, Xu L, Ping F, Li W, Sun Q, Li Y, Zhu H, Zhang H 2021. Synchronous distance education vs traditional education for health science students: A systematic review and meta-analysis. *Medical Education*, 55(3): 293–308.

Henaku EA 2020. COVID-19 online learning experience of college students: The case of Ghana. *International Journal of Multidisciplinary Sciences and Advanced Technology*, 1(2): 54–62.

Iwanaga J, Loukas M, Dumont AS, Tubbs RS 2021. A review of anatomy education during and after the COVID-19 pandemic: Revisiting traditional and modern methods to achieve future innovation. *Clinical Anatomy*, 34(1): 108–114.

Khan S, Mian A 2020. Medical education: COVID-19 and surgery. *The British Journal of Surgery*, 107(8): e269.

Krüger J M, Buchholz A, Bodemer D 2019. Augmented reality in education: Three unique characteristics from a user's perspective. *Proc 27th Int Conf on Comput in Educ*, pp. 412–422.

López-Belmonte J, Moreno-Guerrero A-J, López-Núñez J-A, Hinojo-Lucena F-J 2020. Augmented reality in education- A scientific mapping in Web of Science. *Interactive Learning Environments*, 1–15.

Lu S, Liu Y, Li Y, Wang R 2021. Multidimensional performance-based evaluation method of high-performance cold source in green building. *Energy and Buildings*, 231: 110-618.

Luck J, Gosling N, Saour S 2021. Undergraduate surgical education during COVID-19: Could augmented reality provide a solution? *British Journal of Surgery*, 108(3): e129–e130.

Marpa EP 2021. Technology in the teaching of mathematics: An analysis of teachers' attitudes during the COVID-19 pandemic. *International Journal on Studies in Education*, 3(2): 92–102.

Midak LY, Kravets IV, Kuzyshyn OV, Baziuk LV, Buzhdyhan KV 2021. Specifics of using image visualization within education of the upcoming chemistry teachers with augmented reality technology. *Journal of Physics: Conference Series*, 1840(1): 012-013.

Motejlek J, Alpay E 2019. A taxonomy for virtual and augmented reality in education. *ArXiv Preprint ArXiv*, 1906.12051.

Muthuprasad T, Aiswarya S, Aditya KS, Jha GK 2021. Students' perception and preference for online education in India during COVID-19 pandemic. *Social Sciences and Humanities Open*, 3(1): 100-101.

Pears M, Yiasemidou M, Ismail MA, Veneziano D, Biyani CS 2020. Role of immersive technologies in healthcare education during the COVID-19 epidemic. *Scottish Medical Journal*, 65(4): 112–119.

Plancher KD, Shanmugam JP, Petterson SC 2020. The changing face of orthopaedic education: Searching for the new reality after COVID-19. *Arthroscopy, Sports Medicine, and Rehabilitation*, 2(4): e295–e298. doi: 10.1016/j. asmr. 2020.04.007

Raharjo T, Wimbarti S 2020. Assessment of learning difficulties in the category of children with dyslexia. *Jurnal Konseling Dan Pendidikan*, 8(2): 79–85.

Redondo B, Cózar-Gutiérrez R, González-Calero JA, Ruiz R S 2020. Integration of augmented reality in the teaching of English as a foreign language in early childhood education. *Early Childhood Education Journal*, 48(2): 147–155.

Sahin D, Yilmaz RM 2020. The effect of Augmented Reality Technology on middle school students' achievements and attitudes towards science education. *Computers and Education*, 144: 103710.

Saleem M, Kamarudin S, Shoaib HM, Nasar A 2021. Influence of augmented reality app on intention towards e-learning amidst COVID-19 pandemic. *Interactive Learning Environments*, 1–15.

Sleiwah A, Mughal M, Hachach-Haram N, Roblin P 2020. COVID-19 lockdown learning: The uprising of virtual teaching. *Journal of Plastic, Reconstructive and Aesthetic Surgery*, 73(8): 1575–1592.

Soltani P, Morice AH 2020. Augmented reality tools for sports education and training. *Computers and Education*, 155: 103923.

Suppan M, Gartner B, Golay E, Stuby L, White M, Cottet P, Abbas M, Iten A, Harbarth S, Suppan L 2020. Teaching adequate prehospital use of personal protective equipment during the COVID-19 pandemic: Development of a gamified e-learning module. *JMIR Serious Games*, 8(2): e20173.

Toropova A, Myrberg E, Johansson S 2021. Teacher job satisfaction: The importance of school working conditions and teacher characteristics. *Educational Review*, 73(1): 71–97.

Turan Z, Atila G 2021. Augmented reality technology in science education for students with specific learning difficulties: Its effect on students' learning and views. *Research in Science and Technological Education*, 1–19.

Vattøy K-D, Gamlem SM 2020. Teacher–student interactions and feedback in English as a foreign language classrooms. *Cambridge Journal of Education*, 50(3): 371–389.

Wang C, Wang W, Wu H 2020. Association between medical students' prior experiences and perceptions of formal online education developed in response to COVID-19: A cross-sectional study in China. *BMJ Open*, 10(10): e041 886.

Wang S, Hsu CJ, Trent L, Ryan T, Kearns NT, Civillico EF, Kontson KL 2018. Evaluation of performance-based outcome measures for the upper limb: A comprehensive narrative review. *PM and R*, 10(9): 951–962.

Wardley CS, Applegate EB, Almaleki AD, Van Rhee JA 2016. A comparison of students' perceptions of stress in parallel problem-based and lecture-based curricula. *The Journal of Physician Assistant Education*, 27(1): 7–16.

Wardley CS, Applegate EB, Almaleki AD, Van Rhee JA 2019. Is student stress related to personality or learning environment in a physician assistant program? *The Journal of Physician Assistant Education*, 30(1): 9–19.

Wotto M 2020. The future high education distance learning in Canada, the United States, and France: Insights from before COVID-19 secondary data analysis. *Journal of Educational Technology Systems*, 49(2): 262–281.

Yao J, Rao J, Jiang T, Xiong C 2020. What role should teachers play in online teaching during the COVID-19 pandemic? Evidence from China. *Sci Insigt Edu Front*, 5(2): 517–524.

Zhang X, Zhang Q, Sun T, Zou Y, Chen H 2018. Evaluation of urban public transport priority performance based on the improved TOPSIS method: A case study of Wuhan. *Sustainable Cities and Society*, 43: 357–365.

Zhu X, Liu J 2020. Education in and after Covid-19: Immediate responses and long-term visions. *Postdigital Science and Education*, 2(3): 695–699.

Paper received for publication in July, 2022
Paper accepted for publication in August, 2022