Received: 12 October 2022; Accepted: 2 December 2022; Published: 10 December 2022

Educators' Perspective on The Use of Augmented Reality to Create STEM Learning Material

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To cite this article (APA): Mokmin, N. A. M., Ariffin, U. H., & Mohd Hamizi, M. A. A. (2022). Educators' perspective on the use of augmented reality to create STEM learning material. *Journal of ICT in Education*, *9*(2), 191-200. https://doi.org/10.37134/jictie.vol9.2.14.2022

To link to this article: https://doi.org/10.37134/jictie.vol9.2.14.2022

Abstract

Providing learners with educational content based on augmented reality (AR) is a bizarre way to pique their interest in learning. This is because it is predicted that the AR learning material will assist learners to visualise a complex structure, particularly in STEM education. As AR is incorporated into educational settings, it is necessary to take into consideration educators' perspectives as well. Thus, this study presents educators' perspectives on using AR for STEM education. In this quantitative study, 30 STEM educator respondents were asked to fill out questionnaires about their perspectives on the use of augmented reality in learning. These perceptions are based on a number of variables which are, perceived usefulness, perceived ease of use, perceives enjoyment, attitude towards its use, and intention of use. Overall, the findings show that majority of STEM educators support the utilization of AR in STEM education. Aside from that, in terms of the intention of use, 87% of the respondents indicated a desire to utilize AR to teach their students. This implies that the use of AR applications is important from the viewpoint of STEM educators. As a result, it is hoped that this study will facilitate future studies to support the significance of using AR in STEM education.

Keywords: augmented reality, STEM educators, STEM education, educators' perception.

INTRODUCTION

Teaching and learning (T&L) are rapidly evolving into one of the biggest obstacles that experience by educators globally (Wan Ishak & Yamin, 2020). Even if the material covered in the class is excellent, there is no guarantee that students will stick around for the entirely of the discussion of the topic. This could be due a result of the conventional methods of instruction, which consisted of delivering information in the form of a lecture and presenting the class material via PowerPoints presentations, handouts, and websites (Yip et al., 2019). Since the conventional method of education is still utilised

in the contemporary educational system, educators are expected to put in their best effort and devote adequate time to thoroughly explain and illustrate the material being taught to their students. However, in some instances, when only a two-dimensional medium is utilised for instruction, students may struggle to fully grasp three-dimensional concepts (Stull et al., 2018). Thus, some additional resources as supplements in teaching are needed.

Immersive learning technologies represent an innovative approach to STEM education. Virtual reality (VR) and augmented reality (AR), in particular, are playing an important role as an effective platform for motivating and attracting the next generation of STEM fields (Al-Azawi et al., 2019). The terms "virtual reality" (VR) and "immersive environment" (IE) are frequently used interchangeably in the context of virtual reality. In most cases, the user is required to wear a head-mounted display (also known as an HMD) in order to get the full immersive experience. It gives the user the ability to interact in a realistic manner with computer-generated three-dimensional environments (Christou, 2010). In addition to this, it enables the user to comprehend systems or objects that exist on vastly varying scales and assists them in gaining an understanding of abstract ideas (Daniela, 2020). On the other hand, it might pose dangers to children. The psychological effects of virtual reality technology on children are still not fully understood by researchers, although efforts are being made to do so. This is as a result of the research that was carried out by a previous researcher named Bailenson and his team, who discovered that, in certain instances, the children who participate in an activity in which they swim with whales in a virtual environment created a false memory of having been to SeaWorld in real life (Kennedy, 2018). Thus, when virtual reality is utilised in the classroom, the children are required to have supervision, which cuts into the amount of time they spend learning.

While virtual reality (VR) immerses the viewer in a simulation, augmented reality (AR) concurrently combines real-world and virtual things (Daniela, 2020). It is a technology that augments the reality by incorporating digital information to the user's real environment. It is common practise to refer to the two methods that AR employs in order to track the information from the real world when describing this technology. The first kind of AR is called marker-based AR, and it works by recognising a marker or an object to bring up digital information. The second type, known as the location-based AR, make use of a device's GPS to identify locations on top of which computer-generated information should be superimposed (Ibáñez & Delgado-Kloos, 2018). This has made the AR technology quickly become one of the most popular choices for educators as an educational supplement. This is due to its equipment which relatively inexpensive and does not require for expensive hardware such as HMD (Akçayır & Akçayır, 2017).

In STEM education, AR is not a novel concept. It had been employed by numerous researchers in STEM fields like science (Herfana et al., 2019; Yapici & Karakoyun, 2021), and mathematics (Pritami & Muhimmah, 2018). Some researchers have also concurred that AR could advocate advantages for kids. One of them claimed that AR can benefit students by enhancing their achievements and their academic performance, expanding their conceptual understanding, and fostering interaction between students, educators and environment (Yu et al., 2022). However, even while it has numerous

advantages to the students, it is also important to consider how STEM educators will perceive this adoption. Does this study seek to:

i. What level of technological adoption does AR have among STEM educators?
ii. What do STEM educators think about the use of AR technology in STEM education?

TAM MODEL AS TECHNOLOGY ACCEPTANCE

Once the technology has been integrated in the current educational environment, it is essential to ensure it is actively accepted, and the technology is actively being used. It is an indicator that the technology has either been successfully adopted by the end-user or has failure. Thus, the study that aims to quantify the level of acceptability that users have for technological adoption has become a prominent topic of research for many different domains of interest.

In an effort to solve this issue, the vast majority of researcher made used Technology Acceptance Model, often known as TAM, as the theoretical model to anticipate the user's acceptance of the technology. The TAM is a model which was initially conceived upon and put out by Fred Davis in the year 1989 (Davis, 1989). It was developed based on the Theory of Reasoned Action (TRA) created by Ajzen and Fishbein in 1980 which intended to predict an individual's behavior in light of their intentions and attitudes.

In recent times, the study of TAM is always developing and expanding into a variety of theoretical models to anticipate how users will respond to new technologies. By adopting TAM as their grounding framework, a variety of model such as TAM2, UTAUT and so on have been developed. Thus, the original TAM will be served as the theoretical model for this study, on user's technology acceptance.

According to this TAM model as shown in Figure 1, the positive attitudes towards two factors are what will determine whether or not the new technology will be successfully adopted the current educational sector at the present time (Allen, 2020). These elements are (i) Perceived usefulness and (ii) Perceived Ease of Use.

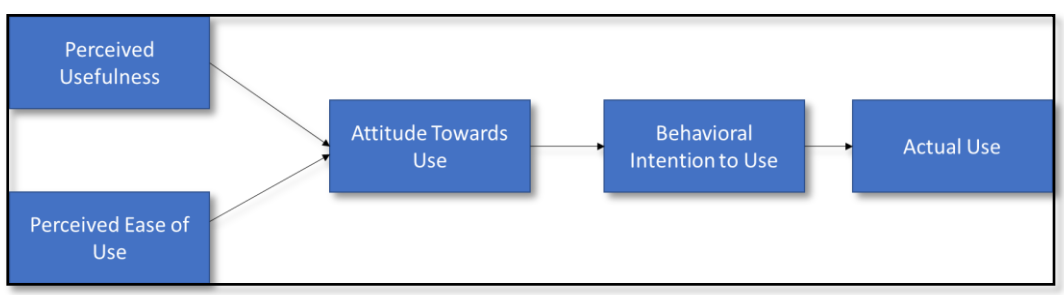

Figure 1: Theoretical model of TAM

The degree to which an individual believes that using a certain piece of technology would improve their performance is referred to as their perceived usefulness (Granić & Marangunić, 2019). While perceived ease of use refers to the degree to which the individual is projected to find the technology to be easy to use (Granić & Marangunić, 2019). These factors might influence a person's behavioural desire to interact with the technology, which can be interpreted as an indication of the individual's acceptance of the technology (Ammenwerth, 2019).

In spite of this, the TAM model will be extended with one more variable for the purposes of this investigation so that its effects on technology acceptance can be evaluated. This variable refers to the perceived enjoyment. The activity that using an AR technology is fun, regardless of how using the technology might affect performance, is referred to as perceived enjoyment. As a result, the theoretical model used in this study will look like the Figure 2.

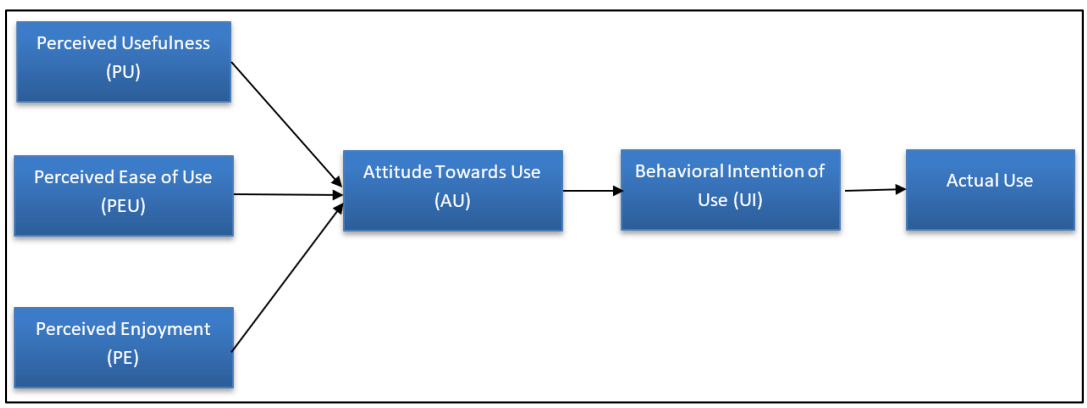

Figure 2: Theoretical model for the study

METHODOLOGY

Materials and Research Method

This study utilised the research design known as quantitative research. According to Creswell, the quantitative method is helpful when characterising the patterns that are present in a population or the relationship that exists between the variables that are being researched. This is because the quantitative method is based on numerical data. The primary data for the study was collected through the use of a questionnaire in the form of a survey. Through the use of a Google Form, it was made available to the participant. The Likert Scale was used to assign points to each of the items in the questionnaire to determine the extent to which respondents agree or disagree with the assertions that are offered in the questionnaire. A Likert scale with five points was utilised for this particular piece of research. The scale was anchored by (1) Strongly disagree, (2) Disagree, (3) Natural, (4) Agree, (5) Strongly agree.

This study makes use of an Anatomy AR application as shown in Figure 3 that was created prior to the study's execution as its source of information. Its note, which was enhanced using AR, served as the application's marker. In this AR-enhanced note, a three-dimensional object would float on top of the two-dimensional image as the user scanned it. This is visible on the mobile device's screen. The following is how this augmentation is visualised.

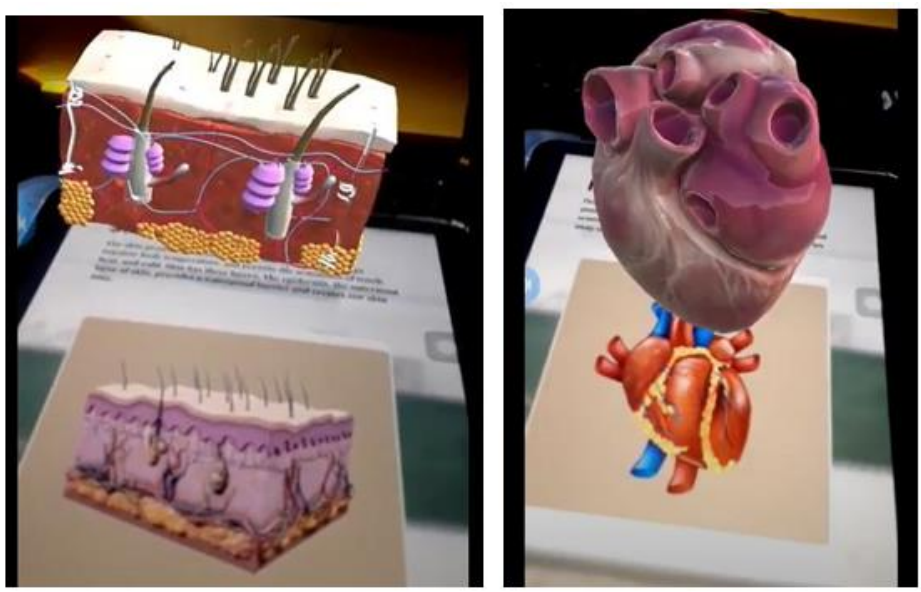

Figure 3: Augmentation in anatomy AR apps

Sampling

The study included 30 STEM instructors from Pulau Pinang who participated in an Augmented Reality Development session. These individuals come from a variety of backgrounds and teaching areas. It is made up of lecturers, primary school teachers, and secondary school teachers who work at institutions and schools throughout Pulau Pinang. As a result, the following information about the educator's background is as shown in Table 1.

Table 1: Data sampling

Type of STEM Educators	Frequency (f)
Primary School Teacher	6
Secondary School Teacher	12
Lecturer	2
Others	10

Instrument

To carry out the research with reference to prior studies (Cabero-Almenara et al., 2019; F. Davis, 1986), a set of questionnaires to gauge the educator's technological acceptance was devised. This instrument is composed of twelve components that are dispersed in five dimensions (Perceive Usefulness, Perceived Ease of Use, Perceived Enjoyment, Attitude Towards Its Use and Intention of Use). Table 2 contains all of the item measurements.

Table 2: Measurement items

Constructs	Items	Description
Perceive Usefulness (PU)	PU1	I believed the use of AR can ease the student's comprehension of certain concepts
	PU2	I believed the AR application is useful when the student is learning
	PU3	I believed student's performance will increase with the use of AR
Perceived Ease of Use (PEU)	PEU1	I believed AR technology is easy to use
	PEU2	I believed learning how to use AR is not a problem for the students
Perceived Enjoyment (PE)	PE1	I enjoyed using the AR technology
	PE2	I believed the students will have fun using the AR technology
	PE3	I believed the AR technology allows student to learn while playing
Attitude Towards Its Use (AU)	AU1	I believed the use of AR technology makes learning more interactive
	AU2	I believed the use of AR technology in the classroom is a good idea
	AU3	I believed the students will not feel bored while learning using AR
Intention of Use (IU)	UI1	In the future, I would like to use AR technology to teach students.

Instrument Reliability

When doing an analysis of any quantitative research instrument, the two important factors to evaluate are reliability and validity. In this study, the instrument's reliability will be assessed using the Cronbach alpha reliability coefficient computation. According to George and Mallery (2003) rule of thumb for Cronbach alpha, values beginning with 0.7 and higher are considered acceptable. In light of this, Table 3 displays the Cronbach alpha ranking value.

Table 3: Value of the Cronbach alpha reliability coefficient

Cronbach Alpha Value	Category
>0.9	Excellence
>0.8	Good
>0.7	Acceptable
>0.6	Questionable

>0.5	Poor
<0.5	Unacceptable

The reliability test was used in this study to determine the reliability of the 'Educator's Technology Acceptance Questionnaire.' The SPSS software was used to calculate the primary data from this instrument. As a result, this instrument's Cronbach alpha or reliability score is 0.877. Based on the aforementioned rule of thumb, this suggests that the instrument is genuine and reliable for use.

Research Procedure

This research is divided into three stages.

i. The participants learned about the Anatomy AR apps in the first phase. This was followed by the download of the apps for their mobile devices and the augmented reality-enhanced notes.
ii. In the second phase, the participants have 30 minutes to try out the application and get an experienced for the augmentation process.
iii. During the last phase, a set of questionnaires in a Google Form was distributed to the participants through the WhatsApp app. They have to respond to all of the questions in the Google form provided.

Data Analysis

With the aid of SPSS software version 26.0, the data will be analysed. Before entering any primary data into the SPSS, all of the data will first be screened. The means value and standard deviation of the data will be computed using descriptive forms of analysis. As a result, the findings will be examined to find the pertinent and useful data needed to fulfil the study's goals.

RESULTS

The SPSS version 26.0 software have been used to filter and analyse the primary data collected from the questionnaire. The mean values and standard deviation for each instrument's dimension and item are displayed in the Table 4. The mean values recorded for the entire instrument were 4.338, exceeding the mean of the scale (2.5). This demonstrated that STEM educators have a certain level of acceptance for augmented reality technologies.

Table 4: Mean values and standard deviation of the instrument

Dimensions	Items	Mean	Std. Deviation
Perceive Usefulness (PU)	PU1	4.53	.571
	PU2	4.53	.629
	PU3	4.33	.661
Perceived Ease of Use (PEU)	PEU1	3.77	.774
	PEU2	4.00	.788
Perceived Enjoyment (PE)	PE1	4.27	.521
	PE2	4.53	.507
	PE3	4.53	.507
Attitude Towards Its Use (AU)	AU1	4.53	.571
	AU2	4.27	.691
	AU3	4.50	.572
Intention of Use (IU)	UI1	4.27	.691

The greatest mean values are among educators' perceptions of usefulness, with a mean value of 4.53, according to the data in the above table. This shows that adopting this AR technology or Anatomy AR apps as additions to instructional materials is beneficial from the perspective of educators. However, the perceived ease of use has the lowest mean value (3.885). This could be because the AR quality is poor and occasionally stutters, or because the augmentation process is malfunctioning and tracking the image incorrectly.

Additionally, the other instrument dimensions—perceived enjoyment, attitude toward usage, and intention of use—show an adequate mean score. This demonstrates how much the educators are enjoying using augmented reality for teaching, as well as their interest in and intention to do so. The final questions on the survey demonstrate which questioned instructors if they intended to use augmented reality (AR) technology to teach their students in the future or not. As a result, 87 percent of the participants indicated that they were in favour of using augmented reality (AR) to teach their kids.

CONCLUSIONS

It is hypothesized that augmented reality technology could be a useful addition to the educational sector that exist now. With the ability to engage with the three-dimensional objects which so-called AR objects, this technology offers the edutainment strategies that can be used to helps the students to learn. This feature can help the STEM educators to simplify and communicate more effectively on the more complex thoughts of learning. Thus, students will have an easier time comprehending the material, which ultimately leads to an improvement in their academic achievement.

As the conclusion, the purpose of this study is to determine, from the point of view of STEM educators, how openly educators are willingly to utilise the AR technology during their teaching. It includes STEM educator's future plans or intention of adopting AR in STEM education too. Based on the results from this study, it can be concluded that majority of the STEM educators are open to use AR technology in their classrooms. This accomplished the first research objectives of the study. On the other hand, in term of intention to use, the STEM educators, are majority agreed having intention to implement this technology in the future. Thus, as a result, the data as a whole demonstrate that academics in STEM fields are open to the implementation of AR technology.

ACKNOWLEDGEMENTS

This work was support by the Ministry of Higher Education Malaysia for the Fundamental Research Grant Scheme with Project Code: FRGS/1/2021/SSIO/USM/02/10.

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