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Employing Technology Acceptance Model to Assess the Reality of Using Augmented Reality Applications in Teaching from Teachers' Point of View in Najran

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Abstract

The effective use of augmented reality applications is related to teachers' perceptions and realization of their expected benefits. The technology acceptance model is one of the models that has proven effective in predicting the factors that can negatively or positively influence the effectiveness of technology and the user's realization of its usefulness and acceptance in use. Therefore, the current study aimed to take advantage of this model in revealing teachers' perceptions of the expected benefits of augmented reality applications and their level of acceptance to be employed in teaching. The study employed the descriptive approach. A six-dimensional scale was designed in light of the components of the model and then was applied to a sample of (127) male and female teachers in Najran. The results of the study revealed a strong positive correlation between ease of use, attitude towards using augmented reality in teaching, and perceived benefit. Also, a positive correlation was shown between the perceived benefit, attitude towards use, and intentions to use augmented reality applications in teaching. In addition, there was a weak positive correlation between ease of use and both the facilitating conditions and intention to use, however, a weak negative correlation between the expected benefit and both anxiety and facilitating conditions was found. Finally, the moderately predictive ability of perceived usefulness and ease of use in predicting the attitudes towards use and intentions of use was revealed whereas a weak predictive ability to predict perceived usefulness through anxiety, facilitating conditions, and expected usability was shown.

Keywords: technology acceptance model, augmented reality, augmented reality applications.

INTRODUCTION

Augmented Reality (AR) technology has achieved various benefits, perhaps the most prominent of which are educational benefits. It is a product of successive developments in information and communication technology, rapid access to data over the Internet, in addition to rapid developments in the technology of manufacturing mobile devices. The idea of augmented reality is based on the integration of virtual objects with the real environment. Khamis (2020) defined augmented reality as merging two environments, virtual and real. The virtual reality environment recorded on smartphones or tablets is placed as additional information layers on top of the real physical environment where the learner exists. The learner interacts with the two environments at the same time by watching a set of meaningful experiences. Augmented reality is also the simultaneous integration of some digital media with the concrete components of the real world by adding layers of information using some digital tools: video clips, animations, and/or audio clips. Accordingly, it can be said that

augmented reality is a technology that relies on integrating virtual learning objects into the learner's real-world so that the learner can view them as in their default context.

Augmented reality can achieve several educational benefits (Hanid et al., 2020; Lham et al., 2020; Enjai et al., 2021). Among these benefits are solving the problem of teaching complex and complicated skills, providing content at any time and from anywhere, enhancing the learner's ability to engage in learning, and improving his ability to understand and deeply learn. Also, augmented reality can provide authentic learning experiences rich in attractions and suspense, increase the level of motivation and retention of learning as well as the ability to recall, link abstract concepts with their real embodiment, and provide thinking and problem-solving skills.

Augmented reality is an extension of virtual reality technology, but it differs from modifying real reality by adding digital objects. Augmented reality can be used in the classroom by displaying virtual objects in the learner's real environment. It also provides the learner with opportunities to interact with virtual objects in three-dimensional images with the ability to move and interact with them. Accordingly, the importance of augmented reality in teaching and learning is clear, but at the same time, attention must be paid to identifying the reality of its use and the factors affecting the level of use to describe the users' behavior. The users' behavior can predict the intentions of its use in the future, especially for teachers as users of this technology. Revealing the reality of the use of augmented reality contributes to developing plans and providing needs that enhance its effectiveness and reduce the effects of its poor use. Also, the effectiveness of augmented reality is not only related to its efficiency as a technology or application but also the reality of its use and acceptance by users.

Despite the interest of several studies in revealing the educational effectiveness of augmented reality such as Alkhattabi (2017), Alfalah (2018), Tzima et al. (2019), and Alalwan et al. (2020), few studies have targeted teachers' perceptions of augmented reality and its uses in education (Patterson & Han, 2019; Fransson et al., 2020; Geng et al., 2021). However, these studies did not deeply reveal the factors affecting the teachers' acceptance of augmented reality (AR).

Acceptance of new technologies is considered an educational challenge that influences the effectiveness of that technology and its employment success. This challenge relates to teachers' resistance to change. Therefore, there is a need to research the pillars of reducing teachers' resistance to change and enhancing their acceptance of the use of technology. This can be done through interpreting their behavior and predicting their intentions to use.

Technology Acceptance Model (TAM) is one of the main models that have been used to explain the behavior of individuals to use technology. This model is based on two main components: Perceived Usefulness and Perceived Ease of Use, in addition to a set of external factors (social influence, facilitating conditions, attitudes towards use, actual use, behavioral intentions, usability, anxiety, self-satisfaction, self-efficacy, perceived pleasure, and experience). These factors were a result of the development stages that this model went through (Guner & Acarturk, 2020).

Several studies have used this model in explaining individuals' behaviors towards dealing with technological innovations and applications (Al-Qaysi et al., 2020; Abuhassna et al., 2020; Buabeng-Andoh, 2021; Buabeng-Andoh, 2021; Casey et al., 2021). Some studies also indicated a positive relationship between the acceptance of the use of technology and the level of achieving its expected benefit (Lew et al., 2019; Abuhassna et al., 2020; Camilleri & Falzon, 2020).

The effective use of augmented reality applications depends basically on the teacher's perceptions and realization of their expected benefit. Also, Technology Acceptance Model is one of the models that have proven effective in predicting the factors that can positively or negatively influence the effectiveness of technology and the user's perception of its usefulness and acceptance of use. Therefore, the researchers attempted to benefit from the Technology Acceptance Model in revealing teachers' perceptions and awareness of the expected benefits of augmented reality applications and their level of acceptance to use them in teaching. The study examined the employment of the Technology Acceptance

Model (TAM) in diagnosing the reality of using augmented reality applications in teaching from the point of view of teachers in Najran in the Kingdom of Saudi Arabia.

Statement of the problem

In light of the current developments and the rapid growth of virtual learning environments, several applied concepts have emerged as a direct result of the expansion in the use of virtual learning environments, including augmented reality applications. Several studies have been conducted to reveal its effectiveness (Kahouf & Abdel Rahman, 2019; Mansour, 2021). The results of those studies found the effectiveness of augmented reality in improving memory, increasing motivation to learn, enhancing interaction ability, reducing anxiety and psychological tension, reducing the effects of feelings of fear, shyness, and introversion. Also, augmented reality was found effective in developing self-regulation skills, increasing achievement rates, developing skills of analysis, and classification and representation information and knowledge. Since the effectiveness of augmented reality is not influenced only by its advantages but also by the teacher and the learner who will use these applications. Therefore, there is a need to explore the reality of the use of augmented reality applications among teachers.

Also, the need for this study is confirmed by what was recommended by Ali (2019) and Al-Hafizi (2020). They suggested revealing the factors that influence the effectiveness of augmented reality and the variables related to the teacher, the learner, and the learning environment, which may affect the effectiveness of augmented reality in educational uses. Therefore, there is a need to reveal the factors that predict the teachers' acceptance of augmented reality and their perceptions towards it and awareness of the perceived benefit.

Among the models that were concerned with revealing the factors that predict learners' acceptance of educational technologies and their use in a way that achieves the expected benefit is the Technology Acceptance Model (TAM). Several studies have been conducted and confirmed the validity of this model for predicting the factors of acceptance of the use of technological applications (Ali, 2019). They reached results confirming the contribution of the model in predicting the patterns of interaction and behavior of learners towards e-learning environments in general, and in the context of the model's capability to predict the effectiveness of augmented reality in particular and its acceptance factors. Several studies on using Technology Acceptance Model were conducted Lin & Chen, 2017; Guest et al., 2018; Yunarto et al., 2018; Majid & Shamsudin, 2019; Ibili et al., 2019; Elshafey et al., 2020; Jang et al., 2021). The results of those studies reached the ability of the model to identify and interpret the factors that shape the teacher's interaction patterns and intentions of behavior towards the use of augmented reality applications. Therefore, the researchers attempt to benefit from this model in predicting the effectiveness of augmented reality applications by interpreting and analyzing the factors of teachers' acceptance of the use of augmented reality in teaching.

In light of the above, the research problem can be crystallized in the following main question: "How can Technology Acceptance Model (TAM) be employed in diagnosing the real use of augmented reality applications in teaching from the teachers' point of view in Najran? The sub-research questions are:

- What are the factors that influence the effectiveness of using augmented reality applications in teaching from the teachers' point of view in light of the components of the Technology Acceptance Model?

- What is the relationship between the factors that predict teachers' acceptance of the use of augmented reality applications in teaching?

Objectives of the study

The study aims to reveal the factors influencing the effectiveness of using augmented reality applications in teaching from the teachers' point of view in light of the components of the Technology Acceptance Model. Also, it targets to identify the nature of the relationship between the factors that predict teachers' acceptance of using augmented reality applications in teaching.

Significance of the study

The results of this research can be useful in shedding light on the reality of using augmented reality applications concerning the components

of the Technology Acceptance Model, which will reflect positively on enhancing the requirements for benefiting from it and achieving its educational effectiveness. Also, it is of significance in presenting results that may benefit planners and developers of e-learning environments and e-learning delivery institutions by shedding light on the factors that enhance the acceptance of teachers' use of technologies in general and applications of augmented reality in particular. In addition, the study will shed the light on the areas of professional development to be taken into account when designing professional development programs in the fields of e-learning techniques in general and augmented reality applications in particular. Finally, the study will provide a set of guiding measures to improve teachers' perceptions of virtual learning environments in general and augmented reality applications in particular.

Review of literature

The current developments - whether in the increase in the pace of digital transformation or the emergence of epidemics whose impact has extended to the educational sector - have imposed a strong need for electronic and virtual learning environments. These environments are characterized by their ability to provide various opportunities to deliver teaching and learning, as well as the various learning resources, and diversification of learner interaction patterns. These patterns include patterns of the learner's interaction with other learners, the teacher, and the learning context and its content. Also, electronic environments can employ diversely teaching and learning strategies that suit the characteristics of the target groups and achieve the required effectiveness in education.

In conjunction with calls for the adoption of e-learning systems and virtual learning environments, the need for educational environments that enhance the learner's presence, whether educationally, socially, or cognitively, has emerged so that his feeling is transformed from being virtual to virtually real. Therefore, the term, virtual reality, appeared. It is a virtual technological environment that relies on a set of software applications that make the learner feel his presence within a three-dimensional environment, using a set of devices of cameras and glasses connected to computers. The learner interacts with and responds to them at the same time. However, with difficulties related to the skills needed to design, produce, and use virtual reality as well as the cost of devices needed to operate and display it, the search for a reality that provides the same educational services, but without the need for specialized skills or expensive devices has begun. The so-called augmented reality appeared, which is referred to as a three-dimensional technology that integrates the real world with virtual reality. This occurs through the integration and merging of the scene that the learner sees and the virtual scene displayed electronically, supported by digital sources that enhance his sense of real presence (Khamis, 2015).

Augmented reality is an extension of virtual reality technology, but it differs from modifying real reality by adding digital elements to it. Augmented reality can be used in the classroom by displaying virtual objects in the learner's real environment. It also provides students with opportunities to interact with virtual objects in three-dimensional images with the ability to move and interact with them. For the learning environment to be called an augmented reality environment, it must have three main components: mixing real and virtual elements, allowing user interaction at the same time, and including three-dimensional technologies. Thus, it can be said that augmented reality produces a mixed presentation for the learner, integrating between the real scene that is viewed and the virtual scene displayed by devices to enhance the real scene of the learner through the embedded digital information elements.

In the context of the effectiveness of augmented reality in education, some studies such as Hanid et al., 2020), Bistaman et al. (2018), Anuar et al. (2021), Adedokun-Shitu et al. (2020), and Jang et al. (2021) indicated that augmented reality can achieve plenty of benefits. These benefits include increased academic achievement, motivation to learn, retention rates for learning, improved learning engagement and self-confidence skills, and increased learning satisfaction and increased motivation. It also can contribute to linking theory to practice in the learner concerning practical skills. In addition, it translates the principles of the constructivist theory of learning into a concrete reality as it is

characterized by simplicity and the ability to interact and to enhance cooperation among learners at the same time. Furthermore, it contributes to reducing the effects of fear, shame, and introversion among some learners. It can increases the motivation to learn, the desire to learn, improve the levels and patterns of educational interactions, positively affect the development of scientific concepts and scientific research skills, and help to develop metacognitive skills. It can contribute to the development of self-regulatory skills for learning. In the same context, Qahouf and Abdel Rahman (2019) concluded in their study that augmented reality increases the motivation for achievement and the survival of the learning effect.

In the context of revealing teachers' perceptions of the benefits and uses of augmented reality, Lham et al.'s (2020) study indicated that the availability of teacher training on the skills of using augmented reality led to an improvement in their attitudes towards it and an increase in their ability to use it. Also, Enzai et al. (2021) confirmed that the use of augmented reality, if well-planned, contributes to teachers' better perceptions. Adedokuh-Shitru et al. (2020) also recommended the need to research the factors that would enhance teachers' adoption of augmented reality while Saez-Lopez et al. (2020) recommended the need to evaluate policies and trends associated with improving teachers' perceptions about the use of augmented reality.

In light of the foregoing, the importance of augmented reality in teaching and learning is clear, but at the same time attention must be paid to identifying the reality of its use and the factors affecting the level of use to describe its users' behavior, which predicts the intentions of its use in the future, especially for teachers as users of this technology. Revealing the reality of the use of augmented reality contributes to developing plans and providing needs that enhance its effectiveness and reduce the effects of its poor use. To reveal these perceptions requires frameworks and models prepared for this purpose. They are called models to predict user behavior and acceptance of the use of technologies. The predicting models vary using modern technological applications. Several models have emerged. They can explain user interaction and the use of technology. Technology Acceptance Model (TAM) is one of the models that can explain the responses of learners and teachers regarding dealing with technological applications.

Technology Acceptance Model was developed by Davis (1989) as a conceptual framework for predicting, analyzing, and justifying applications acceptance. He supposed that the more the user views the technology as being easy to use and useful, the more positive his attitudes towards it are. This will positively reflect on the level of learning and motivation towards using technology. Thus, it can be said that Technology Acceptance Model is a conceptual framework that includes some factors that are used to predict and explain how and when the learner or teacher will adopt the technology and the level of its use.

The technology acceptance model includes a set of factors. Perceived benefit expresses the extent to which the individual believes that his use of technology will improve his performance. Ease of use indicates the extent to which the individual believes that his use of technology will contribute to providing the effort required of him to complete tasks. The attitude towards use is determined in light of perceived utility, ease of use. Use intentions refer to the nature of desire resulting from the situation of use. Actual use is related to the individual's use intentions. Finally, it includes external variables, whether personal, social, organizational, or technological (Lew et al., 2019).

Technology Acceptance Model has been associated with many models and theories such as the Unified Theory of Reasoned Action (UTAUT), which consists of four main components: expected performance, expected effort, social impact, and facilitating conditions. It has also been linked with the theory of Reasoned Action (TRA), which is based on two components. They are the attitude towards behavior or the individual's or feelings towards technology and the social norm, which refers to the extent to which the individual realizes that the people who influence him should accept technology. In addition, the model is related to the Technology Acceptance Model (TAM) theory, which is based on two components: the expected benefit and the expected ease of use. Furthermore, it is related to the Motivational Model (MM), which includes extrinsic and internal motives towards accepting the

technology, and Theory of Planned Behavior (TPB), which is an extension of the Theory of Reasoned Action but adds a third component, which is the degree of perceived control over the behavior or the individual's ability to perform a specific behavior (al-Qaysi et al., 2020).

The pillars/components included in the Technology Acceptance Model in its developed version (Abuhassna et al., 2020; Guner & Acartturk, 2020; Venkatesh & Bala, 2008) can be summarized in the following components:

-Perceived Usefulness (PU) refers to the extent to which the user is convinced of the benefits of a particularly innovative application in a specific context, and it will contribute to improving its performance.

- Perceived Ease of Use (PEU) refers to the extent to which the user is satisfied with the ease of use of a novelty in a specific context and without the need for much effort.

- Attitude refers to the nature of the user's positive/negative feelings toward the use of a novelty in a specific context.

- Behavioral Intention (BI) refers to the user's perceptions of their possible use of a novelty in the future.

- Social Influence (SI) is the individual's perceptions of the opinions of influential individuals towards the use of an innovation.

- Facilitating Conditions (FC) are the expected range of facilities (material, expertise, knowledge and skills, help, and support) that an individual needs to use a novelty in a specific context.

- Anxiety refers to the degree to which an individual feels afraid of using a novelty.

- Self-satisfaction refers to the individual's conviction and satisfaction with the use of a novelty in a specific context.

Majid and Shamsuddin (2019) believe that the Technology Acceptance Model can achieve several benefits. The most important of which are exploring and analyzing user behaviors towards technological applications. The researchers recommended the need to explore learners' behavior patterns towards virtual reality applications. Yunarto et al. (2018) concluded that the inclusion of augmented reality applications contributed to increasing the acceptance of the use of educational games. Jang et al. (2021) indicated that the Technology Acceptance Model contributed to determining the factors that shape teachers' readiness and their tendency towards integrating augmented reality applications into teaching. Ali (2017) concluded the validity of the Technology Acceptance Model in revealing the effectiveness of assistive technology based on adaptive learning applications. In the same context, several studies were conducted such as Guest et al. (2018), Elshafey et al. (2020), and Lin and Chen (2017). These results of those studies concluded that the Technology Acceptance Model was valid for predicting some of the factors affecting the efficacy of augmented reality. Ibili et al. (2019) emphasized that understanding and analyzing teachers' perceptions of augmented reality applications using the Technology Acceptance Model contributed to helping the developers of learning environments based on augmented reality applications understand the factors that make augmented reality effective and ensure its acceptance among users.

The effective use of augmented reality applications depends basically on the teacher's perceptions and realization of their expected benefit. Also, the Technology Acceptance Model is one of the models that have proven effective in predicting the factors that can positively or negatively influence the effectiveness of technology and the user's perception of its usefulness and acceptance of use. Therefore, the researchers attempted to benefit from the Technology Acceptance Model in revealing teachers' perceptions and awareness of the expected benefits of augmented reality applications and their level of acceptance to use them in teaching.

The model of the study

In light of the previous literature that was reviewed with regard to diagnosing the reality of using augmented reality as well as the pillars on which the Technology Acceptance Model is based, the research model has been formulated as shown in the following figure:

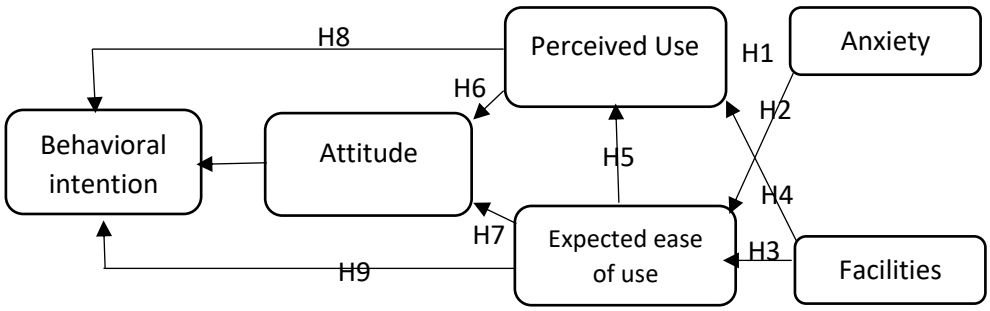

Figure 1. *Model of the study*

Based on this model, the research has proposed the following hypotheses:

1. There is a statistically significant positive relationship between the external variable (anxiety) and the perceived benefit of teachers' use of augmented reality applications in Najran region.

2. There is a statistically significant positive relationship between the external variable (anxiety) and the expected ease of use of augmented reality applications for teachers in Najran region.

3. There is a statistically significant positive relationship between the external variable (the facilitating conditions) and the perceived benefit of teachers' use of augmented reality applications in Najran region.

4. There is a statistically significant positive relationship between the external variable (the facilitating conditions) and the expected ease of use of augmented reality applications for teachers in Najran region.

5. There is a statistically significant positive relationship between the expected ease of use and the perceived benefit of teachers' use of augmented reality applications in Najran region.

6. There is a statistically significant positive relationship between the perceived benefit and the attitude to use augmented reality applications among teachers in Najran region.

7. There is a statistically significant positive relationship between the expected ease of use and the attitude towards using augmented reality applications among teachers in Najran region.

8. There is a statistically significant positive relationship between the perceived benefit and intentions of teachers in Najran region for augmented reality applications.

9. There is a statistically significant positive relationship between the perceived ease of use and the intentions of teachers in Najran region to use augmented reality applications.

Methods

The current research used the descriptive-analytical approach. It aimed to describe the phenomenon under study, the reality of teachers' use of augmented reality applications. It attempted to identify the factors affecting this reality in the light of the Technology Acceptance Model. To achieve the objectives of the study, a questionnaire was used to collect and analyze responses and then reach results and conclusions.

Population and sample of the study

The research population included male and female teachers in the Najran region, specifically the teachers of the elementary, intermediate, and secondary stages. A random sample of (127) male and female teachers was selected from the schools of Najran city.

Instrument of the study

In light of the objective of the study, questions, and hypotheses, a scale was designed to diagnose the reality of Najran region teachers' use of augmented reality applications concerning the factors included in the Technology Acceptance Model. Previous studies were reviewed such as Buabeng-Andoh (2021), Guner and Acarturk (2020), Camilleri and Falzon (2020), and Casey et al. (2021). Accordingly, the initial version of the scale was prepared. It included six dimensions. The first

dimension is perceived benefit (PU) and included (5) items. The second dimension is perceived ease of use (PEOU) and included (4) items. The third dimension is attitude to use (ATU) and included (5) items. The fourth dimension is behavioral intentions (BI) and included (4) items. The fifth dimension included the first external variable, Anxiety, and included (5) items. Finally, the sixth dimension included the second external variable, the facilitating conditions (FC), and had (5) items. It was also decided on the use of the five-point Likert scale to rate the level of response. Response (1) indicates strongly disagree, and repose (5) indicates strongly agree.

Validity and Reliability of the study instrument

The external validity was calculated by presenting the scale to (11) experts to verify the accuracy, clarity, suitability of the scale items of the scale. It was also presented to a group of (7) teachers to verify the clarity and purpose of the scale's items. Amendments were made to the wording of some items of the scale so that all items of the scale were clear and free from typographical and linguistic errors.

- Discernment Validity (DV) was calculated using three criteria (Cronbach's alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) as shown in Table 1:

Table 1. *The results of discernment validity coefficients*

Variable	Cronbach's alpha	CR	AVE
Perceived benefit (PU)	0.708	0.802	0.554
perceived ease of use (PEOU)	0.766	0.755	0.648
Attitude to use (ATU)	0.732	0.720	0.551
Behavioral intentions (BI)	0.776	0.738	0.501
Anxiety	0.887	0.913	0.678
Facilitating conditions (FC)	0.708	0.732	0.515

Table 1 shows that the discernment validity of the scale dimensions is statistically significant. The values of Cronbach's alpha coefficients for all dimensions were higher than 0.70. It is the minimum value specified for accepting Cronbach's alpha coefficient according to Hair et al. (2017). The Composite Reliability coefficient values were all higher than 0.70 for all the dimensions of the scale. According to Hair et al. (2017), they are acceptable. Average Variance Extracted (AVE) values came all acceptable. They were higher than the value by Hair et al. (2017), which is (0.50). Accordingly, all the dimensions of the scale are characterized by an acceptable discernment validity. The correlation coefficients between the dimensions of the scale were calculated as shown in Table 2.

Table 2. *Discernment validity coefficients of the scale dimensions*

Variable	Perceived benefit (PU)	perceived ease of use (PEOU)	Attitude to use (ATU)	Behavioral intentions (BI)	Anxiety	Facilitating conditions (FC)
Perceived benefit (PU)	**0.674**	0.507	0.549	0.587	0.212-	0.054-
perceived ease of use (PEOU)		**0.669**	0.766	0.465	0.376-	0.530
Attitude to use (ATU)			**0.793**	0.611	0.408-	0.486
Behavioral intentions (BI)				**0.673**	0.650-	0.231
Anxiety					**0.823**	0.054-
Facilitating conditions (FC)						**0.545**

Table 2 shows that the value of the correlation coefficient between each dimension (variable) and itself is higher than the values of the correlation coefficients between the dimension and other dimensions. Accordingly, it can be concluded that the scale is valid for diagnosing the reality of using augmented reality applications in light of the variables of the Technology Acceptance Model as shown in Figure 2.

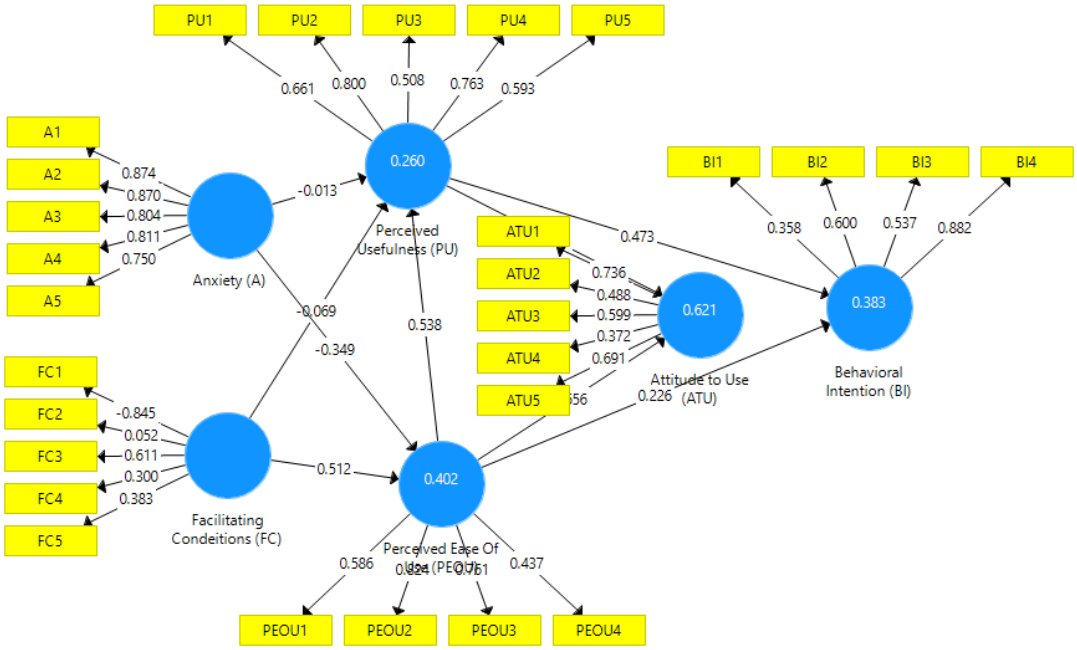

Figure 2. *Dimensions of the scale and associated items*

Results and discussion

The current study aimed to reveal the factors that influence the effectiveness of using augmented reality applications in teaching from the teachers' point of view in light of the components of the Technology Acceptance Model. It also examined the nature of the relationship between the factors that predict the teachers' acceptance of the use of augmented reality applications in teaching, attitude, and intentions to use.

To achieve the objectives of the study and to test the hypotheses, the SMART PLS V 3.0 program was used. The data of the scale that was applied to the research sample, (127) male and female teachers in Najran schools were analyzed. The results were as shown in Table 3.

Table 3. *The results of the relationship between dependent and independent variables*

H	Variables	Standardized Beta	Standard error	T value	P value	Sign
H1	Anxiety>> Perceived ease of use	0.349-	0.051	6.873	0.000	Accept Reject
H2	Anxiety>> perceived benefit	0.013-	0.089	0.149	0.881	Accept Reject
H3	Facilitating conditions >>perceived ease of use	0.512	0.400	1.279	0.201	Accept Reject
H4	Facilitating conditions >> perceived benefit	0.069-	0.141	0.489	0.625	Accept Reject
H5	Perceived ease of use>> attitude to use	0.656	0.070	0.9.37	0.000	Accept Reject
H6	Perceived ease of use>> intentions to use	0.226	0.158	0.1.44	0.153	Accept Reject

H7	Perceived ease of use>> perceived benefit	0.538	0.104	5.190	0.000	Accept Reject
H8	Perceived benefit>> attitude to use	0.217	0.104	0.2.093	0.000	Accept Reject
H9	Perceived benefit>> intentions to use	0.473	0.086	0.520	0.000	Accept Reject

Table 3 shows the results of the tests that explain the nature of the relationships between the dependent and independent variables (dimensions) as follows:

1. Reporting and interpreting the results related to the first hypothesis (the relationship between anxiety as an external variable and the perceived ease of use): As shown in Table 3, the standardized Beta value (-0.349) was negative. This indicates the existence of an inverse relationship between the level of anxiety about the use of augmented reality applications and the extent to which the ease of use of those applications is expected in teaching. Also, this value is statistically significant, indicating that the first hypothesis was accepted. This result can be attributed to the fact that the factors of anxiety and fear of innovations and new applications lead to teachers' reluctance to use these innovations. Similarly, this is what applied to teachers' feelings about the applications of augmented reality. Also, their lack of sufficient knowledge and skill has contributed to enhancing the feeling of anxiety and thus resulted in fear of the use process. This result is consistent with that of Guner and Acarturk's (2020) study.

2. Reporting and interpreting the results related to the second hypothesis (the relationship between anxiety as an external variable and the perceived benefit): As shown in Table 3, the standardized Beta value (-0.013) was negative. This indicates the existence of an inverse relationship between the level of anxiety about the use of augmented reality applications and the extent to which the perceived benefit of use of those applications is expected in teaching. Also, this value is not statistically significant, indicating that the second hypothesis was rejected. This result can be attributed to the fact that the factors of anxiety and fear of innovations and new applications resulted in not recognizing the value and benefits of augmented reality applications. Also, teachers did not feel its usefulness and advantages in teaching, which resulted in poor awareness of the benefits of augmented reality applications and a lack of awareness of its educational and teaching benefits. This result agrees with that of Guner and Acarturk (2020).

3. Reporting and interpreting the results related to the third hypothesis (the relationship between anxiety as an external variable and the facilitating conditions): As Table 3 shows, the standardized Beta value (0.512) was positive. This indicates a positive relationship between the level of anxiety about the use of augmented reality applications and the facilitating conditions of using those applications in teaching. Also, this value is not statistically significant, indicating that the third hypothesis was rejected. This result can be attributed to the fact that the teachers' feeling of the availability of physical and human facilities and support factors enhanced their motivation and need to use and benefit from augmented reality applications. These results are consistent with the findings of Cameleri and Falzon's (2020) study.

4. Reporting and interpreting the results related to the fourth hypothesis (the relationship between facilitating conditions as an external variable and the perceived benefit): As displayed in Table 3, the standardized Beta value (-0.069) was negative. This indicates an inverse relationship between the level of facilitating conditions about the use of augmented reality applications and the perceived benefit of using those applications in teaching. Also, this value is not statistically significant, indicating that the fourth hypothesis was rejected. This result can be attributed to the fact that the teachers' feeling of the availability of material and human facilities and support factors enhanced their sense of reassurance about achieving several educational and teaching benefits as a result of using augmented reality applications. These results are consistent with those of Cameleri and Falzon (2020).

5. Reporting and interpreting the results related to the fifth hypothesis (the relationship

between the perceived ease of use and attitude to use): As shown in Table 3, the standardized Beta value (0.656) was positive. This indicates a positive relationship between the level of the perceived ease of use and attitude to use those augmented reality applications in teaching. Also, this value is statistically significant, indicating that the fifth hypothesis was accepted. This result can be traced back to the fact that the ease of use of augmented reality applications by teachers and their possession of the necessary skills to use them strengthened their positive attitude and intention towards future use. This result is consistent with the findings of Lew et al. (2019) and Cameleri and Falzon (2020).

6. Reporting and interpreting the results related to the sixth hypothesis (the relationship between the perceived ease of use and intentions to use): as depicted in Table 3, the standardized Beta value 0.226)) was positive. This value is not statistically significant, indicating a weak correlation between the level of the perceived ease of use and intentions to use those augmented reality applications in teaching. Also, this indicates that the sixth hypothesis was rejected. This result can be attributed to the fact that the ease of use of augmented reality applications by teachers and their possession of the necessary skills to use them strengthened their positive attitude and intention towards future use. This result is in line with the findings of Lew et al. (2019) and Cameleri and Falzon (2020).

7. Reporting and interpreting the results related to the seventh hypothesis (the relationship between the perceived ease of use and perceived benefit): as presented in Table 3, the standardized Beta value 0.538)) was positive. This value is statistically significant indicating a positive relationship between the perceived ease of use and the perceived benefit of using augmented technology applications in teaching. Also, this indicates that the seventh hypothesis was accepted.

8. Reporting and interpreting the results related to the eight hypothesis (the relationship between the perceived ease of use and attitude to use): as displayed in Table 3, the standardized Beta value 0.217)) was positive. This value is statistically significant indicating a positive relationship between the perceived ease of use and attitude to using augmented technology applications in teaching. Also, this indicates that the eighth hypothesis was accepted. This result can be because teachers' feelings and awareness of the importance and benefits of augmented reality applications resulted in an increase in their awareness of the importance and need to use them, and an improvement in their attitudes towards them. This result accords with those findings of Lew et al. (2019) and Abuhassna et al. (2020).

9. Reporting and interpreting the results related to the ninth hypothesis (the relationship between the perceived ease of use and intentions to use): as shown in Table 3, the standardized Beta value 0.473)) was positive. This statistically significant value indicates a positive relationship between the perceived ease of use and intentions to use augmented technology applications in teaching. Also, this indicates that the ninth hypothesis was accepted. This result can be because of teachers' feeling and awareness of the importance and benefits of augmented reality applications increased their awareness of the importance and need to use them, and an improvement in their attitudes towards them. This result agrees with that of Lew et al. (2019) and Abuhassna et al. (2020).

To identify the extent of the influence of the independent variables together on the dependent variables and the percentage of the explained variance in the dependent variables as a result of the independent variables, the values, and the determinant factor R2 and adjusted R2 were calculated. This expresses the percentage of variance in the dependent variable that can be predicted through the independent variable(s), as shown in Figure 3.

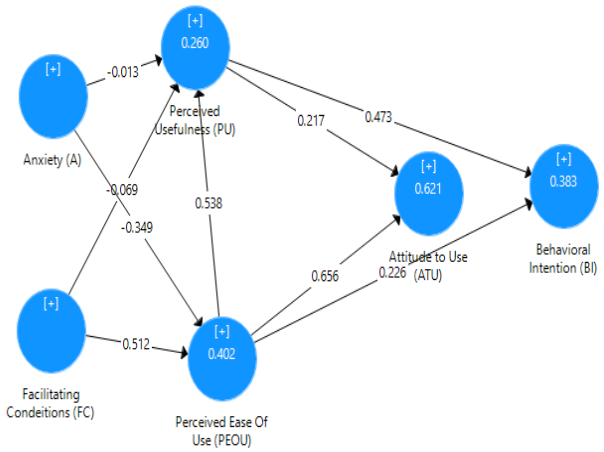

Figure (3) *The nature of the relationship between the variables and values of the determinant R2 coefficient*

Table 4 shows the results of calculating the values of the determinant R2 and adjusted R2 coefficient (which takes into account the number of independent variables) as follows:

Table 4. *The results of calculating determinant R2 and adjusted R2. coefficient*

Independent variables	Dependent variables	R^2	R^2 adjusted	Sig.
Anxiety, facilitating conditions, and perceived ease of use	Perceived benefit	0.260	0.242	Low
Anxiety and facilitating conditions	perceived ease of use	0.402	0.393	Medium
Perceived benefit and perceived ease of use	Attitude to use	0.621	0.615	Medium
Perceived benefit and perceived ease of use	Intentions to use	0.383	0.373	Medium

According to Figure 3 and Table 4, the R2 value of the perceived benefit variable as a result of the influence of the external variables (anxiety, facilitating conditions, expected ease of use) combined was (0.260). This value is low. The adjusted R2 value was (0.242), indicating that the three variables together explain 24% of the real change in perceived benefit. The perceived ease of use variable is more likely to predict the perceived benefit. The results also indicate that the R2 value of the expected ease of use variable as a result of the influence of the external variables (anxiety, facilitating conditions) combined was (0.402), and their value was medium. Also, the adjusted R2 value (0.393) indicates that the two variables (anxiety and facilitating conditions) explain 39% of the real change in the perceived ease of use. In addition, the facilitating conditions variable is more close to predicting the level of perceived ease of use. Accordingly, it can be said that the variables of anxiety and facilitating conditions can be used to predict changes in the perceived ease of use. The results also indicate that the R2 value of the variable attitude towards using augmented reality applications in teaching as a result of the influence of the independent variables (perceived benefit, perceived ease of use) combined was (0.621), and their value was medium. The value of the adjusted R2 was (0.615). It indicates that the variables (perceived benefit, perceived ease of use) explain 61% of the real change in teachers' attitudes towards using augmented reality applications in teaching. The perceived ease of use variable is more close to predicting teachers' attitude towards using augmented reality applications in teaching. Accordingly, it can be said that the variables of perceived benefit and perceived ease of use can predict changes in teachers' attitudes towards using augmented reality applications in teaching. The results also found that the R2 value of the future behavior intentions variable for teachers towards the use of augmented reality applications in teaching as a result of the influence of the independent variables (perceived benefit, perceived ease of use) combined was (0.383), and their value scored medium. The adjusted R2 value was (0.373) and indicates that the variables (perceived benefit, perceived ease of use) explain 37% of the real change in teachers' intentions to use augmented reality applications in teaching in the future. In addition, the perceived benefit variable is more close to predicting teachers' intention towards using augmented reality applications in teaching in the future. Accordingly, it can be said that the two variables of perceived benefit and perceived ease of use can predict changes in teachers' intentions towards using augmented reality applications in teaching in the future.

Conclusion

The results of the current study showed a strong positive correlation between ease of use, attitude to use, and perceived benefit, and between perceived benefit, attitude to use, and intentions to use. Also, there was a weak positive correlation between ease of use and both the facilitating conditions and intention to use. In addition, there was a weak inverse correlation between the perceived benefit and both anxiety and available facilities, and a strong inverse

correlation between anxiety and ease of use. The results also indicated a medium predictive ability for anxiety and facilitating conditions in predicting the perceived benefit as well as a medium predictive ability for perceived benefit and ease of use in predicting the attitude towards use and intentions to use. Furthermore, there was a low ability to predict the perceived benefit through anxiety, facilitating conditions, and perceived benefit.

Recommendations

In light of the results of the current study, the researchers recommend planning and implementing workshops for teachers on using augmented reality applications, training on their production and use skills. Also, there should be guides that contribute to reducing their feelings of anxiety. This will result in their expectation and feeling of ease of use. In addition, the researchers recommend the availability of augmented reality applications, the provision of devices, and the appropriate physical environment to enhance training opportunities and their ease of use. Furthermore, the study recommends educating teachers about the benefits and uses of augmented reality applications in teaching, which results in realizing their importance, increasing willingness and motivation towards their use, and taking measures, procedures, and planning for their future use. Moreover, it is recommended that the curricula include educational activities that can be implemented using augmented reality applications to enhance teachers' motivation towards using augmented reality applications in implementing these activities. Finally, sufficient support must be provided by educational institutions for male and female teachers, and all necessary facilities for the use of augmented reality applications must be provided.

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