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RESEARCH ARTICLE

The Requirements of Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in the Light of the Theory of Reasoned Action (TRA), from the Perspectives of Teachers

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ABSTRACT

The present study aimed to investigate the requirements of employing augmented reality (AR) technologies in teaching the science curriculum to secondary school students in Hail City, in the light of the Theory of Reasoned Action (TRA), from the perspectives of teachers. The population of the study consisted of teachers working schools located in Hail City; the final sample included (140) teachers. The study adopted the analytical descriptive design, and data were collected via questionnaire. The study obtained several findings, including, most importantly, the following: "The requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view" were (high) from the sample members' point of view; there were statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the questionnaire axes and the total score according to (Gender), in favor of females, with a mean of (4.32); there were no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the questionnaire axes and the total score according to (Years of Experience); there were no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the questionnaire axes and the total score according to (Educational Qualification). The study presents recommendations that include the following: benefiting from successful administrative experiences in other schools in applying artificial intelligence technologies in teaching; providing a guide within the school on how to activate augmented reality technologies; and training teachers to have the ability to reconcile augmented reality technologies and the human aspects of the educational process.

INTRODUCTION

Science curriculum is among the most important elements of any educational system. It is widely viewed as a significant factor contributing to a country's technological and scientific progress. Providing a high quality science curriculum plays a significant role in developing students' theoretical knowledge and practical skills and also contributing to the momentum of science trends in society (AlMuraie, et al., 2021). Despite its importance, science education is often associated with certain challenges. A persistent challenge that affects the outcomes of science education is students' negative attitudes towards science. The development of such attitudes is attributable to a variety of factors, such as low learning motivation and irrelevance of scientific in real life. The perceived irrelevance of scientific concepts stems from that students do not normally implement such concepts on daily life situations (Laine, et al., 2016).

One of potential solution for boosting students' motivation and performance in learning science is the incorporation of technology in teaching and learning activities. The contemporary field of education has witnessed the rise of a variety of technological innovations. One of the most prominent of them is augmented reality. Although augmented reality technologies can be used as an instructional tool in many areas, science is one of the main fields that can benefit from the use of these technologies greatly, as learning science can often be challenging due to curriculum containing a range of abstract concepts (Arici, et al., 2021). The use of augmented reality also affords students opportunities for experiencing learning science in more interactive ways. For example, the use of augmented reality technologies can improve students' laboratory skills and inspire positive attitudes toward science. Moreover, augmented reality helps in visualizing content in the form of multi-dimensional representations that cannot be displayed in other ways in traditional classrooms (Yilmaz, 2021).

Despite the benefits of augmented reality, its adoption in education could constitute a challenge. Therefore, it is important to understand the behavioral factors underlying the adoption of technology. One prominent theory used in analyzing such factors is the theory of reasoned action, which has been used for proposing theoretical models for explaining technology adoption behaviors, such as the Technology Adoption Model (TAM). The theory of reasoned action itself is also commonly used as a foundation for analyzing and understanding the behaviors of adopting new technologies and innovations (Otieno, et al., 2016).This brief introduction highlights the potential role of augmented reality as a tool for teaching science curricula in schools. However, the challenges associated with using such a complex technology should not be underestimated or ignored. Therefore, the perspective of the theory of reasoned action may of value in understanding these challenges and proposing solutions for addressing them and meeting the requirements of effective and successful adoption of augmented reality technologies in education.

Research Questions:

1. What are the administrative requirements for employing augmented reality technologies in teaching science curricula for secondary school students in Hail City in light of theory of reasoned action (TRA) from the perspective of teachers?
2. What are the technical requirements for employing augmented reality technologies in teaching science curricula for secondary school students in Hail City in light of theory of reasoned action (TRA) from the perspective of teachers?
3. What are the material requirements for employing augmented reality technologies in teaching science curricula for secondary school students in Hail City in light of theory of reasoned action (TRA) from the perspective of teachers?
4. Are there statistically significant differences regarding the requirement for employing augmented reality technologies in teaching science curricula for secondary school students in Hail City in light of theory of reasoned action (TRA) from the perspective of teachers, according to the variables of (Gender – Years of Experience)?

Research Objectives:

1. Framing the present reality of using augmented reality technologies in teaching science curricula in secondary schools.
2. Providing the appropriate recommendations to achieve the requirements for employing augmented reality technologies in teaching science curricula in secondary schools.
3. Investigating the administrative requirements for employing augmented reality technologies in teaching science curricula for secondary school students in Hail City in light of theory of reasoned action (TRA) from the perspective of teachers.
4. Investigating the technical requirements for employing augmented reality technologies in teaching science curricula for secondary school students in Hail City in light of theory of reasoned action (TRA) from the perspective of teachers.

5. Investigating the material requirements for employing augmented reality technologies in teaching science curricula for secondary school students in Hail City in light of theory of reasoned action (TRA) from the perspective of teachers.

Significance of the Study:

The significance of the current study comes from the importance of using augmented reality technologies in teaching science curricula in secondary schools, because of its importance in improving the outcomes of the educational process and enhancing academic achievement among students, the significance of the study can be highlighted through the following:

- **First: Theoretical Significance**
  - The current study may contribute to identifying teachers' needs to use augmented reality applications in teaching science curricula in secondary schools in the Kingdom of Saudi Arabia, whether administrative, material or technical requirements, and how to fulfill them.
  - The current study may contribute to draw the attention of educational officials to providing the requirements for using augmented reality applications in teaching in secondary schools by developing the administrative regulations and systems in effect in schools in line with the use of these applications.
  - The current study may contribute to enriching Arab libraries on the requirements for using augmented reality applications in teaching science curricula at the secondary level in the Kingdom of Saudi Arabia from the teachers’ point of view in light of modern teaching trends, in light of the lack of many studies in this field – as far as the researcher knows.
- **Second: Applied Significance**
  - The findings of current study may contribute to presenting the appropriate recommendations to provide the requirements for using augmented reality applications in teaching science curricula at the secondary level in the Kingdom of Saudi Arabia.
  - The findings of current study may contribute to dissemination of research results to various stages of public education in the Kingdom.
  - The findings of current study may contribute to opening the way for conducting more research and studies on the professional needs that teachers must have to enhance the use of augmented reality applications in teaching.

Statement of the Problem

The education field is witnessing increased adoption of ICTs. One technology that has been gaining increased prominence is augmented reality. Employing this technology requires several tangible requirements, such as hardware and accessories. However, it is important to understand the nature of intangible requirements, especially those internal to the use (i.e., teacher). The perspective of the theory of reasoned action might be of value in exploring these requirements, as the theory links attitude to behavior.

Recent studies have investigated the requirements of employing augmented reality technologies in teaching. For example, the study of (Koutromanos, et al. 2024), which used the theory of reasoned action as the basis of its theoretical model, indicated that the intention to use augmented reality technologies is influenced by facilitating conditions, perceived usefulness, and attitude. However, this study is a rare example of investigation of the requirements of using augmented reality technologies with direct linking to theory of reasoned action. Some other studies investigated these requirements indirectly, by using a related theory as the theoretical model. For instance, (Alroqi, 2021) examined secondary school teachers' perceptions on factors that influence the acceptance and adoption of augmented reality technology, in the light of the Unified Theory of Acceptance and Use of Technology (UTAUT2), which is based on the theory of planned behavior and theory of reasoned action. The study's findings indicate that using these technologies is reliant on several varied requirements, such price in relation to value, hedonic motivations, social influence, and facilitating conditions. The preceding discussion shows that there is a research gap in investigating the requirements of using augmented reality technologies in teaching. The present study aims to present a contribution to addressing this gap by examining the requirements of employing augmented reality technologies in teaching the science curriculum to secondary school students in Hail City, in the light of the theory of reasoned action.

Definition of Terms

- **Augmented Reality**

The term "augmented reality" refers to a technology in which the real world and virtual objects are blended and can interact with each other (Yildiz, 2022, 3). It can also be defined as a system that uses a virtual object to supplement the real world (Yuliana, 2021, 34).

Another definition of augmented reality is that it is the projection of virtual objects in real time in an environment in the real world (Cieri, et al., 2021, 1786).

- **Science Curriculum**

The term "science curriculum" refers to a curriculum that encompasses a wide range of topics in the areas of physics, chemistry, biology, environmental science, and biology, synthesized to provide a unified, holistic body of knowledge on science (Chima, 2021, 101). It can also be defined as a range of relationships constructed among contextual factors, procedural strategies, and conceptual schemes related to science (Struthers, 2015, 67).Another definition of science curriculum is that it is a instructional tool that presents opportunities for learning about science topics and developing skills related to arguing based on data (Morris, et al., 2015, 2708).

- **Theory of Reasoned Action**

One of the definitions of theory of reasoned action is that it is a range of related hypotheses suggested by psychologists for predicting and understanding human behavior (Otieno, et al., 2016, 1).

It can also be defined as a framework for exploring how the decisions that people make are influenced by perceived norms, beliefs, and behavioral controls (Rinaldo, 2022, 44).Another definition of theory of reasoned action is that it is a theory in the field of social psychology that is interested in explaining the link between attitudes and behaviors, first introduced by Fishbein in 1967 and later expanded by Fishbein and Ajzen (Bishri and Sahad, 2024).

LITERATURE REVIEW

(Buabeng-Andoh, 2018) explored the viability of integrating the theory of reasoned action and technology acceptance model to develop a model to explain and predict university students' use of technology in m-learning contexts. The population of the study consisted of students in two universities in southern Ghana; the sample included (487) students. The study adopted a descriptive research methodology, and data was collected using questionnaires. The study obtained several findings, including the following: the study's proposed model strongly explains and predicts sample members' behavioral intention to use technology in m-learning.

The study of (Jones, 2019) investigated the intentions among faculty members to use social media in presenting distance learning courses, in the light of the theory of reasoned action. The population of the study consisted of faculty members of a public research university located in the southeastern part of the United States; the final sample included (399) individuals. The study obtained several findings, including the following: sample members' intentions to use social media in distance learning courses are influenced by subjective norms and attitudes.

(Alroqi,2021) examined secondary schools teachers' perceptions on factors that influence the acceptance and adoption of augmented reality technology. The study adopts the Unified Theory of Acceptance and Use of Technology (UTAUT2), which is based on the theory of planned behavior and theory of reasoned action. The sample of the study included (25) secondary school teachers from Riyadh region, Saudi Arabia. The study adopted a qualitative research methodology, and data were collected by interviewing. The study obtained findings that include the following: both teachers who use and who do not use augmented reality held favorable attitudes towards augmented reality technologies; and several factors influence teachers' acceptance and technology, and these factors mainly include price in relation to value, hedonic motivations, social influence, and facilitating conditions.

The study of (Ateş and Garzón, 2022) aimed to present a model for predicting science teachers' intention to employ mobile applications in teaching. The study's theoretical model is based on flow theory, theory of planned behavior, and the Technology Acceptance Model (TAM), of which that latter two are, in turn, based on the theory of reasoned action. The sample of the study included (1,203) in-service and pre-service science teacher from several cities across Turkey. The study adopted a descriptive research design, and data was collected using questionnaires. The study arrived at the following findings: perceived ease of use positively influences perceived usefulness and attitude; and perceived usefulness and attitude positively influences teachers' intention to employ mobile applications.

(Koutromanos, et al. 2024) investigated the factors the influence in-service and pre-service teachers' use of mobile augmented reality. The study's theoretical model is based on the theory of planned behavior and theory of reasoned action. The population of the study consisted of in-service teachers in Greece and pre-service teachers attending the University of Ioannina (Greece); the sample included (169) in-service and (137) pre-service teachers. The study adopted the descriptive methodology, and data were collected via questionnaires. The study obtained several findings, including, most importantly, the following: facilitating conditions, perceived usefulness, and attitude were found to positively influence intention; perceived enjoyment and perceived relative advantage were found to positively influence perceived usefulness; facilitating conditions and mobile self-efficacy were found to positively influence perceived ease of use; and no effect was found of perceived ease of use on attitude or perceived attitude.

Overview of Augmented Reality Technologies

Augmented reality is a technology that allows placing virtual elements, such as two-dimensional images, three-dimensional animations, or annotations on top of a view of a real-world environment. This is achieved using a number of technological components, including visual markers, cameras, content rendering, and machine learning algorithms. The augmented reality software components analyze the camera feed in order to determine where the virtual objects should be located in relation to the scene captured by the camera; the result is virtual content generated and placed on top of the view captured by the camera. The content generated by the augmented reality system is updated and changed in real time with the changing of the camera's view and position (Laine, et al., 2016).

It is important to note that augmented reality differs from other types of environments, mainly the following (Arena, et al., 2022):

- Real environment: the physical environment in which a person lives and in which laws of physics exist.
- Augmented Virtuality: a virtual reality environment in which real-life objects can be seen and interacted with.
- Virtual reality: a digitally generated world in which the user is immersed.

These environments, along with augmented reality, can be represented on a reality-virtuality continuum, as outlined in Figure 1 below (Arena, et al., 2022).

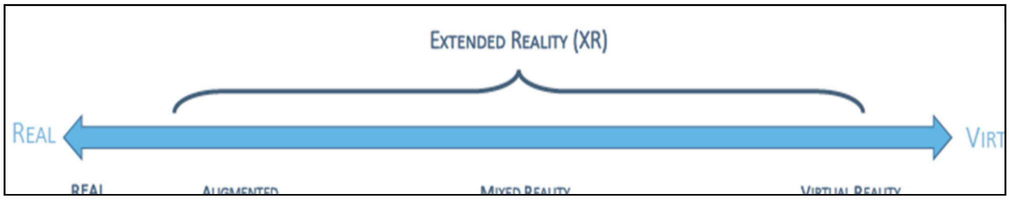

Figure (1): The reality-virtuality continuum (Arena, et al., 2022)

A typical augmented reality system relies on the use of three types of technology. Table (1) provides a brief description of these types.

Table (1): The main types of technology used in Augmented Reality systems (Chen, et al., 2019)

Technology	Description
Intelligent Display Technology	This technology is used to display information to the user. The technology is categorized into the following categories: 1. Helmet display: using this helmet, it is possible to impose graphical elements on the view of the real-world scene, combining elements from the real and virtual worlds. 2. Handheld device display: handheld devices are popular in augmented reality applications due to being light, small in size, and capable of displaying video content. 3. Other display devices: examples of such devices include personal computers (PCs).
3D Registration Technology	This technology handles the processes of superimposing images on top of the display of the real-world environment. The process of 3D registration occur over two steps: first, determining the relationship between the model, virtual image, and position and direction of the display device or camera; and second, rendering the model and image onto the display of the real-world environment in order to produce a combined final image. Moreover, the 3D registration process can be carried out in several ways, which include registration based on hardware tracker, computer vision, wireless network, or mixed registration. The latter two ways are particular popular in modern augmented reality applications.
Intelligent Interaction Technology	There are various ways for facilitating interaction in augmented reality systems, including using special hardware or based on location, tags, or information. The interaction technology not only superimposes virtual images on top of views of real-life environment, they also allow for interacting with virtual objects from the real-world environment.

Source: Chen, Y., et al. (2019).An overview of augmented reality technology. Journal of Physics: Conference Series, 1237(2), 1-5. https://doi.org/10.1088/1742-6596/1237/2/022082

The preceding discussion highlights the main characteristics and capabilities of augmented reality. It can be stated that augmented reality is a unique technology because it allows for integration of real and virtual worlds in a manner that can provide new opportunities for interaction with physical environments. Superimposing interactive and illustrative elements in the real time provides informative capabilities in learning in the real world that cannot be afforded by virtually any other technology. Therefore, augmented reality holds significant potential for improving experiences of learning, especially when engaging with content that includes practical components or abstract constructs, which are elements the distinctively characterize science.

Approaches of Augmented Reality Used in Education

Augmented reality is implemented in education using different approaches. Table 2 below lists the approaches of augmented reality used in education.

Table (2): The main approaches of implementing augmented reality in education (Hassan, 2023)

Category	Description
Market-based Augmented Reality	This approach involves detecting and incorporating objects from the real-world environment with the use of certain pictures as markers. The markers inform the system on where to place objects in the view displayed to the user. The system is designed to be capable of detecting certain picture patterns in the physical world. The detection of picture patterns allows the system to superimpose 3D objects on the user's view correctly. The main components of a marker-based augmented reality framework include a camera as well as systems for image capturing and processing and marker tracking.
Marker-less Augmented Reality	Location-based augmented reality: Virtual objects in the environment are displayed depending on the user's place in relation to the physical objects. This approach is implemented by placing sensors of a smart device in order to use data of the real-world environment in order to place virtual objects at their correct places.
	Projection-based augmented reality: This approach of augmented reality focuses on representing virtual objects within the users' real-world environment. This approach is preferred when the real-world setting does not require movement of components. Therefore, the user can move within the environment freely, with a tracking camera and projector installed independently. The system projects virtual effects of light onto flat surfaces in the real-world environment to simulate visual appearances of direction, depth, and location of objects.
	Overlay augmented reality: This approach of augmented reality involves placing 3D objects in the user's view. It also provides the ability to display additional information about the displayed object.
	Contour-based augmented reality: This approach relies on the use of advanced photography equipment, which detects outlines (lines) in certain objects to generate input for the virtual content generation process.

Source: Hassan, A. (2023).Design and development of an augmented reality-based application to facilitate STEM education, master's thesis, University of Eastern Finland https://dspace.uef.fi/bitstream/handle/123456789/30455/urn_nbn_fi_uef-20231098.pdf?sequence=1&isAllowed=y

History and Evolution of Augmented Reality Technologies

The term "Augmented Reality" was coined by Tom (Caudell, 1995). Since then, the use of augmented reality technologies has witnessed growth. Early explorations of the benefit of using augmented reality in education were attempted in the early 21st century, with special focus on chemistry. Augmented reality was found to hold significant potential in teaching the abstract concepts presented in chemistry. Since then, the idea of adopting augmented reality in education contexts, especially in teaching chemistry, has gained increased popularity (Romainor, et al., 2022; Garzón, et al., 2019).The popularity of augmented reality technologies has surged beginning from 2010, largely due to the advancement of model technologies in terms of functionality and processing power, as augmented reality systems have become increasingly compatible with mobile technologies, thereby leading to significantly increasing the number of people who can easily access and use augmented reality systems (Garzón, et al., 2019).

Overview of the Theory of Reasoned Action

Theory of reasoned action is a cognitive theory that provides a framework for understanding human behaviors in various situations. The theory posits that behavioral intention is the strongest predictor of engagement in a behavior. Behavioral intention, in turn, is postulated to be influenced by subjective norms and attitudes. In other words, the more positively one perceives a certain behavior and the more they view it as valuable to those in their social circle or surrounding environment, the higher the likeliness that they form an intention to engage in the behavior (LaCaille, 2020). An attitude is a subjective and enduring assessment of a certain idea and can be either positive or negative. The components of an attitude include the attitude's content, knowledge linked to the attitude, strength of the relationship between the attitude and the associated knowledge, and link between the attitudes and other related attitudes. A social norm is a subjective assessment based on one's normative beliefs on the nature of appropriate behaviors and responses. In general, social norms vary significantly from one individual or social setting to another (Sulak, et al., 2014). The relationships among components of the theory of reasoned action include those outlined in Figure 2 below.

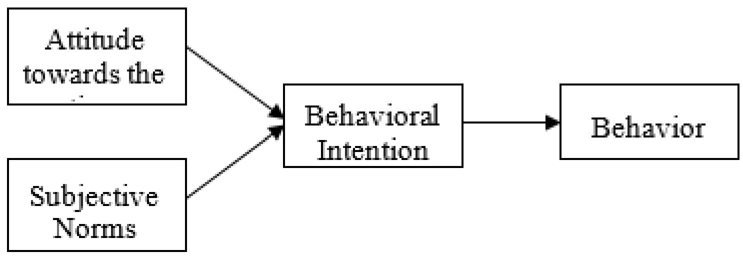

Figure (2): Relationships among components of the theory of reasoned action (Sulehri & Ahmed, 2017).

Despite its value as a theoretical framework for analyzing human behavior, the theory of reasoned action has been subject to criticism. The theory has been criticized for not taking into consideration perceived behavioral control as a factor potentially influencing behavior. Perceived behavioral control is one's belief that committing a behavior is easy or difficult (Nomi & Sabbir, 2020).

Potential Challenges of Using Augmented Reality Technologies in Education

As the case is with any other technology, the use of augmented reality technologies in education is associated with a variety of challenges. Examples of such challenges include difficulty of use, resistance by teachers, and overload of information for students. Moreover, several other challenges commonly emerge during implementation in classrooms, such as difficulties in the detection of certain elements, such the user's location, visual patterns, and certain objects that are relatively difficult to detect accurately, such as doors (Garzón, et al., 2019).

Many teachers encounter complex challenges resulting from poor technical support and that hinder effective use of augmented reality technologies in teaching. Examples of these challenges include the following (Lai & Cheong, 2022):

- Lack of relevant training.
- Limited knowledge on the concept of augmented reality.
- Limited experience in using augmented reality systems.
- Poor support from educational institutions.

Another study that investigated the challenges of using augmented reality technologies in education is the study by (Hassan, 2023). According to the study, there are certain limitations of the idea of incorporating augmented reality technologies in education. These limitations include:

- Augmented reality applications can cause wasting resources and time if not well designed, which is an issue likely to arise in using this type of technologies.

- Augmented reality technologies are difficult to use for those who are not familiar with them.
- Many teachers lack the skills needed to deal with technical issues that might arise during the use of augmented reality technologies in the classroom.
- The intricate nature of learning tasks, required amount of knowledge, the need to use several devices, and immersive learning capabilities are all factors that might result in confusion for students when using augmented reality technologies while learning.

These findings are line with those obtained by (Talan, et al. 2022), who highlight challenges of using augmented reality in education, which include the following:

- Obtaining the required material for implementation is difficult and costly.
- Issues in implementation, such as those concerning calibration and monitoring.
- Ethical issues, such as those concerning privacy, security, and confidentiality.
- Excessive cognitive load, especially in implementations incorporating mixed or multiple learning task.
- Difficulty of designing applications those are easy to use.
- Difficulty of developing appropriate material for training on using augmented reality technologies.

Based on the above, it can be stated that the use of augmented reality in education, although potentially beneficial, is likely to encounter a variety of technical and administrative challenges. The aforementioned challenges should be granted as much as attention as the benefits and advantages. From among these challenges, teachers' lack of skills and preparation is probably the most deserving of attention, as it is frequently cited in relevant research. Due to the critical role that a teacher plays in promoting learning in students, the lack of teaching skills related to employing augmented reality in teaching and learning activities is likely to result in poor use of this technology, leading to poorer learning outcomes for students.

Requirements of Employing Augmented Reality Technologies in Science Education

Employing augmented reality in education, especially for a challenging curriculum such as that of science, is reliant on the availability of a wide range of requirements. The main categories of requirements of employing augmented reality in science education include financial, technological, and administrative requirements. Below is a brief discussion of each of these requirement categories.

- **Financial Requirements**

The study of (Arici, et al.,2021) suggests a list of requirements for employing augmented reality technologies in science education, in the light of the theory of reasoned action. The study's findings show that the use of augmented reality applications is associated with improving teachers' attitudes towards these applications. Therefore, the study recommends providing teachers with adequate information and access to augmented reality technologies.

Financial investment for acquiring the required physical resources is also essential to the success of adopting augmented reality technologies in schools. Financial investment is needed for building the needed IT infrastructure, including ensuring the availability of needed devices and stable internet connectivity (Fearne & Hook, 2023).

- **Technological Requirements**

An important consideration for employing augmented reality technologies in science education concerns the preferred technologies of use. In recent years, there has been growth in the development of augmented reality applications for smartphones and tablets. Therefore, the use of such applications would be preferred. However, this does not mean that other types of augmented reality application (e.g., those used with head-mounted displays) should be abandoned, despite the associated challenges. For instance, innovations in such applications are limited, especially that most implementations of head-mounted displays are at the prototype level. Despite these issues, the use of head-mounted displays holds a significant advantage over portable devices as hardware components for augmented reality applications, and that is the freedom head-mounted displays give to users in moving their hands freely and doing concrete things (Salmi, et al., 2017).

Augmented reality applications should also be developed while taking into careful consideration the nature of students' needs. Additionally, it is important that the developers ensure that applications are free of technical problems, such as difficulties in detecting objects in the real world or generating representations in the users' view (Omurtak & Zeybek, 2022).

- **Administrative Requirements**

One of the main administrative requirements of employing augmented reality technologies in science education is the provision of training to both teachers and students. The value of this requirement stems from the fact that the lack of training is among the most significant impediments to the use of augmented reality in education. Providing teachers with on-the-job training can be of value in that regard, not only in helping teachers with regards to deployment of augmented reality technologies, but also in overcoming teachers' resistance to these technologies and speeding up the adoption process. The inclusion of implementation of augmented reality in both student curricula and teacher training programs can provide students and teachers with adequate understanding of these technologies, resulting in ensuring their use in a sustainable manner (Abdullah, et al., 2022).

Another important administrative requirement for ensuring effective use of augmented reality in science education is the allocation of adequate time with accordance to students' needs. The importance of this requirement stems from that among the most significant challenges that students encounter in learning using augmented reality are the lack of time and the time-demanding nature of this approach of learning. (Omurtak & Zeybek, 2022)

The preceding discussion highlights that employing augmented reality in science education is a demanding endeavor. The sophisticated nature of augmented reality makes effective adoption of this technological innovation strongly reliant on the availably of sufficient resources and proper coordination to ensure the seamless integration of technologies into the educational process. The provision of these requirements necessitates attention not only from teachers and schools but also from competent educational and governmental institutions, as these agencies play a significant role in affecting systematic change toward effective adoption of augmented reality technologies.

The Potential Value of Using Augmented Reality in Teaching the Science Curriculum

The use of augmented reality technologies can yield a variety of benefits in teaching the science curriculum. It can boost students' learning motivation. It can also help students inspect abstract concepts in more accessible and concrete way; this effect is especially evident when learning certain scientific concepts such as chemical structures (Laine, et al., 2016).

The use of augmented reality allows for creating learning environments that are more immersive and interactive. It can also play a significant role in meeting specific learning needs. For example, the use of augmented reality can make up for the lack of access to laboratory equipment or environments in school. Moreover, these technologies can be used as both evaluative and supplementary materials, especially in the contexts of workshop and laboratory studies as well as in virtual learning environments (Talan, et al., 2022).

According to (Saidin, et al., 2015), the main benefits of using augmented reality in education include the following:

- Facilitating the interaction between real and virtual environments and allowing for manipulating virtual objects.
- Creating new ways for making the learning material more comprehendible by augmenting physical elements of the real world with virtual illustrations and annotations.

- Providing students with new ways to learn outside class time.
- Visualization of complex scientific concepts those are difficult to imagine without illustrations, such as chemical interactions among proteins and amino acids. The process of visualization can use a combination of static 2D and 3D images and animations.

The study of (Garzón, et al., 2019) also indicates that the use of augmented reality can improve several improve learners' performance in several aspects, which include those outlined in Table (3) below.

Table (3): Benefits of augmented reality for learners' performance, according to (Garzón, et al., 2019)

Learning Benefit	Description
Learning Gain	This is one of the most reported benefits of using augmented reality systems in education. Students who use these systems in learning often have higher scores than those who learn using traditional approaches only.
Motivation	Students who use augmented reality systems in learning are often more motivated to learn compared to those who use other educational tools or approaches. Learning using augmented reality systems adds enjoyment to learning experiences. Moreover, it fosters sensory engagement, which is akin to how students, especially at younger ages, learn in their natural environments.
Learning Abstract Concepts	Augmented reality is considered an ideal approach for explaining concepts that cannot be observed in real life.
Memory Retention	Not only is using augmented reality associated with improved comprehension, but it can also improve the retention of acquired knowledge. This may be attributable to that augmented reality systems employ certain elements that can improve the performance of long-term memory. Examples of such elements include vision-haptic visualizations, contextual visualizations, and real-world annotations.
Autonomy	Augmented reality combines elements of both virtual and real worlds. This combination can promote autonomy because it encourages students to take into consideration their own motivation and natural abilities when using augmented reality technologies.
Collaboration	Augmented reality allows students to interact with the same virtual objects integrated into real-world environments. As a result, students can collaborate with peers in interaction with the educational content.

Source: Garzón, J., et al. (2019).Systematic review and meta-analysis of augmented reality in educational settings. Virtual Reality, 23(4), 447-459. https://doi.org/10.1007/s10055-019-00379-9

A significant reason for the potential value of augmented reality in science education is that it provides students with the ability to practice informal learning in virtual environments. Thus, it is different from other educational media that provides learning opportunities in either real environments or formal contexts (Salmi, et al., 2017). Figure (3) illustrates the difference between augmented reality (and other related or similar technologies), on the one hand, and other educational media, on the other.

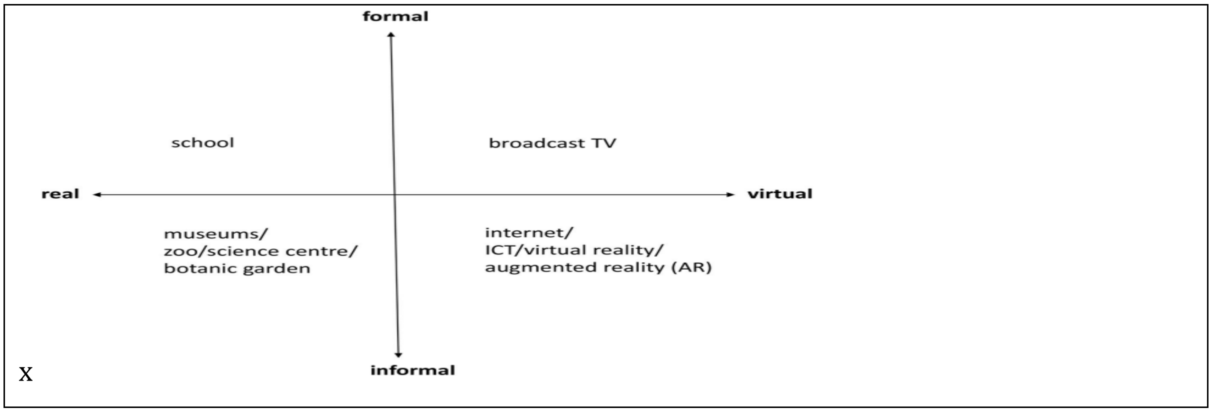

Figure (3): Difference, in terms of formality/informality and reality, virtuality, between augmented reality (and other related or similar technologies), on the one hand, and other educational media, on the other (Salmi, et al., 2017).

METHODOLOGY

Study approach

To achieve the study objectives, the current study will follow the analytical descriptive design as the study approach, which is "one of the forms of scientific analysis and interpretation organized to describe a specific phenomenon or problem and quantify it by collecting data and specific information about a phenomenon or problem, classifying, analyzing, and subjecting it to accurate study.

Study Population and Sample:

The study population consists of all science teachers in Hail schools, and the researcher selected a random sample of (140) teachers to represent the population.

Characteristics of the Sample:

Frequencies and percentages of the sample were calculated according to (Gender – Years of Experience – Educational Qualification).

Table (4): Distribution the study sample

Distribution of the sample according to gender		
Male	89	63.6%
Female	51	36.4%
Total	140	100.0%
Distribution of the sample according to educational qualification		
Bachelor's degree	87	62.1%
Diploma in education	39	27.9%
Postgraduate qualification	14	10.0%
Distribution of the sample according to years of experience		
From 1 to 5 years	62	44.3%
From 6 to 10 years	21	15.0%
More than 10 years	57	40.7%
Total	**140**	**100.0%**

Table (4) shows that (63.6%) of the sample are males, and (36.4%) are females; while (62.1%) have a bachelor's degree, (27.9%) have a diploma in education and (10.0%) have a postgraduate qualification; (44.3%) have experience for a period of 1 to 5 years, (15.0%) have experience for a period of 6 to 10 years and (40.7%) have experience for a period of more than 10 years.

Research Instrument

After reviewing the educational literature and previous studies related to the study topic, the researcher built and developed a questionnaire, and used five-point Likert scale (very high – high – average – low – very low) to investigate the Requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers.

- **Validity of the study instrument:**

1) **Validity of internal consistency of the instrument**

a) **Validity of internal consistency of study axes**

Internal consistency was calculated according to the answers of the pilot sample (n=30) by calculating the Pearson correlation coefficient between the scores of each statement and the total score of the axis to which the statement belongs as shown in the following Table (5).

Table (5): Pearson correlation coefficients between the scores of each statement and total score

First axis: administrative requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers					
Item no.	**Correlation coefficient**	**Item no.**	**Correlation coefficient**	**Item no.**	**Correlation coefficient**
1	0.559**	5	0.657**	9	0.720**
2	0.540**	6	0.708**	10	0.865**
3	0.574**	7	0.821**		
4	0.904**	8	0.772**		
Second axis: technical requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers					
1	0.780**	5	0.755**	9	0.612**
2	0.760**	6	0.679**	10	0.852**
3	0.880**	7	0.829**		
4	0.654**	8	0.910**		
Third axis: material requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers					
1	0.677**	5	0.679**	9	0.595**
2	0.645**	6	0.808**	10	0.840**
3	0.897**	7	0.802**		
4	0.712**	8	0.826**		

** Statistically significant at (0.01) level. *statistically significant at (0.05) level

Table (5) shows that correlation coefficients of the statements with the total score of the axis were all statistically significant at (0.01) level. The values of all correlation coefficients were high as they ranged between (0.540-0.904) in the first axis "administrative requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"; and between (0.612-0.910) in the second axis "technical requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"; and between (0.595-0.897) in the third axis "material requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School

Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"; This indicates a high degree of internal consistency validity of the questionnaire statements.

b) General structural validity of the questionnaire axes:

Structural validity of the questionnaire axes was verified by calculating correlation coefficients between the total score of the axis and the total of the questionnaire, as shown in the following table.

Table (6): correlation coefficients between the total score of each axis and the total score of the questionnaire axes

s	Axis	Correlation coefficient
1	First axis: administrative requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers	0.825**
2	Second axis: technical requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers	0.944**
3	Third axis: material requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers	0.959**

** Statistically significant at (0.01) level

Table (6) shows that the values of the correlation coefficients of the questionnaire axes to the total score of the questionnaire were high as they ranged between (0.825-0.959), and all of them were statistically significant at (0.01) level; this indicates a high degree of structural validity for the questionnaire axes.

Table (7): Cronbach's Alpha reliability coefficients of the questionnaire axes

s	Axis	Number of items	Cronbach's Alpha coefficient
1	First axis: administrative requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers	10	0.975
2	Second axis: technical requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers	10	0.930
3	Third axis: material requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers	10	0.918
Total		**30**	**0.948**

Table (7) shows that the values of the reliability coefficients of the questionnaire axes were high, as they ranged between (0.918-0.975), and the total reliability coefficient value was (0.948); These values indicate the applicability of the questionnaire and the possibility of relying on and trusting its results.

Presenting and Discussing the Study Questions

What are the Requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers?

To answer the first question, the arithmetic mean and standard deviation for each of the questionnaire axes were calculated, and then those axes were arranged in descending order based on the arithmetic mean, as shown in table (8).

Table (8): Frequencies and arithmetic means to explain "the Requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"

s	Axis	Mean	Standard deviation	Axis rank	Response degree
1	First axis: administrative requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers	4.19	0.628	1	High
3	Third axis: material requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers	4.14	0.761	2	High
2	Second axis: technical requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers	4.12	0.771	3	High
Total score of the questionnaire		**4.15**	**0.641**	**---**	**High**

Table (8) shows that "the Requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers" was high from the perspective of the sample members, as the total mean of the questionnaire was (4.15) with a (0.641) standard deviation, and the standard deviations of the axes ranged between (0.628-0.771).

The first axis "administrative requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers" came in first place with a (4.19) mean and a (0.628) standard deviation; followed by third axis "material requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers" in second place with a

(4.14) mean and a (0.761) standard deviation; and in last place, came the second axis "technical requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers" with a (4.12) mean and a (0.771) standard deviation.

The researcher believes that the administrative requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in Hail city in light of the theory of reasoned action (TRA) from the perspective of teachers have a high degree of response from the sample members' point of view, which may be attributed to the existence of many administrative obstacles facing teachers that limit their ability to teach based on augmented reality applications, and their conviction that if school administrations develop some systems and regulations, this may contribute to a large extent to increasing their activation of augmented reality applications in teaching science, given the strong positive role of these technologies in improving the outcomes of the educational process in science.

This finding is in line with those obtained by (Alroqi,2021), who indicated that facilitating conditions are among the factors required for adopting technologies. From this perspective, it may be plausible to consider management support as part of these conditions.

Presenting and Discussing the Results of the Study Hypotheses:

- **First hypothesis: there are no statistically significant differences at the level of (0.05) on the questionnaire axes and its total score according to (Gender).**

To detect the statistically significant differences at the level (0.05) regarding the questionnaire axes and the total score according to (Gender), the researcher applied the (t) test "Independent Samples T Test" to clarify the significance of the differences in the answers of the study sample according to the gender variable, as shown in the following table (9).

Table (9): Results of the "Independent Samples T Test" for differences in the answers of the study sample on the questionnaire axes and the total score according gender

Axis	Gender	No.	Mean	Standard deviation	D.F	"T"	Sig.	Sig. level
The first axis "administrative requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"	Male	89	4.1371	0.653	138	-1.410	0.161	Not significant at > 0.05
	Female	51	4.29	0.576				
The second axis "technical requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA),	Male	89	3.98	0.830	138	-2.922	0.004	Significant at > 0.05
	Female	51	4.37	0.588				

from the Perspective of Teachers"								
The third axis "material requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"	Male	89	4.05	0.829	138	-1.956	0.053	Significant at > 0.05
	Female	51	4.31	0.599				
Total score	**Male**	**89**	**4.06**	**0.694**	**138**	**-2.405**	**0.017**	Significant at > 0.05
	Female	**51**	**4.32**	**0.502**				

The results of Table (9) show that:

- There are no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the first axis: Administrative requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view according to the Gender.
- There are statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the second axis: Technical requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view according to the gender variable in favor of females, with a mean of (4.37).
- There are statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the third axis: Material requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view according to the gender variable in favor of females, with a mean of (4.31).
- There are statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the questionnaire axes and the total score according to the gender variable in favor of females, with a mean of (4.32); which indicates that the first hypothesis is invalid.

The researcher believes that this result may be due to the fact that the female teachers in the study sample face more difficulty than the male teachers in activating augmented reality applications, whether on a personal, training or administrative level, which caused a difference between their answers and the answers of the male teachers in the sample.

This finding is similar to those obtained to by the study by (Jones, 2019), which found gender not to be a factor that influences the behavioral intention to adopt and use technology.

- **Presenting and discussing the second hypothesis: there are no statistically significant differences at the level of (0.05) on the questionnaire axes and its total score according to (years of experience).**

To answer this question, a One-Way ANOVA test was conducted to clarify the significance of the differences in the answers of the sample members on the questionnaire axes and the total score according to (years of experience); and the results of the analysis were as shown in the following Table (10).

Table (10): Results of the One-Way ANOVA for the differences in the answers of the sample members on the study axes according to the difference in the years of experience

Axis		**Sum of squares**	**D.F**	**Mean square**	**f**	**Significance**	**Significance level**
The first axis "administrative requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"	Between groups	3.248	2	1.624	4.307	0.515	Not significant at > 0.05
	Within groups	51.656	137	.377	---		
	Total	**54.904**	**139**	**---**	**---**		
The second axis "technical requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"	Between groups	0.446	2	.223	.371	0.691	Not significant at > 0.05
	Within groups	82.369	137	0.601	---		
	Total	**82.816**	**139**	**---**	**---**		
The third axis "material requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"	Between groups	0.430	2	.215	0.367	0.694	Not significant at > 0.05
	Within groups	80.179	137	0.585	---		
	Total	**80.609**	**139**	**---**	**---**		
Total score	Between groups	1.014	2	0.507	1.235	0.294	Not significant at > 0.05
	Within groups	56.260	137	0.411	---		
	Total	57.274	139	---	---		

The results of Table (10) show that:

- There are no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the first axis: Administrative requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in light of the theory of reasoned action (TRA) from the teachers' point of view according to years of experience.
- There are no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the second axis: Technical requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in light of the theory of reasoned action (TRA) from the teachers' point of view according to years of experience.
- There are no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the third axis: Material requirements for employing Augmented Reality technologies in teaching science curriculum to secondary school students in light of the theory of reasoned action (TRA) from the teachers' point of view according to years of experience.
- There are no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the questionnaire axes and the total score according to years of experience; this indicates the validity of the second hypothesis.

The researcher believes that this result may be due to the frequent contact between most of the sample members during work and their awareness of the work they do related to employing augmented reality technologies in teaching science and their work under the same conditions despite the difference in their school administrations; which brought their answers to the questionnaire axes and the overall score closer together.

This finding is congruent with those of the study by (Ateş & Garzón, 2022), which did not level of experience to be an influential factor in adopting and using technology in education.

- **Presenting and discussing the third hypothesis: there are no statistically significant differences at the level of (0.05) on the questionnaire axes and its total score according to (Educational Qualification).**

To answer this question, a One-Way ANOVA test was conducted to clarify the significance of the differences in the answers of the sample members on the questionnaire axes according to (Educational Qualification); and the results of the analysis were as shown in the following Table (11).

Table (11): Results of the One-Way ANOVA for the differences in the answers of the sample members on the study axes according to the difference in Educational Qualification

Axis		**Sum of squares**	**D.F**	**Mean square**	**F**	**Sig.**	**Sig. level**
The first axis "administrative requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"	Between groups	3.248	2	1.624	4.307	0.515	Not significant at > 0.05
	Within groups	51.656	137	0.377	---		
	Total	54.904	139	---	---		
The second axis "technical requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"	Between groups	.446	2	0.223	0.371	0.691	Not significant at > 0.05
	Within groups	82.369	137	0.601	---		
	Total	82.816	139	---	---		
The third axis "material requirements for Employing Augmented Reality (AR) Technologies in Teaching the Science Curriculum to Secondary School Students in Hail City, in light of the Theory of Reasoned Action (TRA), from the Perspective of Teachers"	Between groups	.430	2	0.215	0.367	0.694	Not significant at > 0.05
	Within groups	80.179	137	0.585	---		
	Total	80.609	139	---	---		
Total score	Between groups	1.014	2	0.507	1.235	0.294	Not significant at > 0.05
	Within groups	56.260	137	0.411	---		
	Total	57.274	139	---	---		

The results of Table (11) show that:

- There are no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the first axis: Administrative requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view according to educational qualification.

- There are no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the second axis: Technical requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view according to educational qualification.
- There are no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the third axis: Material requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view according to educational qualification.
- There are no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the questionnaire axes and the total score according to educational qualification; which indicates the validity of the third hypothesis.

The researcher believes that this result may be due to the similarity of needs, knowledge, and regulations governing the activation and use of augmented reality applications and technologies in classrooms to teach science; which brought their answers to the questionnaire axes and the overall score closer together.

This finding is similar to those obtained by (Koutromanos, et al., 2024). The study highlighted the role of factors included in the TRA model in influencing the use of augmented reality technologies in education. However, in similarity to the present study, educational qualification was not found to influence the use of these technologies.

RESULTS AND DISCUSSION

- "The requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view" were (high) from the sample members' point of view.
- The first axis: "Administrative requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view" came in first place with a mean of (4.19) and a (0.628) standard deviation, followed-in the second place-by the third axis: "Material requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view" with a (4.14) mean and a (0.761) standard deviation, while the second axis: "Technical requirements for employing augmented reality technologies in teaching science curriculum to secondary school students in the city of Hail in light of the theory of reasoned action (TRA) from the teachers' point of view" came in last place with a (4.12) mean and a (0.771) standard deviation.
- There were statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the questionnaire axes and the total score according to (Gender), in favor of females, with a mean of (4.32).
- There were no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the questionnaire axes and the total score according to (Years of Experience).
- There were no statistically significant differences at the level of (0.05) in the opinions of the sample members regarding the questionnaire axes and the total score according to (Educational Qualification).

Recommendations:

- Benefiting from successful administrative experiences in other schools in applying artificial intelligence technologies in teaching.

- Providing a guide within the school on how to activate augmented reality technologies.
- Training teachers to have the ability to reconcile augmented reality technologies and the human aspects of the educational process.
- Replacing traditional curricula with interactive curricula to apply augmented reality in teaching science.
- Providing the necessary devices to employ augmented reality in schools.
- Allocating a sufficient budget to introduce academic disciplines in augmented reality within the school's academic programs.
- Providing a budget to provide fast communication devices between teachers and students.
- Providing sufficient financial support to purchase the modern programs and technologies used.

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