UTAUT model for the use of Augmented Reality in education and training

Sara Jeza ALOTAIBI

The Institute of Public Administration, Riyadh, Saudi Arabia

alotaibisar@ipa.edu.sa

Abstract: Since practically all sectors - from the education sector to the healthcare sector and the military one - are embracing Augmented Reality (AR) for the help it can provide in the context of specific training, Augmented Reality (AR) has played a significant part in revolutionising the present-day learning processes. For example, as it increases the proficiency and accuracy of students and surgeons, it plays a crucial role in enhancing the overall effectiveness of the learning processes. However, even if time efficiency, cost savings, and the simplicity of training techniques are only a few advantages of using AR, this application also comes along with its share of difficulties, as more and more industries have started utilising the AR technology. In any case, it has undoubtedly enhanced virtual reality and the incorporation of real-time events in learning through augmented reality and virtual simulation. This article focuses on the topic of AR and assesses user acceptance of the application of augmented reality in the context of learning and training by using the UTAUT Technology Acceptance Model.

Keywords: User Acceptance Model, Augmented Reality, Learning, Training.

1. Introduction

AR can be defined as ‘the use of the virtual world so as to enhance the real world’, and it can either be context-aware, or context-free. In the latter version, the specimen is projected from a mirror through a computer (Angra, Sharma & Sharma, 2022), thereby allowing its users to combine the real-life sensory experiences by their observing of reality through superimposed virtual objects. Indeed, context awareness is only achieved with the aid of computer vision. It is widely acknowledged that both AR and VR play an essential role in the manipulation of real objects. Furthermore, because they are helpful when it comes to making the training process less hectic and time-consuming (Angra, Sharma & Sharma, 2022), these techniques are utilised within training in various fields.

A live, direct, or indirect real-world environment can have computer-generated virtual picture information superimposed over it in real time using the technology known as augmented reality (Baskoro, Amat & Kuswana, 2014). Since individuals intend to encounter a computer-generated virtual environment with VR, AR differs from VR in this regard. In augmented reality, the actual world is expanded with data and images from the system. In other words, AR seamlessly connects the actual and the virtual worlds (Boud et al., 1999).

The earliest technology for augmented reality, which dates back to the 1960s, also supported virtual reality (Caetano et al., 2014). It utilised a head-mounted optical see-through display that was tracked using either an ultrasonic tracker or a mechanical tracker. Only extremely basic wireframe drawings could be rendered in real time at that time due to the computing power limitations (Baskoro, Amat & Kuswana, 2014). Since then, a number of large corporations have used augmented reality for training, visualisation, and other uses. Former Boeing researcher Tom Caudell is credited with coining the phrase ‘augmented reality,’ which is said to have happened around 1990 (Cardoso et al., 2013).

According to some experts, virtual and augmented reality can help students and trainees improve their educational realism-based practices and increase their enthusiasm for learning. Despite extensive research over the past two decades, implementing augmented reality (AR) in 403 learning and training settings remains difficult due to problems with its integration with conventional learning methods, the expenses for developing and maintaining the AR system, and a general aversion to new technologies (Faudzi et al., 2014). AR in education and training is thought to offer a more simplified approach that has a greater appeal to users now that it has the potential to

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draw in and excite learners by allowing them to explore and manipulate content from a variety of various angles that have so far not been considered in real life (Caetano et al., 2014).

By 2023, there will likely be 2.4 billion mobile Augmented Reality users globally, indicating that the AR experience is growing as a notable trend, despite the fact that, in 2015, there were only 200 million users (Caetano et al., 2014). It is impossible to overlook the significant increase in numbers. This article, however, focuses on the use of augmented reality in training and educational settings. Many of us are only aware of Augmented Reality's application on social media platforms, such as Snapchat, and in the case of smartphone apps, like Pokémon Go. However, another key area in which this technology might excel is in education and training (Angra, Sharma & Sharma, 2022).

The remainder of this paper is structured as follows: Section 2 includes a comprehensive overview of AR, including a review of the literature and background information. The proposed and evaluated UTAUT Model is presented in Section 3 with a view to employing augmented reality in education and training. Finally, the summary and conclusion and the possible directions for future study are provided in Section 4.

2. Literature review

Augmented Reality and Virtual Reality employ the same hardware technology and share many characteristics, such as computer-generated virtual scenarios, 3D objects, and interactivity. The primary distinction between them is that, while augmented reality complements the physical world, virtual reality seeks to completely replace it (Blum et al., 2009). Displays, computers, input devices, and tracking equipment are the basic augmented reality hardware components. There are two main types of displays used in augmented reality: see-through and monitor-based (Angra, Sharma & Sharma, 2022). The two forms of see-through displays are optical see-through systems and see-through displays (Han et al., 2022). Displays used on the head or as a component of a helmet are known as head-mounted devices, which feature a tiny optical display in front of either one or both eyes as it is shown in Figure 1 below.

Figure 1. Head-mounted Devices

Whilst AR dates back to the 1960s, its use nonetheless became widespread alongside the widely used technologies of today (Chon & Kim, 2019). It serves to fulfilling real-time interaction, coupled with the 3D reflection of real and virtual objects, both of which, in tandem, make the information more precise and constructive when it comes to solving relevant issues (Angra, Sharma & Sharma, 2022). Indeed, the integration of augmented reality has been witnessed in almost all aspects of life, for example in the context of medical education, such as through students being able to create human body models, which, in turn, contributes to their autonomy, this has also been the case in military training in the form of conflict simulations, and, most importantly, in all types of surgeries by conducting of training on virtual patients (Baskoro, Amat & Kuswana, 2014). As it can be seen here, the incorporation of augmented reality in learning has taken the whole training aspect to a whole new level, with more and more nations acquiring resources to improve employee training in technical skills, multi-step tasks, and during on-boarding. Moreover, it facilitates practical knowledge training, focusing on learning through simulation so as to provide available simulation gadgets (Blum et al., 2009). This is especially valuable for those that require real-time experience in order to boost training.

AR is applicable to a range of different fields, including education, medicine, music, and even imaging, although medicine is the field in which it is most dominant, being particularly used in medical imaging in order to aid users in better understanding the human anatomy and in interpreting the images using an ultrasound simulator (Caetano et al., 2014). The AR provides the trainer with adequate knowledge for after-action review. Furthermore, in order to facilitate medical training and ensure accuracy (whilst also minimising compromise), it adopts augmented reality techniques. In this case, the quality of the main tools determines their proficiency when it comes to increasingly precise transformation and simulations of real-life experiments, and, also the similarity between the virtual world and the real world (Cardoso et al., 2013). There are several uses for augmented reality in education and training, one of which is an app called 'Dinosaur 4D+', which has a series of flashcards that allow users to view 3D dinosaurs by scanning the flashcards, Students may utilize the app's rotation, zooming, and other functions while watching the behaviour of dinosaurs. Additionally, the application offers basic details pertaining to each dinosaur (Hu, Guo & Chen, 2022).

Another example is the Elements 4D AR software, a potential application of augmented reality in education that makes learning chemistry enjoyable. By simply placing two paper cubes in a particular element block, the program allows users to determine the atomic weight, chemical elements, interaction between two chemicals, and their names (Otono et al., 2022). Google Expeditions, which allows users to view 3D things in the classroom including volcanoes, hurricanes, and even DNA, is another remarkable example of AR/VR in education. This program offers more than 100 augmented reality explorations, covering topics like the moon landing and the development of technology (Caetano et al., 2014).

Another example is video-see-through systems, which are handy when seeing things remotely or when employing an image enhancement system (Park et al., 2016). As it can be seen in Figure 2 optical see-through systems mix computer-generated scenarios with a 'through the glasses' representation of the actual world (Han et al., 2022).

Figure 2. Video-see-through systems

2.1. Training and Augmented Reality

AR is very promising with regard to offering potent, on-site learning experiences that are contextually relevant, as well as discovery of the interconnectedness of information in the actual world (Peng et al., 2017). Although less often than traditional learning and training approaches during the past two decades, augmented reality has been experimentally used in both educational and corporate contexts (Nguyen & Meixner, 2019). A number of educational uses for augmented reality technology are also more practical now that the technologies that make them possible are more potent than ever which offer AR experiences to both corporate and academic environments using personal computers and mobile devices. Additionally, wireless mobile devices, such as smart phones, tablet PCs, and other technological advancements, are bringing augmented reality (AR) technology into the mobile sector, where the AR applications hold enormous potential, particularly in learning and teaching (Park et al., 2016).

One possible instance of augmented reality's implementation within training could be that of image stitching of textures in medical training (Caetano et al., 2014); indeed, with the combination of real and virtual object training technology, augmented reality could also be applied different aspects of training. As an example of this, doctors undergo a virtual training session before conducting real-time operations (Caetano et al., 2014), since such a visualisation helps to eliminate errors when conducting real surgery through mapping and object rendering. Having said that, the Medical Fraternity has struggled to eliminate any errors and make demonstrations of surgery as accurate as possible through image registration (Chon & Kim, 2019), which entails information extraction. This involves a significant degree of realism, as objects are being mapped onto a 3D model, and yet it has sometimes been seen to fail in the medical realm as a result of colour techniques being insufficiently effective in illustrating an image detail (Han et al., 2022). Moreover, AR is utilised when carrying out digestive surgeries, since it aids in the visualisation of the digestive system - something that is particularly necessary, since the digestive system is one of the most complex systems requiring surgery. Indeed, augmented reality keeps on growing in popularity as more people show interest in learning about it (De Andrade et al., 2022). This is likely fuelled by the fact that it has facilitated visualisation in 3D medical imaging, as well as the navigation through patients' anatomy. Indeed, when it comes to clearly understanding the embedment of organs, surgeons are likely to be more accurate after conducting such pre-procedures (Faudzi et al., 2014).

While allowing surgeons to better visualize a patient`s, the fusion of the real and virtual anatomy system, followed by minimal manipulation, improves sight lines (Faudzi et al., 2014). The focus shifts from medicine to a different field, modern architecture, AR technology has been repeatedly used when it comes to reconstruction in China, a classic example being the reconstruction of the famous Yuanminyuan garden that was looted decades ago (Peng et al., 2017). Its reconstruction process was significant for Chinese history, and this was aided by the use of augmented reality. Indeed, such a technology is also used to train architects to complete even the most challenging of reconstructions (Chon & Kim, 2019).

Furthermore, AR can be used to develop interaction and orientation methods in welding simulation, such as when it comes to the retention angles, or the interaction between the plate, so as to ensure that the students improve their competence in this area (Hu, Guo & Chen, 2022). Moreover, the use of cameras and visualisation techniques has aided students in the calibration processes, thus enhancing accuracy (Han et al., 2022). Disaster recovery is also an area where augmented reality has aided in, since this can help in successful evacuations: here, residents can receive real-time information concerning the impending disaster, which improves crisis awareness and to that, citizen response (Zhang et al., 2022).

Another crucial aspect of augmented reality is its role in military training systems, since they are known to use algorithms whereby a monocular camera defines trajectories and ascertains a given shooting range. Indeed, such technology helps a given military training system in visualising situations that are likely to occur in real life, thus increasing its proficiency in this area, by pinpointing the improvements soldiers need to make before facing conflict by using their performance analysis algorithm and comparing it with the DGPS (Angra, Sharma & Sharma, 2022). Although the system was not fully embraced for extensive and intensive training, it has certainly seen successful events for the small number of activities it has been integrated with - and, indeed, it is likely to see more integration in the coming years (Nguyen & Meixner, 2019). Additionally, during the training of engineering students, augmented reality is frequently used within physics laboratories - something that is especially handy when it comes to understanding the structure of laboratory machines and the process of working on them. This, of course, serves to increase their competency and enables them to grasp the material they are learning with less difficulty (Kaviyaraj & Uma, 2022).

Many experts and academics have been creating practical ideas and applications for the integration of AR into both academic and corporate contexts over the past few decades (Zhang et al., 2022). These investigations led to the creation of various AR technologies that are now being utilised to improve the effectiveness of training and learning for both students and workers. In addition, several researches are being conducted to enhance the compatibility of augmented reality with education and training criteria and practicality of augmented reality (Park et al., 2016). However, there remain many unsolved problems regarding its application in education and training, including cost effectiveness and the effectiveness of AR educational systems in comparison with more traditional approaches (Pretto et al., 2008).

Augmented reality tools for universities can be highly beneficial for students who wish to pursue technical or humanitarian disciplines (Zhang et al., 2022). With an AR program that simulates the human body from the inside out, for instance, medical students may learn anatomy and practice doing physical examinations (Peng et al., 2017). In addition, several colleges are employing augmented reality to teach students about astronomy, engineering, arithmetic, and many other subjects (Peng et al., 2017). Additionally, augmented reality for pupils improves the safety and engagement in the learning process (Zhang et al., 2022). The use of technology makes it possible to perform experiments like combining various chemicals to observe what happens without endangering the wellbeing of the students or damaging university property (Tokuyasu et al., 2014).

According to different studies, AR-assisted training increased General Electric workers' job productivity by 34% and by 46% in the case of GE Healthcare (Si et al., 2018). To understand the body’s anatomy and structure, AR is employed. Additionally, The Specialist Schools and Academies Trust (SSAT) showed how instructors may utilise augmented reality technology to depict what human organs are made of and how they look by using 3D computer-generated models in actual classroom settings (Si et al., 2018). Additionally, with the use of camera-equipped laptops and AR markers that link PCs with AR data on the biological features of the human body, students may be able to study human organs on their own (Wang et al., 2019). Entry-level experts and those changing jobs can quickly pick up skills and knowledge by using augmented reality training (Otono et al., 2022). For instance, it will enable them to gain a thorough understanding of the theory and working environment without endangering the company or the employees’ health. For instance, training in AR logistics aids in both staff organisation and training (Yechkalo et al., 2019).

2.2. The advantages and disadvantages of Augmented Reality

Augmented Reality is widely considered to be one of the greatest recent technological breakthroughs, particularly when it comes to the resolution of technical operations (Nguyen & Meixner, 2019), (McVeigh-Schultz & Isbister, 2022). It combines the virtual and the actual reality by modifying machines to transfer knowledge related to the different processes. Furthermore, in an era where high-performance and low-cost hardware is most desired, it certainly fulfils the population’s current wants (Nguyen & Meixner, 2019). Hence, the integration of augmented reality has been witnessed in different gadgets, such as mobile devices, which are integrated with gyroscopes and computers and other forms of global sensors, which, in their turn, help in entertainment and navigation (Otono et al., 2022).

Another great advantage of AR is its inherent flexibility – something that is particularly valuable in the maintenance industry. It is applicable to the automobile and aviation industries since they constantly require up-to-date technology to discern their ever-changing complexities (Park et al., 2016). Furthermore, another advantage of augmented reality is that it promotes interactive learning, and it serves as a motivation for learning in and of itself. It also provides pre-leaning instructional materials while conducting different research studies, thereby motivating educators to construct their knowledge through integration with technology and to disseminate it to others through the AR technology (Han et al., 2022).

Since educational institutions frequently lack current teaching resources, many students are forced to acquire out-of-date knowledge or do independent research at home. Augmented reality in education facilitates access to learning materials (Huang, Liu & Wang, 2009). AR apps download the newest data and show it interactively. Furthermore, adopting AR enables access to virtual tools. An augmented reality application can display the appropriate 3D model and useful explanations in situations when it is important to investigate a specific equipment and learn how to utilise it (Wei, Nahavandi & Weisinger, 2013).

This makes the content of conventional learning materials more useful. Moreover, as students learn a topic more thoroughly through immersion, which increases the feeling of reality and relevance, AR helps to increase student engagement (Umeda et al., 2017). Many people find this to be an exhilarating experience and a significant change of pace (Wang et al., 2019). Also, AR encourages safer behaviour. Students no longer need to dissect live animals for studies on their anatomy because this can be precisely replicated by software. Students receive the same amount of experience without causing any damage or using potentially hazardous equipment (Venkatesh & Bala, 2008). Additionally, AR supports quicker learning by shortening the overall learning period. There is therefore more time for practice and in-depth analysis of specialised areas (Nguyen & Meixner, 2019). Using these learning tools has advantages, but they also have certain drawbacks. The biggest drawback is that older phone models and those running OS versions that do not enable immersion cannot run AR applications (Zhang et al., 2022). The purchase of smartphones or smart glasses may be out of the question because schools are not often recognised as having the most cutting-edge technological equipment. In addition, some instructors may not embrace or even understand how to use current technology, which results in a dearth of tech experience amongst teachers (Si et al., 2018). When the instructor is required to demonstrate how a certain gadget functions and assist pupils in case of problems, this might be an issue. Moreover, the implementation of AR depends on the incurred costs; additionally, due to its technologically advanced nature, its improvements might take quite some time to adjust to (Baskoro, Amat & Kuswana, 2014).

Overall, there are many more advantages for employing augmented reality applications for education than drawbacks (Umeda et al., 2017), (Yechkalo et al., 2019). Additionally, the aforementioned difficulties may be easily overcome.

3. The proposed model for Augmented Reality in training and education

AR is considered to be the future of learning at the workplace, with the coming generation recognised as likely to deliver nearly all education through AR. Activities such as data creation will become abundant within classrooms (Peng et al., 2017), with adopted technology being able to make the jobs more comfortable, efficient, and quicker. Furthermore, workplace models are likely to be operated via graphic files for visualisation in the coming years, and, based on current trends, the future of AR is overall promising (Pretto et al., 2008). The medical field has seen the most dramatic increase in the use of AR, witnessing the possibility of oscinine endovascular surgeries being conducted and more workable conditions for upcoming surgeries (Angra, Sharma & Sharma, 2022).

The elements at play in aiding one's understanding of the degree of anticipated acceptance for a given new piece of technology make up one factor which largely determines the technology's ultimate success, just like the amount of positive reviews/income garnered for it. Hence, this section analyzes the building of a reliable framework that could determine to what extent the acceptance of the use of augmented reality in training can be explained, comprehended, and forecast?

Notably, the UTAUT model (Tokuyasu et al., 2014), which was created via the merging and testing of a variety of other models within four separate business IT system (two voluntary, two mandatory) (i.e. The Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), Social Cognitive Theory (SCT), The Theory of Reasoned Action (TRA), Decomposed Theory of Planned Behaviour (DTPB), and Diffusion of Innovation (DOI) Theory) in light of ICT use, has not been widely utilised within many studies exploring the implementation of different systems which tended to focus on adopting other technology acceptance models. Furthermore, Unified Theory of Acceptance and Use of Technology (UTAUT), which was built by Venkatesh, had to have its constituent frameworks (i.e. those cited above) examined with regard to their efficiency and reliability during three different time slots: directly after training, one month post-training, and three months post-training (Nian et al., 2023).

When it comes to establishing what user behaviour and degree of acceptance is at play here, the factors effort expectancy, facilitating conditions, performance expectancy, and social influence are most influential, although there are also various other factors that could be taken into account when assessing the expected degree of acceptance of a given technology (Tokuyasu et al., 2014).

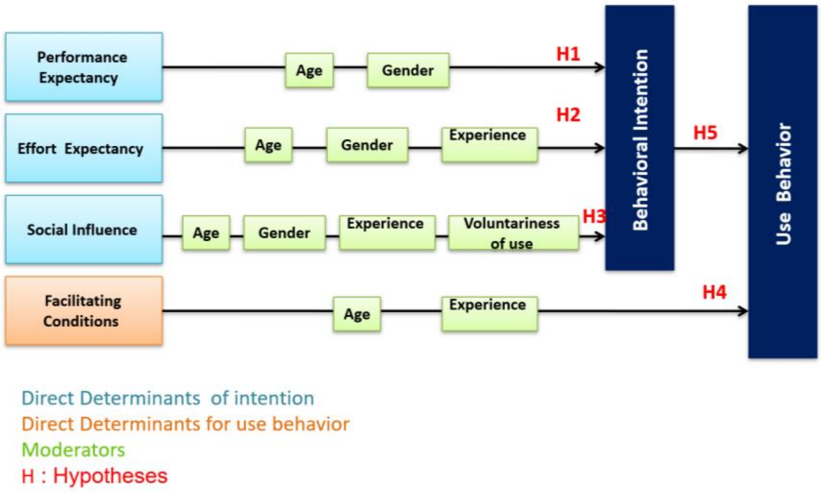

Figure 3. Theoretical framework of hypotheses. UTAUT model

In a similar vein, experience, age, voluntariness, and gender are four other factors that moderate this (Tokuyasu et al., 2014), facilitating conditions and behavioural intentions being widely acknowledged as the elements that influence behaviours linked with AR implementation. Furthermore, as it is shown in Figure 3, there is a clear causal relationship between social influence, performance expectancy and effort expectancy - the influencers of behavioural intention. Anxiety, attitudes towards technology, and self-efficacy are notably some factors that, whilst essential in ensuring technology acceptance, are not determined as direct causes of intention (Tokuyasu et al., 2014). Furthermore, when it comes to the factors discussed above, it is necessary to acknowledge the fact that these factors and their links with each other are moderated within the framework, which indicates the opportunity to analyse these factors separately within the context of ICT.

With the above in mind, this paper, in the context of the implementation of augmented reality, aims to assess the ways in which Internet technology and computers are impacted on by the factors of age and gender. Indeed, the UTAUT constructs can be defined as follows (Pardamean & Susanto, 2012), (Si et al., 2018), (Tokuyasu et al., 2014).

Effort expectancy is acknowledged to be essential when it comes to assessing how much effort is needed to be exerted for technology implementation, and is defined by Venkatesh & Bala (2008) as the lack of complexity linked with the system's implementation. Further on, social influence comprises internalisation (genuinely changing one's own beliefs), identification (responding to possible increases in social status), and compliance (simply responding to social pressure) (Tokuyasu et al., 2014), and encapsulates the idea that user behaviour largely sways according to how people believe, they will be perceived by others - and, thus, in this context, the extent to which they feel they are obliged to accept the novel system. Next, performance expectancy could be acknowledged as one of the most influential factors at play here, considering that the implementer will always want to evaluate the possible benefits of such an implementation before carrying it out. Notably, Venkatesh & Bala (2008) defines performance expectancy as the extent to which a person believes a system's implementation will benefit him in enhancing his job performance. Finally, the facilitating conditions factor is defined as the extent to which a person believes the system's infrastructure has been introduced for the key purpose of making the system itself reliable for use (Tokuyasu et al., 2014).

This paper aims to assess the impact age and gender has on Internet technology and computers in the particular context of augmented reality implementation in light of the fact that the

UTAUT model has been built so as to involve the age, voluntariness of use, gender, and experience moderators Venkatesh & Bala (2008) (Figure 3). In an attempt to move this analysis forward, a list of hypotheses have been formulated:

- H1: There is a positive relationship between behavioural intention and effort expectancy when it comes to university students' augmented reality implementation;
- H2: There is a positive relationship between behavioural intention and performance expectancy when it comes to university students' augmented reality implementation;
- H3: There is a positive relationship between behavioural intention and social influence conditions when it comes to university students' augmented reality implementation;
- H4: There is a significant relationship between the students` usage behaviour and the facilitating conditions involved in augmented reality implementation;
- H5: There is a significant relationship between the students` usage behaviour and the behavioural intentions behind augmented reality implementation.

Within this analysis, the online questionnaire of Venkatesh & Bala (2008) as provided to a sample of students from the King Abdulaziz University College of Sciences in Saudi Arabia, querying them about their experience with some of the variations of augmented reality implementation (i.e. element 4D1, anatomy 4D2, and animal 4D3), and the AMOS 20 statistical software was particularly utilised in order to weigh up the validity of the measurement tool used (SPSS), as well as the validity of the construct itself (Tokuyasu et al., 2014). Notably, 68% of the students in the framework of this study had no experience in using augmented reality applications, while 15.6% stated they used it a weekly basis and 12% stated they used itdaily. Furthermore, 23% of the participants were male, and the overwhelming majority of 77% were female participants, with 4.4% of these individuals stating they used this application monthly. In the first half of the survey a seven-point Likert scale (with items ranging from strongly agree to strongly disagree) was provided to students in order for them to answer the questions in the questionnaire. A total of 200 questions were included, and 132 of them were answered. This means a 66% average response rate, and the results of the study indicate a non-preferable lack of utilisation of augmented reality applications within the current generation of students at the above-mentioned Saudi university.

Table 1 illustrates the UTAUT framework's descriptive statistics; indeed, it suggests that the vast majority of the students involved in the survey either somewhat agreed or moderately agreed with the statements provided, since most of the mean values for performance expectancy, effort expectancy, and social influence range between five and six.

Table 1. Demonstration of the UTAUT framework's descriptive statistics

Descriptive Statistics		
Indicator	**Mean value**	**Std. Deviation**
pe1: I found that my study benefited from the introduced AR applications.	6.2	1.91
pe3: I found that I was more productive when utilising the introduced AR applications.	5.9	1.84
pe4: I found my chances of getting a good grade were enhanced when using the introduced AR application.	5.7	1.73
ee1: I found my interaction with the AR applications to be very clear and understandable.	5.6	1.84
ee2: I found the use of AR applications easy.	5.4	1.73
ee3: I found using the provided AR applications easy.	5.5	1.78
ee4: I found it easy to use the provided AR applications.	5.4	1.75
si3: I found that when it came to using the AR applications, my professors were helpful.	4.9	1.65
si4: The People who are important to me believe my using AR applications would be beneficial.	5.6	1.85
fc1: I have the required resources to use the AR applications.	5.8	1.83
fc4: I found that when I encountered problems with using the AR applications, someone was able to help.	4.9	1.63

bi1: I plan to use the AR applications I used here in my next semester.	4.8	1.66
bi2: I forecast that I will use the AR applications provided here in my next semester.	6.1	1.92
bi3: I plan to use the AR applications I used here in my next semester.	6.2	2.01
use2: When learning in class, I tend to use the AR applications provided.	4.9	1.64
use3: When it comes to accessing personal materials, I tend to use the AR applications provided.	5.1	1.79

Table 2 includes a summary of the links identified between performance expectancy (PE), facilitating conditions (FC), effort expectancy (EE), social influence (SI), Usage Behaviour (UB) and Behavioural Intention (BI). Indeed, the results of the survey have clearly shown that, when this is required and when such amenities are available, university students will essentially always accept and use any augmented reality applications for their education; this was indicated by the clear significant relationship between BI and effort expectancy. Hence, in light of such results, it can be concluded that universities should prioritise teaching their students about the practical uses of the provided AR software.

Table 2. Summary of the links of the UTAUT framework

Hypotheses	Path			Estimate	Standard Error	Composite Reliability	Proba bility value
H1	Behavioural Intention	⇐	Effort Expectancy	0.457	0.17	2.31	0.015
H2	Behavioural Intention	⇐	Performance Expectancy	0.187	0.148	1.346	0.162
H3	Behavioural Intention	⇐	Social Influence	- 0.031	0.091	- 0,42	0.781
H4	Usage Behaviour	⇐	Facilitating Conditions	0.272	0.089	2.74	0.003
H5	Usage Behaviour	⇐	Behavioural Intentions	0.115	0.084	1.37	0.199

4. Summary and conclusion

AR has triggered a vast improvement in technology advancement as more technological tactics are being created to improve the current ones; however, there are some serious shortcomings of AR that have sometimes jeopardised its application in the industrial environment, especially when it comes to employing AR for conducting various operations. Indeed, such flaws have hinderedits spread throughout the industrial realm. Nevertheless, with the increase in AR technologies and techniques, an improvement in neurosurgery training has been witnessed. Indeed, neurosurgeons seek the guidance of technology, coupled with imagine modality and spatial relationships, in order to enhance their operational efficiency and further improve their precision, and so AR is the perfect companion to meet this need.

This analysis clearly identifies the fact that there is a significant positive relationship between BI and performance expectancy, effort expectancy, and social influence in the context of using augmented reality within universities; meanwhile, it was noted that BI and facilitating conditions have a significant relationship in this area, and that facilitating conditions and effort expectancy could successfully forecast the utilization of these applications. As it can be seen, from the above, the model presented by Ventakesh (Tokuyasu et al., 2014) aided this analysis by fulfilling its aim of gaining a further understanding of students' attitudes towards augmented reality implementation. Indeed, the analysis also reached the conclusion that, when university administrators guarantee user-friendliness in AR use, students will be far more likely to integrate such applications into their classroom and independent learning. Notably, one drawback of this analysis is the limited scope of the sample used, since it only focused on students from one university; hence, the researchers advise that any future studies conducted within this field should use a sample with a wider scope so as to account for the differences between several environments and the impacts they could have on the obtained results.

AR has gained significant momentum in the education business over the last decade. The advancements that are being implemented into the EdTech sector will be extremely beneficial for the next generation. The calculations predict that the AR industry will be valued at $6,139 billion by 2023. With the aid of AR, the education and training sector is able to take a fresh approach to the learning process, facilitating information acquisition through deep learning. Additionally, it enhances the analytical and critical thinking skills of professionals and students, piquing their interest in AR. It gives the students a memorable experience that is vital for their success.

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Sara Jeza ALOTAIBI is Deputy General Manager for Business Development and Partnerships and General Supervisor of the Gender Balance Center within the Institute of Public Administration in Riyadh, Saudi Arabia. She is the author of a high number of published papers and three books in the field of IT and public administration arena, and is a driven, motivated young woman focused on education, self-development, professionalism and, above all, on making a difference while teaching others how to do the same.