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**Research Article**

# The Effectiveness of Implementing Augmented Reality (AR) in E-Training to Enhance Trainees' Performance and Achievements

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**ABSTRACT**

The innovation and applications of Augmented reality (AR) in the education and training sector have risen. The AR technology provides a view of the actual universe while coordinating with the simulated objects and the powerful tools, increasing trainees' performance and motivation. This paper examined trainees' performance after adopting AR in the e-training. These trainees enrolled in a First-Aid training course offered online during the pandemic by the Saudi Red Crescent Authority (SRCA), which cognates the structure of the human body, assimilating AR with various studying modes. Results have been analyzed and investigated to find the effectiveness of AR in a learning environment against a traditional learning environment. The finding showed that the trainees in the experimental group with the AR technology attained a more excellent score than the trainees from the control group. The experimental group had a significantly higher mean (M= 87, SD = 1.87) than the trainees who were in the control group (M= 77, SD = 1.78). Moreover, trainees showed positive perceptions toward adopting AR in the e-training. Those who had AR in training for the first time were excited and wanted to have the same experiment again in other courses to develop their skills.

**Keywords:** Augmented Reality (AR); learning performances; interactive environment; enhance trainees.

## Introduction

Usually, the traditional methods of studying health education, understanding human bodies, and learning about the human body are attained by attending lectures. Publishing books or creating videos used in learning the human body published pictures of two dimensions with an allegorical interpretation that cannot give the required information in traditional learning.

Further, shifting to e-learning during the pandemic makes learning more difficult. Training becomes hypothetical and hard to facilitate trainees in studying the other complicated body parts of the human being and remembering the topics in a different learning approach (Fenrich, 2006). However, in the asynchronous online training, the didactic lessons about the human body did not attract the trainees, and they could not develop enduring know-how. However, understanding the structure of the human body is not restricted to raising the skills of the health trainee. It enhances the promotion of healthy habits that can establish a positive attitude in their health science skills.

In this study, I work to adopt AR to reinforce the training process and offer an interactive environment for trainees. Besides, trainees can maintain a resilient understanding by conducting experiments and shifting the perception to an enduring memory. In recent years, the innovation, and applications of Augmented reality (AR) in the education and training sectors have been seen rising slowly. The AR technology provides a view of the actual universe while coordinating with the simulated objects and the powerful tools, too, which increases the trainees' performance and motivation.

AR establishes the reality that mechanization can escalate the perception of facts and give out chances of coexisting computerized data. It has been known to be a technology with the most promising and influencing

learning activities. Augmented reality technology combines digital data with natural environments, unlike virtual reality (VR), which uses full artificial environments. The natural environment is then enhanced with digital data to expand the quantity of information a person can absorb from their surroundings (Curcio et al., 2017).

Trainees freely navigate in a replicated environment, commemorate the aspects from various contexts, and mesh up with the chosen computer-generated purpose. The AR can provide visualization and interaction that have been used successfully to enhance spatial abilities and assist the trainees in perceiving the theoretical aspects (Demir, 2016).

An exciting and intriguing learning tool, augmented reality (AR) technology can be beneficial when used in conjunction with conventional approaches. The research focuses on developing more reliable teaching scenarios and assessing the system's performance and learning scenarios through in-depth user studies using AR (Liarokapis & Anderson, 2010).

Bacca et al. (2014) stated that most of the researchers in their studies have suggested that AR has benefited students' discovery and grasping of complex topics, like the body of human beings. It allows the coexistence of computerized information that is not further with the natural environment, minimizing the emotional capacity and promoting trainees' discovery process.

AR in learning is more interesting than traditional learning, which applies to e-learning, making trainees more active in discovering and influencing learning experiences. This paper looks at how AR creates an expressive discovering environment that gives students opportunities for great recognition of the human body's three-dimension (3D) structure with empirical uphold. Trainees can quickly view every internal organ of the human being at various angles in an expressive 3D mode (Ganguly, 2010).

Moreover, AR in health education is still beginning; hence, few studies explain students' discovery styles in preference for using AR in their learning activities. This paper's primary goal is to analyze AR's application in education and examine its effects on students' performance.

## Literature review

AR is a tool that gives a chance to digitalize implicit conceptions of information. It incorporates the actual reality with simulated objects, affirming association and displaying a three-dimension (3D) item (Shaw, 2016). Different computer-generated things are used in AR: quotations, statues, recorded video clips, tone, models of 3D, and animations. These computer-generated objects will be observed as existing together in real-world conditions. The AR model can be perceived with different instruments, such as a transparent head-mounted display (HMD), PCs, computers, and even smartphones with a single camera. AR has three features. Namely, it relates actual and simulated intent in the natural environment through actual and simulated objects and utilizes real-time and interactively (Rasimah, 2012).

The alertness given to AR through the rising applications in education by delivering interesting properties like involvement, contact, and operations is anticipated to enhance the trainees' satisfaction and comprehension knowledge. AR's development and use have strengthened the trainees to understand science field that involves microbiology, biomedical science, and natural science. AR has enhanced trainees to explore and engage with existing tools that students wish to analyze and extend the best chances of discovering by exploiting things across the substantial shifts in the affluent perceptible spatial context. Studies have suggested that mesmerizing and dependent competence nourishes the trainees' motivation and engagement and is potentially significant in discovering activities where experimentation is required. AR's main pedagogical element is the proficiency of rescaling the simulated objects, enabling trainees to understand better the manipulations of the features and association of things, which would be hard to examine its effectiveness. Trainees can perform the verification in more collective and sensible ways and implement the ability and prowess discovered in the classroom (Tarng & Ou, 2012).

### *Discovery/learning mode*

Learning mode is the discovery preference of an individual in perceiving information in any studying environment. Learning mode is a particular pattern of habits depending on the advances in the personal experience of learning. Learning is all about consistency and enduring tendencies. There are situations where learning mode can be initiated to trainees' variations with different needs. Getting to know the preferred learning mode is vital in designing a suitable environment for learning technology.

In the education sector, recognizing the style used in learning is significant for trainees and teachers. The instruction designers need to consider the trainee’s types of learning when drafting various syllabi and the material for attaining students' utmost state of knowledge. Trainees can also understand the discovering mode preferences that aid them in intensifying their acquired skills and positively influence their academic achievements (Yen et al., 2013).

Various learning modes have theories that were suggested in multiple studies. This studying style was chosen among the different learning modes because it was mainly initiated for trainees and developed a reliable and valid education set. This mode grouped trainees into two main learning groups: experimental and control groups.

The contemplative method assigns a processing dimension, the perspective dimension is established, and the intuitive mode, the input measurement, is verbal and visual. In contrast, the understanding dimension is determined by sequential and global learning methods. AR technology's growth influences the learning style in this modernized active discovering environment, which is still in the early stages (Wu et al., 2013).
Every study design of the trainees may be different, either less or more, hence getting the unique learning design for trainees to enhance learning efficiency, which is prioritized for teachers to teach trainees effectively. The trainees' achievements are easily increased when teaching methods align with their studying styles, from childhood to adult classes.
AR has been much appreciated as a new technology that can provide the potential of learning science because it renders new techniques of both tactile and visual interactions that can be crucial in improving the learning results/outcome.
Approval of AR is slowly being enacted to enhance ancient studying instruments in learning environments. The spatial abilities in science have been boosted using the properties of visualizations of AR. It cannot be concluded that the increased use of technology in learning can improve all students' positive attitudes and performance despite having various behaviours. In addition, insufficient research aims to examine the styles of knowledge and the learning achievements in the education sector with the help of the AR environment (Moro et al., 2017).

### *Application of AR in education*

AR technology gives out a new method of interaction with the actual surroundings and creates the involvement that could only be possible in a complete real world. It has a specific ability to establish immersive hybrid learning environments and use actual and simulated objects. It enhances the students to experience the impossible scientific phenomena in the real world. The experimentations of simulated tools with the observed events, which are hard to be observed in the actual universe, can be hastened with AR technology. This studying style encourages students' realization prowess and raises their theoretical understanding of events that cannot be seen or are not easy to recognize and rectify any misconceptions. AR technology deals with dis-covering issues, mainly experienced with visualizing the unobserved phenomena.
With the developing technology, the trainees can develop and learn new skills acquired by AR technology. Immersion and interactive learning styles can motivate trainees to indulge in discovering events, which may increase the encouragement of the trainees. Highly interactive experiences can establish authentic students' learning activities and influence realism's great point. The association with the universe is vital in learning, and besides the actuality, AR is among the best technique to facilitate such interactions. Also, those who want to apply AR in education correctly must follow these five main instructions (Garzón et al., 2019):
(1) When designing AR systems, we should ensure that this system fits trainees' characteristics and needs.
(2) Should integrate AR systems into previously unexplored fields of education.
(3) Integrating AR systems into the learning processes of new focus groups.
(4) Integration of AR technologies is recommended for all education systems, and it is helpful to make other systems more practical such as business and industry.
(5) Designing the AR environment by following Instructional Design Models to offer an effective pedagogical environment.

## Methods

### *Aim of the research analysis*

This paper focuses on examining the medical training careers of the human body's structure in an e-learning and the effect of adopting AR in the e-training, discovering surroundings compared with the ancient learning environment associated with the learning modes of each trainee. There is no statistically significant difference between experimental and control groups learning the First-Aid courses.

### *Research questions*

(1) Are there statistically significant differences between trainees' achievements toward using AR in the E-Training during the Coronavirus Pandemic?
(2) What are the trainees' perceptions of Adopt Augmented Reality (AR) in the E-Training During the Coronavirus Pandemic?

### *Experimental design*

According to the closing of traditional learning and shifting to distance learning based on the Coronavirus pandemic (COVID-19), some learning topics faced critical issues in teaching, and practical subjects, such as medical and First-Aid training courses, completed the training parts.
Saudi Red Crescent Authority (SRCA) is an authority that provides emergency medical services and training programs to all people in the community and those who want to volunteer, which is the parallel authority to the Red Cross Authority in other countries.
SRCA offers many face-to-face training programs. These training courses were classed when the pandemic started because more was needed. For that, SRCA started to provide online courses and live broadcasting to

cover the needs through training on a website called Muta'aheb. Muta'aheb is an Arabic word that means a prepared person.
This website is open to all who want to join the training courses, it offers free and paid training workshops with three options; in class (which were closed in the pandemic), online, and live. To join the website and enroll in its training course, register with national ID numbers through its link: https://mutaaheb.srca.org.sa/Home/Index, see appendix A.
Muta'aheb offers three categories of courses: Basic Life Support, Life Ambassador First-Aid program, and Interactive Online Courses; see appendix B. However, the two options, online and live broadcasting, focus on synchronous and asynchronous presentation, which could not ensure getting the skills could ideally and need to provide more tools to make it clear.
This article analyzed the benefit of adopting AR technology in e-training courses to ascertain a dependent learning environment. Also, to enable trainees to see presentations in the lectures to apprehend the 3D structure of the lesson during learning about a human body with viewable support through the application adopted in the training process.
This application allows trainees to study human anatomy in a 3D manner that facilitates identifying the details of the body systems and any organ in this system to be placed in an easy, interactive, and more in-depth way. They were getting the internal organs of the human body and techniques from various points in connected 3D models. Trainees were asked to download the application anatomy 3D atlas; see appendix A, on their smartphones through their phones' store or open the application's website through https://anatomy3datlas.com, then download the application on their smartphones or their computers. Anatomy 3D atlas is an application available on iOS, Android, macOS, and Windows 10. This application allows trainees to study human anatomy in a 3D manner that facilitates identifying the details of the body systems and any organ in this system to be placed in an easy, interactive, and more in-depth way.

### *Processes*

The research focused on life ambassador first-aid program training courses, which focused on medical training considering the structure of the human body. In the beginning, two training groups assigned to take the course in the Saudi Red Crescent Authority in Tabuk were chosen randomly and signed into the same online training. These groups were named experimental and controller groups; then, trainees in the groups took a pre-test about Musculoskeletal, Cardiovascular, Respiratory, and Digestive. Also, how to deal with emergency cases to check their prior knowledge; this test is an evaluation offered by SRCA to evaluate the trainees' knowledge after finishing the training course. I used it as a pre-test and post-test in both groups. After that, both groups trained online with the original training content offered by the Saudi Red Crescent via Muta'aheb.
In addition, the experimental group trained through AR environments plus the traditional online course, AR examples, and educational kits. The trainees used the application to view muscle anatomy and the anatomy of arteries and blood vessels; see appendix C.
In addition, trainees were asked to spend more time figuring out more about the human system through the Anatomy 3D atlas, which provided 3D access to pictures after attending the course.
Instead, the control group was given lectures and recorded presentations online in Muta'aheb. After a month, trainees completed all the learning courses in a life ambassador first-aid program. All the trainees were exposed to the post-test at the end of the training. Trainees in the experimental group after finished the course were asked to provide their perceptions of using AR through three open questions sent to them after the course finished. two questions, which are:
(1) Did you have difficulties dealing with and using AR during the course? Describe your activity and learning in this course with AR.
(2) Do you prefer to add AR in all coming courses, or is it unnecessary and over your ability?

## Results

This study was designed to determine the effect of adopting AR on the trainees' achievements and performance during the e-training and review their perceptions of using AR. The study has two research questions asked in this study; in this section, the findings are appaired and discussed.
*To answer the first question, are there statistically significant differences between trainees' achievements toward using AR in the E-Training during the Coronavirus Pandemic?*
The study evaluated the difference between the two learning environments; these environments take the same online course, but the experimental group associated with implementing AR technology with the online course. Instead, the control group was taught the only online course available on the website, Muta'aheb, using presentations. Before starting the study, A pre-test was applied to find the homogeneity between the two groups. After using the pre-test, the finding showed no significant difference between the two groups, and the difference appeared insignificant, meaning the two groups were homogeneous. The experimental group average was 59, and the control group was 58, see table 1.

**Table 1.** Results of the pre-test.

| | N | Mean | SD | df | T | Sig. |
|---|---|---|---|---|---|---|
| Control Group Without using AR | 20 | 58 | 1.80 | 64 | .27 | .79 |
| Experimental Group With using AR | 20 | 59 | 1.83 | | | |

Hence, after that, trainers in the experimental group used the presentation on Muta'aheb and saw the additional educational kits that used AR technologies through Anatomy 3D Atlas. The control group was trained through the Muta'aheb website. A post-test was applied at the end of the courses to measure the trainees' performance and achieve the training course outcomes. The results showed a difference in the post-test between the mean test scores of trainees from both groups; this difference was statistically significant at $\alpha \leq 0.05$. Therefore, the answer to this question includes the statistically significant differences between the experimental group and the control group; this difference is positively attributed to the benefit of the experimental group, as presented in table 2.

**Table 2.** Results of the post-test

| | N | Mean | SD | df | T | Sig. |
|---|---|---|---|---|---|---|
| Control Group Without using AR | 20 | 77 | 1.78 | 64 | 7.28 | .00* |
| Experimental Group With using AR | 20 | 87 | 1.87 | | | |

* $\alpha \leq 0.05$

*In addition, to answer the second question, what are the trainees' perceptions of adopting AR in the e-training during the coronavirus pandemic?*

Trainees in the experimental group in this study were asked to provide their perceptions of using AR through two open questions sent to them after the course finished. These questions are:

(1) Did you have difficulties dealing with and using AR during the course? Describe your activity and learning in this course with AR.

Participants were divided into three groups based on their answers to this question. The first group was the biggest, representing 85% of the participants; they were satisfied with AR and could use it effectively. They wrote that they never had any difficulties and reported that they became more active and cooperative with the application. One of the participants wrote, “this is the third time to take a course with SRCA; the first one was face-to-face before the pandemic and offers training on the body model. The second time was fully online during the pandemic and before this course, and we could not have the ability to practice. However, in this course, the AR clips help me to understand the anatomy as I am in the class and give me the ability to review and rewatch the clips as much as I need.” another participant wrote, “I felt that I saw actual anatomy using AR in this course.” Also, one of them wrote, “I had used AR technology in games and could seal with it easily and supported my understanding of the course perfectly.” Another participant wrote, “AR technology helped me to understand the course easily.”

This group directly mentioned the positive perceptions and benefits of adopting AR technologies. They clearly understood the human anatomy they learned in the course, and these positive perceptions indicate the use and adoption of AR in the e-training.

The second group had participants who faced difficulties using the AR at the begging of the course, equal to 10% of the participants. The first participant in this group wrote, “I used AR for the first time; in the beginning, I was afraid of falling and could not understand how to deal with it, but with the use of AR became excited and wanted to repeat the same experiment.” And another one wrote, “I heard about AR technology, my kids use it in their games, but I did not think it could use for learning. I thought it was a gaming technology, so when I heard about it in this course, I felt disappointed, but after I used it, I found the great benefit of adopting AR in training and learning. This group has two participants. These participants did not have difficulties using AR, but they had different perceptions based on their prior knowledge or fear of using new technology. However, they feel comfortable, excited, and satisfied using it during the course. That means they had no difficulties using AR.

The last group represented 5% of the participants in the experimental group, and it had only one participant; this participant reported he had an issue using AR because he did not have a smartphone, but he stated that “I do not have a smartphone, but I started using my son’s phone to attend the AR practicing. Sometimes my son is not able to give his phone. I could not practice except until his son’s phone be available.”

(2) Do you prefer to add AR in all coming courses, or is it unnecessary and over your ability?

Participants were asked if they preferred to take the courses with AR technology, and all of them reported they would enroll in all coming courses that adopted AR. They gather all the benefits of adopting AR in learning and training to develop their skills. One of them wrote, "I wish to adopt the AR technology in all courses that are available online, so we could feel the details and understand deeply." The most impressive comments were, "I did not think this technology could be helpful and it is only for gaming, but after I used it, I been shocked, and at the same time disappointed of why it is not used in the education as well as all training courses."

Another participant wrote, "these technologies help me for deep understanding, and it is a common technology used with our kids in their games, it is important to adopt it in all their education to make it more effective."

## Discussion and Conclusions

This analysis focused on examining the academic knowledge of trainees in the course in both groups being taught with AR. After taking the courses, the results showed a value improvement in their understanding with improving means. In the control group, the mean score was 58 and raised to 77, and the mean score in the experimental group was 59, then rose to 87, which is a logical result of learning new knowledge, but this improvement differed between the groups. This differs compared to adopting AR technology in the teaching process for the experimental group with a significantly higher mean (M= 87, SD = 1.87) than the trainees in the control group (M= 77, SD = 1.78). This finding agreed with other results of the preceding researchers that also indicated the positive impacts of AR technology in improving the achievements of trainees and their motivation compared to the traditional learning environment (Alzahrani, 2020; AlNajdi et al., 2020; Cheng, 2016; Ersozlu et al., 2019; Garzón et al., 2019; Khan at al., 2019; Radu, 2014).

Using AR in the bossiness became command, and education started to adopt this technology at all levels because this generation is digital and uses technologies daily in their life, games, and bossiness. The Ministry of Education (MOE) in Saudi Arabia adopted AR in education by connecting iEN Ethraia with students' textbooks via QR codes that transfer students to the iEN Ethraia. iEN is an Arabic word that means eye, and Ethraia means worthiness; this website has many competencies that help students to learn. During the pandemic, it became one of the primary helpful environments for students, teachers, and parents. It provides more than 100 AR experiments, these AR experiments available are provided as pictures in the books. Students can use their smart devices to transfer these pictures to AR experiments images provided in their books then these images switch to AR experiments (AlNajdi, 2022). However, this adoption is still in the begging phase. Schools, universities, and training authorities should expand AR technology to offer a more effective, enjoyable, and motivating learning environment.

This analysis examined the impacts of AR application on the trainees' achievement. AR technologies increase trainees' performance without any concerns about using AR. The AR technology also enables the trainees to work with little help. Hence it can be deduced that applications established by the AR technology can be used as an efficient instrument in health courses. From the analysis in this paper, the AR had paramount importance for trainees. Also, AR technology boosted the trainees' performance. New studies can be done in various fields using different samples using the same approach. Designing the AR environments through the instructional design models would be better to ensure these environments will achieve the learning outcomes. Tablets could be a solution in applying AR technology to avoid the issue of the small screen in smartphones being small screen for display.

Most educational AR applications still use traditional learning activities by viewing 3D pictures without interactions from the trainees. This gives the SRCA goad indicators about how to develop their online courses, focuses on trainees' abilities, and follows the Saudi National e-Learning Center (NeLC) standers to design online courses.

These standers have two levels: for institutions which are three main standers, each stander has some sub-standers, and for programs which are four main standers, each stander has some sub-standers. These standards are designed to ensure the availability of quality e-training in Saudi Arabia. Agencies or authorities are requested to be licensed to provide programs and have a license for each program to ensure it follows the standers of offering e-learning in Saudi Arabia. Adopting AR in the training programs provides better and more effectively online and traditional ways to give trainees a more precise understanding and achieve learning outcomes (NeLC, 2020).

Even though augmented reality has been around for a while, academics have recently begun inventing and putting real-world applications in various fields, such as entertainment, medical, construction, collaborative design, military, archaeology, and more. Before AR learning environments can be a standard part of higher education, a wide range of user studies inside universities and the training authorities must be finished. As a result, several technology-related difficulties also need to be improved (Liarokapis & Anderson, 2010).

As specialists in education technology, we should focus on training instructors and trainers to use and implement these technologies in the learning process. This technology now becomes a trend and new technology. However, with the development of technology, it will be part of the learning and training process as it became famous and commented on in gaming.

Technology advancements make augmented reality (AR) teaching and learning applications simple, efficient, and effective. From primary to higher education, augmented reality technology ensures that the teaching and learning process is accessible whenever and wherever it is needed (Singaravelu, 2021). In addition, Instructors with designers could provide AR based on theories and Instructional design models to resolve this challenge and make it comment in education and training (Zhu et al., 2015).

**Data Availability Statement:** Data sharing does not apply to this article as no datasets were generated or analyzed during the current study.

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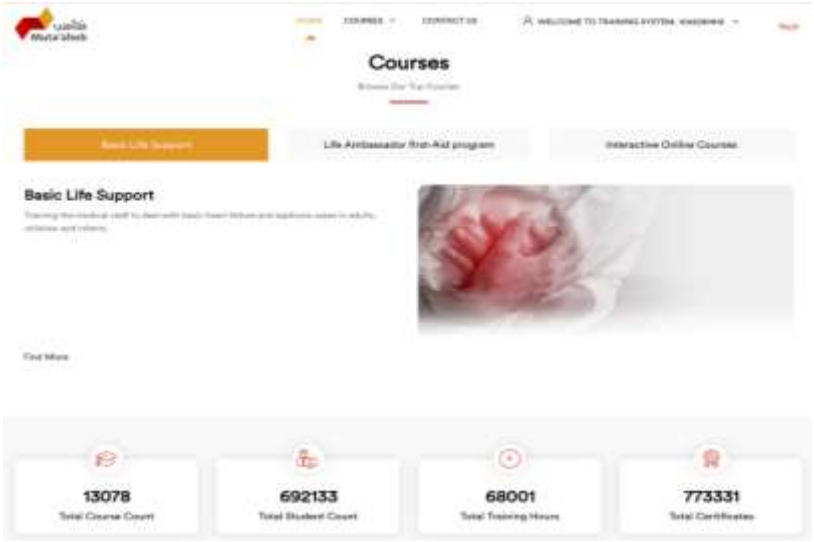
**Appendix A**
The main page of Muta'aheb


Course categories and statistics




**Appendix B**
The main page of the Anatomy 3D Atlas website


**Apps conceived and designed to provide an innovative way to study human anatomy**

## ANATOMY 3D ATLAS

ANATOMY 3D ATLAS allows you to study human anatomy in an easy and interactive way. Through a simple and intuitive interface it is possible to observe every anatomical structure from any angle. Highly detailed 3D models, with textures up to 4k resolution, enable to examine the shape of each structure of the human body with great depth.

Systems: Musculoskeletal, Cardiovascular, Nervous, Respiratory, Digestive, Urogenital (male and female), Endocrine, Lymphatic, Eye and ear.

This application is aimed at medical students, doctors, physiotherapists, paramedics, nurses, athletic trainers and in general anyone interested in deepening their knowledge of human anatomy.

**Appendix C:**
An example of the anatomy of an organ in the Musculoskeletal and Cardiovascular systems (adopted from Anatomy 3D Atlas application)
Musculoskeletal system

Cardiovascular system