The use of Mobile Augmented Reality in health education review

Djamila Djibril [1]*, Hüseyin Çakır[1]

[1]*Computer Science Department, Graduate School of Informatics, Gazi University, Ankara, Turkey

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ABSTRACT

This paper aims to present the analysis and synthesis of studies in Mobile Augmented Reality in health education, with a critical approach, and to develop suggestions for future researchers. The use of Mobile Augmented Reality technology has shown recently an improvement in teaching and instructing methods, several scientific articles and researches showed how this new technology has a positive impact on education and improving the learning and teaching methods and also has a positive impact on student's performance. A basic qualitative method was used, Therefore, a total of 52 studies including theses and articles submitted electronically between 2010-2020, were obtained from the National Dissertation database and Dergi Park. The result of those articles has shown different relationships between variable factors selected in health education and Mobile Augmented Reality, and the findings indicated that most of the studies used the academic scale assessment tool to find out how this technology positively affected student's performance and their academic achievement. In addition, the findings in this study suggest that there should be more experimental studies especially when there is a new development and models are being created every year to make the students experience more related to the real world, however, there were limitations identified, that the researches were limited between 2010-2020, which is carried out only in Turkey.

1. INTRODUCTION

Technology recently been rapidly involved in education and started to play the main role in the teaching process success, different technologies were presented and one of them is Augmented reality, this technology started to be used to present a solution to the problems that face education and create an interactive learning environment that can be an advantage to improve students learning and increase their knowledge and skills.

Augmented reality is a technology that is used to show the interaction between the real world and virtual world where the users can place the models and the objects in the real world and then interact with it. With a combination of hardware and software AR technology, the applications that are designed with it provided a new opportunity for more interaction with learners and also attracted more attention to the education and provided education gains, and enhanced the effectiveness of the learning process.

After this technology was presented and used in computers the developers thought about methods to make this technology available to every user and everywhere and at any time this led developers to design applications that can be used in mobiles and tablets and all handheld devices

helping the technology to spread and be famous and mostly used from entrainment apps like Snapchat and Facebook to e-commerce and presenting the products in 3D models, to finally being part of education methods, the AR applications made it easier for the mobile users to experience more related to real-world, the mobile devices that support AR are getting expanded and with reasonable costs and with the different features and devices outcomes made it simpler for users to create a part of their day by day actuates.

In this article, we tend to discuss the use of mobile AR in health education since 2007 where it gets to be the utilize of this innovation simpler the designers have begun making distinctive sorts of applications that can offer assistance to pick up the student's consideration and offer assistance to them increasing their achievement success a few studies expressed that mobile AR applications had tremendous capabilities in progressing students involvement, based on a study by Bhadauria and Bhatnagar (2019) stated that today's Mobile Augmented Reality (AR) in health education serves several purposes students effortlessly procure it, get it, and keep in mind the data. By using the

different channels as visuals, Mobile AR makes learning itself more locked in and inviting.

This research article aim is to draw light on all these needs in health education the impact of Mobile AR become extremely involved in the learning process within the capacity of Mobile AR innovation to combine pictures, content, audios, and media with liveliness and combining virtual and augmented together bringing advantage in learning something more curiously, to discover the potential and the use of this technology and the effect of it we conducted an efficient audit of the writing that has been distributed related to the instruction use combined with a meta-analysis of the articles related to the use of it. Its impact through student experience with certain criteria of the students conjointly levels of the instruction that utilized in this technology evaluating the in the general victory of this innovation in education is achieved and how it is developed through the years.

2. LITERATURE REVIEW

With literature examination, it is stated that many studies have been carried out for the use of AR application in education, from research conducted by Yılmaz and Göktaş (2018). To understand this technology concept, we need to first understand how this technology works augmented reality and virtual reality concepts can be confused with each other mobile-generated virtual reality and augmented reality concepts are seen as using similar items but different from each other between the real and virtual world, while virtual reality is based on the virtual world, augmented reality is based on the real world. Augmented reality is a variation of virtual environments or virtual reality. In the development process of augmented reality, many expressions describing the relationship between virtual and real have been used (see Fig. 1.).
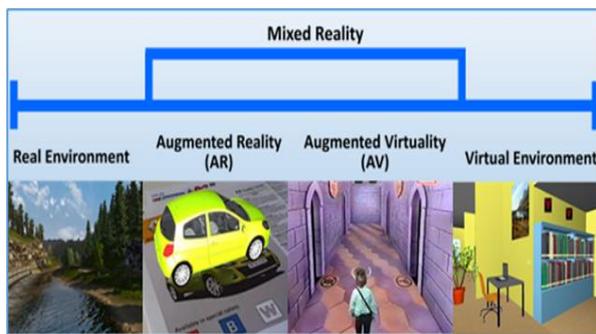
Fig. 1. Augmented reality and virtual reality (Education Cyber, 2021)

The theory plane showing the relationship between virtual and real will make the definitions on this subject more understandable. A study by İçten and Güngör (2017) stated when augmented reality is used in instruction in classes and universities; it brings with it a portion of the benefits and helpful excerpts. In addition, due to its prominence, it can be used at nearly all levels of instruction and during all grades. Enabling augmented reality-rich interaction gives natural participation and increases interest and inspiration in expansion, it increases translation capabilities, problem-solving and creative thinking and gives students the ability to adapt when teaching is coordinated reasonably, it can reinforce diverse learning approaches such as learning in good faith, situational learning, and constructive learning. Other than, the benefits of using augmented reality in teaching for instance Dey and Swan (2018). Their study states that augmented reality technology which has been used as computer-based for years has recently started to be used in devices with different applications developed for mobile devices.

Mobile Augmented Reality applications are mobile applications that enable the creation of augmented reality via a mobile device and use location, picture or pointer icons, since Mobile Augmented Reality applications will be examined within the scope of this study, it will be useful to first focus on the concept of augmented reality, science is seen by numerous as difficult and it regularly requires a high degree of reflection, a study by Sural (2017), results show that AR may be utilized to decrease confusion and stress so that students can easily focus and perform. AR can offer assistance to diminish the regularity in studying or conducting lessons in classes in a few ways. In the study, it has set up a list of five highlights of affordance in AR, juxtaposing data, learning in 3D, and seeing the undetectable are three of these. These three can offer assistance to decrease student's cognitive exertion to attain an understanding of a phenomenon, for example, a virtual 3D model of a heart that pumps blood with compared data approximately the various parts empower the learner to rapidly see how the different parts are interrelated and influence each other, which can provide students more cognitive capacity to get it and to understand.

3. MOBILE AUGMENTED REALITY

The primary position and heading based AR were utilized on cell phones the reason is to include data on the screen in the shape of content, picture, 3D objects or video. The data made it easier for the user to control the application and experience the technology more effectively, Mobile Augmented Reality applications have been designed in many different areas but lately the studies have started conducting experimental researches on the use of technology in education first as placement for face-to-face education in the classroom sharing computerized images,

giving the students the ability to interact with 3D models in the real world giving the students to interact with it and move each model, a study by Basoglu and Daim (2018) states that one of the advantages that the developers and researchers pay more attention to how the applications are designed and how to attract students and make sure they remain attracted and allow being entitled to the design of the application the Mobile Augmented Reality has a different effect on education the skills that students gain The cognitive workload may be diminished by joining numerous sources of data.

Mobile AR may empower students to lock in learning exercises and helps them to memorize easily, mobile AR gives exceedingly intuitively encounters and can create learning improvement, interactivity and a high level of authenticity a study by Khan et al. (2019) found that some of settings components skills in health education are thought particularly suitable for mobile learning, for example, the 3d models designed for human anatomy appear ideally suitable to be presented in Mobile Augmented Reality not only the models the ability to present the images and PDFs in Mobile Augmented Reality in a way that makes the students paying more attention, but our review also try to explore if the device settings are changed and applying different features and using the other devices that can be used in augmented reality, in another study that was based on the impact of VR and AR applications on students studying science by Atalay and Akgün (2020). It showed in their recent study Mobile AR appears to be more successful since it liberates up cognitive assets something else committed to visual channels, permitting the sound-related data to be handled more altogether, not only giving attention to the design only but also to the AR application created and tried has demonstrated to be accommodating in understanding complex concepts of Anatomy Course that normal students have much trouble in understanding and also the full care to the application design and framework affordance as creators focus on some of the android requirements but it is also necessary to give full attention the affordance of the device on the side of the students. In this study, we focus on how AR learning has brought a new measurement where the students can effectively visualize what is happening and effectively get its complex concepts. The low-cost framework that has been proposed can track and distinguish both marker-less and marker-based pictures, several tests have to be carried out to decide a set of best phones for the advancement and utilization of such AR applications.

3.1. Using Mobile Augmented Reality technology in education

Recent studies have confirmed that learners through technology-enhanced with mobile phones and mobile learning benefits learners as they can use mobile devices to bring out a lot of understanding and awareness and facilitate memorization for learners, where organized learning, real learning, context-aware learning and unexpected learning, and Mobile Augmented Reality learning is encouraged this will allow learning to move increasingly outside the classroom and in this way mobile innovation becomes more organized, individual, collaborative and deep-rooted, allowing learners from different cultures to express themselves faster compared to face-to-face circumstances as well, learners can benefit from innovation to create communities of learners, where Learners can teach and assist each other within the learning handle, this could be the first time in history that learners have had the opportunity to allow people from all over the world to access educational assets from any educational center to enable education for all**.**

For the mobile AR technology there are several applications used in education that includes: For example, an earth-moving preparation application with an excavator, after each trial, the remaining earth mess virtual can be cleared up by squeezing a button reset. Augmented Reality applications can make course readings lively, which is in this way characterized as AR books, they are ordinarily gotten in front of your computer's webcam, with computerized data showing up. A study by Demirtaş et al. (2019), investigated how an AR book called AR-Dehaes made a difference in students visualizing and performing spatial designing assignments. The inquiry appeared the involvement was simple to utilize and valuable and the preparation had a quantifiable and positive effect on students.

While a study by Yıldırım and Seçkin (2019), stated that there is a lot of Mobile Augmented Reality applications that can be used in different sectors and professions some of them are intended to be used in education like language applications, history applications and many more thought not only this will help the design of the applications in the future but it will also lead to the future development in this technology that sure will lead to new ways of learning and teaching that follow today's innovation.

In this study, several of these applications will be mentioned but with the focus on the purpose that software used for this review also, we will try to cover the different features used to make software.

3.2. The advantages of using Mobile Augmented Reality in health education

In this study we aimed to focus on how the use of Mobile Augmented Reality help health education be improved and changing the techniques of teaching and learning methods, numerous studies conducted the effectiveness of Mobile Augmented Reality in medical education most of the applications designed with Mobile Augmented Reality are easily accessible by all the society, In expansion, most of the research conducted on AR to date appears that students

are energized and interested to learning using this innovation, in a study conducted by Klopfer (2020) students gave positive feedback around the combination of the virtual and augmented in education there were several advantages include

Improved information: the applications developers not only tend to focus on not only the application design but also the information that the application contains to be on a date and correct regarding the information provided, also providing the application information characteristic and features and availability and use.

easy visualization: mobile AR visualization based on latest reviews and google trends statement that Mobile Augmented Reality, the steady growth in the studies try to cover mobile AR use in education are getting increased and its showing that soon will show more growth in the applications designed in AR

Unique user experience: another advantage in Mobile Augmented Reality is the advantage of making the information presented in 3D and HoloLens world which make the user self-reliant without any assistance or real-time information, thus it encourages the student to think in creative ways and improve their understanding and experience.

It helped to improve the students thinking which reflects positively in their academic success in addition most of the recent researches and review studies show that students are very happy about experiencing the new technology helping in improving their classroom experience and face-to-face education, students also count the learning through Mobile Augmented Reality an asset especially in distance learning the applications mostly contain a free quizzes and questions and answers samples that help students in their education and make it easier for them to understand the concepts more, one of the advantages of the mobile AR that does not seem obvious is that they are low of cost which makes it easily available.

Not only the price but also the technical design makes more possible to develop more applications which increase the number of application users, when comes to health education its started to be applied in the health field taking advantage of the 3D models designed from human anatomy to presenting videos and books in AR also the surgical preparation which make it easier to understand patients anatomy there also other advantages which helps the students is the availability of the applications and the models that can replace the physical models and visiting the laboratories

Learning gains: Since the most of materials and information is available, online using mobile AR applications helps to limit the number of sources and also make it more related to what they try to find and search for like specific information or topics some of the AR applications cover a wide range of topics and includes many online and offline sources.

Performance and Academic Achievement: the use of Mobile AR in education generally and health education specifically has shown that the students learning performances and their motivation gets higher the studies in Table 10, show how are the students experience using Mobile AR in their studies and also with their learning material such as books, and coursework.

Memory Retention: the students in health education experience a lot of information especially during their first year and also the information is not organized and requires a lot of models designs memorization which requires have a sample of each model due to that Mobile AR helped to reduce student's motivation and memorization since mostly 90% of students carry mobile phones and can use it anywhere any time.

4. THE PURPOSE OF THE RESEARCH

The purpose of the study is to highlight the results of the previous studies that have been conducted about the use of Mobile Augmented Reality in health education with the focus on critical approach and to develop a suggestion that will guide the future researchers and the experts who will develop Mobile Augmented Reality application curriculum based on health education, as stated before that Mobile Augmented Reality is effective in the health education field and that many studies cannot be underestimated however there is no comprehensive study that states how the Mobile Augmented Reality handled In terms of the methodologies that are been used in the studies and the information in it, the findings used and its recommendations is important but also showing the deficiencies regarding the future studies in this field and the research questions goes by:

Problem Statement: identify if Mobile Augmented Reality design guarantees the improvement of students learning performance in health education?

Subproblems:

- Which approaches and areas of knowledge have been applied to mobile augmented used in the educational contexts that have been handled in the studies and what has been achieved?
- How the Mobile Augmented Reality approaches used for health educational purposes have been developed in terms of the platform?
- How have the methodological characteristics followed in studies been handled in terms of research type, study group, data collection style and tools, and analysis style of data?
- Studies: How are their findings organized? How are the educational effects of the results obtained from the findings defined in terms of suggestions for teachers, students, school, and further research?

5. METHOD

5.1. Research design

We conducted a Qualitative research method for the literature articles that have been published in different journals, a total of 52 studies thesis and dissertations in the electronic format submitted between 2010-2020, and were obtained from the National Dissertation and Thesis database and Dergi Park the time was set between 2010-2020, with focus on Mobile Augmented Reality impact on health education, the area of research that has been investigated in the last five years as shown in Fig. 2., the rise in the articles that focus mobile AR in health education.

The qualitative method is the advancement of a solid conceptual framework that facilitates the choice of suitable consider strategies to minimize the predisposition characteristic in subjective considerations and help readers to believe the inquire about and the analyst.

 Qualitative studies ordinarily reflect plans in which data collection and examination are done concurrently, with results of progressing investigation educating proceeding data collection following the methods conducted in a study by Johnson et al. (2020), the objective of the study is to provide a comprehensive literature review for the review of the use the mobile in AR in health education and provide a result of Mobile Augmented Reality use by the students in health education and how it affected and improved student performance there have been several literature review articles that have been published it has addressed various aspects of the use of AR in health education.

In this study, we aimed to investigate and examine those studies and evaluate their quality. The study method structure and results are followed by examining the subject in the study and providing analysis through conceptual innovation.

The keywords used in this review are "Augmented Reality". "Mobile Augmented". "Augmented Reality in Health Education", the articles were collected for review and were analyzed to extract the information that is related to the article objectives and goals, the methods applied to persuade the analysis of the data collected are exclusion inclusion process and according to that it will be listing the study potential and the purpose that is been used for and the ranges that are been used in and lastly highlight the features that used in the design of the applied Mobile AR application, and the levels of the education that is applied to in the higher education this analyze will be an asset to know how this technology can help the students in future.

Qualitative methods in general aim to understand the experience and the attitudes of the students. The method used is answering the research questions by establishing a conceptual criticism based on examining the research perspective and methodologies conceptual advancement.

The purpose of this study is defined as evaluating how Mobile Augmented Reality issues are handled in health education.

With taking into account the weaknesses and the straightens of the studies conducted in the subject, many studies were conducted about the use of Mobile AR in health education in the recent study by Parsons and MacCallum (2021) with the focus on conducting general analysis across medical education, but the focus on the health education was different other than surgeries practices, it was shown in both reviews the studies conducted in health education and medical education is increasing and expanding but the studies conducted in mobile AR in health education faced challenges and due to those challenges made those studies short or more related to other areas of knowledge.

5.2. Data collection

The minister national education carried out to change the approach to education in 2004 by creating a platform that contains all the educational researchers and studies, not only there but also there is also Dergi-Park which also a platform for studies in turkey, the list of the analysis studies was limited from 2010-2020 between those years the keywords that are used is "Augmented reality". "Mobile Augmented". "Augmented reality in Health Education", the graduate studies published both in higher education council and Dergi Park and the articles published in university's journals in these context 21 graduate theses and 31 articles were selected and open access.

Table 1. Distribution of graduate thesis and articles examining mobile AR in health education

Year	Master thesis	Doctor thesis	Article
2010	1	-	-
2015	-	2	2
2016	1	-	1
2017	1	-	1
2018	2	-	8
2019	9	2	9
2020	4	-	10
Total	17	4	31

As it was observed in Table 1, shows there has been an increase in the number of graduate studies has been in published since 2010, and with 9 (17.30%) the most of graduate research were in 2019 while when it comes to the articles in 2020, 10 (19.23%) while the least studies were conducted 2010, 2016, 2017, with 1 (1.92%) postgraduate and articles, and from the 21 selected studies, only 4 are Ph.D. thesis, for example, Kurt (2019) as well as Boyaci and Aslan (2020). The remaining was mostly master thesis and articles and it is determined that the number of the studies in Mobile Augmented Reality is higher in both of them as it

can be understood from the selected articles is examined by years 2 (3.84%) in 2015, 1 (1.92%) in 2016 and 2017, but it was started getting more attention with 8 (15.38%) in 2018, and 7 (13.46%) in 2019 and finally 10 (19.23%) and there were no studies conducted in 2010.

The search indicates that as previous studies have stated, the number of published studies is increasing year after year. Yuliono (2018) also, Pavón and Baldiris (2019).
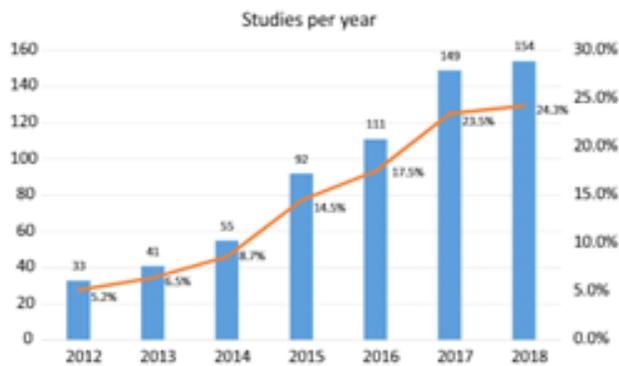

Fig. 2. Studies related to AR in education through years Pavón and Baldiris (2019)

5.3. Data analysis

The data analysis will be applied to analysis the studies that have been selected in inclusion criteria the analysis include choosing the studies to be included based on a certain characteristic the number of articles that focuses on health education and the use of Mobile Augmented Reality is limited therefore to meet the criteria a qualitative review was applied this strategy has been utilized by a few authors to as an attempt to initialize results from studies that mixed quantitative and qualitative.
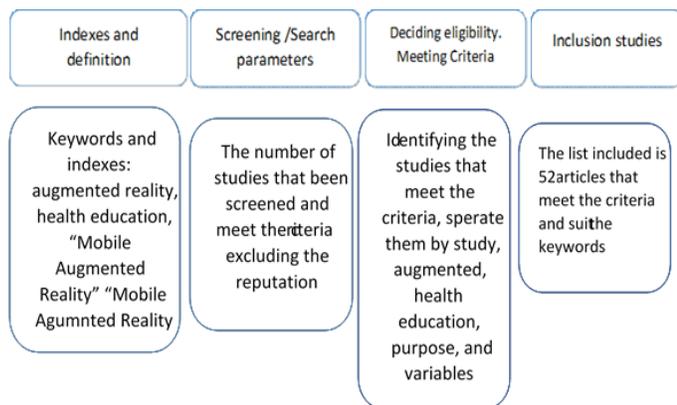

Fig. 3. Flowchart of inclusion of studies Yücelyiğit (2021)

As Manimozhi and Srinivasan (2018) stated in their study, the data analysis focus will be on studies by the

concept handled and the methodology used, and the user's experiences.

6. FINDINGS

The answer to the first question is we have to estimate the approaches applied to Mobile Augmented Reality in the health education context. The variables that will be examined are the reference of the study, knowledge area selected in the study, which we examined the chosen articles.

6.1. Research questions

In terms of Answer to the research first question knowledge ranges in which the approaches of augmented reality and their assets have been connected to education

Table 2. Knowledge ranges and approaches

Dimensions and approaches to mobile AR	F
Science	10
Medical and health science	27
Technology	15

As shown in Table 2, the 52 studies in Table 2, shows that 27 of them are about medical studies and 15 of them are examining the design of the mobile augmented related from the design perspective and only 10 of them were toward the science and in those studies all these researchers they addressed the use of the Mobile Augmented Reality in education in general and in health education-related topics in specific and it was been stated that medical diminution is examined in Table 2 this categorization of knowledge area presented in Table 2 is to present the studies grouped in the most areas that are been covered in health education, which will be an asset to the researchers to cover the works in one of the three majors, those specific variables selected will make it easier to examine how the use mobile AR was a successful case in health education.

Table 3. Developed platforms

Platform	F
Unity 3D android SDK	20
iPhone SDK	1
Mixare	-
AR-media	8
Mobile media	17
Addie	1
Hologram	1
Game studio, Microsoft visual studio	1
did not specify	3

It is observed that the relationship between methodology and literature review is not discussed for most of the studies

dealing with Mobile Augmented Reality in medical or science and technology its observed that analyzing the studies shows that the area of knowledge selected contributes to the teaching and learning process of students.

It can be understood from Table 3, that regarding the platform used SDK plugin framework we find some different platforms measured in the 52 studies and each of t of those platforms are being utilized within the development and utilize instructive approaches on mobile devices, it is required to the features to be evaluated based on three categories: the recognition of the 3D objects and the ways the models being displayed, the tracking system cameras or system that is rendering the objects, the rendering objects: which animation, 3D objects, Videos, Audios. The designers should also give the full consideration of the system meet the pedagogical goals and methods and most important the educational effect on the targeted audience which as Table 3 show that the studies used different platforms for example Unity 3D in 20 studies out of 52 are being used with Android SDK, but it was different some studies used Vuforia (5) and Wikitude (3), AR learn (8), ARCore (4), while in some studies the platform used is Mobile media (8), AR SDK or Frameworks: ARToolKitPlus (9), most educational effect studies focus on designs that combine both mobile learning and at the same time combine the materials like 3D, videos, Images, PDF books, and audios, the findings demonstrate a rise in the technology development and support a creation approaches in the augmented reality that has occurred for the past few years, it is also should be taken into consideration that most of the used platforms are known and available.

Table 4. Variables considered in studies examining mobile augmented reality in health education

Reference	F
Motivation	8
Learning	29
Technology acceptance	1
Satisfaction	4
User experience	7
Attitude towards lesson	7
Gender	2
Performance academic success	19
Parent education status	1
Relationship with the teacher	1

The variables have been examined in Table 4. When the table is examined closely, it shows that most of the common variable used in the 52 studies is learning variable in 29 out of 52 studies and most discussed variables, performance academic success, motivation, user experience, attitude toward lesson and the least common variables are technology acceptance, parent education status, Relationship with the Teacher. It was determined that the

relationship between Mobile Augmented Reality and health education and variables was examined and how these variables predict Mobile Augmented Reality achievement in academic success, in some of the studies the variables were combined and used for example the study by Herpich and Tarouco (2019) where the study focused on academic achievement. Which in this table shows that most studies like Atalay and Akgün (2020), the study focused on taking direction toward making the applications more educational effect each of these studies presents the potential and usefulness of AR supported learning, to answer the third research question method of studies Examining Mobile Augmented Reality in health education Information regarding research type and model from features, within the scope of the methodology of the studies in the table below.

Table 5. Represent the research model were defined

| Research model	F
Qualitative relational scanning model	11
Quantitative - experimental model	16
Qualitative-quantitative (mixed) approach	22
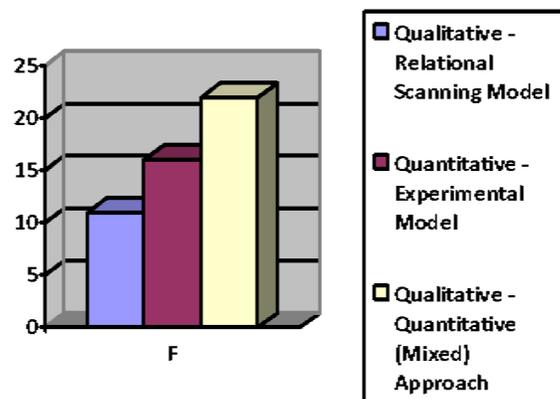
Fig. 4. Research model charts

In Table 5, when the method used in the studies examined the Mobile Augmented Reality in health education It was determined that 22 of 52 of the studies were quantitative, and qualitative mixed-method and 16 of them were quantitative, and 11 of them used qualitative research method, as it shows most of the studies 22 out 52 of it tended to mixed-method to test the Mobile Augmented Reality applications technology and to measure its impact on the individuals, researchers examined the relationships between various variables we identified that in the studies there were also different multimedia represented some 3D, videos, images, texts, Books resources are considered developed in the approaches in the educational area which has a lot of effect on the data results represented.

The majority of the studies focused on the experimental model are 8 studies the models designed in the studies was augmented reality mobile application, for example, Kösal

(2019) as well as Aydındoğan and Ürey (2021). Those studies that used experimental methods in creating models for health education and medical students the studies only focused on how to present a model in more practical form and suggested for future researchers to use the models to measure user experience in a wide range, and for the qualitative studies like Aslan and Erdoğan (2017) the study focused more on content analysis method result to measure the impact of designed technology on education and work filed, and for example, the mixed-method studies like Yıldrım (2018), focused more on using mixed methods that qualitative and quantitative with different participants which also made the studies more effective to change the range of participants that it will be applied and tested the applications in the real world cases.

Table 6. The Information about the study group, among the Method Properties of the Studies Examining the Mobile Augmented Reality in health education

Study group	F
Middle school	3
High school	9
Primary school	3
College	19
Others	18
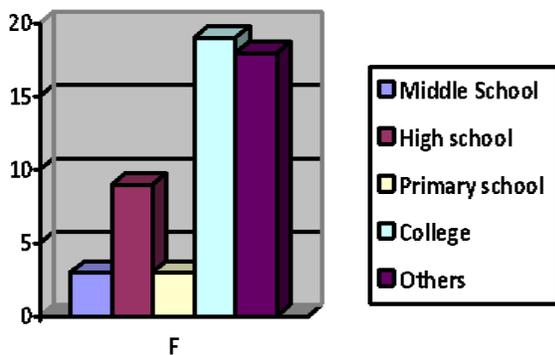
Fig. 5. Study group chart

As shown in Table 6, where the study group of the 52 studies that been collocated and to explain further the focus was related to education field where most the studies applied to regarding the evaluation factors the secondary school level where 9, in the middle school and primary school they were 3, the highest is in the college level 19, for example, Akkiren (2019) Also Küçük and Göktaş (2016) studies were directed to students studying in universities and especially in undergraduate levels and also the students that lack experience in the medical training. and different levels which divided into physicians: 6 studies, for example, Akbulut and Aydın (2019), and medical: 5 studies for example Duncan and Stevenson (2021), and clinics and patients: 4 studies for example Basoglu and Muge (2018)

biology and science experts: 3 studies, for example, Arslan et al. (2020).

In Table 7, we see the data collection tools in all the studies the tools were also in some studies combined since the majority of the studies were quantitatively and qualitative mixed-method some used the open-ended questionnaire and some used semi-structured questionnaire the two methods mostly used in the studies are in the interview form then comes the academic achievement scale measurement, scholarly accomplishment is nearly completely measured with course grades.

Table 7. Information on data collection tools from method properties of studies examining Mobile Augmented Reality in health education

Studies data collection tools	F
Personal information form	1
Interview form	18
Motivation scale for health education	5
Problem-solving inventory	11
Attitude scale toward instructional technologies	9
Positively negative perfectionism scale	6
Academic achievement	13

The achievement of learning targets and the securing of abilities and competencies can be measured at the course program. It was determined that the variables are based on the data collocation for example Basoglu and Muge, (2018). Also Kurniawan and Witjaksono (2019), both studies combined the data collection tools some pre-test and post-test and academic scale measurement questionnaires to measure the effect that the application used to have on students' performance questionnaire with the use of the interview questionnaire to know how this technology can be combined to their educational materials, the studies conducted used Preparation of questionnaires and the pre-test and post-test, the surveys for sample selection were assessed by five specialists who were specialized within the field of data innovation and science to check the result acknowledgement and performance of students.

In Table 8, the most used data analysis techniques in research Anova method and pre-test post-test method in comparing the mean between two groups in most of the studies using post-test and pre-test method with Anova method, the distant predominant elective is to require both the pre-test and the post-test into consideration within the fundamental analysis, this can be frequently fulfilled by fitting a 2 (control vs exploratory bunch) $\times$ 2 (pre-test vs post-test) repeated-measures Anova.

This strategy is prevalent to only utilize the post-test scores as each member presently serves as their control, which diminished the blunder change and consequently the measurable control. For some studies used different scale measurement like study by Rosario (2021) used Likert scale to measure the different anatomy teaching tools integrated

to the teaching method, and in other study where the study used the alpha scale method by Akbulut and Aydın (2019) and its measured the same variables of the questionnaire items, some studies combined achievement test, cognitive load scale, questionnaire, and interview form in the study by Küçük and Göktaş (2016), where it combined it all using cognitive load method and a study conducted by Kurt (2019), where a frequency, percentage, t test, chi square test, Mann Withney U test, Friedman test, Wilcoxon sign test, Kruskall Wallis test, Kappa analysis and correlation tests were used, while in some studies like Bhadauria and Bhatnagar (2019) and a study by Kösal (2019) content analysis were used substance investigation strategy based on stages such as "visualizing data", more than one information examination method was utilized within the ponders and it was watched that the information examination strategy reasonable for the research method utilized within the studies was chosen.

Table 8. Statistics analysis of data from the methodological properties of the studies

Statistical techniques	F
Anova	27
t-test	6
Content analysis	23
Factor analysis	4
Pearson product moment correlation coefficient analysis	1
Pre-test Post-test	18
Mancova	1
Kruskall Wallis test	1
Wilcoxon sign test	1
Friedman test	1
Mann Whitney U test	1
Chi square test	1
Alpha test	1
Likert scale	1
Cognitive load scale	1

6.2. Organizing the findings

In the first part of the research questions, we examined the approaches and knowledge areas that have been applied to the selected studies we also measured the study group and research model in this section we cover the findings and their effect on health education when the findings of the 52 studies of Mobile Augmented Reality on health education were examined the relationship between the different variables determined the result that will be conducted and based on that the findings show how the Mobile Augmented Reality and health education in the analysis, its shown in different studies that 29 out of 52 were examining the relationship between Mobile Augmented Reality and health education and learning for example Yildirim (2020) as well as Güner et al. (2018). Those studies focused on measuring the effect of using Mobile Augmented Reality in health

education from a learning perspective testing the applications in a real-world environment has shown a different result when it is applied with a different focus on technology and medical and science.

The results differed but mostly were positive and proved that the technology is a good asset to help improving learning and teaching methods, the second variable that has been related to our analysis is academic success and performance analyzing the selected studies the three different knowledge area that has been selected that used Mobile Augmented Reality into their research to provide as part of teaching material tried to prove how this technology contribute to students' academic success and how it can make their performance and learning process higher compared to the traditional teaching methods, for example, a study by Coşken (2019) showed that it can be combined with traditional teaching method and the study by Kuyucu (2017). Those studies findings have shown that there is a positive relationship between the variable academic success and the use of Mobile Augmented Reality in health education. The results between these studies differ due to the study group differences but the final result stated that this technology is the key factor to increase student academic achievements.

6.3. The effect of findings on health education

How the educational effect the findings were represented in through suggestions (for teachers, schools, students, and future research) some of the studies that is not been related to the educational field were excluded including studies that have non-teacher and non-student study groups except the future research findings which are based on all studies.

Table 9. Defining the findings in terms of suggestions to teachers and students and future research

Suggestions to teachers	F
Lecture with new approaches	9
Participation in-service training program	25
Creating a democratic and supportive classroom environment	14
Ensuring trust in students	1
Effective teacher and student communication	7
Including activities to increase motivation	22
Including activities for increasing self-efficacy	20

As it can be understood from Table 9, it shows that there are variables higher in the frequency which is three participation in in-service training program, including activities to increase motivation, including activities for increasing self-efficacy, and suggested for teachers to include in the teaching process to improve teaching and learning methods in our total 52 studies there is 31 studies that is directed toward the educational effect the most

frequent suggestion was to include activate to increases motivation and including activities for increasing self-efficiency in those studies it was suggested that they will help the students in providing activities that will increase their efficiency and motivation with help from the schools administration in the studies like Fokides and Mastrokoukou (2018), the least suggestion category were ensuring trust in students some stated that the students today are familiar with the technology more than the past five years and the fact that it is easier to be used since everyone uses phones daily for the studies by Celik et al. (2020) and Kul (2019) are example for the studies with the highest frequency suggestion was to include participation training program which is related to the teachers and students and schools, its suggested that teachers need to be informed about the technology and given a full information about the concept and the technology use in education applications in different area, with providing with porpita training until they become more comfortable in using the technology as source in education materials, the studies reached a common conclusion which is that Mobile Augmented Reality technology can enhance learning and teaching methods.

Table 10. Suggestions they bring for students in the studies investigating Mobile Augmented Reality in health education

Suggestions for students	F
Developing a positive attitude	14
Adopting the efficient study method	6
Believing they will succeed	13
Getting rid of negative thoughts against the lesson	2
Raising self-efficacy	17

As shown in Table 10, the students have fewer negative thoughts toward the use of the technology but unfortunately, the students do not show that much trust in using it during the exams or being part of their training process in schools only two studies the students were supporting it the variable with higher frequency was the raising self-efficiency with 17 studies and then comes the developing a positive attitude toward the use of the technology in a classroom, they do not create negative attitudes and prejudices against health education, on the contrary, to develop a positive attitude towards the lesson, to move away from their prejudices and in the form of believing that they can be successful in health education. It is suggested to students to adopt an efficient study method in the use of the Mobile Augmented Reality, as suggested in that the students receive a seminar and training suggested in the study by Coşken (2019), it is also found that the students do not have a negative thought toward the use the technology in health education furthermore in some studies like Kurt (2019), it was suggested to raise the students to trust and believe that the technology can help them achieve the same result when the study from traditional materials(books, notebooks) the

study's results a rise in the students' academic achievement and motivation.

Table 11. Suggestions of studies examining Mobile Augmented Reality in health education for school

Suggestions for School	F
Ensuring-school-family-teacher Cooperation	2
Cooperation with the school counselling service	4
Organizing seminars on health education and Mobile Augmented Reality	11
Keeping in touch with the teacher	3
Organizing motivation-raising events	10
Using technology tools in education	26
number of activities and working times	20
Training and technique help	26
Safety measures	5

As shown in Table 11, the variable with higher frequency is training and technique help and using the technology tools in education with the same number of frequencies 26 studies suggested that the schools should be equipped with educational equipment that supports the technology and represented to the teachers and students these suggestions are mostly discussed with administration board there should be a communication between the school counsellor and the teachers and the students a suggestion mentioned in the study by Erbaş (2016) and Güner et al. (2018) suggested that the school administration should carry out activities to the students to increase student's motivation and self-efficiency with help and guidelines from the teachers. And some studies suggested that the teachers take a good training before the use of the technology and help in organizing seminars and grouping the students for an individual meeting and conducting interviews to know their opinions and their suggestions, on health education and the mobile augmented technology this will give the school administration a good view of how this technology is affecting the education and learning process.

Table 12. Suggestions of studies examining Mobile Augmented Reality in health education for future research

Suggestions for future research	F
Continuous update and development of attitude and health education tests	25
In-depth examination with studies with quantitative and qualitative methods	17
Doing studies to reduce the use of Mobile Augmented Reality in health education	30
Research on different learning groups with different variables	24
Implementing the same research in different geographical regions	18
Do more study at the primary and university level	16

When the suggestions for future studies are examined in Table 12, all of the studies examine the relationship

between some variables and the use of Mobile Augmented Reality in health education the most offered suggestion is in this direction. It is seen, more different variables for future research suggesting research on different learning groups are offered. Some studies like Altan (2019) suggests that research on different learning groups with different variables, while some studies where only experimental for example a study by Aydındoğan and Ürey (2021) suggests for future researchers to do in depth examination with studies and add methods in quantitative and qualitative methods, but most of the studies suggested that future researchers should do more studies to reduce the use of the, mobile augmented in health education while if we check the literature review of some studies you will notice that the study groups were short to primary and secondary education a study by Atalay and Akgün (2020) suggests that there should be more study groups but in different levels in schools and universities the study that been carried out by Akkiren (2019) mentioned in the literature review that the latest studies were permitted to the high school and primary but to certain levels it was suggested do more study at the primary and university level, however there were suggestions also to do more research in different geographical regions in the study by Aslan and Erdoğan (2017) and Ağaçayak (2019) while some other studies suggested to use updated tools especially the experimental studies for example: Ürey (2021) as well as Boyaci and Aslan (2020), augmented reality in health education and how the use of this technology it is to give the students the opportunity to learn anywhere anytime and also increased the leaning, and understanding in the students thanks to the easy-to-use technical methods that used to make it easier for the students to easily understand the instruction use of the applications which increasing the success rate and achievement, which also decrease the amount of time needed in training in health education the analysis of the data gathered in this study also show how the use of this technology is been developing through the years regardless of the number of the studies showing the level of the education is applied it shows the positive increase in the response and the use of the technology and the majority of the study has a positive results within the studies conducted on the subject, AR applications have a positive impact on academic success and hence based on the study by Batdı and Talan (2019) as earlier mentioned not only it has learning and performance gains and retention the memory it also helps improving the skills of solving problem and the progresses the degree of participation among students and among the reasons that increase the academic success in the students is the it can facilities the students to increase their motivation and the positive response toward the course and the technology most of the studies focus on higher education and the self-improvement that the students get while using the applications in AR is another major advantage that is been mentioned in the listed studies the combination

between the real world and the virtual world gives the students to test their natural abilities and motivate them toward technology development.

Combination and working-together mobile AR allows collaborating and also contributing toward not only the design but also the virtual content that can be presented through the design students mostly enjoy contributing to the application designs and also providing their perspective and opinions their participation helps the designer to know what the students need specifically and also gives the learners to contact their partners and share their ideas, the technology provides opportunities for creativity and not only create the mobile applications but also add the other technologies the AR also use different tools that also attract the students' attention like head seats and gaze tracking tools magic leap and Microsoft HoloLens.

AR can emphatically contribute to the classroom environment through educating non-observable subjects, decreasing the rate of mistakes with the opportunity for redundancy, and giving inventive, practical, collaborative, and intuitive situations stand out in this ponder. In addition, it is recommended as another advantage of the utilization of applications is that it offers a more dynamic and colourful learning environment that is distant from repetitive, by giving openings to do an assortment of activities.

7. RESULTS AND DISCUSSIONS

In this section examining the result of the gathered studies from 2010-2020, that focused on health education were represented, starting with year of publications its shows that the studies been increasing year by year that means many researchers are trying to focus on Mobile AR approaches, which is important key that show how this technology success in health education is increasing, applying qualitative method to get the experience and the attitudes of the students the method answering the research questions with setting up conceptual feedback are based on analyzing and inquiring about viewpoint and strategies conceptual progression the reason of this consider is characterized as assessing how Mobile Augmented Reality issue is handled in health education, the main problem statement was to address how the Mobile Augmented Reality in health education has a positive impact on student performance, and how applying this technology can be part of learning and teaching process, the result of the studies of the research questions that been answered in the data analysis sector shows that the mobile AR has a positive impact on students learning and performance and success achievement, examining the results we first focus on the estimating the approach and the area of knowledge applied to the use of the technology and it shows that mostly the studies focused on three areas which is science, medical,

and technology which is representing solutions to the education and training related to the medicine and health education training fields, the aim of this specific categorizing was to show how are the areas that is related to health education diversities can also show different ways of the technology approach to students learning and teaching.

Secondly, when examined the results of studies according to the platforms used and applied to the studies it showed that most of the experimental studies focused on designing and applications that meet the pedagogical education goals it was mentioned in the study by Atalay and Akgün (2020) in their result section that the utilize of smartphones and tablets permitted easy to get to the resources, it also showed that with multiple uses its easier to understand the system design, while modern innovations can spur and upgrade student learning, making educates comfortable with utilizing new advances is a basic viewpoint for picking up a positive impact on learning.

Thirdly it was examined the methods applied in the studies, the variables and tools of statistical data analysis and the targeted study groups have represented the studies collocated examined had shown in the variables section that most studies focus on learning and performance and academic success achievement which is been measured like for example in a study by Celik et al. (2020) the study focused on designing an application that is suitable for the laboratory training from teachers perspective that showed a positive effect on learning and the application future Potential on students laboratory learning about heart anatomical structure and the future teaching concepts and structure, in the tools section it showed that the most studies focused on data statistical tools that based mostly on experimental measurement the evaluative data recommends a few positive effects of AR application on student learning, for example in a study by Boyaci and Aslan (2020). Also, Fokides and Mastrokoukou (2018) in those studies the data statistical tools that are used were pre-test and post-test and showed that 3D models designed in those studies may well be a supportive instructive fabric, the study groups differed from students in different levels of education levels were from primary students, high school students, and middle school students and college students and other professionals specialized in health education and medical studies wither teachers and physicians and nursing specialized and that focus was applied to show where the technology was applied is more effective and which study group has shown more positive response and easy adaptation of this innovation.

Fourthly suggestions as a solution for the future researchers have different sides to be mentioned some suggestions were addressed to the teachers to be more open and knowledgeable about the use of the technology and offer it the students and it was also suggested that the teachers need to participate in training programs and help to make the technology easier to be applied in the structure and

teaching curriculum, there were suggestions to the students that they need to develop a positive attitude toward the use of the technology at the same time, there were also suggestions in a study by Akkiren (2019) for schools to provide educational tools to be added to the teaching structure and also providing the material that will help to apply the technology in schools with technical materials at the same time organizing events to introduce the technology to the students and increasing the number of working times and training for both teachers and students.

Every technology used in every field has shortcomings that can be noticed when it is used, some of the problems that come with this technology are divided between technical problems and limitations on the studies that researched this field. Nevertheless, specialized issues such as scanning issues, moderate Internet response times, and inconsistent smartphones disappointed students, possibly affecting their learning process.

Technical issues with AR can rapidly be gotten to be an issue and a source of student disappointment with the learning experience. were mentioned in study by Garrett et al. (2018), the shortcomings also related that this new technology does not get enough support from the universities or the education facilities which make the experimental researchers very short and unclear results always cause gabs if this technology would have been helpful, there is also some shortcomings that is been seen in the review there is no studies that show the result of the use the technology in labs there should be further researchers that supports mobile AR exploration and study strategies that need to be applied in the activities in labs, in the study by Barmaki and Navab (2019) it was mentioned in the limitation section there was few topics that support health education the studies needs to be more specific, future studies try to be more longitude focusing on students motivation, performance, but there was no evidence studies that addresses students' needs and there was no applications that been designed for students with special needs within this sense mobile AR may offer an inclusive based setting that can offer unique advantages and settings, most of the limitations that studies highlighted are technique problems that comes with using the application such technical issues can be approved so the technology can be applied to wide are of education.

There is also the number of limitations faced on the foreign languages based on the gathered studies from Turkish journals and carried in Turkish written were limited because the use of the technology is still in the development sector and also limited studies related to health education topic, the studies also were short in specifying a theoretical framework for the studies which can affect the result of the findings, the lack of it made the concept that the researchers discussing their studies unclear and even the dimensions and the area of knowledge as we specified is divided some

studies did not specify to which dimension considering the definition the study is about.

8. CONCLUSIONS

In conclusion, identifying the new technology as a learning tool today has the main rule in teaching and learning methods, and applying the new technology today has shown that it can contribute to the learning process and make it available to the students.

In recent years AR field has been expended resulting in dramatic increase in the studies that focus on the use of the technology in education in general there is several limitations that is related to the studies that covers the topic of the use of Mobile Augmented Reality in health education and also that the technology today been developed with different hardware and software been presented every day the studies that cover or try conduct experimental methods are very few as it been mentioned the study by Aslan and Erdoğan (2017) that unfortunately will cause a gap between the technology provided and how that can used in education there is also a need for a new AR user research that be categorized and a new classification and measurement applied to the future research papers, in this paper we reviewed papers but due to the limited studies we tried to collect still there is no specific analysis that been conducted in the use of Mobile Augmented Reality in health education researchers working in AR applications can take inspiration from the papers that cover health education topic and seek more usage to perform more studies related to the real-world scenarios.

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