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AUGMENTED REALITY IN OPEN AND DISTANCE LEARNING

Abstract:

Open and Distance Learning constantly seeks to enrich learning experiences and processes by trying out innovative technologies and brings forward the best practices. Among these innovative technologies, Augmented Reality, draws attention due to the interactivity it enables within learning environments. Augmented Reality allows for the integration of theory and practice, and offers the potential to deliver learning through open and distance practices on disciplines such as medicine and engineering, which were once deemed impossible through distance learning mechanisms. This article aims to provide brief information on Augmented Reality and discusses its potential in the field of education.

Keywords:

Open and Distance Learning
Augmented Reality
Virtual Reality
Distance and Blended Education
Online Learning

JEL Classification: I29

1 Introduction

Since the advent of early examples of Open and Distance Learning practices dating back to 19th century, technology has always played a pivotal role in shaping Open and Distance Learning (ODL) systems and educational practices undertaken in ODL. The intimate bond between technology and ODL, which began with printed learning resources, has evolved into intelligent adaptive systems, which allow the enrichment of learning environments with web-based interactive tools (Aydin, 2011). The recent years in ODL history has witnessed experimentations with innovative technologies such as Mobile Learning (m-learning), Gamification, Learning Analytics, Virtual Reality, andAugmented Reality (AR). The aforementioned technologies, which have been gaining popularity in ODL practices during the past decade, place learner in the center of learning processes. Furthermore, these innovative technologies make substantial use of the potentials brought about by hardware and software developed for mobile devices, which enables considerable improvements in learner modelling and thereby personalization of learning processes (Bacca, Baldiris, Fabregat, Graf & Kinshuk, 2014). Among the innovative technologies shaping today's landscape of ODL, ARposes significant, yet under-tapped, potential in enriching learning environments, providing situational learning, and personalization of learning.

Augmented Reality is defined as applications aiming to superimpose the physical and the virtual worlds in the same frame and in real time (Özarslan, 2011). AR applications allow the integration or supporting an object in the real world with digital information. The final product of this integration is a superimposed frame involving both the real and the virtual world resulting in the enrichment of the real world, thus AR (Azuma et.al, 2001). However, AR applications are not limited to visual sense only; they have the potential to be associated with hearing, touch, and smell. The main difference between AR and Virtual Reality is that while the user is completely immersed in the virtual world replacing the real world in Virtual Reality; instead of providing an alternative world, ARseeks to enrich the real world with virtual elements. The bond between the real and the virtual points to the immersion between the real world and the virtual world.

2 Augmented Reality: Educational Potential

The financial budgets allocated for education have been shrinking, in contrast, the demand for, and thus populations in education has been increasing steadily worldwide. Moreover, the amount and the variety of information and knowledge that a learner must get hold of is growing exponentially. In addition, the learner demographics is not the same as a decade ago. Today learners demand more meaningful and personalized learning experiences that will allow them to function in today's digital age surrounded by connective technologies.Considering all these developments, the innovative learning approaches enabling personalized and enriched learning experiences with less financial and temporal costs will have to be put into practice to meet the requirements of the digital age. When they are properly and effectively adopted in educational spaces, AR offers the potential to both provide more enriched learning experiences and trigger high-order cognitive skills due to the experiential and sensory affordances.

Conventional instructional approaches fail to cater for the development of the 21st century skills including critical thinking, problem solving, communication, collaboration, creativity, and innovation skills(Trilling & Fadel, 2009). On the other hand, AR applications allow the immersion of learners into enriched learning environments through interactive learning elements that enable learning by doing and learning by experience. Through increased interactions with the real world enabled by AR applications, learners have the opportunities to analyze, evaluate and apply knowledge, and develop 21st century skills.

Learners today are surrounded by a plethora of tools and applications that potentially interrupt the learning processes and distract learners from academic studies. Therefore, learning interventions are needed that have the capacity to increase curiosity and motivation among learners as well as make a habit of learning. Within this respect, content created through AR applications provide the means for learners to efficiently engage with the learning materials. Also, several studies have asserted the potentials AR applications pose for the development of learner motivation (Liu & Chu, 2010; Di Serio, Ibáñez & Kloos, 2013; Chang et al.,2014).

Augmented Reality offers the means to create innovative learning environments through bringing the digital learning resources and the objects in the real world. To this end, AR in the educational landscape provides opportunities for situated learning (Wang, 2012).In addition, AR practices in educational environment have the potential to facilitate constructivist learning through allowing the learners to control their own learning processes in contact with both the virtual and the real world. As a result, AR can make the learning experiences more engaging, thus, create deep impacts on the learning processes and environments.

The richness and variety of the virtual world is limited only with the human imagination.AR with its potential to challenge human imagination provide enriched learning environments tailored for the characteristics of unique learners. As previously stated, AR applications that support constructivist learning allow the learners to manage their own learning processes by manipulating the objects in the real world (Wang, 2012). It is a known fact that deep learning occurs when theoretical knowledge is supplemented with practical knowledge. Therefore, it becomes vital to supplement ODL systems with technologies that support the theory and practice synergy. In this regard, AR can bridge the gap between theory and practice and provide the practical means for achievement of learning outcomes for various disciplines based on practical knowledge development. The content developed using AR applications are designed in a way to react to learner actions (Ribeiro, 2016). With the utility of AR applications, learning blocks including dangerous and risky scenarios can be realized in the virtual world averting the dangers and risks associated. Also, accidents or undesireable results that may arise from practical trainings in the real world can be avoided with the use of learning content created using AR. For instance, a dangerous medical operation or a dangerous chemical experiment in the real world can be tried repeatedly with no harm to both learners and the subjects involved. Therefore, the AR applications in education and training help achieve dangerous and risky learning tasks in addition to reducing financial and temporal costs.Another practical utility of AR for educational purposes, including ODL, is through animating the coursebook with multimedia content. The static textual content can be enriched through AR applications by having the learners interact with the digital content superimposed on the static text or images in the coursebook (Martín-Gutiérrez et.al., 2010).

Augmented Reality offers wide range of potentials for the educational landscape including the enrichment of learning content and achievement of dangerous and risky learning tasks in the real world. However, despite the many affordances AR brings to the instructional designers table, it is vital to align learning outcomes, specific disciplinary requirements and the particular AR applications properly. An AR educational intervention which do not correspond well to the particular learning objectives of the specific course content may only be viewed as fun element and hinder the achievement of learning objectives. This particular research aims to review the graduate theses published in Turkish Higher Education Council Thesis Database to investigate the trends,potentials and challenges in educational utility of AR in the Turkish context. For this purpose, this review article seeks answers to the following research questions:

RQ1: What is the distribution over time of the graduate studies published in the Turkish Higher Education Council Thesis Database regarding educational utility of AR?

RQ2: What subject domains and educational levelsare the graduate studies conducted in?

RQ3:What are the methodology trends in researching the potential of AR in education?

RQ4: What potentials and challenges are reported regarding educational utility of AR?

3 Method

Literature review studies help visualize the current status of the field at hand allowing researchers to identify research gaps for future investigations (Akçayır & Akçayır, 2017; Karatas, 2008). In addition to contributing to the development of further understandings and insights into the field,literature review studies enablepolicy makers to make better informed decisions regarding policy developments and funds allocation. Besides, the review of previous research in a specific context (i.e. Turkish Higher Education context) help to reveal the research trends and current practices within a constrained context thereby allowing the comparison of different contexts (e.g. the Turkish and the Austrian). Therefore, this research review study focuses on a particular context, namely the Turkish, in order to investigate the research trends and aims to reveal current practices in the educational utility of AR.

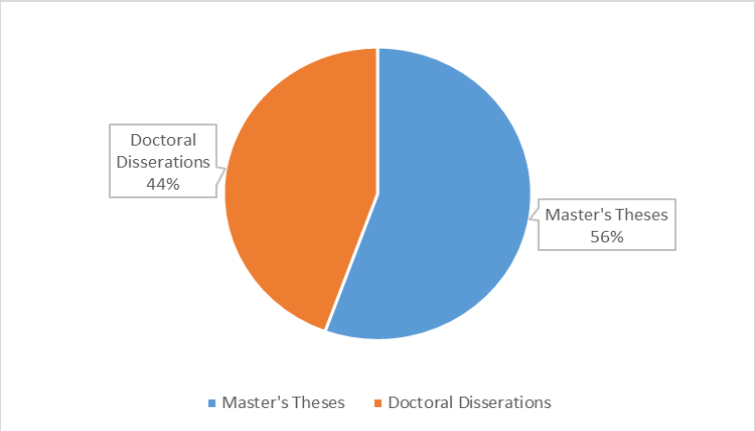
For this review study, in alignment with the purpose of the review, theses to be reviewed was selected from the official database of the Turkish Higher Educational council, which is the overseeing governmental body for national higher education in Turkey.The search for the graduate studies on AR was conducted using augmented reality as the keyword[1]. The search yielded a total of 54 graduate theses, which were later reviewed to eliminate the studies conducted on fields other than education. The preliminary review for the subject domain left 27 graduate studies conducted in the field, therefore a total of 27 graduate theses were subjected to content analysisfor the purposes of this study.

4 Results

This section reports the results of the review study conducted on the educational utility of AR in the Turkish context via examining the graduate theses published in the Turkish Higher Education Thesis Database. It was found that, of the 27 theses selected for review 12 were Doctoral Dissertations (44%) and 15 were Master's Theses (56%), which indicates similar numbers of studies were conducted as doctorate and master's studies (Figure 1).

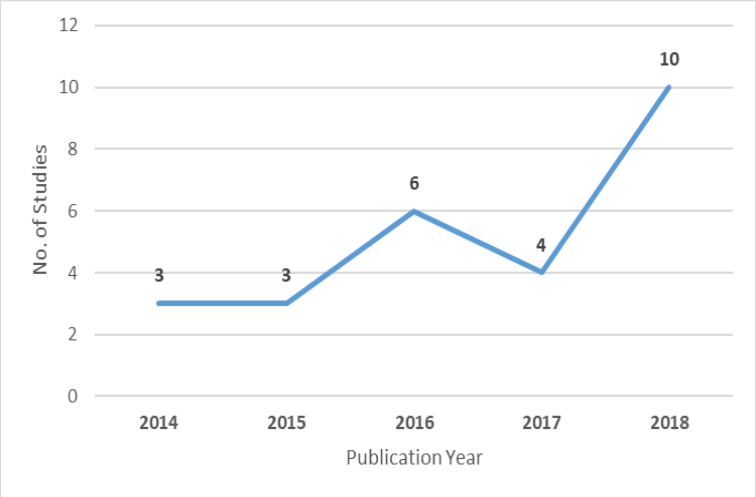
[1] The database was accessed on 15 August 2019 from https://tez.yok.gov.tr/UlusalTezMerkezi/

Figure 1. Doctorate and master's studies conducted on educational AR



In order to map the distribution over time of the graduate studies published (RQ1) the publication year of each of the selected 27 theses were analyzed. The results revealed that there was a significant increase in the number of graduate studies conducted on the educational utility of AR, except for the year 2017 (Figure 2). There was a slight decrease in the number of studies in 2017; however, 2018 saw a comparatively sharp increase, which indicates an increase in interest into examining the educational potential ofAR. The year 2019 was excluded from this analysis considering the year was not over at the time of the analysis. The results show that the first graduate study done on the topic was conducted in 2014. Considering that the first educational AR research was done in 2007 (Akçayır & Akçayır, 2017), AR failed to attract graduate interest until later. However, the increase in the number of published graduate studies is in line with the global trend as indicated by the review studies by Akçayır & Akçayır (2017) and Bacca et al (2014). The increase in this interest is attributed to the fact that the use of AR has become more practical and easier dueto thewidespread use of mobile devices, and thus AR apps, particularly since 2010 (Akçayır & Akçayır, 2017).

Figure 2. The distribution over time of the graduate studies published



Another research question (RQ2) this review sought to answer was what subject domains AR studies were conducted in. The results showed that the majority of the graduate theses (n=18, 66%) was conducted in the field of science including biology, physics and chemistry. The domain

of science is followed by English as a Foreign Language (EFL) domain (n=2, 7%). The remaining theses were conducted in various subject domains, one study on each, including corporate training, engineering, information technologies (IT), literature and math. Also, a doctoral dissertation was published as a review study (Kara, 2018) and another was published as a meta-analysis study (Küçük Avcı, 2018) (Figure 3). Thefact that the majority of graduate studies focus on science education in the Turkish context is in line with the global trend as evidenced by the review conducted by Bacca et al (2014).

Figure 3. The distribution of subject domains

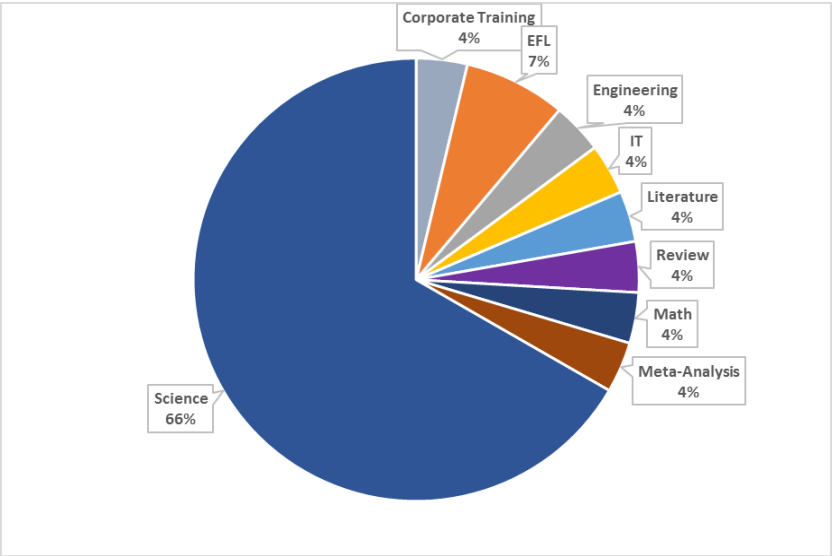
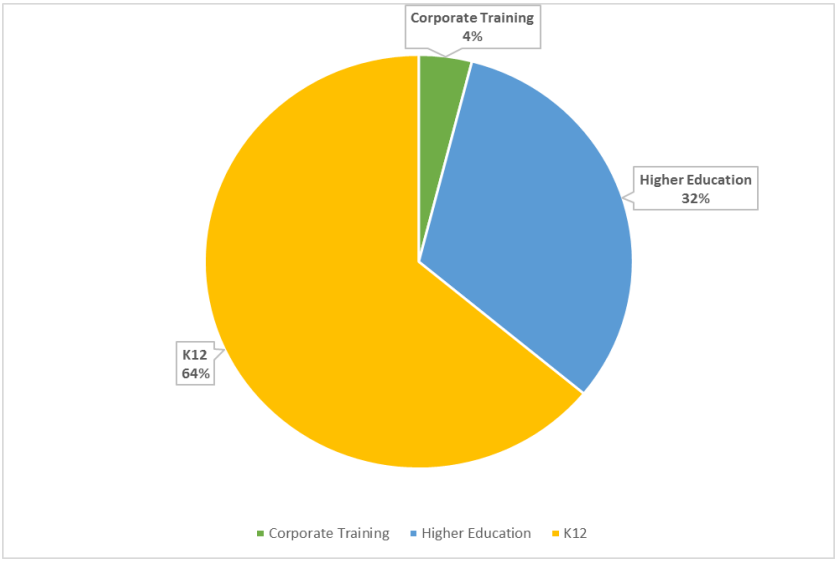


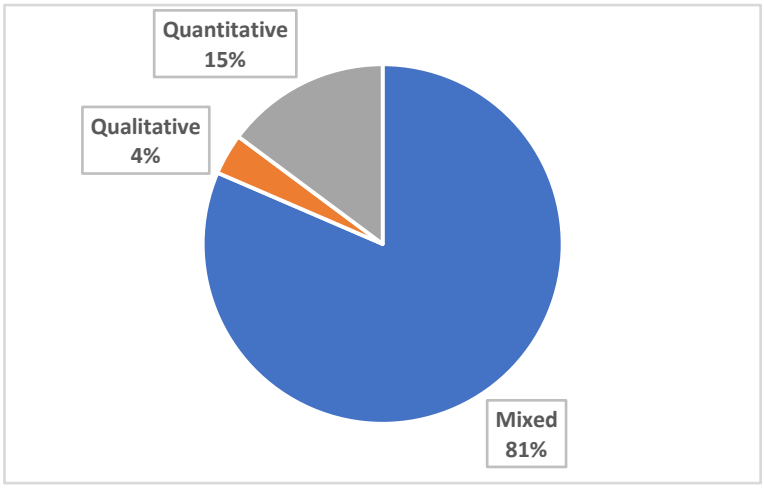
Figure 4 below demonstrates the educational level graduate theses targeted, which indicates that most graduate studies were undertaken in K12 settings (n=16, 64%). 32% (n=8) of the studies were conducted in higher education context and one study in corporate education (adult education) setting. Similar literature review findings were also reported on the global context regarding educational utility of AR (Akçayır & Akçayır, 2017; Bacca et al 2014), which reveal that most studies were conducted in K12 settings followed by Higher Education.

Figure 4. Targeted educational levels



In terms of research methodology trends employed in AR studies (RQ3), the results indicated that a good majority (n=22, 81%) of the graduate studies examined employed mixed methods (Figure 5). On the other hand, 15% used solely quantitative methods (n=4) while only 4% employed solely qualitative methods (n=1).

Figure 5. Research methods employed in AR studies



The review of graduate theses within the scope of this paper yielded both reported potentials and challenges in utilizing AR for educational purposes (RQ4). Table 1 below presents the list of the reported potentials and subject areas these potentials have been reported. The results showed that a total of 21 studies out of the 27 analyzed in this study (78%) focused on researching the impact of AR practices on academic success. Graduate studies reporting significant impact on academic successare listed on Table 1 below. The results also demonstrated that most of the graduate studies reporting improved academic success were conducted in the domain of science (n=14, 70%). Considering the total number of AR studies in the field of science (n=18), a good majority of the studies researching the utility of AR in the field of science are focused on academic success and they report improved academic success (n=14, 78%). Improved academic

success was also reported in other fields including EFL, math, engineering, IT and corporate training.

Table 1. Quantitative Data: Reported educational potentials and subject areas

Educational Potential / Subject Area	Science	EFL	Math	Engineering	IT	Corp. Training	Literature
Academic Success (20 Studies)	14 Studies Abdüsselam, 2014; Altıntaş,2018; Ateş, 2018; Babur, 2016; Demirel,2017; Erbaş, 2016; Eroğlu, 2018; Fidan, 2018; Güngördü, 2018; Küçük, 2015; Özçakır,2017; Sırakaya, 2015; Şahin, 2017; Yıldırım,2016; Yıldırım, 2018	2 Studies Çınar, 2017; Doğan, 2016	1 Study Gün, 2014	1 Study Akkuş, 2016	1 Study Baysan, 2015	1 Study Güner, 2018	
Positive Attitude Toward the Course (5 Studies)	5 Studies Abdüsselam, 2014; Akçayır,2016; Altıntaş,2018; Fidan, 2018; Şahin, 2017						
Positive Attitude Toward AR (5 Studies)	4 Studies Altıntaş,2018; Eroğlu, 2018; Güngördü, 2018; Yıldırım, 2016					1 Study Güner, 2018	
Motivation (4 Studies)	4 Studies Babur, 2016; Demirel,2017; Erbaş, 2016; Yıldırım, 2016						
Spatial Ability (4 Studies)	2 Studies Özçakır,2017; Topraklıkoğlu, 2018		1 Study Gün, 2014	1 Study Akkuş, 2016			
No Anxiety Toward AR	3 Studies Eroğlu, 2018;						

(3 Studies)	Güngördü, 2018; Şahin, 2017						
Satisfaction with AR **(2 Studies)**	2 Studies Eroğlu, 2018; Şahin, 2017						
Low Cognitive Load **(2 Studies)**	2 Studies Akçayır, 2016 Küçük, 2015						
Problem Solving Skills **(1 Study)**	1 Study Yıldırım, 2016						
Self-Efficacy **(1 Study)**	1 Study Fidan, 2018						
Psychomotor Performance **(1 Study)**	1 Study Babur, 2016						
Lab Performance **(1 Study)**	1 Study Akçayır, 2016						
Story Writing Skills **(1 Study)**							1 Study Yılmaz, 2014

The results also showed that a number of graduate studies reported increased positive attitude toward the course (n=5) all conducted in the field of science. In conformity with these studies 4 studies, all conducted in the field of science, also revealed increased motivation toward the course due to the utility of AR. Moreover, studies focusing on learner attitude toward the utility of AR in education report positive attitudes toward AR practices (n=5), four of which was conducted in the field of science and one in corporate training. In line with these studies reporting positive attitude toward AR in education, 3 graduate studies concluded that learners reported no anxiety when using AR application during the educational experience. In addition, two studies report satisfaction with AR practices during educational processes. Other educational advantages reported include increased spatial ability (n=4), low cognitive load (n=2), improved problem solving (n=1), psychomotor skills (n=1) and story writing skills (n=1), increased self-efficacy (n=1).

In addition to the reported educational advantages through quantitative data given above, the qualitative data gathered in the form of interviews and open-ended questionnaires also report educational advantages in the gradute studies examined in this paper.Twenty-two of the 27 graduate studies examined utilized qualitative data to support the quantitative findings. The analysis of qualititive findings in the gradute studies examined for the purposes of this paper revealed that the most recurring theme was improved interest toward the course (see Figure 6). Participants in nine graduate studies reported that learners' interest toward the course improved with the use of AR. Also, in line with these studies, participants in eight theses stated they had fun learning. Besides, the qualitiative data in eight studies also revealed that learners felt that AR facilitated their learning processes making it easier to learn. Other reported advanteges through

qualitative data include concretizing abstract concepts (n=7), positive opinions towards AR in education (n=7), useful for learning (n=5), increasing motivation (n=4), attracting attention (n=3), engaging (n=3), improving academic success (n=2), interactive (n=2) and creative (n=1). Therefore, it could be concluded that the qualitiative data reveals positive opinions toward the use of AR in education. In addition, the findings of the qualitative data confirm the results of the quantitative data in the examined studies.

Table 2. Qualitative Data: Reported educational potentials

Educational Potential	No. of Studies
Improved interest toward the course	9 Studies Ateş, 2018; Babur, 2016; Demirel, 2017; Fidan, 2018; Gün, 2014; Küçük, 2015; Sırakaya, 2015; Topraklıkoğlu, 2018; Yıldırım, 2016;
Fun	8 Studies Altıntaş, 2018; Demirel, 2017; Fidan, 2018; Gün, 2014; Güner, 2018; Sırakaya, 2015; Topraklıkoğlu, 2018; Yıldırım, 2016
Facilitating learning	8 Studies Abdüsselam, 2014; Babur, 2016; Demirel, 2017; Gün, 2014; Fidan, 2018; Sırakaya, 2015; Yıldırım, 2016; Yıldırım, 2018
Concretizing abstract concepts	7 Studies Altıntaş, 2018; Demirel, 2017; Gün, 2014; Küçük, 2015; Sırakaya, 2015; Yıldırım, 2016; Yıldırım, 2018
Positive opinions towards AR in education	7 Studies Abdüsselam, 2014; Akçayır, 2016; Altıntaş, 2018; Ateş, 2018; Eroğlu, 2018; Güngördü, 2018; Küçük, 2015
Useful for learning	5 Studies Akkuş, 2016; Altıntaş, 2018; Doğan, 2016; Güner, 2018; Küçük, 2015
Increasing motivation	4 Studies Erbaş, 2016; Güner, 2018; Sırakaya, 2015; Topraklıkoğlu, 2018
Attracting attention	3 Studies Demirel, 2017; Fidan, 2018; Gün, 2014
Engaging	2 Studies Fidan, 2018; Güner, 2018
Improving academic success	2 Studies Ateş, 2018; Erbaş, 2016

Interactive	2 Studies Demirel, 2017; Güner, 2018
Creative	1 Study Güner, 2018
Promising	1 Study Baysan, 2015

Although several studies report improved academic success with the utility of AR in educational processes, a number of studies concluded no significant difference between control groups (non-AR) and experimental groups (AR)(Baysan, 2015; Erbaş, 2016; Gün, 2014; Tuğtekin, 2019; Yıldırım, 2016), which suggests that the cause for the increase in academic achievement might not be solely attributed to AR practises. Likewise, despite studies reporting improved spatial ability with AR, some studies report no significant differences between control and experimental groups (Akkuş, 2016; Gün, 2014). In addition, a number of studies also revealed that attitudes toward the course did not differ with the use of AR (Çınar, 2017; Topraklıkoğlu, 2018; Yıldırım, 2018) in contrast with studies reporting otherwise (see Table 1). Also, although Fidan (2018) and Güner (2018) reported via qualitative data that learners found AR practises engaging, the quantitative data in Sarıkaya (2015) revealed no significant difference in terms of course engagement. The contradictory conclusions from these studies demonstrate that further investigations need to be undertaken to reveal the variables that may interfere with successful implementation of AR aiming to enrich educational experiences.

Figure 6. Word cloud of qualitative data findings

In addition to no significant difference results in terms of academic success, spatial ability and attitude toward the course, a number of studies reported negative issues when utilizing AR in education. Although several studies reported that AR facilitated learning (see Table 2), Akçayır (2016) found that learners thought AR encouraged rote-learning and it prevented learners from studying at home. Also, through interviews with learners Fidan (2018) discovered that learners suffered from neck, back and hand aches; it caused noise in the classroom and wasted time. Finally, although Özçakır (2017) reported that learners had no technical difficulties, Demirel

(2017) found that some learners had issues with internet connection and problems during implementation phase. In conclusion, despite the many reported advantages, AR use in education is not without issues or challenges. Therefore, the successful implementation of AR in education might depend on how skillfully these challenges are tackled. The design of an effective and engaging learning experience need to take into consideration the unique affordances that AR might bring to the table. AR should be utilized not because it's a new and popular technology, but because of itsunique educational advantages.

5 Conclusion

The real potentials of innovative technologies such as AR to enrich learning environments and provide deep and meaningful learning have recently been better acknowledged in Open and Distance Learning. As the costs of these technologies decline and they become more and more popular, it will be possible to integrate these technologies into learning environments seamlessly, which will lead to an increase in the number of educational interventions that aim to enrich the learning experience. Moreover, the augmented and virtual reality potentially provide the means to carry out virtual tasks deemed impossible once. Therefore, these alternative ways of providing education mayresult in the provision of disciplines such as engineering and medicine through open and distance learning in the future. However, it should be noted that technological devices and applications are but one of the many elements of the bigger equation of the system of education. In addition to educational practitioners and designers, policy and decision makers will need to take the necessary steps to ensure the proper utility of innovative digital technologies beware of the risks, threats and limitations they may pose for educational endeavors.

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