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Investigation of Studies for the Use of Augmented Reality Applications for Educational Purposes: Content Analysis

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Abstract

Augmented reality is a technology used in almost every stage of our daily life. It has become widespread in several fields such as engineering, healthcare, advertising, defense industry, and entertainment. The use of augmented reality technology that combines virtual and real environments is increasing every day. Augmented reality technology, which allows multiple multimedia materials to be used together, is a preferred teaching material in educational environments. This study is a content analysis study. Turkish studies that addressed the use of augmented reality applications for educational purposes and that were published between 2012 and 2019 were analyzed and descriptive analysis was performed according to their distribution by years, a number of authors, research patterns, sample sizes, data collection tools, and data analysis methods. For this purpose, the keywords Augmented reality, educational practices, education technologies and educational technologies were searched in ULAKBİM, YÖK National Thesis Center and Google Academy databases and 106 scientific studies, 60 thesis and 46 articles published between 2012 and 2019 in Turkish were obtained. Then, these studies were examined using the content analysis method. The publication classification form, developed by Sözbilir, Kutu, and Yasar (2012) as a data collection tool, was rearranged in line with the sub-problems. These sub-problems are research patterns, data analysis methods, data collection tools, number of authors, distribution by years and sample sizes. The data were presented with descriptive statistics methods such as frequency and percentage, with graphs and tables. As a result it was found that the studies in the field of augmented were published mostly in 2019. It was also observed that most of the investigated articles had two authors in terms of the number of authors. In addition quasi-experimental design, one of the most common quantitative research methods, was found to be used as the research design. In terms of sample size, it was seen that a sample size between 51-100 was used. It was also observed that the most used data collection tool was the achievement tests prepared according to the purpose of the research. The analysis of the results section of the studies revealed that the t-test, which is one of the the parametric tests, was used most frequently in the analysis of the data. The results of this study will reveal the tendency of the studies and identify deficiencies in the existing studies and thus will be a guide for future studies.

Keywords: Augmented Reality, Educational Practices, Instructional Technologies, Educational Technologies.

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INTRODUCTION

Countries are competing with each other in terms of technological developments. This international competition forces countries to open up new technological opportunities (Şimşek et al., 2007). After the Industry 4.0 revolution in the digitalized world, new technological developments are driving countries into a mandatory transformation. Nine technological developments that have been on the rise with digital transformation are the building blocks of Industry 4.0 (BGC, 2019). These technologies are big data and analysis, smart robots, simulation, horizontal-vertical software integration, internet of things, cybersecurity, cloud services, 3D printers and augmented reality.

With Industry 4.0, these technologies, which we frequently hear in our daily lives, are used in a different number of sectors includimg automotive, entertainment, logistics, education and tourism and thus their effects are visible in almost all spheres of life. Furthermore, it is observed that innovation has started to prevail in the field of education with the Industry 4.0 transformation (Öztemel, 2018). To experience the contribution of technology in education at every stage, current technologies should be used effectively. In this sense, the concept of educational technology stands out. Educational technology refers to the process of planning, implementing, shaping and developing the learning-teacher processes (Alkan, 1997). Educational technology has been influenced by the developing and changing learning theories as well as changing technologies over time, and thus different trends have emerged within this concept (Kılıç Çakmak et al., 2015). The augmented reality, emerged in the 2000s, which can be considered as a new opportunity for our education system, also predicted the change in educational technologies. Therefore, one of the new technologies which can considered as a different alternative source in education is augmented reality technology (Sayımer and Küçüksaraç, 2015).

Augmented reality is a platform where the real world and the virtual world created by computers and programs are combined simultaneously and reach those who use it in the same sensory environment (Özarslan, 2011). As a result of the rapid change of mobile devices, augmented reality has become a widespread technology used by everyone with devices such as tablets, smartphones in daily life. Users can easily use augmented reality applications using their mobile devices and tablets and interact with the environment and objects there (Karaoglan Yilmaz and Yılmaz, 2019).

Augmented reality

The literature analysis shows that a number of different concepts have been used to define augmented reality. However, the most widely used and preferred one seems to be “Augmented Reality” (Köroğlu, 2012; Ercan, 2010; Çavdaroğlu, 2013; Abdüsselam & Karal, 2012). Severel definitions regarding augmented reality, a concept originally introduced by Tom Caudell, exist in the literature. According to Milgram and Kishino (1994), augmented reality is “the real environment in which digital media products are used instead of real-world objects”. Similarlyi Azuma (1997) defined it as the integration of three-dimensional imaging with real and non-real , stating that augmented reality is another dimension of virtual reality, not as a world created entirely in virtual, but as a virtual environment built on reality. Virtual reality and augmented reality environments are constantly confused due to the perception of virtuality. Milgram and Kishino (1994) revealed the relationship between augmented reality and virtual reality in the "Virtual Continuity" chart.

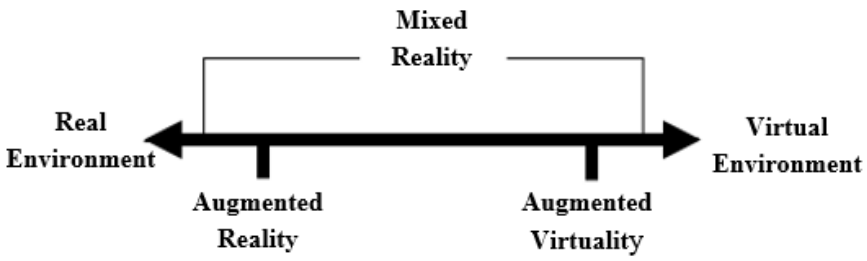

Figure 1: Virtual Continuity Diagram (Milgram and Kishino, 1994)

The augmentation in the concept of augmented reality can be decribed as increasing the meaning of what people feel with their sensory organs by using computer systems (Grubert and Grasset, 2013). As a result, the augmented reality can be defined as the environment where the real world and the world created on the virtual computer are enriched with virtual objects and the real world is combined with the virtual world (Erbaş and Demirer, 2014).

Augmented reality in education

The inclusion of technological tools in education provides new opportunities for individuals to be effective in learning and increase the interaction of individuals as well as affecting motivation positively by making learning more meaningful more effective (Alsumait and Musawi, 2013; Nischelwitzer, Lenz Searle and Holzinger, 2007). Among the new technologies in education, augmented reality technology has attracted attention for being one to one in learning, interacting with virtual and reality, and increasing attention and motivation (Singhal, Bagga, Goyal, and Saxena, 2012).

A majority of the augmented reality practices studies in the literature have reported positive results (Billinghurst, Kato and Poupyrev, 2001; Kaufmann, and Papp, 2006; Kerawalla, Luckin, Seljeflot and Woolard 2006). Augmented reality provides a realistic simulation opportunity in the fields such as astronomy, physics and geography with augmented reality applications (Shelton and Hedley, 2002). Since augmented reality technology allows to embody abstract concepts, experimental studies with augmented reality technology are likely to focus on natural sciences (physics, chemistry, and biology), mathematics and statistics (Özdemir, 2017).

Environments created with augmented reality applications offer new opportunities to the learning environment to obtain the precise information, and this information is understood in the most accurate way and is handled in all aspects (Abdüsselam and Karal, 2012). Augmented reality environments provide students with an environment suitable for their individual pace and their learning experience (Hamilton and Olenewa, 2010).

It is stated that the augmented reality has a positive effect on the motivation of the new generation students, which are called digital natives (Wojciechowski and Cellary, 2013). In addition, it is observed that students focused on the subject for a longer period of time in the augmented reality environment (Abdüsselam and Karal, 2012). In addition, augmented reality technology enables students to take an active role in their learning, as students are involved in one-to-one learning and instant feedback is provided through interaction (Bujak et al., 2013; Yuen, Yaoyuneyong and Johnson, 2011). According to Çakır, Solak, and Tan (2015), the use of augmented reality applications in education has important functions in terms of reviving three-dimensional objects or objects that cannot be brought to class in the real world and attracting the student to the lesson. Chen (2006) states that augmented reality creates environments that are more accepted by blending virtual and real materials and supports students' individual learning. As a conclusion, it can be argued that augmented reality contributes positively to the learning process of students as well as the factors affecting learning.

Purpose of the research

The present study is significance in that it will be an important source for future researchers to realize the negative or positive aspects of the previous studies. In addition, it is thought that it will be an resource for journal referees and editors as it presents a review of the studies in the field between 2012-2019. The answers to the following questions were sought in the present study that deals with the use of augmented reality applications for educational purposes between 2012-2019;

1. How is the number of articles distributed among the determined years by year?

2. How is the number of authors of the research distributed among the determined years?

3. Which research designs were widely used between the determined years?
4. How is the sample size distributed among the determined years?
5. Which data collection tools have been widely used between the determined years?
6. Which data analysis methods have been widely used between the determined years?

Importance of the research

It is argued that examinining and analyzing certain periods or studies in certain periods in order to determine the progress of the field is a common method in literature reviews (Erdem, 2011). It is also stated that the literature review has an important role in order to present the comprehensive information structures efficiently and to reconstruct the accumulated information (Erdem, 2011). Typically, examination and evaluation of the information produced in the field of education at certain time intervals presents information about the characteristics of the research as weel as providing guidance for future research (Erdem, 2011). In this context, the aim of the present study is to examine Turkish studies that addressed the use of augmented reality applications for educational purposes and that were published between 2012 and 2019 according to their distribution by years, the number of authors, research patterns, sample sizes, data collection tools, data analysis methods, and to perform the descriptive analysis. Since, to the best of the researchers, there is not a literature review in this field between the determined years, this study is important.

METHOD

Descriptive content analysis method was used in this study since the aim of this study was to examine augmented reality applications addressing the use for educational purposes in Turkey according to their distribution by years, the number of authors, research patterns, sample sizes, data collection tools, data analysis methods. According to Cohen, Manion and Marrison (2007), content analysis is used to examine the content of written sources, to summarize and specify the information determine a suitable theme. Similarly, the purpose of the content analysis is expressed as collecting similar properties of the data under a heading within the framework of certain concepts and explaining the relations between them (Yıldırım and Şimşek, 2006).

Scope of the research

Theses and articles published between 2012 and 2019 were obtained by searching the keywords 'augmented reality, education practices, education technologies, education technologies' in ULAKBİM, YÖK National Thesis Center and Google Academy databases. As a result, the scope of this study consisted of 106 publications including 60 theses and 46 articles published as of December 2019. These publications were analyzed using content analysis.

Data collection tool

The publication classification form, developed by Sözbilir, Kutu, and Yasar (2012) as a data collection tool, was rearranged according to the sub-problems of this study. These sub-problems are research patterns, data analysis methods, data collection tools, and sample sizes. In this sense; Information regarding name, authors, year, title, research design, data collection tools, data analysis methods, number of authors and sample sizes of the publications were collected.

Data Analysis

The obtained publications were examined one by one with the content analysis. Then, the data were analyzed using the frequency and percentage of the descriptive analysis types with the SPSS 22.0 program. The results are presented in the findings section in graphs and tables.

RESULTS

Data from 106 studies published between 2012-2019 were collected. The data were analyzed in the light of the research questions. In this section, the distribution of the number of studies by year, the number of authors in the studies, research design methods, sample sizes, and data collection tools are presented.

a.The number of studies by years

The number of studies dealing with augmented reality applications in education between 2012 and 2019 are given in Figure 2.

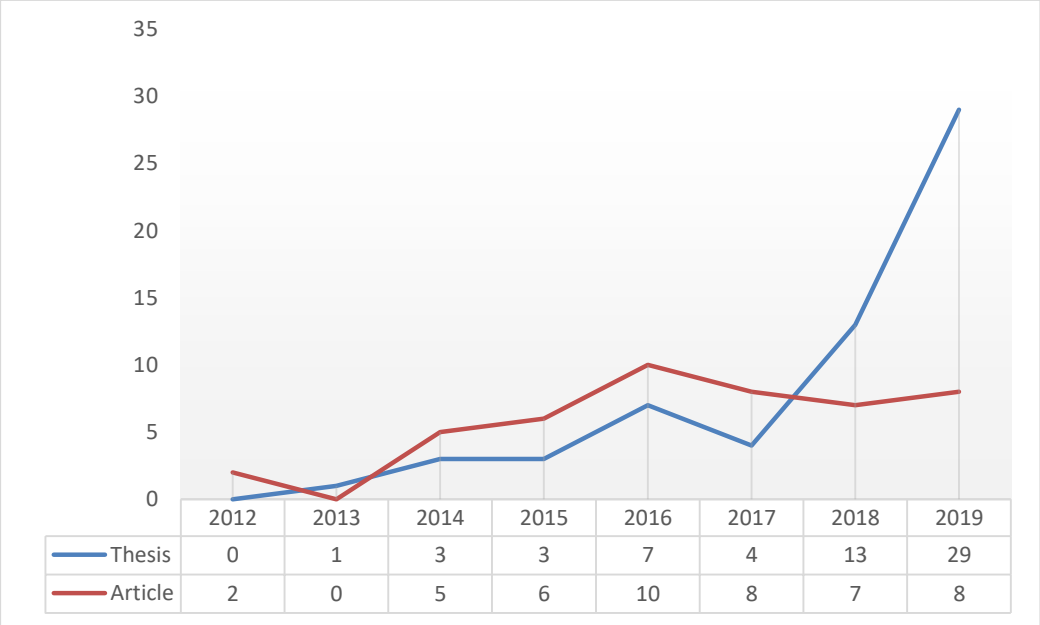

Figure 2. Number of Research by Years

Figure 2 shows that there are 60 thesis studies in total, including master's and doctoral theses. In the process that started with 1 (1,7%) thesis study in 2013, 29 (48,3%) studies were carried out in 2019. The analysis of articles shows that although the first studies was conducted in 2012, the studies intensified between 2016 and 2019. Considering the total number of studies, it can be seen that most of the studies 37 (34.9%) were conducted in 2019. The increasing inclusion of the augmented reality technology in education in recent years may be the reason for the increase in studies in recent years.

b.The number of authors by years

The number of authors in the studies was divided into groups to determine how many researchers conducted each study. The distribution of the number of authors is presented in Figure 3.

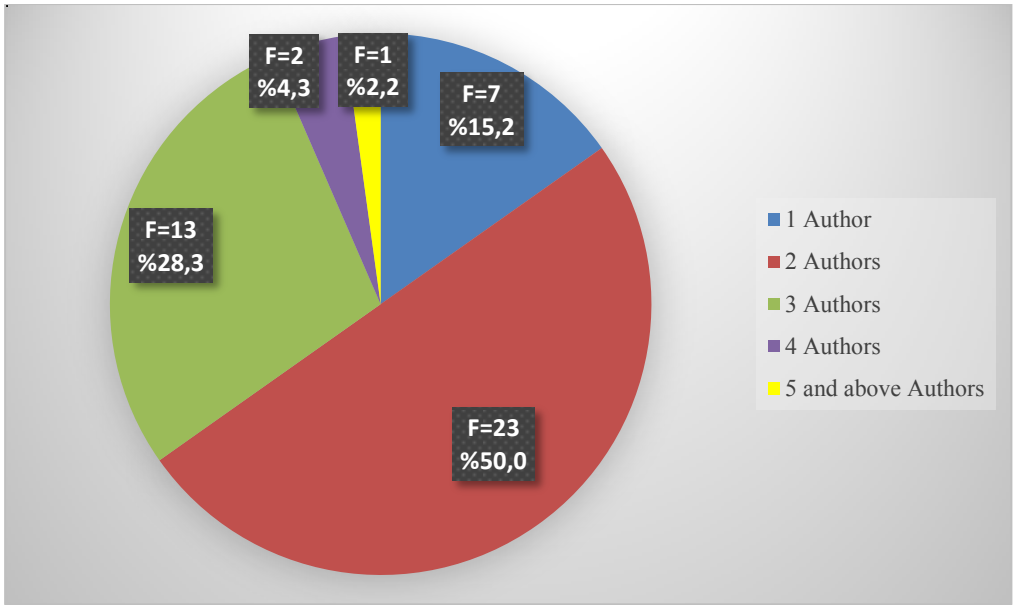

Figure 3. The Number of Authors of the Studies

7 (15.2%) of the articles were single-authored, 23 (50.0%) were two authored, 13 (28.3%) were written by three authors, 2 (4.3%) by four authors, and 1 (2.2%) by six authors. The findings show that most of the studies were two-authored.

c.The distribution of the research pattern used in the studies

The research methods of the examined studies were divided into 5 categories: quantitative, qualitative, mixed, methodological research, and design-based research. Among 106 studies, the used method was not specified in eight studies. The distribution of the methods is shown in Figure 4.

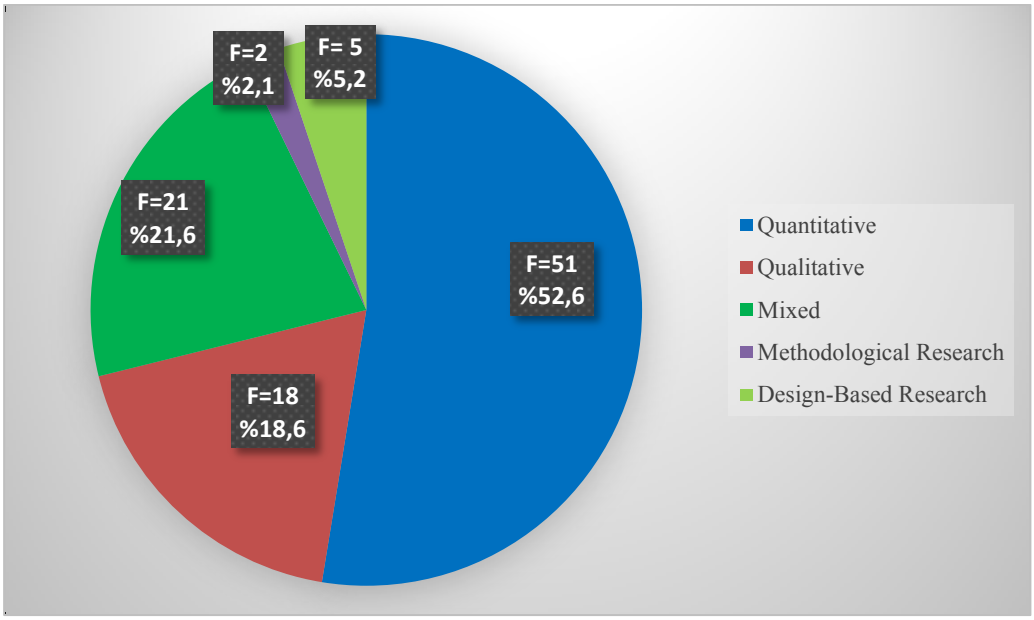

Figure 4. Research Method Distribution

Figure 4 shows that quantitative (52.6%), mixed (21.6%), qualitative (18.6), design-based (5.2%) and methodological (2.1%) research methods were used in the studies, respectively. The percentage and frequency of the research patterns are presented in Table 1.

Table 1. Research Patterns

Method	Pattern	Thesis		Article		Total	
		F	%	F	%	F	%
QUANTITATIVE	Experimental	6	10,0	3	8,1	9	9,3
	Comparative Analysis	-	-	2	5,4	2	2,1
	Scanning	-	-	6	16,2	6	6,2
	Quasi-Experimental	22	36,6	10	27,0	32	32,9
	Factorial	1	1,7	-	-	1	1,0
	Other	-	-	1	2,7	1	1,0
QUALITATIVE	Multiple Polling Model	2	3,3	-	-	2	2,6
	Systematic Review	-	-	1	2,7	1	1,0
	Meta-Analysis	1	1,7	-	-	1	1,0
	Case study	1	1,7	1	2,7	2	2,1
	Content Analysis	1	1,7	1	2,7	2	2,1
	Situation (Case Study)	3	5,0	2	5,4	5	5,2
	Phenomenology	-	-	2	5,4	2	2,1
	Other	-	-	3	8,1	3	3,1
MIXED	Sequential Explanatory	11	18,2	2	5,4	13	13,4
	Embedded	4	6,7	-	-	4	4,1
	Sequential Discoverer	-	-	1	2,7	1	1,0
	Converging Parallel	3	5,0	-	-	3	3,1
METHODOLOGICAL RESEARCH		1	1,7	1	2,7	2	2,1
DESIGN-BASED RESEARCH		4	6,7	1	2,7	5	5,2
	Total	60	100,0	37	100,0	97	100,0

Table 1 indicates that quasi-experimental designs (36,7%) were used the most in quantitative methods and the sequential explanatory pattern (18,3%) in mixed patterns is used the most in thesis studies. When the articles are analyzed, it is seen that quasi-experimental design (27.0%) and scanning (16.2%) methods are used the most among the quantitative methods. When the total of the studies are analyzed, it is seen that quasi-experimental patterns (32.9%), sequential explanatory patterns (13.4%) and experimental patterns (9.3%) are used, respectively.

d.The sample size distribution

The studies were divided into certain intervals in terms of sample sizes. The data are shown in Figure 5.

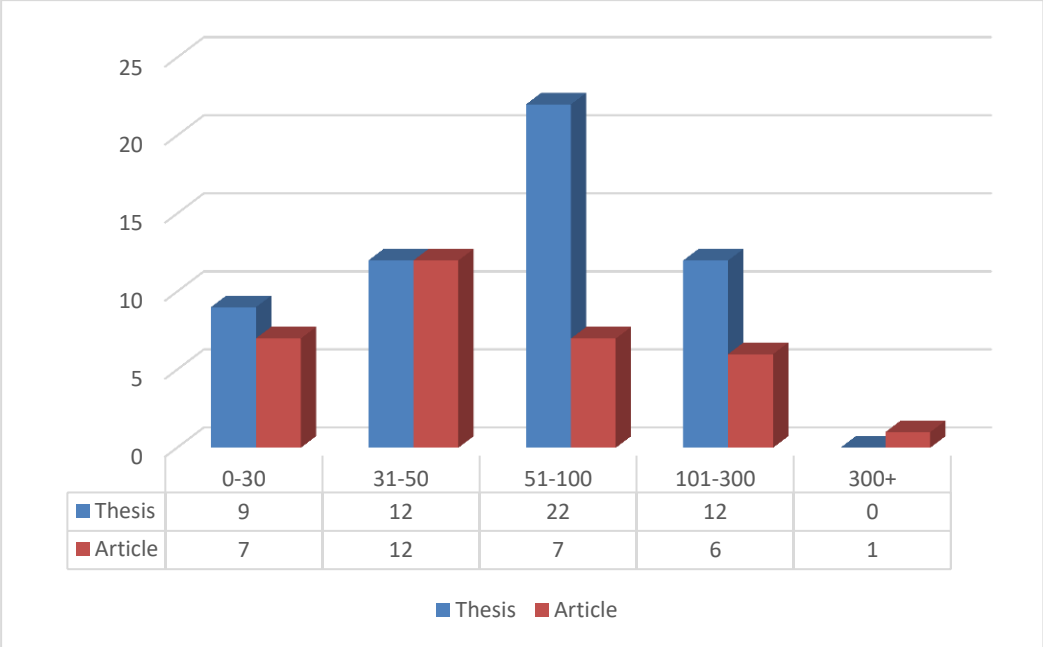

Figure 5. Sample Size Used in the Studies

An analysis of Figure 5 indicates that 22 (40%) thesis included a simple size of 51-100 participants. In addition, a sample size of 300 was not used in the examined thesis. On the other hand, the investigation of the articles shows that 12 (36.4%) studies used a a simple size of 31-50 participants. Contrary to thesis, 1 (3%) research article study included more than 300 participants. When all studies are analyzed together, it can be seen that most studies are in the range of 51-100 participants. There are 29 (33%) studies in the 51-100 range. Furthermore, it is seen that the number of studies is the lowest in the range of over 300 people. Overall, the sample size was found to be minimum of 3 and maximum of 618.

e.The distribution of data collection tools

The frequency of use of data collection tools in research is shown in Figure 6.

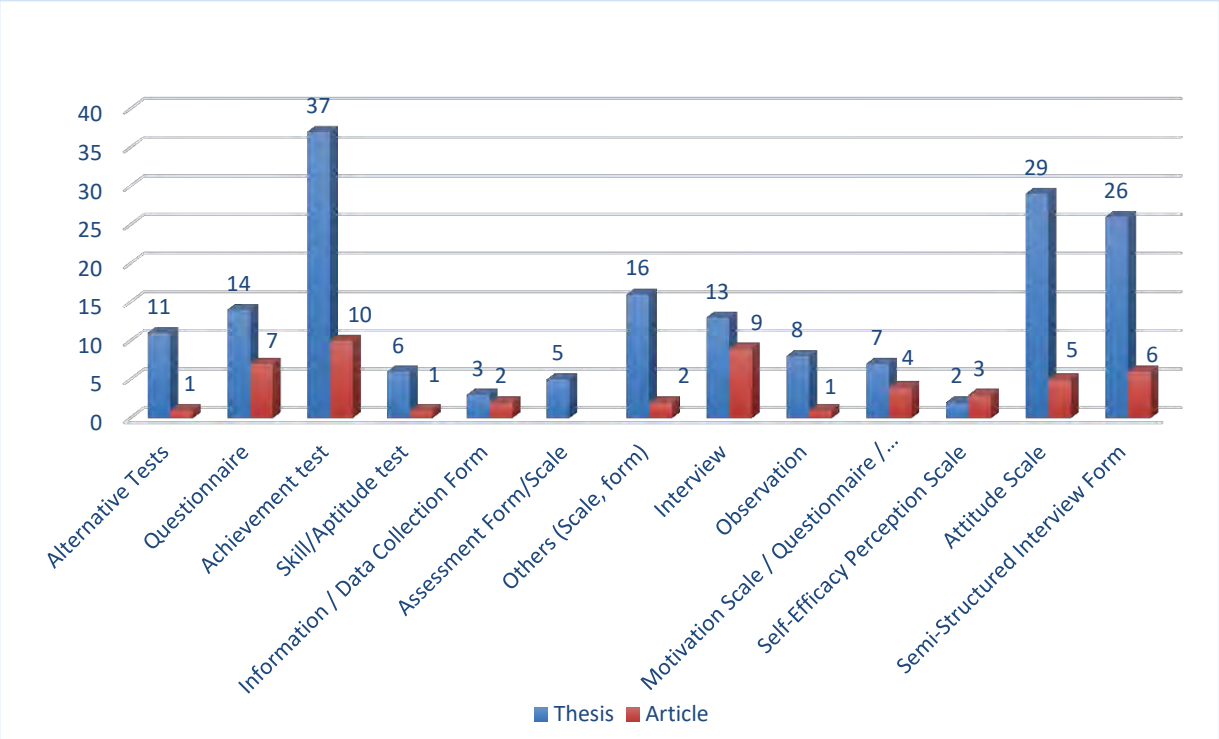

Figure 6. Data Collection Tools used in the studies

When the data presented in Figure 6 are examined, it was seen that the thesis studies mostly used the achievement test (20.9%), attitude scale (16.4%), semi-structured interview form (14.7%) and questionnaires (7.9%). However, In the articles data were collected from the achievement test (19.6%), interview (19.6%) and questionnaires (13.7%), respectively. If the thesis and articles are examined together, it is seen that the achievement test (20.6%), attitude scale (14.9%) and semi-structured interview form (14.1%) are the most preferred data collection tools.

d.Data analysis methods

To determine the data analysis methods, grouping was made under two titles as quantitative and qualitative methods. The distribution of data analysis methods used in the studies is shown in Figure 7.

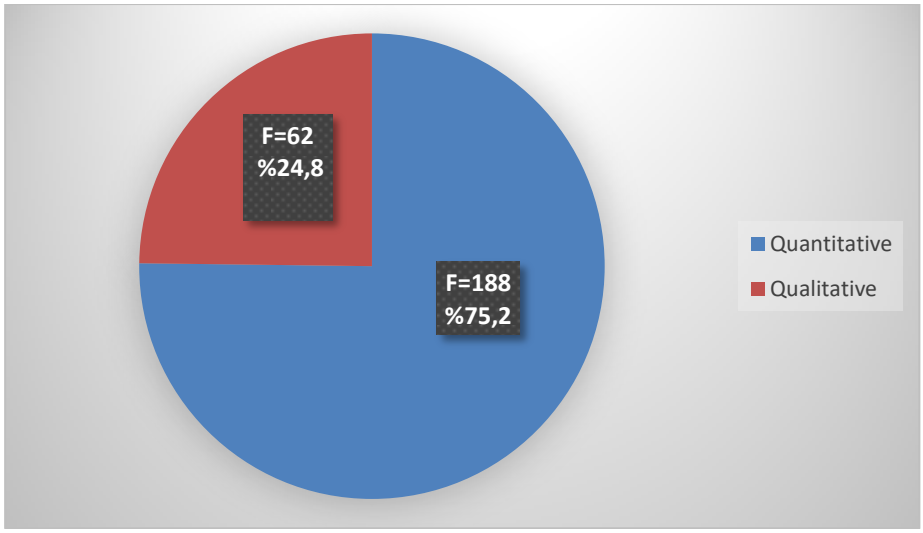

Figure 7. Data Analysis Method distribution

7 indicates that quantitative (75.2%) and qualitative (24.8%) data analysis methods are used in the studies, respectively. The percentage and frequency values of the data analysis types are presented in Table 2.

Table 2. Data Analysis Methods Used in Studies

Data Analysis Method			Thesis		Article		Total	
			F	%	F	%	F	%
QUANTITATIVE	Descriptive	Average-Standard Deviation	31	16,1	14	24,6	45	18,0
		Frequency-Percent	3	1,6	5	8,8	8	3,2
	Inferential	T-Test	37	19,2	10	17,5	47	18,8
		Anova	18	9,3	3	5,3	21	8,4
		Ancova	10	5,2	-	-	10	4,0
		Manova	4	2,1	1	1,8	5	2,0
		Wilcoxon Test	8	4,1	1	1,8	9	3,6
		Mann Whitney U Test	10	5,2	2	3,5	12	4,8
		Shapiro-Wilk	10	5,2	1	1,8	11	4,4
		Kruskal Wallis Test	4	2,1	1	1,8	5	2,0
		Other	11	5,7	4	7,0	15	6,0
QUALITATIVE		Content Analysis	14	7,3	9	15,8	23	9,2
		Descriptive Analysis	22	11,4	4	7,0	26	10,4
		Codification	8	4,1	2	3,5	10	4,0
		Other	3	1,6	-	-	3	1,2
		Total	193	100,0	57	100,0	250	100,0

It can be seen in Table 2 that the t-test (19.2%) is the most used inferential statistical method in the thesis, followed by average-standard deviation (16.1%) and descriptive analysis (11.4%) methods, respectively. On the contrary, the average-standard deviation (24.6%) is the most used descriptive statistical methods in the articles. This is followed by the t-test (17.8) and content analysis (15.8) methods, respectively. When the all of the studies are analyzed, it is seen that the t-test (18.8%), average-standard deviation (18.0%) and descriptive analysis (10.4%) methods are mostly used, respectively.

DISCUSSION AND CONCLUSION

This study is a content analysis study that investigates augmented reality publications addressing its educational uses in Turkish context between 2012 and 2019. To do that, descriptive analysis is performed according to their distribution by years, a number of authors, research patterns,

sample sizes, data collection tools, and data analysis methods. For this purpose, 106 studies published between 2012-2019 were included in the content analysis method.

The findings indicate that most of the research was done in 2018 and 2019, and the least in 2012 and 2013. Although the number of the studies on augmented reality was only 2 in 2012, a total of 37 studies were carried out in 2019. Over the years, it is seen that augmented reality technology gains value in educational sciences. This is due to the fact that augmented reality is a technology that has developed with the Industry 4.0 trend and has gained importance in the integration of education recently. In addition, the easier and faster preparation of applications made with augmented reality technology, the easy integration of the prepared applications into augmented mobile devices, and their availability for all age groups are important factors.

Regarding the number of the researchers, the studies have two authors (50.0%), three authors (28.3%), one author (15.2%), four authors (4.3%) and six authors (2.2%), respectively.

It is seen that there are a limited number of studies with four or more authors. This finding is consisted with those in Doğan and Tok's study (2018) who found that the number of authors is mostly two and three while studies with four and above authors is limited. In the study by Çiftçi and Ersoy (2019), it is seen that the number of authors is usually two authors. In another study, Gül and Maksüdünov (2019) examined the number of authors and stated that there was mostly one author study and that this was followed by two authors.

The findings of the present study also show that many methods were used in the investigated studies. It is seen that quantitative (52.6%), mixed (21.6%) and qualitative (18.6%) research methods are used the most. However, quantitative methods were used more than other methods. The reason for this finding may be that quantitative method analysis provides the opportunity to present more achievable results in less time and with less cost. These results are similar to the results of Yıldız, Baydaş, and Göktaş (2019) who alse carried out a content analysis study investigating the studies on the ARCS motivation model between 1997-2018. According to the results of content analysis of Yıldız, Baydaş, and Göktaş (2019), the most used method was quantitative method, also the mixed and qualitative studies gave close results to each other. In another study, Dilek, Baysan, and Öztürk (2018) analyzed the content of the studies on social sciences education and stated that the qualitative methods were used the most as a result of the studies examined. As a result of the studies examined, it is seen that the purpose of using the augmented reality technology in educational sciences is mostly made to examine student achievement, motivation and attitude. In line with these purposes, it is seen that quantitative and mixed studies serve their purpose.

In terms of research methodology, the quasi-experimental pattern (32.9 %) was found to be the most used methodolohy in the quantitative studies and case study was the most preferred methodoly in the qualitative research. In mixed studies, it is seen that the descriptive pattern (13.4%) is used. These findings are in line with the results of Selçuk, Palancı, Kandemir, and Dündar's study (2014) published in the journal of 'Eğitim ve Bilim'. They stated that the experimental and quasi-experimental designs were the most used ones in quantitative studies; case studies and phenomenological patterns were used in qualitative methods; and the descriptive pattern was used the most in mixed designs.

There is a difference in the sample size of the studies. The findings showed that there were 29 (33%) studies with sample size between 51-100. It is seen that the number of studies with sample of 300 and above is limited. Moreover, the minimum sample size was found to be 3 and the maximum participant number was 618.

The findings show that there are differences in data collection tools as well. Data collection tools vary according to the purpose and method of the research. In quantitative studies, tests and scales are preferred as they provide fast data collection. However, the finding of this study showed that the achievement test (20.6%), attitude scale (14.9%) and semi-structured interview form (14.1%) were the most preferred data collection tools. It can be said that the use of achievement test, questionnaire and

scales results mostly from the need to obtain data from large samples (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2009). Similarly, Uygun and Sonmez (2019) stated that the achievement test, the questionnaire, and the interview form were the most used data collection tools in studies on mobile learning. In a different study, Dönmez and Gündoğdu (2016) examined the studies published in the field of Turkish education programs and stated that the achievement test and interviews were the most used data collection tools in the studies.

Considering the distribution of data analysis methods in the study, quantitative (75.2%) and qualitative (24.8%) analysis methods were used in the examined studies. For quantitative research methods, t-test (18.8%) and the average-standard deviation (18.0%) are the most used ones. Among the qualitative data analysis methods, descriptive analysis and content analysis methods were preferred the most. These finding are similar to those in the literature. In the content analysis of Yıldız, Baydaş and Göktaş (2019), they stated that quantitative data analysis methods are used more than qualitative data analysis methods. In addition, they stated that the t-test is mostly used in quantitative data analysis methods, and descriptive analysis is used more than content analysis in qualitative data analysis methods. As a result of the study conducted by Erdem (2011), it is seen that t-test is preferred among quantitative data analysis methods, and descriptive analysis is the most preferred method of qualitative analysis. In this context, the reason why t-test and descriptive analysis are mostly used is that quantitative studies are intense.

RECOMMENDATIONS

As a result of this study investigating the studies dealing with the use of augmented reality applications for educational purposes, the following suggestions can be made for future studies:

- The mixed research method, in which qualitative and quantitative methods are used together, can be applied more frequently.
- The number of studies involving large sample groups can be increased.
- The number of studies using different data collection tools can be increased.
- Not only studies in Turkish but also studies in English can be included in the content analysis study.

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