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Research Trends on the Use of Augmented Reality Technology in Teaching English as a Foreign Language

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The main aim of this research is to display research trends in studies on augmented reality (AR) in teaching English as a foreign language by using bibliometric mapping and content analysis. For this purpose, 64 studies in total published up to 2019 were accessed for bibliometric analysis. In addition, 49 articles published between 2007 and 2019 were reached for content analysis. The bibliometric mapping results indicated that related studies mostly focused on the effectiveness of mobile and ubiquitous learning. In addition, early childhood education, mobile learning, and gamification have become the focus of recent research. While Thorne, Azuma and Squire are the mostly cited authors in this field, Computers & Education, Educational Technology & Society, British Journal of Educational Technology and Computers in Human Behavior are among the journals cited most. Content analysis results revealed that academic achievement and motivation were the most commonly examined variables in the studies. These results revealed that most of the studies were grounded on quantitative research designs, especially experimental designs. Questionnaires and achievement tests were the most used data collection tools. While purposive sampling was the most preferred sampling method, there was an increase in the adoption of random sampling in 2011. Finally, descriptive statistics, T-tests, ANOVA-ANCOVA, and correlation analysis were mostly performed quantitative analysis methods, and content analysis was mostly used in qualitative analysis.

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Introduction

The widespread use of educational technology can be seen in many aspects of human life, including education. Educational technology, which is to be adapted even more widely in the future and which is to lead continuous innovation (EDUCAUSE, 2021), has been appreciated with regard to its contributions from motivational and pedagogical perspectives (Bacca, Baldiris, Fabregat, Graf, & Kinshuk, 2014; Dash, Behera, Dogra, & Roy, 2018). Among the areas in which the integration of technology has reflected its unique effects in education is the particular field of language education (Kessler, 2017). Such various forms of technological advances as computer-assisted language learning (Garrett, 2009; Wang & Liao, 2017), mobile-assisted language learning (Miangah & Nezarat, 2012) and ubiquitous language learning (Fallahkhair, Pemberton, & Griffiths, 2007) have been examples of technology-enhanced processes contributing to language education. Among these technology types, augmented reality (AR) has also taken its unique place in language education (Azuma, 2016).

The initial application of AR technology dates back to the 1950s when it was integrated into the film industry (Carmigniani, Furht, Anisetti, Ceravolo, Damiani, & Ivkovic, 2010). Then in the 1990s, AR technology was integrated into the fields of medicine, aviation and computing as a training design (Bajura, Fuchs, & Ohbuchi, 1992; Feiner, MacIntryre, & Seligmann, 1993). Along with the improvements in Web 2.0 technology and continuous developments in computing and mobile technology, AR has been adopted in teaching and learning, supporting educational processes (FitzGerald et al., 2013), including language education (Blyth, 2018). Regarding its state between reality and virtuality, Azuma (1997) states that AR presents a combination of real-life experience and digital perceptions. Offering a more comprehensive definition, Cabero and Barroso (2016, p. 44) maintain that AR utilizes "a set of technological devices that add virtual information to the physical one" forming a real-time display of physical and digital information. Clearing the mid-state position of this technology, Kapp and Balkun (2011, p. 101) explains that "on one end we have reality, and on the other, virtual reality, where we re-map as many senses as possible through the use of communication technology to present an alternate interface to the world around us" and further comment that AR "is a predominantly real-world space in which virtual elements are inserted in real-time."

Introducing a novel combination, AR technology brings major advantages to educational processes in general and language education in particular. The major contributions of AR technology in language education cover its strength in a) offering enjoyable learning atmospheres (Safar, Al-Jafar, & Al-Yousefi, 2017), b) being a significant visual-aid attracting learners' attention and helping them better concentrate on the learning process (Kim & Kim, 2018), c) increasing learner attention and concentration to enhance understanding and cognition (Shelton, & Hedley, 2004), d) encouraging learners to take active part in learning practices (Chen, Zhou, Wang, & Yu, 2017; Ho, Hsieh, Sun, & Chen, 2017), e) increasing learning accomplishment while lowering learners' cognitive load and anxiety (Solak & Cakir, 2015), f) maintaining interactive learning environments where learners can develop their communicative skills in the target language (Chen, et al., 2017; Liu & Tsai, 2013) and g) supporting collaboration among students and enabling the practice of language skills (Dörnyei & Ushioda, 2011; Hsu, 2017; Liu, Holden, & Zheng, 2016; Liu & Tsai, 2013). The advantages listed about the contributions of AR technology in education point at the increasing popularity of the integration of this particular technology in language education and the investigation of its effects from different dimensions in the literature.

Literature Review

The related literature reveals that AR-integrated language education has become an area receiving growing attention worldwide with an increase in research, especially in the last two decades. The research studies on AR integration have been carried out at four educational levels ranging from pre-school education to higher education, according to which the related studies are presented in this sub-section.

One of the sample groups with which AR research has been carried out was pre-school level language learners. In these studies, on AR integration in pre-school language education (Chen, et al., 2017; Dalim, Dey, Piumsomboon, Billinghurst, & Sunar, 2016; He, Ren, Zhu, Cai, & Chen, 2014; Lee, Chau, Chau, & Ng, 2017; Martinez, López Benito, Artetxe González, & Bilbao Ajuria, 2017), the effects of AR technology on vocabulary development have been the major research focus. The results of these experimental studies revealed the benefits of integrating AR technology into English language education since the technology promoted active and interactive learning situations, enabled the learners to develop their vocabulary knowledge and skills without contextual and temporal constraints, increased learner interest and motivation, and maintained active participation. Examining the effectiveness of AR technology in teaching the English alphabet to pre-school children was also among the areas presented in the related literature. In experimental studies, Safar et al. (2017) and Dash et al. (2018) reported that AR integration promoted the process of alphabet teaching since it increased retention and learning success.

Primary-level English language learners were another sample group with which AR studied were conducted. As it was the case in research on pre-school language education, the major focus in primary level English language education is vocabulary development (Barreira, Bessa, Pereira, Adão, Peres, & Magalhães, 2012; Chen & Wang, 2015) and phonics instruction (Limsukhawat, Kaewyoun, Wongwatkit, & Wongta, 2016). The results of these experimental studies pointed at the benefits of AR technology in supporting vocabulary development with its particular dimensions. Besides its effects on vocabulary development, AR technology was also examined in relation to achievement, learning performance, cognitive load, attitude, and motivation variables (Castañeda, Guerra, & Ferro, 2018; Hsu, 2017; Kucuk, Yilmaz, & Goktas (2014). These studies showed that AR technology promoted English language development since it decreased primary school students' cognitive load, helped them develop positive attitudes towards language learning, and stimulated their motivation, learning performance and achievement.

Another sample group involved in AR research in English language education was secondary level students. At this educational level, AR technology was studied about the development of conversational skills (Liu, 2009), the perceptions of teachers and students (Hsieh, 2016a) and the technology acceptance level of the particular learner profile (Hsieh, 2016b). The studies conducted at the secondary level indicated that AR technology was efficient in enhancing learner motivation, increasing concentration and positively affecting learning behaviors and experiences.

English language learners studying at higher education level were also among the participants involved in AR research. Such variables as perceived satisfaction and usefulness (Chang, Chen, Huang, & Huang, 2011), learner motivation (Li, Chen, & Vorvoreanu, 2014), learning strategies (Ho et al., 2017) and instructor perceptions (Aksoy & Dimililer, 2017; Chen & Chan, 2019; Cevik, Yilmaz, Goktas, & Gulcu, 2017; Hsieh, 2016a) were among the most

frequently studied aspects in relation to AR integration into tertiary English education. The effects of the technology on the development of overall language knowledge and skills (Richardson, 2016) and the development of English composition (Liu & Tsai, 2013) were also investigated in AR research in higher education.

It can be concluded from the overall evaluation of the research studies that the integration of AR in the process of English language education has become an interesting topic of investigation. The effectiveness of AR on such variables as learning success, learner motivation, satisfaction, cognitive load, and learner engagement have been the major issues that were examined in the existing literature. In addition, the examination of the AR-integrated language education at different educational levels generally highlighted the positive contributions of the technology in enhancing the process by increasing learners' attention, concentration, and motivation. A summary of some studies on AR integration in language education at different educational levels is provided in Table 1.

Table 1. Studies on AR integration in language education at different educational levels

Author(s) of the Study	Aim of the Study	Results of the Study
Lee et al. (2019)	To examine the integration of AR technology to enhance language teaching and learning in kindergarten and to explore its effects in long-time use	The preliminary results pointed at the contributions of the technology for students, teachers and parents
Taskiran (2019)	To investigate AR-supported game-based language learning experience	According to the results of the questionnaire, AR-supported learning was considered motivating and enjoyable
Zhang (2018)	To examine existing literature on AR in foreign language learning	The review underlines the integration of AR in skill development, adopted AR tools as well as the advantages and disadvantages of AR-supported language learning.
Ibrahim et al. (2018)	To examine the contributions of AR in learning vocabulary	The results indicated that AR is more enjoyable and efficient in vocabulary learning.
Dash et al. (2018)	To study AR integration in alphabet teaching to kindergarten students	The adoption of the marker-based AR application offered an engaging and motivating experience for the particular age group.
Castañeda et al. (2018)	To highlight the integration of AR technology in language education	The statistical analysis of the experimental results revealed that AR integration supported the educational process and increased the learning performance.
Lee et al. (2017)	To teach basic English vocabulary to kindergarten learners	The tool was beneficial and effective as the learners could use the tool to learn vocabulary any time and any place actively and interactively.
Chen, Zhou, Wang, & Yu (2017)	To evaluate the effectiveness of AR integration in vocabulary learning	The AR tool raised learner interest and increased active participation in learning vocabulary.
Safar et al. (2017)	To reveal the effectiveness of AR tools in teaching the English alphabet	The AR-instructed group outperformed the control group in terms of retention and learning success.
Hsu (2017)	To design different AR-supported game systems	Regardless of the learning approach, the AR tool enhanced the language learning experience motivating the participants.
Ho et al. (2017)	To study the effects of cognitive styles and learning strategies in AR-supported learning	Differences in learning styles and strategies led to differences in learning performance in AR-supported learning.
Dalim at al. (2016)	To teach basic level English vocabulary and compare AR technology to traditional teaching methods	The AR tool was reported to be effective and enjoyable compared to traditional learning.
Amaia, Iñigo, Jorge, & Enara (2016)	To examine AR effectiveness in learning vocabulary	The AR design promoted vocabulary learning and it supported learner autonomy and self-evaluation.
Limsukhawat et al. (2016)	To design an AR-supported tool to develop learners' phonics learning	Students who learned with this application improved their phonics learning performance and revealed positive attitudes towards the application.

Richardson (2016)	To examine how AR-supported games promote language learning	The AR games enhance language learning by engaging learners.
Hsieh (2016b)	To investigate learner and teacher perceptions regarding AR materials	The AR technology increased motivation and concentration and improved learner behaviors.
Hsieh (2016a)	To present AR-based technologies to develop and evaluate a mobile English learning system	The AR tool promoted learner attention and improved learning behaviors.
Chen & Wang (2015)	To examine learning styles in AR-supported vocabulary learning	Field-dependent learners utilized the AR tool more and learner achievement affected the performances.
Li et al. (2014)	To evaluate the motivational effects of an English vocabulary learning application built upon AR technology	AR was shown to potentially raise learner motivation.
Kucuk et al. (2014)	To assess learners' attitude, achievement and cognitive load levels in learning English via Augmented Reality	The participants enjoyed the learning experience and had low anxiety.
He et al. (2014)	To use the AR technology in vocabulary teaching at the pre-school level	The results showed that AR-supported vocabulary learning was more effective in pre-school language education.
Liu & Tsai (2013)	To develop AR-based mobile learning material in EFL English composition	The AR material promoted linguistic knowledge and content knowledge in writing.
Barreira et al. (2012)	To use MOW in teaching English animal names	The AR game promoted learning progress compared to the traditional methods.
Chang et al. (2011)	To study learner satisfaction and intention while evaluating the system effectiveness	System quality and perceived self-efficacy affected perceived satisfaction and usefulness in using the AR tool.
Liu (2009)	To design an AR tool to promote language learning	HELLO enhanced the participants' listening and speaking skills in English.

In addition to the above-mentioned experimental studies, there are also several reviews and meta-analysis studies on using technology in English language education presented by Avgousti (2018), Chiu, Kao, and Reynolds (2012), Golonka, Bowles, Frank, Richardson, and Freynik (2014), Turan and Akdag-Cimen (2019) and Yousefi and Biria (2019). However, though there are review studies on the integration of technology in different educational fields, there is scarcity in such systematic studies focusing on AR integration in English foreign language education. Among these few studies, Zhang (2018) conducted a review study with 10 studies and concluded that these studies, most of which were conducted with learners at higher education, focused on learning English as a foreign language among other languages and vocabulary learning in the educational process. Khoshnevisan and Le (2018) also did a review study in which they examined 19 studies in terms of the contributions and limitations of AR in language education and its affective and educational results. When the review studies are examined, it is observed that these studies are small-scale studies that are based only on content analysis. The present study aims to contribute to the literature by presenting a bibliometric analysis of the research in the Web of Science and content analysis of the studies with full-texts. In this sense, this study is thought to give new insights to future research in the field.

In the light of these conclusions, this study aims to present a bibliometric mapping and content analysis of the research on AR in foreign language education published studies in Web of Science database. Within this scope, this study is expected to contribute to the field by revealing the AR research trends in terms of the trend subjects, leading authors and journals, examined variables, methodologies, data collection tools, sampling methods and data analysis. Below are presented the research questions on which this study is based:

(1) Which keywords are used most in research on the use of AR in foreign language education?
(2) Which words are used most in the abstracts of research on the use of AR in foreign language education?
(3) Which researchers are cited most in articles on the use of AR in foreign language education?
(4) Which journals are cited most as regards the use of AR in foreign language education?
(5) Which variables were examined most in research on the use of AR in foreign language education?
(6) Which methodological trends, data collection tools, sampling methods, sample groups, sample sizes and data analysis methods were preferred most in research on the use of AR in foreign language education?

Method

Content Analysis

For the content analysis in this study, research on the integration of AR in foreign language education, conducted between 2007-2019, was selected since there is no relevant study before 2007. In order to reach the studies, all indexes in the Web of Science database were selected as the literature source. The year interval was determined between 2007 and 2019 and “English” as the language. Initially, TOPIC: ("augmented reality"

AND (English OR ESL OR EFL)) keywords were used and 39 studies were accessed. Then, TOPIC: ("English education" OR "English learning" OR "English teaching" OR "foreign language" OR "second language") AND TOPIC: ("augmented reality" or "AR technology") keywords were used and 20 studies were reached. As a result of this process, 59 studies on AR-integrated foreign language education in "education scientific disciplines" and "education educational research" categories were accessed (Access date: Oct, 2019).

The full-text-downloaded studies were all analyzed by three researchers in the light of inclusion and exclusion criteria. The researchers started the analysis process by analyzing ten articles together. Then, one of them completed the content analysis with the rest of the selected articles. In the case of conflicting situations, all the researchers analyzed the article to reach a common decision. The first inclusion criterion was the selection of research on foreign language education and the second was analyzing AR applications in the studies. The research which was not particularly related to foreign language education or AR technology and the review of technical studies were excluded from the analysis. As a result of this inclusion and exclusion process, a total of 49 studies which were published in different journals between 2007 and 2019 were selected for content analysis. The study selection process followed in this study is displayed in Figure 1.

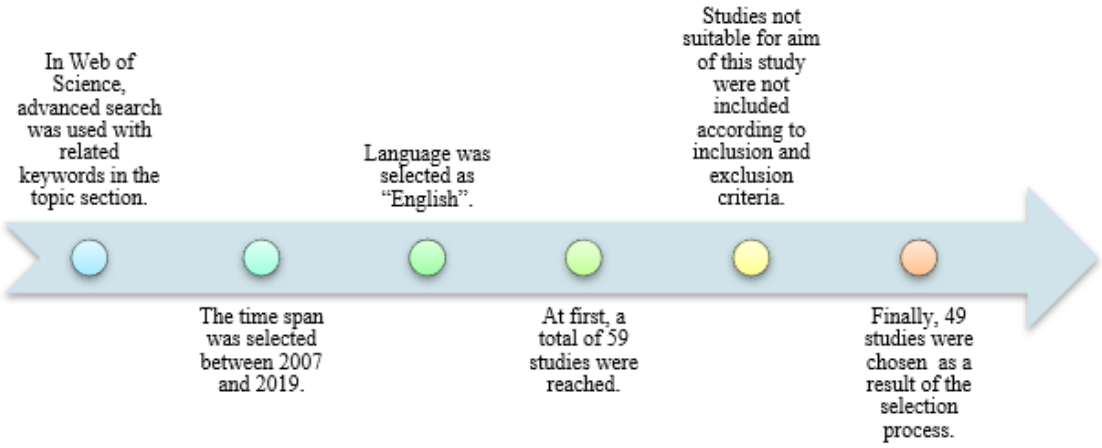


Figure 1. Study selection process for content analysis

Bibliometric Mapping Analysis

Web of Science was preferred as the database for bibliometric mapping analysis with no particular time. The keywords selected for content analysis were also used for the bibliometric analysis. 64 studies on the integration of AR in foreign language education were accessed (Access date: Oct, 2019). Full-texts and cited references in these studies were downloaded in tab-delimited (Win) file format. The file was used in the VOSViewer program.

The Data Coding and Analysis

The VOSViewer program was used in the bibliometric mapping analysis to display network visualization. In this context, co-occurrence analysis was used to create a map showing the most used keywords. The relatedness of items is determined based on the number of documents in which they occur together. For content analysis, The Publication Classification Form, developed by Goktas et al. (2012), was adopted. The

form involved five categories including the research title and author(s) name/s; journal name; research methodology; data collection instruments; participants and data analysis process. Using this form for content analysis, the three researchers analyzed and discussed the data in collaboration. The findings were analyzed with descriptive statistics.

Findings

Bibliometric Mapping Analysis Findings

Words Used Most in Abstract Sections in the Reviewed Studies

To create a map showing the words used most in the abstracts, 'abstract and binary counting method' was chosen in the field section. Figure 2 shows the map created as a result of the analysis. Three clusters were displayed and "game" was the word used most in the abstracts (*f=12*). Language (*f=11*), content (*f=9*), language learning (*f=9*), teacher (*f=9*) and effectiveness (*f=9*) were the keywords used most. The results showed that there is a focus on the effectiveness of AR technology and teachers were the agents involved in the studies most. A year-by-year analysis shows that the examination of AR in foreign language education is gaining popularity. Figure 3 presents the distribution of the words used most in the abstracts.

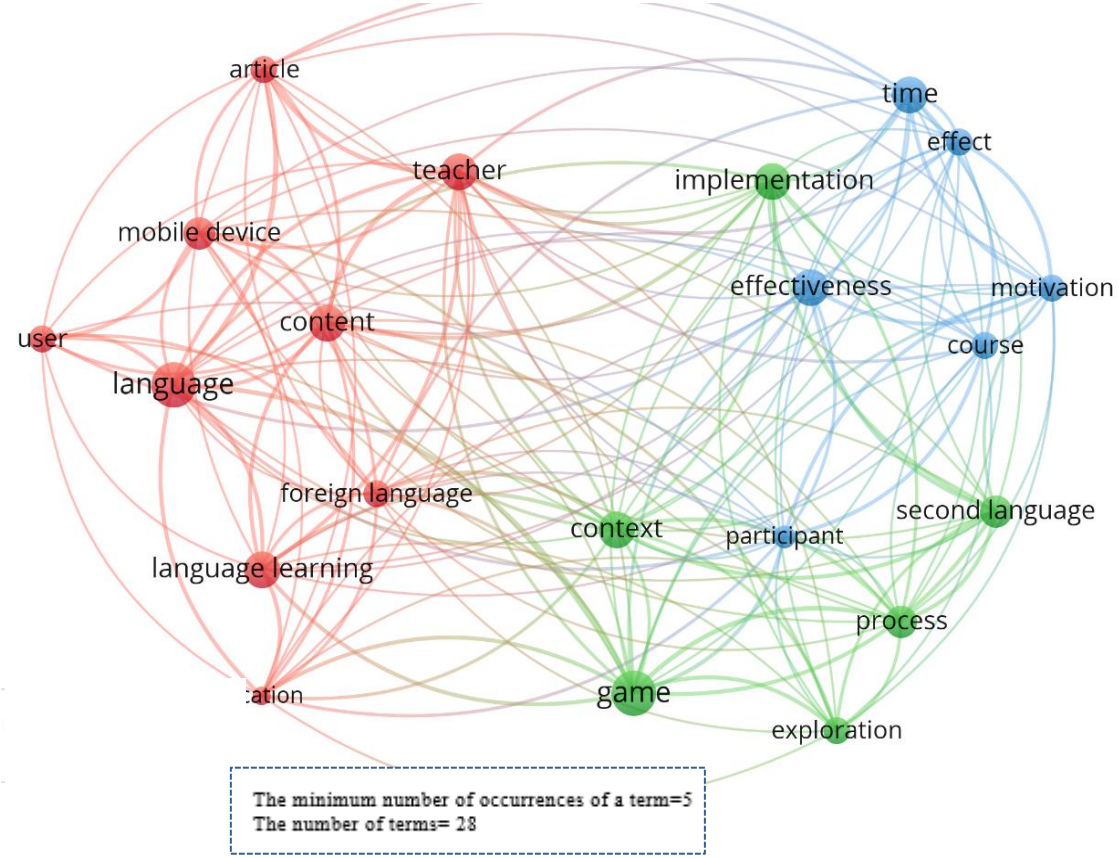


Figure 2. Words used most in abstracts.

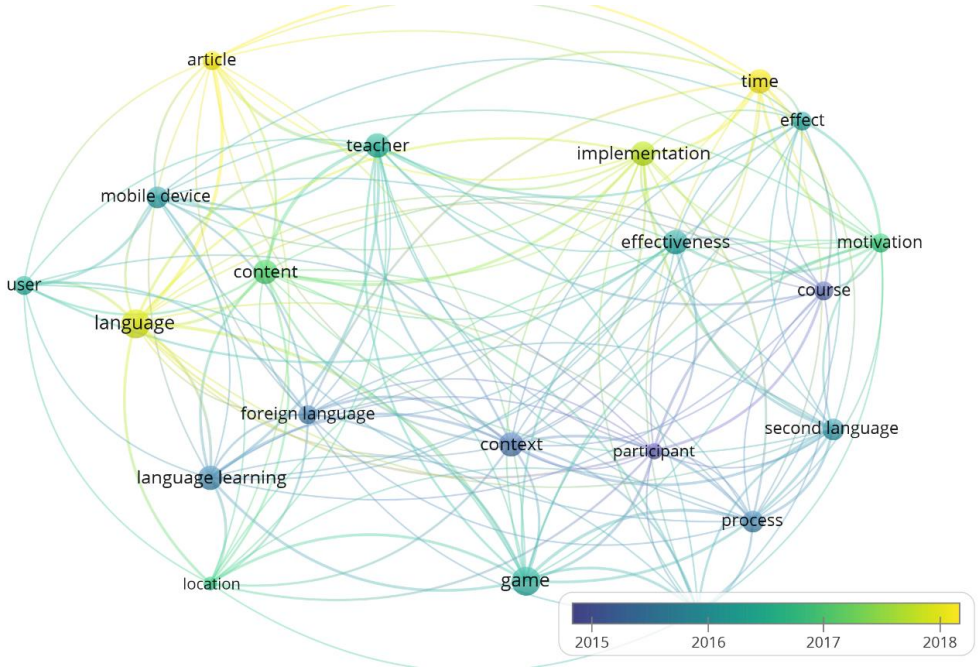


Figure 3. Distribution of the words used in abstracts most by year

Keywords Used Most in the Reviewed Studies

To create a map showing the most used keywords, co-occurrence analysis was used. The map is presented in Figure 4.

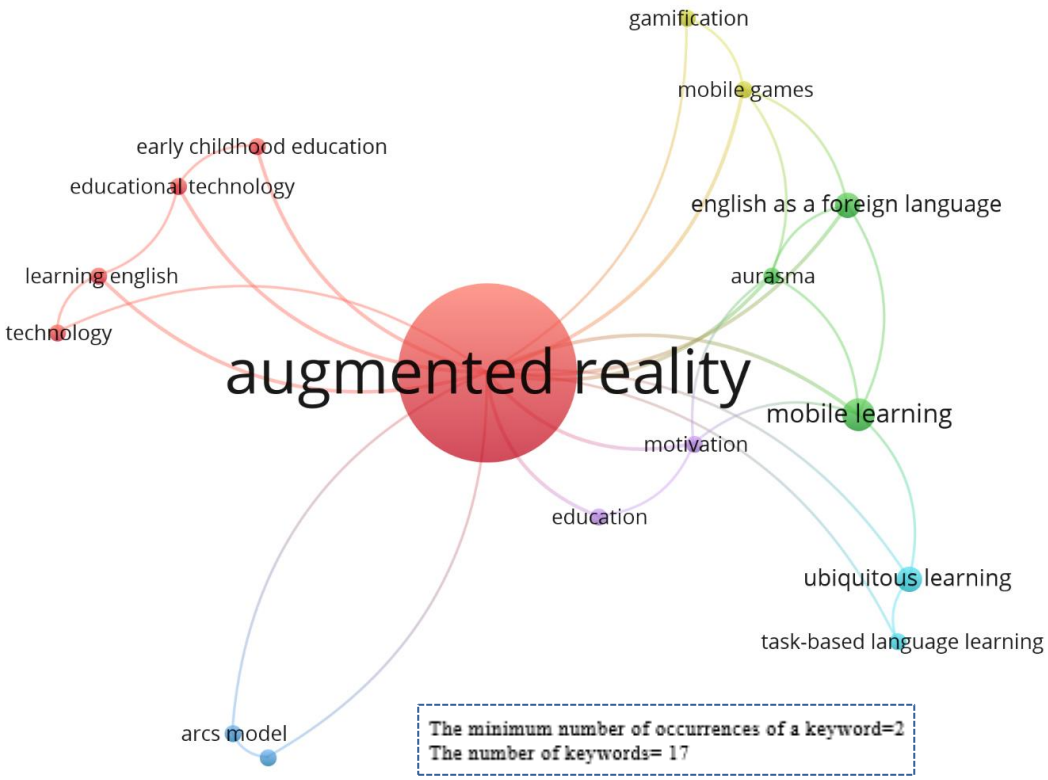


Figure 4. The keywords used most

As shown in Figure 4, there are six clusters and the keyword used most is 'augmented reality' (*f=25*). Besides, 'mobile learning' (*f=4*), 'English as a foreign language' (*f=3*), 'ubiquitous learning' (*f=3*), 'aurasma' (*f=2*) and mobile games (*f=2*) were among the keywords used most. These results show that mobile learning, ubiquitous learning, and mobile games in foreign language education were the aspects examined in the related studies. A year-by-year analysis presented in Figure 5 indicates that early childhood foreign language education in English, mobile learning, gamification, and mobile games have become the focus of recent research.

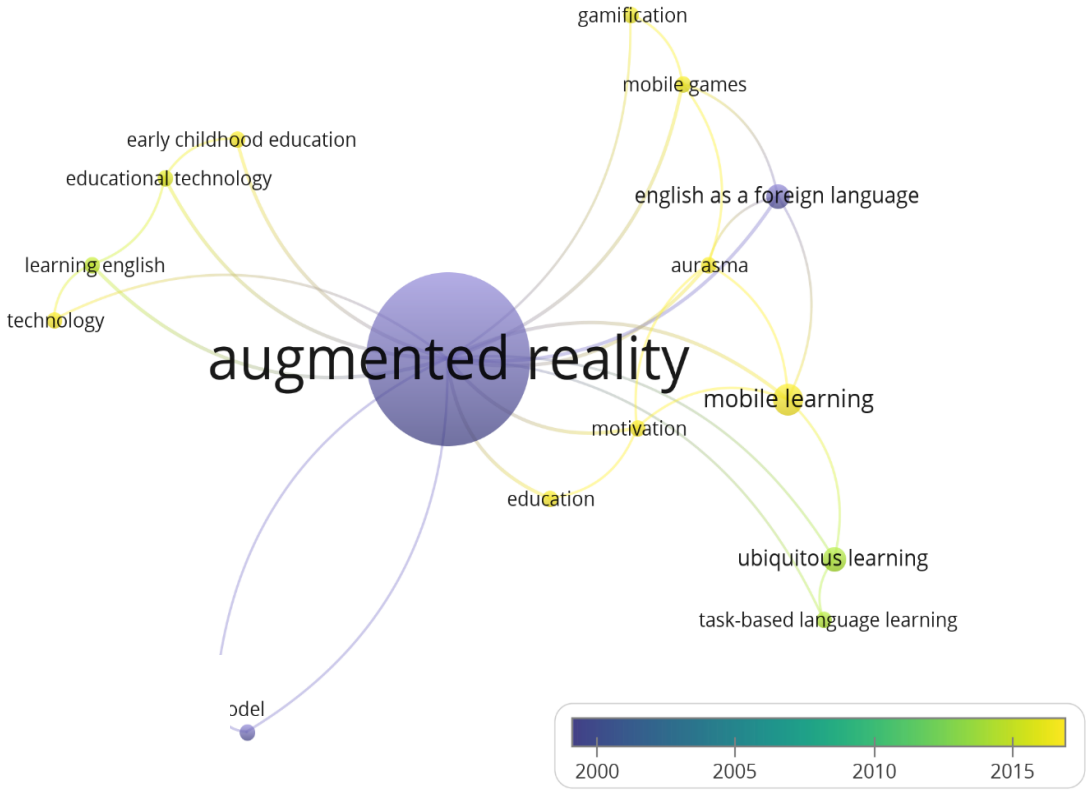


Figure 5. Distribution of the number of keywords by year

Authors Cited Most in the Reviewed Studies

Citation analysis and authors were chosen to create a map showing authors cited most. Figure 6 shows the created map. The analysis showed that Liu, T.Y. (*106 citations*), Liu, Pei-Hsun Emma (*34 citations*) and Tsai, Ming-Kuan (*34 citations*) were the authors cited most in this field.

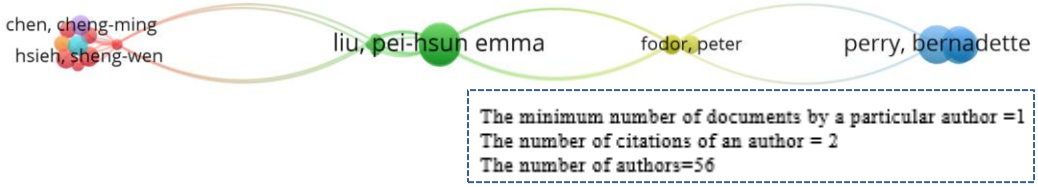


Figure 6. Authors cited most (Citation analysis)

Co-citation analysis and cited authors were also revealed. Figure 7 shows the created map. As a result of the analysis, Thorne (*19 citations*), Azuma (*17 citations*) and Squire (*17 citations*) were observed to be the authors most cited (co-citation) in this field.

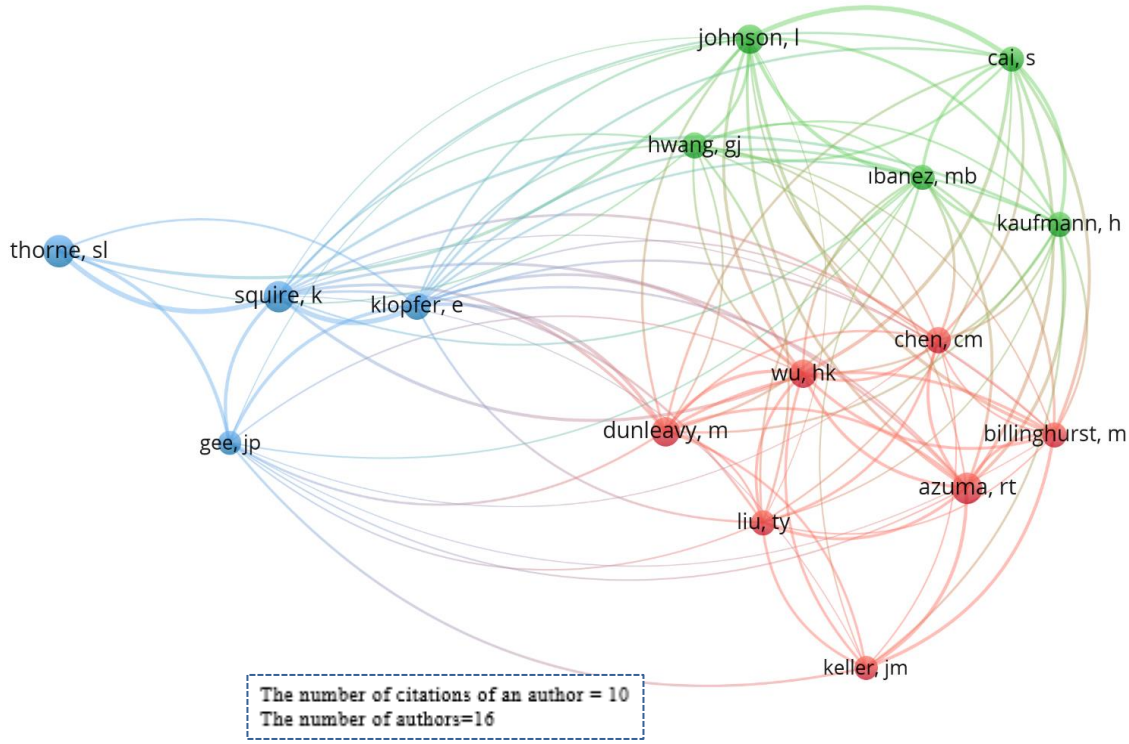


Figure 7. Authors cited most (Co-citation analysis)

Journals Cited Most (Citation and Co-Citation) in the Reviewed Studies

To create a map showing the most cited journals, citation analysis and sources were selected. Figure 8 shows the created map. The analysis showed that Journal of Computer Assisted Learning (106 *citations, 1 document*), British Journal of Educational Technology (54 *citations, 2 documents*), Educational Technology & Society (*28 citations, 3 documents*) and Computers & Education (*19 citations, 1 document*) were the journals cited most.

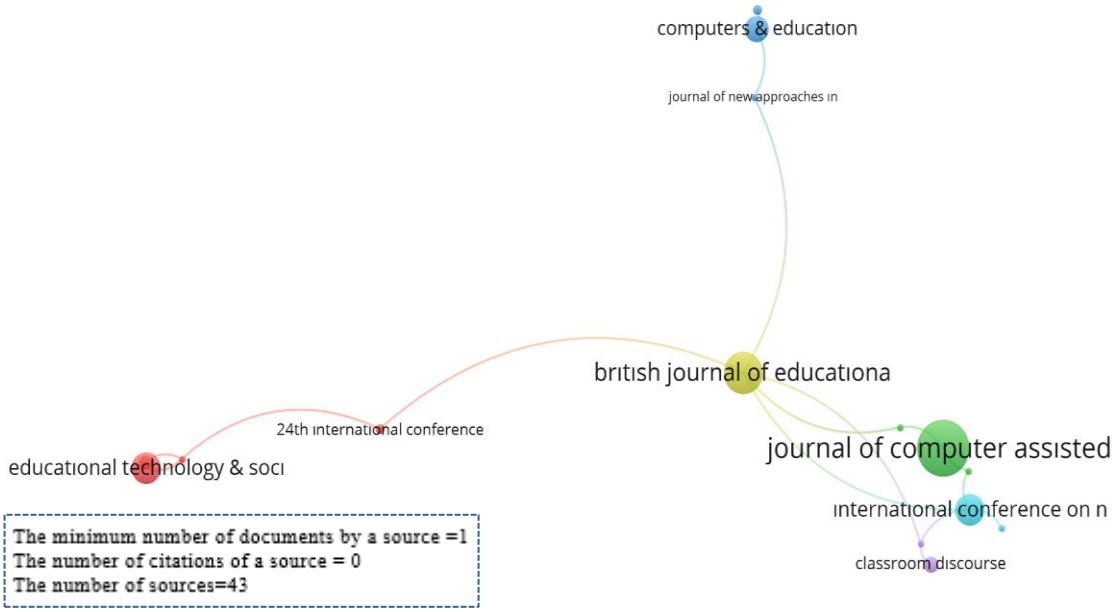


Figure 8. The journals cited most (citation analysis)

Co-citation analysis and cited sources were also chosen. Figure 9 presents the created map. Computers & Education (*136 co-citations*), Educational Technology and Society (*36 co-citations*), British Journal of Educational Technology (*25 co-citations*) and Computers in Human Behavior (*23 co-citations*) were the journals cited most.

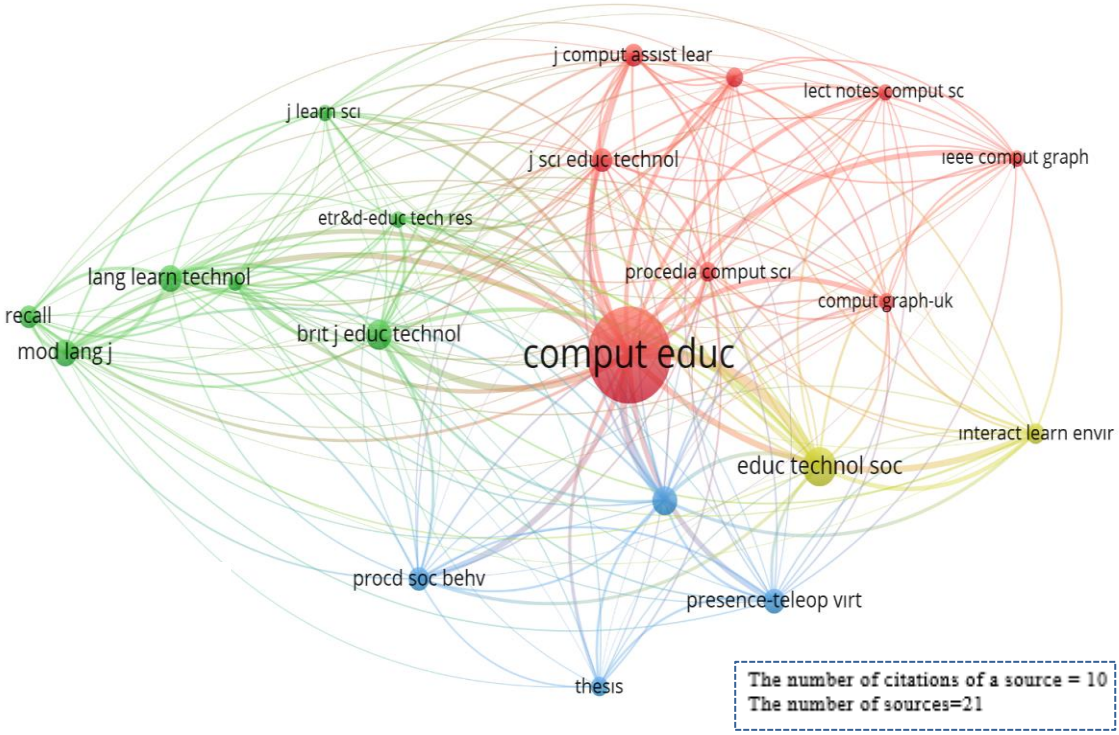


Figure 9. Journals cited most (co-citation analysis)

Content Analysis Findings

Mostly Examined Variables in the Reviewed Studies

The variables examined in the selected studies were determined as a category, which is presented in Table 2. Since one study may point at more than one variable, the total frequencies were high. The main variables were reported as follows: "Learning/Academic Achievement/Educational Performance" (*f=16*), "Motivation" (*f=13*), "Interest" (*f=4*), "Technology Effectiveness" (*f=4*), and "Attitude" (*f=4*). In addition, such variables as perception, cognitive load, learning approaches/styles, satisfaction, and perceived usefulness were analyzed in the reviewed studies.

Table 2. Frequency of the examined variables in the studies

Examined Variables	Number of Studies	Examined Variables	Number of Studies
Learning/Academic Achievement/ Educational Performance	**16**	The Current Needs	1
Motivation	**13**	Foreign Language Learning Anxiety	1
Interest	**4**	Cultural Understanding	1
Attitude	**4**	Communicational Skills	1
Technology Effectiveness	**4**	Language Development	1
Perception	3	Benefits And Limitations	1
Cognitive Load	2	Information Expression	1
Learning Approaches/Styles	2	Flow Experience	1
Satisfaction	2	Early Learning Experiences	1
Perceived Usefulness	2	Embodied Cognition	1
Recall	1	Concentration	1
Recognition	1	Content Adaptability	1
Retention	1	Self-Evaluation	1
Scientific Creativity	1	Engagement	1
Technical Creativity	1	Usability	1
Potential of AR	1	Learning Strategies	1
Literacy	1	Cognitive Styles	1
System Acceptance	1	Collaboration	1
Learning Behavior	1	Behavioral Intention	1
Learning Quality	1	Interaction	1
Parent Perspectives	1		1

Method Trends Used in the Reviewed Studies

As displayed in Figure 10, the quantitative research design was adopted in 72%, qualitative design in 12%, review/meta-analysis in 10% and mixed design in 6% of the examined studies. Quasi-experimental (29%) and pre-experimental (16%) designs within the quantitative paradigm; triangulation (4%) in mixed methods research and case study (16%) within the qualitative paradigm were the most adopted research designs in the research published between 2015 and 2019. The methodological trends are shown in Table 3.

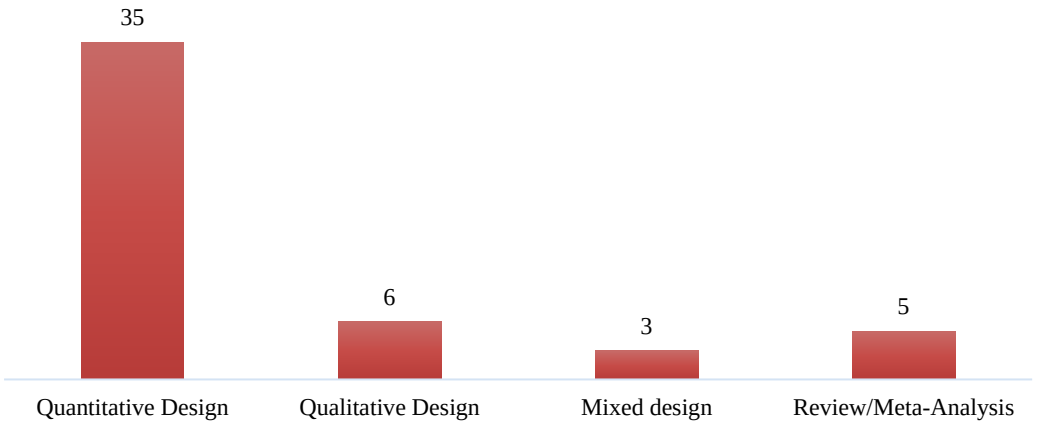


Figure 10. Frequency of the research methods

Table 3. The method trends in the studies on the use of AR in foreign language education by years

			2007-2010	2011-2014	2015-2019	All Year	
Research Methodologies		**Research Methods**	**f**	**f**	**f**	**f**	**%**
Quantitative	**Non-experimental**	Descriptive	1	2	3	6	12.24
		Comparative		1	1	2	4.08
		Case study		1	1	2	4.08
		Total					**20.41**
	Experimental	Quasi-experimental	3	2	9	14	28.57
		True-experimental			1	1	2.40
		Pre experimental	2		6	8	16.33
		Total					**47.30**
Qualitative		Case Study		1	7	8	16.33
		Total					**16.33**
Mixed		Triangulation		1	1	2	4.08
		Explanatory		1		1	2.04
		Total					**6.12**
Other		Literature review		3	1	4	8.16
		Meta-analysis			1	1	2.04
		Total					**10.20**
Total						**49**	**100**

As to the distribution of research methods by years, there was an increase in quantitative methods from 2015 to 2017. As presented in Figure 11, the quantitative design was most adopted between 2017 and 2018 while no variation was observed in review studies and studies adopting mixed methods research designs. After 2012, qualitative research started to be adopted in related studies. In 2019, the quantitative design was the most used method in studies.

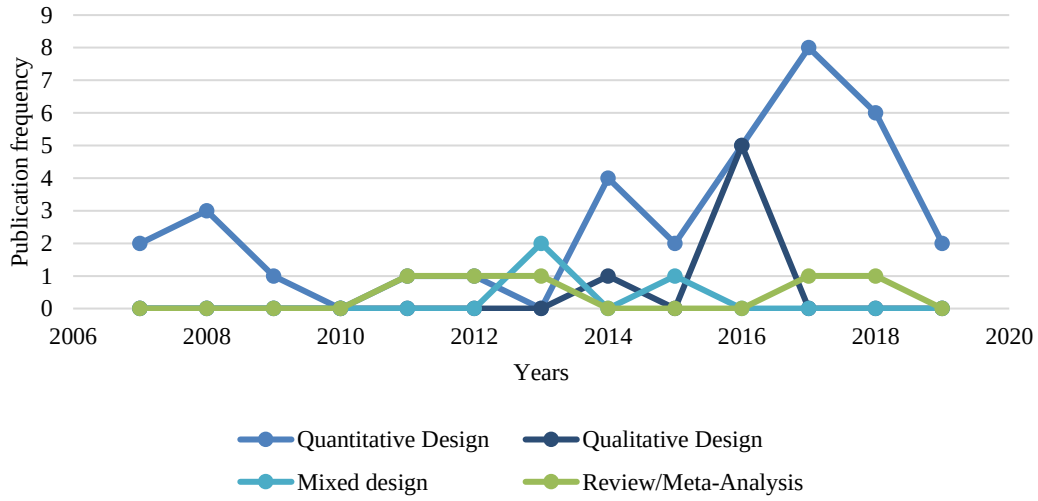
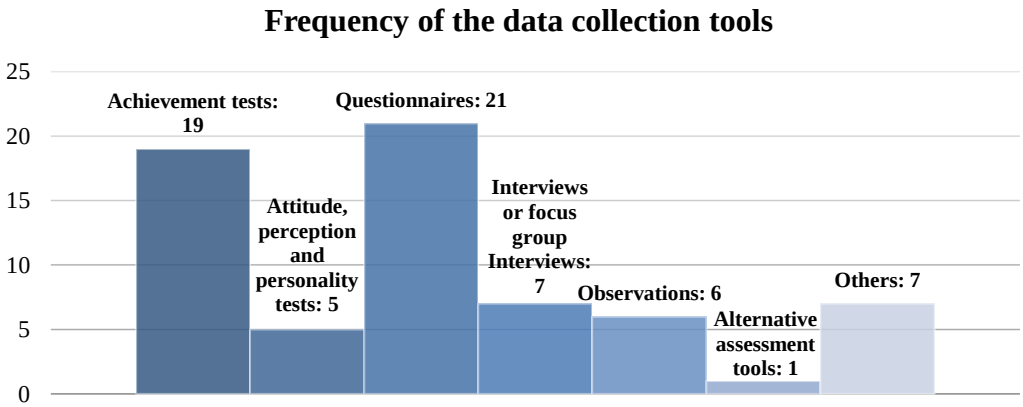


Figure 11. Distribution of the research methods by years

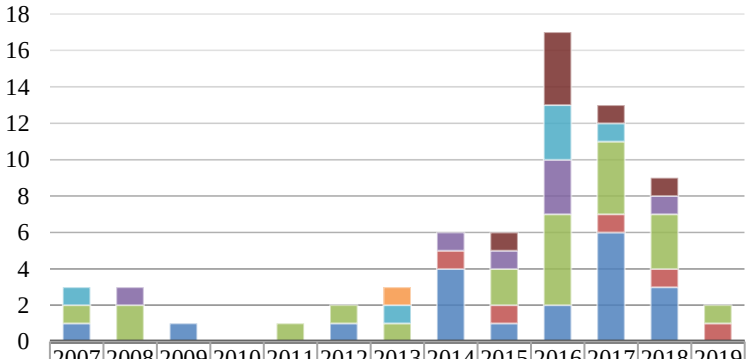
Data Collection Tools Used in the Reviewed Studies

In the examined studies, questionnaires (43%), achievement tests (39%), and interviews (14%) were the most-frequently-used tools. Through questionnaires were used throughout the examined publication period, an increase was observed in their adoption

starting from 2016. Achievement tests were used most frequently in 2015. The frequencies of the instruments by year are presented in Figure 12.



Distribution of the data collection tools by years



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Others									1	4	1	1	
Alternative assessment tools							1						
Observations	1						1			3	1		
Interviews or focus group Interviews		1						1	1	3		1	
Questionnaires	1	2			1	1	1		2	5	4	3	1
Attitude, perception and personality tests								1	1		1	1	1
Achievement tests	1		1			1		4	1	2	6	3	

Figure 12. Frequency of the data collection tools and distribution of them by years

Sample Used in the Reviewed Studies

As shown in Figure 13, purposive sampling (25%) and other sampling methods (37%) were frequently used in the examined research. A year-by-year analysis revealed that the adoption of random sampling increased in 2011. The preferred sample size was observed to be 11-30-participant groups (25%) and 31-100-participant groups (25%), as presented in Figure 14.

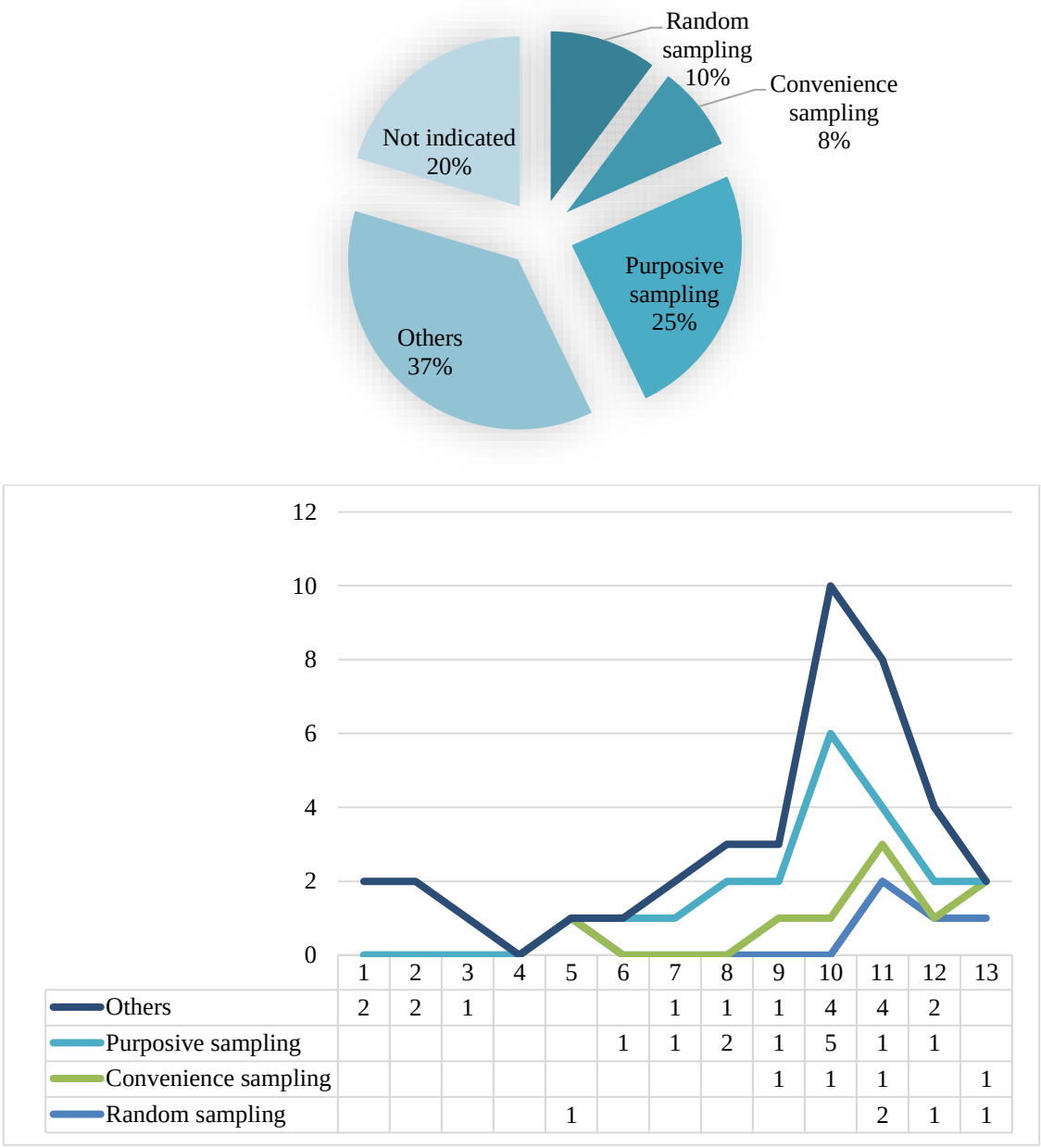


Figure 13. Frequency of the sampling method in the studies and distribution of them by years

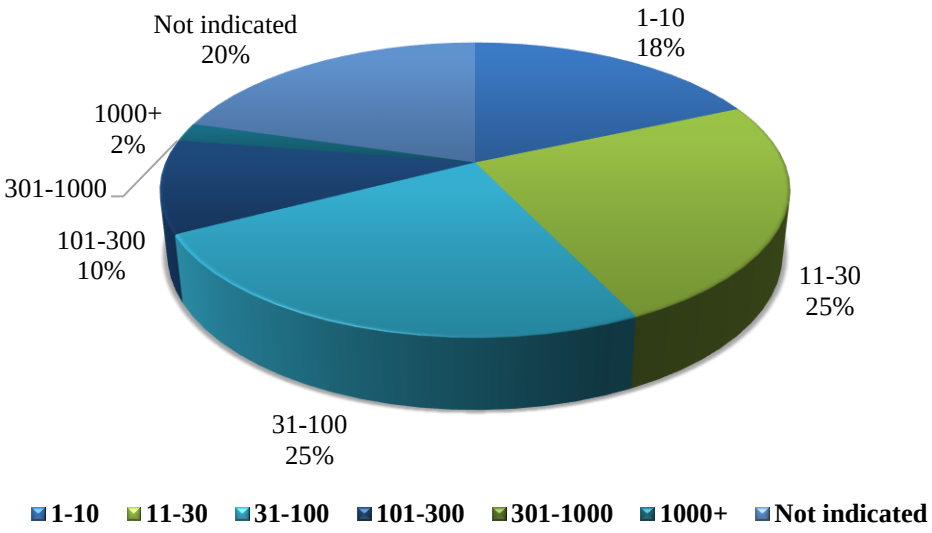


Figure 14. Frequency of the sample size

The frequently preferred sample groups were graduate students (27%) and primary (1-4) students (20%) while undergraduate students (2%), secondary (9-12) students (2%) and faculty members (2%) were the least-selected sampling groups. Primary school students (1-4) were selected as a sample group in 2012 and pre-school students were most commonly selected in 2017. The frequency of sampling groups is presented in Table 4 and the distribution by years in Figure 15.

Table 4. Frequency of the selecting sampling groups

	2017-2019	
Sampling groups	**N**	**%**
Graduate students	13	26.5
Primary (1-4) students	10	20.4
Pre-school students	8	16.3
Others	4	8.2
Teachers	3	6.1
Primary (5-8) students	3	6.1
Not indicated	3	6.1
Parents	2	4.1
Undergraduate students	1	2.0
Secondary (9-12) students	1	2.0
Faculty members	1	2.0

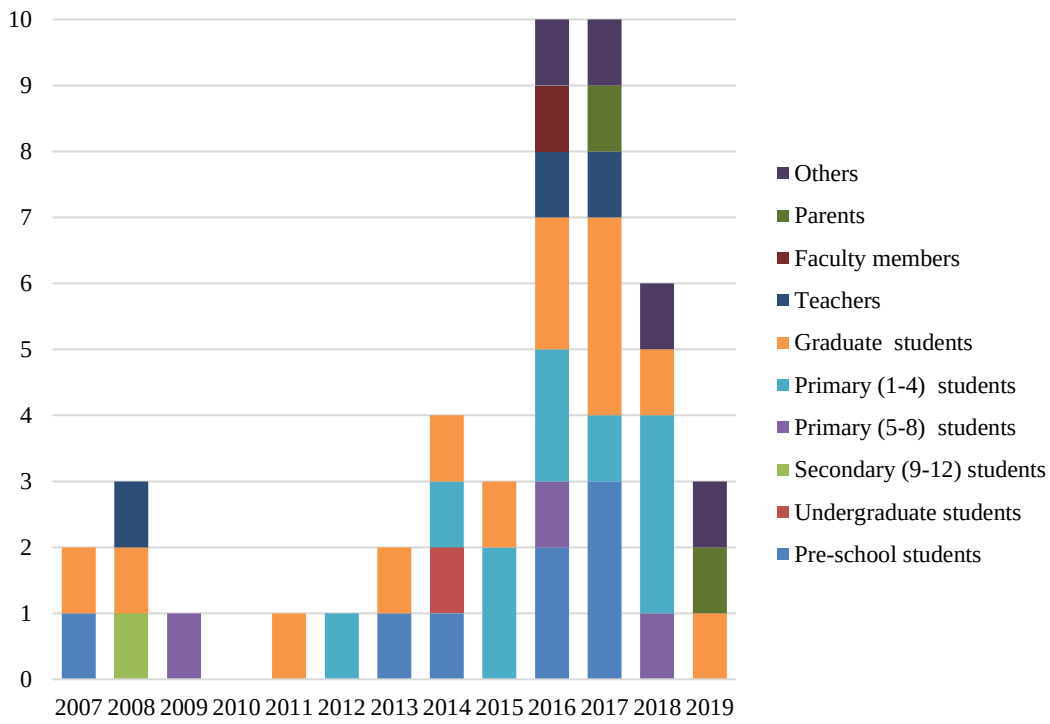


Figure 15. Distribution of the sampling groups by years

Data Analysis Methods Used in the Reviewed Studies

The content analysis indicated that the most commonly used data analysis methods were frequencies, percentages, tables (27%) and means, standard deviations (22%). As presented in Table 5, T-tests (16%), ANOVA/ANCOVA (10%) and correlation tests (6%) were observed to be the most frequently adopted inferential techniques in quantitative analysis and content (20%) and descriptive analysis (8%) were in qualitative analysis.

Table 5. Distribution of the data analysis methods

		2007-2010	2011-2014	2015-2019	All years	
		f	f	f	f	%
Descriptive analyses	Frequencies, percentages, tables	-	3	10	13	26.53
	Means, standard deviations	2	2	7	11	22.45
	Graphs	1	2	4	7	14.29
Inferential analyses	T-tests	3	1	4	8	16.33
	ANOVA/ANCOVA	1	-	4	5	10.20
	Non-parametric tests	-	-	1	1	2.04
	Correlation tests	-	2	1	3	6.12
	Regression	-	1	-	1	2.04
	MANOVA/MANCOVA	-	1	-	1	2.04
Qualitative Analyses	Content Analysis	-	1	9	10	20.41
	Descriptive Analysis	-	-	4	4	8.16

Discussion

This study, based on content analysis and bibliometric analysis, revealed the methodological trends, data collection tools and data analysis methods of the related research on AR-integrated foreign language education. The bibliometric analysis indicated that the keywords used most in the abstracts were game, language, content, language learning, teacher, and effectiveness. It can be concluded from this result that the effectiveness of AR technology is the focus of most articles (Chen et al., 2017; Safar, et al., 2017) and teachers were the main agents involved in these studies (Hsieh, 2016a). A year-by-year analysis indicated that implementations for foreign language education have gained importance in recent research (Chen & Chan, 2019; Wu, 2019). As regards the keywords used most, augmented reality, mobile learning, English as a foreign language, ubiquitous learning, Aurasma, and mobile games were the keywords encountered most in the examined research on AR in foreign language education. The focus of these studies was mobile learning (Sydorenko, Hellermann, Thorne & Howe, 2019; Wang, 2018), ubiquitous learning (Ho, et al., 2017; Liu, 2009), and mobile games (Hao & Lee, 2019; Liu, et al., 2016) in foreign language education with AR (Baykara, Gurturk, Atasoy, & Percin, 2017). A by-year distribution of the articles showed that early childhood education (Chen & Chan, 2019; Lee, Chau, Chau, Ng, Wong, Yu, & Wu, 2019), mobile learning, gamification (Castañeda et al., 2018), and mobile games were the most used keywords. This focus may be explained by the accessibility of AR applications.

According to the citation and co-citation analysis, Liu T.Y. was the most cited author, and Thorne, Azuma, and Squire were the most co-cited authors in this field. This can be an expected result since these authors are the pioneers in AR research (Azuma, 2016; Liu, 2009; Squire, 2010; Thorne, Hellermann, Jones, & Lester, 2015). Computers & Education, Educational Technology and Society, British Journal of Educational Technology, and Computers in Human Behavior were the journals cited most, which is also supported by Altinpulluk (2019) who stated that Computer & Education was the most-cited journal in the AR field. This is also an expected result because of the leading roles of these journals. However, a deeper analysis shows that the AR research has been mainly published in journals on technology integration. Therefore, future research on AR-integration in foreign language education is suggested to be published in language-related journals.

For the content analysis, the examined variables, methodological trends, data collection tools, sampling methods and data analysis methods were examined, revealing five points to be discussed. The first point for discussion is related to the variables examined in the existing research. The content analysis showed that "learning/academic achievement/ educational performance" were among the variables that were mostly examined in the related studies. The result reported in this study were in parallel with the results reported by Cai, Chiang and Wang (2013), Hwang, Wu, Chen, and Tu (2016), and Yilmaz (2018) who also highlighted the focus on academic achievement as a variable commonly examined in AR research. This common result may point at the rationale behind integrating technological tools in language education in order to increase the effectiveness of the process. As suggested by Golonka et al. (2014) and Ching-Hsue and Chung-Hsi (2019), integrating technological tools, AR for this study as a current form of educational technology, contributes to the betterment of language education by increasing learning achievement. Another commonly examined variable was "motivation" as a significant affective factor. Gardner (2006) notes that motivation is a driving force in the language learning process. Learners need high levels of motivation to be engaged in the process

(Zhang, Lin, Zhang, & Choi, 2017). Also, it can be expressed that motivation is a prominent factor affecting the learning process in general; attitudes, learning interest, and learning achievement in particular. Therefore, it can be concluded that relevant studies have also focused on the motivational effects of AR integration in language education (Chen, Hung, Chang, Lin, & Lai, 2018; Ho et al., 2017). In a review study, Altinpulluk (2019) also touched upon this point and stated that achievement and motivation were the variables examined most. Such variables as "learning interest" and "attitude" were also examined in the studies. One can infer from the examination of these variables that AR as a novel form of technology is expected to contribute to the development of positive attitudes towards language learning (Kucuk, Yilmaz, & Goktas, 2014) and to the maintenance of learning interest in the process (He et al., 2014). As reported by Li et al. (2014) and Limsukhawat et al. (2016), AR technology is observed to increase learners' interest and help them develop positive attitudes towards language learning, which is an essential step in maintaining learning motivation. Related to the above-mentioned variables, perceived usefulness, technology acceptance, and satisfaction were also among the examined variables. Considering the examination of the relationship between AR integration and perceived usefulness, technology acceptance and satisfaction, Joo, Lim, and Kim (2012) and Sung, Hwang, Lin, and Hong (2017) comment that these variables are essential factors having an indirect influence on learner motivation and learning achievement.

The second point for discussion is the methodological trends in research on AR in foreign language education. The content analysis of the method trends revealed that there was more reliance on the adoption of quantitative studies in examining AR integration. Among the quantitative studies, those adopting quasi-experimental designs predominate the other quantitative research methods (Hsu, 2017). As regards this result, it can be stated that experimental designs were among the commonly preferred research designs as they allow researchers to examine the effectiveness of AR integration. In addition, the advantage to make objective evaluations regarding the effectiveness of AR technology in foreign language education can be among the main reasons for adopting quantitative methods, which is also reported by Cheng and Tsai (2013) and Arici, Yildirim, Caliklar, and Yilmaz (2019). According to the results of this study, the adoption of quasi-experimental design (29%) and pre-experimental design (16%) can be explained as the reflection of the inclination to particularly test the effects of AR integration in foreign language education. This result is in line with the suggestions of McMillan and Schumacher (2014) who comment that experimental designs allow researchers to make objective evaluations of the effectiveness of particular variables. As for the adoption of qualitative research designs, their relatively limited adoption compared to quantitative designs in the analyzed research can be because of the limited objectivity in analyzing the effectiveness of the AR technology. However, the by-year analysis showed an increase in the number of qualitative studies on AR integration in foreign language education between 2015 and 2017, which is to be because of the aim to examine AR integration from different perspectives (Hsieh, 2016a; Li et al., 2014). At this point, it is suggested that mixed research designs should be adopted as it increases validity and reliability (Fraenkel, Wallen, & Hyun, 2012).

The third point for discussion is the data collection tools. Questionnaires (43%) and achievement tests (39%) were the most preferred data collection tools in the analyzed research. The basic reason for using these tools is probably because of holding the quantitative research paradigm in examining AR integration in foreign language

education. With the adoption of these instruments, researchers can reach larger numbers of participants to reach more generalizable results (McMillan & Schumacher, 2014). Specific consideration of the adoption of questionnaires and achievement tests can be because of the aims in the analyzed studies to examine the attitudes and success of learners as a result of receiving AR-supported language education, which is a rationale also reflected in research examining such variables (Chang, Chung, & Huang, 2016). The increase in the use of achievement tests can particularly point at the emphasis placed on English language education. At this point, in order to reveal learner experiences and alternative assessment techniques in AR integration, it is suggested that studies should also involve observation in the research process. In the qualitative paradigm, the results showed that interview was the commonly used qualitative data collection instrument. The tendency to reach in-depth conclusions and the increase in conducting mixed method research can be the reason for using the interview as a qualitative instrument. The result regarding the adoption of interviews in AR research supports those reported in the studies by Arici et al. (2019), Bacca et al. (2014), and Chen, Liu, Cheng, and Huang (2017).

The fourth point for discussion has to do with the sampling methods, sample size and sample population in the analyzed research. As regards the sampling methods, purposive sampling was frequently adopted. This sampling method could be selected because the researchers wanted to reach particular participant groups who were expected to reflect their views on the effectiveness of AR-integrated language education (Etikan, Musa, & Alkassim, 2016; Patton, 1987), especially in qualitative designs. The by-year analysis also revealed that there was an increase in the adoption of random sampling. This increase can be an expected outcome coming along with experimental designs (Arici et al. 2019). The sample size was observed to be between 11 and 30 (25%) and between 30 and 100 (25%). The former sample size may be due to the inclination to integrate qualitative perspectives in the research and the latter may be due to test the effectiveness of AR technology in quantitative studies. The analysis of the sample population in the examined research showed that graduate students (27%) and primary-level students (20%) were among the groups most commonly participating in AR research. This case points at the increase in the importance placed on foreign language education at all educational levels. The reason for selecting graduate students maybe because they are more conscious of the learning process and they have accumulated experience in developing their language knowledge and skills over years. The selection of graduate students in AR research was also reported by Chen et al. (2017). The reason for selecting primary-level students can be their interest and motivation in learning new knowledge through new tools.

The final point for discussion is about the data analysis methods in the examined studies. In the research grounded on quantitative designs, frequencies, percentages, and tables (27%), and means and standard deviations (22%) were the most preferred analysis methods. As for statistical analysis, T-tests (16%), ANOVA/ANCOVA (10%) and correlation tests (6%) were the common analysis methods. The adoption of these analysis methods was high probably because of the research design according to which the studies were conducted. This is an expected result considering the research basis of the existing studies as most of them adopted a quasi-experimental research design. In the qualitative paradigm, content analysis (20%) and descriptive analysis (8%) were used mostly because content analysis provides a detailed analysis of the results. The results related to the data analysis methods in this study are also supported by the related literature (Bacca et al., 2014; Baydas, Kucuk, Yilmaz, Aydemir, & Goktas, 2015).

Since AR is a novel technology, examining its effects in foreign language education holds great significance. The review of the relevant literature indicates that AR-integrated language education has become an issue of growing interest. Therefore, in the light of the research examined in this study, the following suggestions can be made:

- Such areas as early childhood education, mobile learning, gamification and mobile games should be examined in future research on AR-integrated foreign language education as these are becoming the trend topics in recent research.
- Since AR is a new technology, its effects on learning achievement, performance and motivation have been mostly examined in the related studies. However, there is comparatively limited emphasis on such variables as attitude and acceptance. Therefore, future research can be suggested to investigate both teachers' and students' attitudes and acceptance levels of this technology in foreign language education.
- As shown in the content analysis, the number of quantitative studies overweigh that of qualitative studies. Therefore, in order to reach deeper insights regarding AR-supported foreign language education, more studies grounded on qualitative research designs can be conducted.
- The reliance on quantitative studies was observed to promote the frequent adoption of questionnaires and achievement tests in the examined research. It is expected that the increase in qualitative research will promote the adoption of qualitative data collection tools like interviews, observations, journal keeping, and reflective reports.
- Studies adopting mixed-methods research design should be carried out in order to increase validity and reliability.
- The sampling population was observed to be mostly graduate and primary-level students. Future research can be suggested to select more participants from other educational levels in order to tests the effectiveness of the technology at different stages. In addition, it can be suggested that teachers are selected as participants as they are the leading figures guiding their learners in adapting to the AR technology in language learning. Therefore, studies carried out with language teachers can give insights concerning the applicability and practicality of such technologies.
- The analyses indicated that the studies on AR-integrated foreign language education have been published in technology-related journals instead of language-related journals. Therefore, it is suggested that such pedagogy studies should be published in language-related journals.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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