
Mobile learning for preschoolers: a systematic literature review

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Abstract: Mobile learning for preschoolers has evolved into a significant area of research. This paper reports on the Systematic Literature Review (SLR) conducted to investigate the state-of-art in mobile learning for preschoolers. SLR was performed using research papers extracted from eight commonly used databases. A total of 72 papers were retrieved, of which 54 papers were relevant to our study. The results highlighted an upward publication trend, good quality studies published in the domain, and mobile applications like games, language and literacy, and art and colouring developed for preschoolers. Finally, the paper concludes by identifying the research gap and providing avenues for future research.

Keywords: mobile learning; preschool; systematic literature review.

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1 Introduction

Mobile learning uses portable devices such as smartphones, iPads and tablets to provide an anywhere, anytime learning experience (Cross et al., 2019; Kumar and Goundar, 2019; Kumar and Mohite, 2018). With the enhancement in the mobile devices' hardware and software capability, it has provided the opportunity for learning environments to move from the physical classroom to electronic classrooms (e-classrooms), further advancing to mobile classrooms (m-classrooms) (Hockly, 2013; Kumar et al., 2019; Kumar and Mohite, 2016). Mobile classrooms aim to create an environment where learners can learn at an individual pace and with convenience (Maulana and Shukri, 2017; Bhadra et al., 2016). Mobile learning is seen as an asynchronous way of learning where education is carried out online and offline.

Research on the use of mobile learning in preschool has emerged as an area of interest because learning with the use of technology and multimedia tends to excite and ignite interest in learning for children (Zabatiero et al., 2018; Kabali et al., 2015). Some typical mobile learning applications developed for children include; language translation apps, literacy apps, sketching and drawing apps, music apps, numeracy apps, etc. (Ibrahim et al., 2019; Drigas et al., 2015; Ng et al., 2013; Miller, 2018). Preschoolers find mobile learning applications interactive and dynamic, enjoyable to learn, thus makes children tech-savvy and prepares for future technological growth (Kim and Smith, 2017). Furthermore, it is pleasant, informal and allows children to have a soothing experience compared to traditional classroom-based learning.

In the literature, there are several papers on the use of mobile learning in the preschool environment but lack a review of work done in this field. Motivated by this shortcoming, a review is conducted on the use of mobile learning in the preschool environment to investigate the state-of-art and build a knowledge base to assist researchers working in the field. The selected research method is a systematic literature review, a technique for gathering all evidence in a specific area of study, analysing and deriving conclusions to identify gaps and opportunities to assist future research (Xiao and Watson, 2019; Penzenstadler et al., 2012). This paper is organised as follows: the background section describes mobile learning and its use in preschools. The methodology section describes how the review was designed and executed. The results section provides detailed answers to the research questions. The discussion and conclusion section provides a summary of the research questions and the findings of the study.

2 Background

Mobile devices have taken technological convergence to another new level as it has started to replace devices such as digital cameras, video cameras, desktop computers and gaming devices (Gauch and Blind, 2015; Kumar and Sharma, 2020). With the rapid increase in hardware features and price decreases, the demand for mobile devices has also increased. The increased demand has led to the use of mobile phones to perform computer-based tasks (Beck et al., 2014; Kumar et al., 2019). Mobile devices have greatly influenced everything around us, i.e., banking, reservation systems, travelling, tourism, finance, social media, economy, entertainment and especially education (Shaikh and Karjaluo, 2015; Kim and Kim, 2017; Huebner et al., 2018; Leong et al., 2011;

Yıldız et al., 2020). Mobile learning is a learning model that permits learners to gain access to learning materials anywhere and anytime through mobile phones and internet technologies (Lan and Sie, 2010; Kumar et al., 2020). According to Kumar and Chand (2018), mobile learning is an extension of electronic learning that permits users to accomplish learning through the use of small and portable wireless devices. It makes it easy and possible for learners to learn at a suitable pace and place.

There have been many initiatives to implement mobile learning across schools and universities; a review of literature has jaggged some notable benefits and challenges of mobile learning. The benefits of mobile learning are; (1) it is flexible and provides the freedom to students to learn at an adjustable pace (Looi and Toh, 2014), (2) it increases the performance of learners by making learning accessible (Mehdipour and Zerehkafi, 2013), (3) removes geographical barriers and allows collaboration between foreign individuals and groups (Traxler and Vosloo, 2014), (4) allows learners to have access to a wide variety of multimedia resources as mobile devices are convergent devices (Ansari and Tripathi, 2017), (5) helps student develop a self-centred learning pedagogy (Kumar and Mohite, 2017) and (6) provides a communicative, collaborative and productive learning environment to students situated in remote areas (Fakomogbon and Bolaji, 2017).

Recently, there has been an increased interest in mobile learning for preschoolers. The vast majority of children in the world have access to mobile devices. Compared to other digital devices, mobile devices with touch screens are more popular with preschoolers as sufficient skills have not been acquired and developed to use computer peripherals (Papadakis and Kalogiannakis, 2017, Zaranis et al., 2013). The notable benefits of mobile learning for preschoolers include; i) children get familiar with touchscreen-based smart mobile devices due to the ‘passback effect’ (Judge et al., 2014). A passback effect happens when a parent or an adult passes on their device to the child to keep them busy (Chiong and Shuler, 2010). ii) Preschoolers have the necessary skills to operate a touchscreen-based interface using gestures, such as slide, tap, touch, swipe, drag, and double-tap (Nacher et al., 2015). There have been ample applications created, and research was done over the years to enhance mobile learning for preschoolers.

There are systematic reviews on mobile learning. For example, Tu and Hwang (2020) reviewed the published papers on mobile technologies in hospitality, leisure, sport, and tourism education. Compton and Burke (2018) conducted a systematic review of mobile learning in higher education. Yang et al. (2020) investigated mobile learning trends in physical education by reviewing the journal publications from the Scopus database. These reviews focus on a specific area of the study, and to the best of our knowledge, there is a lack of a review on the use of mobile learning in the preschool environment.

2.1 Research method

Systematic Literature Review (SLR) was conducted using the guidelines proposed by (Kitchenham, 2004; Petersen et al., 2015). The SLR process included three stages; (1) planning, (2) conducting and (3) reporting.

- Planning stage – includes identifying the research question, data sources, search string criteria and study selection criteria.
- Conducting stage – includes searching, selecting research papers from identified sources. Relevant articles were searched and retrieved based on the research

questions identified in the planning stage. The papers were assessed against inclusion and exclusion criteria.

- Reporting stage – includes writing and communicating the results to the research community.

2.2 Research questions

The research questions were designed to investigate state of the art on mobile learning in preschools.

- RQ1: What is the publication trend?
- RQ2: What are the different types of applications developed?
- RQ3: What are the different types of devices used?
- RQ4: What are the different types of papers published?
- RQ5: What is the commonly used research design?

2.3 Data sources

Digital libraries that used to search for relevant studies are provided in Table 1.

Table 1 List of digital libraries

<i>Digital Library</i>	<i>Website link</i>	<i>Journal articles</i>	<i>Conference proceedings</i>
IEEE Xplore	https://ieeexplore.ieee.org/	✓	✓
Association of Computing Machinery (ACM)	https://dl.acm.org/	✓	
Emerald Insight	https://www.emerald.com/insight/	✓	
Springer Link	https://link.springer.com/	✓	✓
Inderscience Online	https://www.inderscienceonline.com/	✓	
Science Direct	https://www.sciencedirect.com/	✓	✓
Wiley Online	https://onlinelibrary.wiley.com/	✓	
Taylor and Francis Online	https://www.tandfonline.com/	✓	

2.4 Search strings

Search strings were executed on digital libraries to retrieve all results related to preschool and mobile learning. The search strings are described in Table 2. As the literature search advanced, the search strings were added, discarded, or refined. The new search terms were re-run on all digital libraries upon changes to ensure relevant papers were carefully retrieved.

Table 2 Search string

Scope	Search terms
Mobile learning	(mobile learning OR m-learning OR mlearning) AND
Preschoolers	(preschoolers OR preschool)

2.5 Inclusion criterion/ exclusion criterion

An inclusion/exclusion criterion was developed to select relevant publications to answer the research questions.

IC1. The paper is focused on mobile phones as a target device,

IC2. The paper reports on preschools.

The papers were excluded:

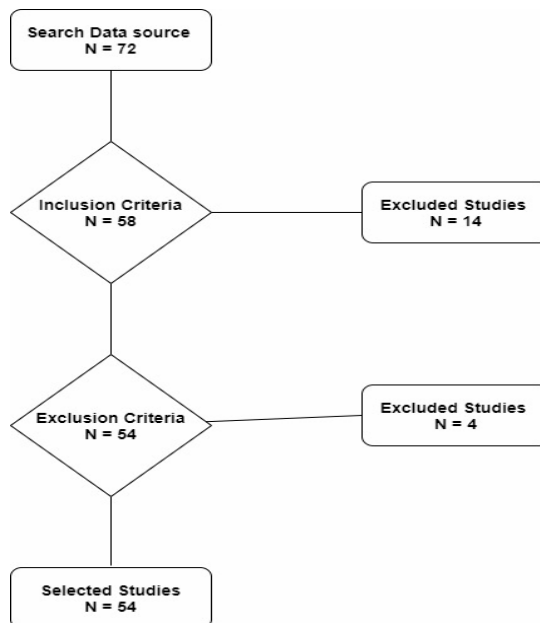
EC1. The paper is listed already in another database

EC2. The article is not written entirely using the English language.

2.6 Study selection

The search was conducted on eight selected electronic databases, and a set of papers were retrieved. In total, 72 articles were selected after assessing against inclusion and exclusion criteria, 18 papers were removed, and 54 were relevant to our research question. The principal researcher extracted relevant data from the studies while the other authors verified data selected data. Figure 1 illustrates the study selection process.

Figure 1 Study selection process



2.7 Data extraction

The entire research team read the abstracts and verified all papers based on inclusion and exclusion criteria. A total of 54 articles were selected for the study. The selected papers are attached as Appendix 1. All papers were thoroughly analysed, and the following statistics were extracted in detail.

- Year of publication
- Country of participating authors
- Types of applications developed
- Type of paper
- Research design.

3 Results

This section presents the answers to the research questions. Table 3 lists the number of papers selected from different data sources.

Table 3 Data source

<i>Database</i>	<i>Journal papers</i>	<i>Conference papers</i>
IEEE Xplore	1	16
ACM	2	–
Emerald Insight	1	–
Springer Link	9	13
Inderscience Online	2	–
Science Direct	5	–
Wiley Online	2	–
Taylor and Francis Online	3	–
	25	29

RQ1: What is the publication trend?

Mobile learning for preschoolers can be seen as an emerging research area that supports teaching and learning in preschools. Research papers in this field have emerged to explore certain areas of speciality. The search on selected databases found a total of 72 papers, and after assessment, 54 papers related to our research questions. Overall it indicates an upward trend in the number of articles published per year from 2012, which supports the idea of the continuing expansion of research in mobile learning for preschoolers. Figure 2 shows the trend in publishing papers on mobile learning for preschoolers from 2012 to 2020. Notably, there are more conference papers than journal articles, which may be because conference proceedings are faster and easier to make results available. It has also been realised that some articles are published in good quality journals with high impact factors. Figure 3 shows the distribution of papers by category.

Figure 2 Papers published per year (see online version for colours)

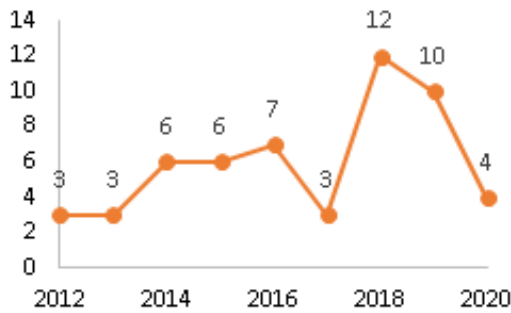
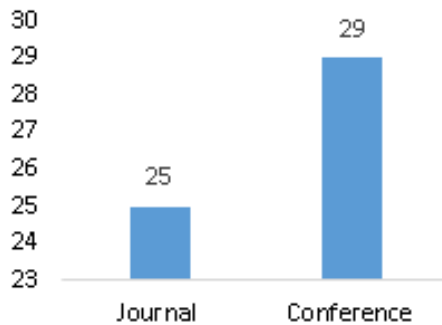
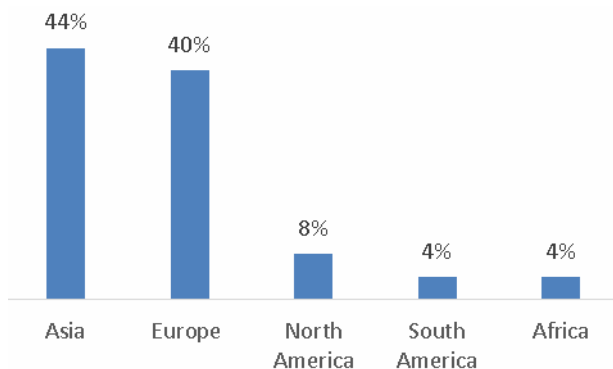


Figure 3 Distribution of papers by category (see online version for colours)



The research findings also looked at the geographical distribution of published studies by country of publication. As depicted in Figure 4, most studies took place in Asian (44%) and European (40%) continents due to more scholars conducting and reporting research on mobile learning for preschoolers as the governing bodies fund more projects. The other continents reported fewer publications, with Northern American, Southern American and African continents displaying figures below 10%. With these data findings, it can be concluded that more Asian and European countries are fast adopting mobile learning in preschools.

Figure 4 Research by continents (see online version for colours)



RQ2: What are the different types of mobile learning applications developed?

Various specialised types of applications have been developed to enhance preschool learning and teaching. Most of these applications have been trialled in classrooms directly under teachers' supervision, while other applications are available for use at parents' will. Specially developed apps focus on the specific subject area. They may associate the content with the school's curriculum with the intent to measure performance, while others may focus vaguely just on child learning with a mixture of contents. The papers analysed concentrate on games, art and colour, numeracy, and language literacy to supplement learning in preschools. Hence, to provide an account of various areas of development, we categorised the apps into the following categories: games, art and colouring, mathematics and science, language literacy, analysis and interpretation, and others. While identifying the apps, some app types were overlapping; however, the primary purpose of the apps was studied, and the main focus of the app was distinctly accounted for and categorised under a category. Table 4 shows the details of the app categories together with a brief description.

Table 4 Mobile application category

<i>Category</i>	<i>Types of applications</i>	<i>Apps produced in each category</i>
Games	mobile games	28%
Language Literacy	language, storytelling, translation	21%
Art and Colouring	colouring, painting, music	18%
Mathematics and Science	mathematics, science	18%
Others	training and coaching, speech therapy	9%
Analysis and Interpretation	imagination, cognitive skills	6%

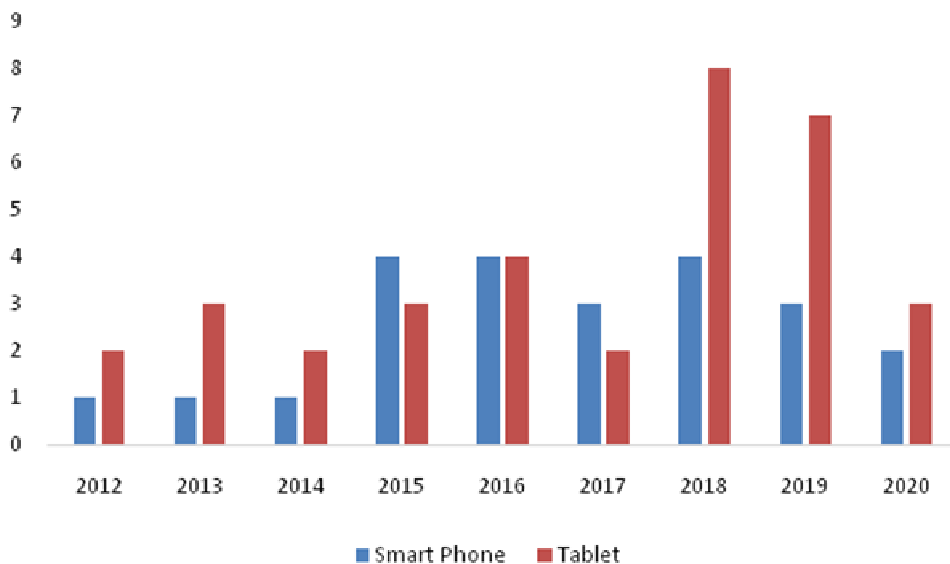
The most popular category was games. A little below 30% of the apps belong to the games category. Games combine several features, such as comparison, matching, pattern setting, arrangements and social and behavioural skills. The second most popular category was language literacy; approximately 21% of the apps accounted for it. This category includes linguistic features such as language learning, mainly English, where English is a second language, language translation, and simple storytelling with animations. Mathematics/science and art/colouring both had the same rate (18%), while analysis/interpretation types of app accounted for the lowest (6%). Mathematics/Science apps include basic numeracy skills, geometry, shapes and patterns, parts of the body, identification of animals and fruits, while art/colouring apps features colour matching, painting tools and musical instruments together with audio/video capabilities. The analysis and interpretation category primarily focused on classification, relatedness, and comparison. The 'others' category accounted for approximately 9%, which includes training and coaching apps for parents, speech therapy and other specialised apps. Of the 54 articles studied, 15 papers did not mention any particular type of app; however, they generalised the study on mobile learning in preschools.

RQ3: What are the different types of devices used?

In the study conducted, it can be noticed that two major types of devices are used; smartphones and tablets. In the early periods of mobile learning adoption in preschools, more tablets were utilised compared to smartphones. The primary factor being more

tablets were manufactured compared to smartphones. Additionally, tablets offered a bigger screen, better resolution, processor capabilities and extensive memory storage than smartphones. Furthermore, as per the collated data, the trend of increased use of tablets over smartphones has continued over the years. It can be concluded that handling a tablet is much easier than smartphones. A preschooler (2- to 5-year-old) may find it comfortable and easier to use tablets as smartphones are too susceptible to mishandling and damages. On the contrary, smartphones have been used less; however, an increasing trend is noticeable due to their portability and converged features. Moreover, smartphones are deemed cheaper than tablets and are expected to outweigh tablets in years to come. Figure 5 shows comparative figures for smartphones and tablet usage from the years 2012 to 2020.

Figure 5 Mobile devices used (see online version for colours)



RQ4: What are the different types of papers published?

Initially, many developers followed agile methodology and created apps to ease learning and teaching among youngsters, while some researchers took systematic approaches in identifying essential components of design and validation techniques. Many have developed mobile apps, observed participants using it, and thereafter analysed gathered data to create and validate models for development. However, some only considered collecting primary data for reporting purposes. Table 5 shows the four common nuclei of the articles under study based on the classification of Wieringa et al. (2006).

The majority of the articles have offered solutions to assist learning at preschool. Approximately 66% of the articles proposed solutions, which encompasses developing or prototyping a mobile app and trialling it in classrooms or at homes. These solutions are being experimented with using mobile devices where participants are observed, results analysed, and recommendations derived. The philosophical papers articulated frameworks and models for the effective implementation of mobile learning in preschools. About 19% of the articles have presented approaches to model developments

and designs, such as integrating cognitive and behavioural contents, applying components of collaboration, and content reusability. Experience papers describe authors’ experience in designing and implementing a solution, which generally is trialled at a small scale with less intensity. Approximately 13% of the articles dedicated their course to details of experimenting and data collation. About 2% of the papers provided studies on validating mobile applications following models or frameworks such as adaptive behaviour systems, heuristics evaluation, or Technology Acceptance Model (TAM).

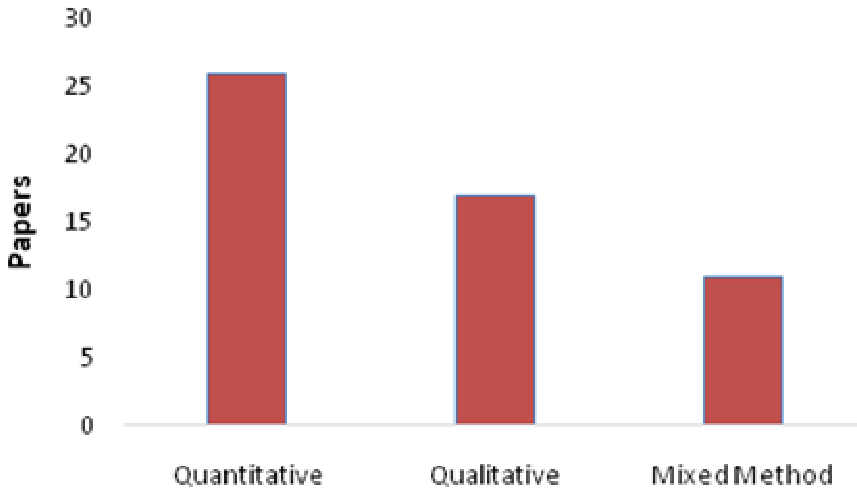
RQ5: What is the commonly used research design?

In this research question, the research design employed was analysed. The papers were categorised into quantitative, qualitative and mixed-method research designs. Quantitative is seen as the most commonly used research design. Within these research designs, the different research methods can also be explored. In quantitative research, three primary research methods were used; case studies (64%), experiments (24%) and surveys (13%). In qualitative research methods, action research (75%) and case study (25%) were used. In mixed methods, we have seen observational, experimental and simulation. Figure 6 provides the distribution of papers by research design.

Table 5 Paper category

Type of paper	Description	Percentage of papers
Proposes a solution	Introduces mobile learning application for preschool	66%
Philosophical Paper	Proposed model or methods to support mobile learning in preschool	19%
Experience paper	Describe the authors’ personal experience in studying mobile learning at preschool	13%
Validation paper	Provides experimental result on the use of mobile learning in preschool	2%

Figure 6 Research design (see online version for colours)



4 Discussion and conclusions

The results of RQ1 demonstrated the rate of research activity in the field of mobile learning for preschoolers. The increasing trend in the number of published papers indicates that mobile learning for preschoolers is an active area of research and with more articles expected to be published in the future. There were a total of 54 papers with a combination of both journal and conference proceedings. All these papers were acquired from different journals and sources; hence, it can be concluded that there is no specific source for reporting on mobile learning applications for preschoolers. In the span of 8 years, papers were published in 5 different continents, with Asia publishing 44% of the papers, Europe publishing 40% of the papers, and the other three continents (North America, South America and Africa) publishing below 10% of the publications. RQ2 presented the different fields in which mobile learning applications for preschoolers have been developed. A comprehensive study indicates that mobile learning apps for preschoolers are on the rise, especially in games, art and colour, and language. Many scholars have focused on STEM (science, technology, engineering and mathematics) related apps; however, analysis and interpretation skills in preschoolers are limited. Several articles have presented mobile apps in a combination of other techniques, such as augmented reality, where a child visualises 3D objects, which make learning interactive and enjoyable, while others have electronic materials or drawings either developed or scanned into systems. Training and coaching apps are also developed for parents and teachers to embrace child supervision and mentor skills.

In RQ3, the studies depicted that two major types of devices were used from 2012 to 2020; smartphones and tablets. Tablets were more widely used over the years compared to smartphones. Tablets proved to be dominant in both physical attributes and specification attributes. Tablets possess a larger screen size, promoting and enhancing the ease of use among preschoolers. Tablets offered a better resolution, processor capabilities and larger memory capacity. Furthermore, tablets are easy and comfortable to handle over smartphones. From the results, it is also noticeable that smartphone use is also rising (2015–2019). Smartphones are becoming a cheaper commodity globally and are a common household item (Dhuvad et al., 2015). With this trend, the use of smartphones among preschoolers may also increase over time, with more children having access to it. RQ4, the papers were divided into four categories; proposes a solution, philosophical paper, validation paper, experience paper. The majority of the papers in the category are the proposal of a solution that reported in developing mobile apps for preschoolers. The focus is limited, and the scope is set for a short-term and small development project which might lack the proficient level of integrity. From the results, we can see that more research is needed to develop a framework and methods to support the development of mobile learning apps. RQ5 investigated different research methods, and it was observed that the quantitative research method is the most widely used.

The findings are essential for subsequent research. Further work can be carried out to scientifically strengthen the field in the following ways:

- Specialised source of reporting – the number of papers published after the year 2012 shows an increasing trend; as more knowledge is unfolded, more researchers would eventually show interest in working in this field. With the growing trend of work and research in the area, there needs to a specialised source of reporting.

- Development framework – the applications in the articles studied had used different methods to create mobile learning applications for preschoolers. The various methods used may have their advantages and disadvantages. There is a need for a framework that may assist researchers and developers in creating mobile learning applications for preschoolers.
- An in-depth study on the use of mobile games – mobile learning applications for preschoolers includes; games, art and colouring, mathematics and science, language and literacy, analysis, and interpretation. The use of games has been the common method to disseminate syllables and knowledge to preschoolers. An in-depth study is required to measure the effectiveness of this method.

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Appendix 1: Selected papers used for the study

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