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A review of using digital game-based learning for preschoolers

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Abstract In recent years, the use of digital game-based learning (DGBL) in the early childhood learning process has been growing. Recent research shows that DGBL has the potential to create new forms of childhood learning, it is not yet clear how applications can affect young students' learning. There are also not sufficient studies to analyze the significant features of DGBL in this area in early childhood. Therefore, to better understand the impact on childhood DGBL education, this article reviews the systematic literature. This review analyzes 37 articles in this area. In this paper, PRISMA's principles analysis of studies on the characteristics of DGBL technology has been used. The classification focuses on four areas: the objectives of current studies, the impact of technology use on children's learning, learning theories, and assessment methods in DGBL applications. The results of this study show that the use of DGBL can have an active effect on strengthening thinking skills and learning in childhood. This article examines the evolution of this evolving technology, the challenges, and issues posed by DGBL, and discusses how it can be useful for younger students to learn and do more research. This study provides insight for researchers, game designers, and developers in the field of DGBL.

Keywords Digital game-based learning · Young children · Empirical evidence reading

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Introduction

Digital game-based learning (DGBL) and related educational technologies are important elements in the education system. Recent studies show that children's access to technologies such as tablets and smartphones is increasing (Castillo, 2019; Konok et al., 2021; Yang et al., 2018). On the other hand, the mobile market is also updating a wide range of games and educational programs. Therefore, children are faced with a large volume of educational programs that offer different ways of understanding, teaching, combining knowledge, mathematics, science, and artistic creativity (Liao et al., 2019).

Today, the new generation of children is well acquainted with tablet computer technologies and new technologies. Many researchers have researched this issue and, in some cases, have even noted that this digital language has become a part of the lives of new generation children that can change their behavior patterns (Konok et al., 2021).

The European Commission also took a different view, saying that children up to the age of eight could acquire their digital skills, with the difference that their ability to achieve cognitive development varies and requires more research. While recent research on the study of the new generation of digital children continues, it is important to focus on some of the characteristics and skills of these children (Horizon, 2020). While the use of information technology in preschool is not yet agreed upon by the educational world, there is still the same resistance to the integration of technology in education. There are several reasons for this disagreement, including the lack of old conditions and devices in kindergartens or lack of sufficient training for preschool teachers to use technologies in integration in education. Another reason is based on the concerns of parents and preschool educators who believe that the use of these technologies is not beneficial at this age and disrupts children's social development early on, leading to some physical problems such as obesity, eye fatigue and aberrations, drowsiness disorders, and social isolation (Nizam & Law, 2021).

Although the capability of computer games for learning and the analysis of the effectiveness of game-based learning is an increasing challenge, only a few studies address the issue of the alternative features of DGBL at the preschool level (Karwowski & Beghetto, 2019). Several scholars have indicated a continued concern in terms of the lack of empirical evidence pertaining to the academic value of digital game-based learning (Hainey et al., 2016). Hence, a comprehensive and coherent study is required to demonstrate the effectiveness of this new technology in the learning of early childhood (L. Lin et al., 2020a, 2020b).

In recent years, due to the spread of the coronavirus virus, many schools had to open online, even at the preschool and kindergarten levels. This is why many researchers are inclined to understand the impact of the online learning revolution on children. This wide range of research has focused not only on online learning but also on offline and online learning games (Castillo, 2019). Further results of this research indicate that online learning, as well as games based on education, have a positive effect on skills such as critical thinking, creativity,

problem-solving. But it is still unclear how and what factors in these programs have led children to learn (Crescenzi-Lanna, 2020). The growing trend in recent years in communities and schools to use games based on online education has also raised concerns among families about the emergence of ambiguities about the negative impact of these games on children too (Konok et al., 2021). For example, some researchers believe that education-based games increase addiction, increase aggression, and reduce motor skills. For this reason, most researchers have highlighted the need for more research to clarify how and factors affect digital games on children (Lazarinis et al., 2020).

Although there are numerous studies in the field of digital educational games, there are not enough studies to analyze the significant features, disadvantages, and advantages of DGBL at the preschool level. Despite similar studies, key questions remain unanswered including what the most important factors in the technology used in DGBL that have influenced children's learning. The literature on digital games is based on fragmented and incoherent education, and it is unclear how and to what extent these games can affect children's learning. This absence in the literature hinders progress in identifying the impact of DGBL on successful processes and approaches. The main purpose of this paper is to analyze the latest approaches in DGBL technology to support children's learning. This study focuses on preschool-level educational activities. The results of this article can be useful for the research community that applies to technology-based learning and digital games.

Based on the studies conducted in this article, 37 studies close to the research topic were selected and systematically reviewed based on the PRISMA analytical method (Moher et al., 2009). In this study, the impact of DGBL factors on children's learning is discussed. The four categories examined in this study include;

1. The goals of DGBL studies at the preschool level and to what extent have they affected children's learning in this research.
2. DGBL how has affected children's learning in this research.
3. Educational theories that have applied these studies focused on DGBL.

And 4. Reviewing the methods used to evaluate DGBL.

Therefore, given the ambiguous course of research from DGBL, it seems necessary to provide an overview of the impact of this emerging technology on children's learning, development, and other skills. This study focuses on providing this overview of DGBL.

Methodology

The authors of this study have used a method of systematic analysis and review of PRISMA in order to understand the latest developments and recent research on DGBL at the preschool level (Moher, 2009).

In this paper, the research and review process include the following steps and are shown in Fig. 1 (Fig. 1);

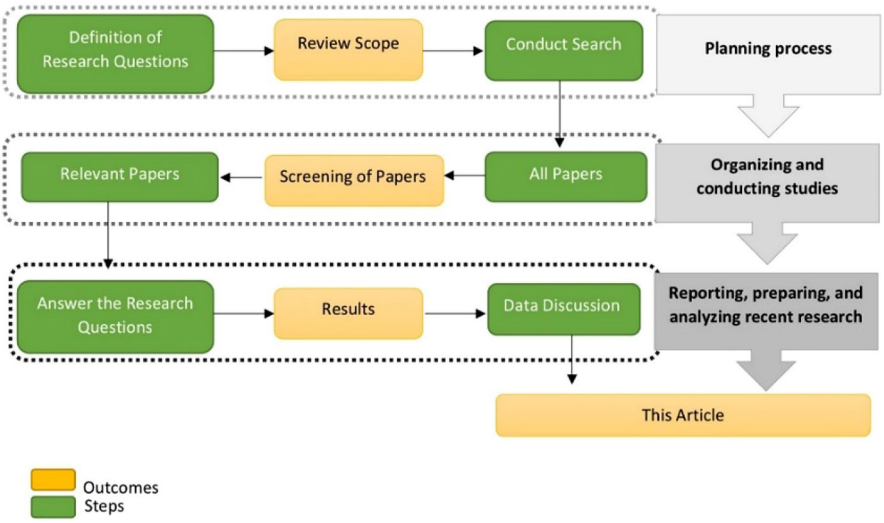

Fig. 1 Mapping of research methodology

1. Planning process; Collection of journals and Internet sites, exit and entry criteria for research and expression of analysis and review steps.
2. Organizing and conducting studies; Selected articles are analyzed and then the data is encoded.
3. Reporting, preparing, and analyzing recent research to understand the recent status of DGBL at the preschool level (Fig. 1).

Definition of research questions and objectives

The authors defined a set of the main research questions and objectives of this research including the following;

RQ1. What goals and approaches have recent studies about DGBL focused on the preschool level?

O1. The design of this question is to find and highlight recent approaches to the impact of DGBL learning on children's education. The answer to this question could be to provide solutions for DGBL interventions with children.

RQ2. What factors and elements were considered in recent studies to eliminate the sense of need for learning and increase children's curiosity in order to raise the level of their intellectual skills?

O2. The answer to this question is to highlight and find the elements and factors that in DGBL can affect children's learning interaction and performance. Finding these factors may be helpful for DGBL development designers.

RQ3. What processes and achievements have been focused on in DGBL to teach and influence the learning rate of children in the preschool year?

O3. The answer to this question is to identify learning processes for the transfer of concepts and knowledge, including cognitive and educational when using DGBL.

RQ4. What are the challenges, constraints, and recommendations for improving future research on DGBL and its impact on children's learning?

O4. The answer to this question is effective in illuminating the future direction of research.

Search term and data collection

In the next stage, after identifying the questions and objectives of the research, the authors conducted several searches in the main online databases using selected and related keywords. Fig. 2 shows the search strings examined in each of the online databases.

The search terms (keywords) used for the purposes of this study include terms for digital games along with terms related to consequences, the effects of games on learning. Several search terms helped the authors determine the scope of the definition of digital games. Because many terms include the word "game" such as "computer games", "video games", "simulation games", "game-based learning" and "serious digital games" with corrections to learning such as "learning" and

Database	Search string	Additional information
Web of Science	Title:(((“preschool level” OR “ young children” OR “early childhood”) AND ((game-based learning*) OR ((digital game-based learning*) AND ((tablet apps*) OR((smartphone*), OR (“educational game”) AND (“education” OR “learning”) AND (“game”))) OR Abstract:(((“young children” OR “preschool level”) AND ((learning applications*) OR ((“impacts” OR “outcomes” OR “engagement” OR “learning” OR “effects”) AND (“education” OR “learning”) AND (“game”))) OR Keyword:(((“preschool level” OR “ young children” OR “early childhood”) AND (“education” OR “learning”) AND (“game”))) AND (((“motivation” OR “skills” OR “critical thinking” OR “creative thinking” OR “problem-solving”))) AND IDIOM: (English) AND TYPE OF DOCUMENT: (Article) Period 2010-2022	• Searched in the WOS Full-Text Collection • Search in the field ‘‘Abstract’’ • Search in all publication dates • 135 initial results
Science Direct	Title: (((“preschool level” OR “young children” OR “early childhood”) AND ((game-based learning*) OR ((digital game-based learning*) AND ((tablet apps*) OR((smartphone*), OR (“educational game”) AND (“education” OR “learning”) AND (“game”))) OR Abstract:(((“young children” OR “preschool level”) AND ((learning applications*) OR ((“impacts” OR “outcomes” OR “engagement” OR “learning” OR “effects”))) Filters Applied: Journals and Conferences 2010 – 2022	• Search in the field ‘‘Abstract’’ • Search in all publication dates • 250 initial results
ERIC	Title:(((“preschool level” OR “ young children” OR “early childhood”) AND ((game-based learning*) OR ((digital game-based learning*) AND ((tablet apps*) OR((smartphone*), OR (“educational game”) AND (“education” OR “learning”) AND (“game”))) AND IDIOM: (English) AND TYPE OF DOCUMENT: (Article) Period 2010-2022	• Search in the fields ‘‘Title’’, ‘‘abstract’’ or ‘‘author-specified keywords’’ • Search in all publication dates • 50 initial results
JSTOR	Title, abstract, keywords:(((“preschool level” OR “young children” OR “early childhood”) AND ((game-based learning*) OR ((digital game-based learning*) AND ((tablet apps*) OR((smartphone*), OR (“educational game”) AND (“education” OR “learning”) AND (“game”))) AND (“game”) Filters: 2010-2022 Research articles	• Search in all fields • Search for all content types • Search in all publication dates • 79 initial results
ESCBO	TITLE-ABS-KEY (((“preschool level” OR “young children” OR “early childhood”) AND ((game-based learning*) OR ((digital game-based learning*)) AND ((tablet apps*) OR(smartphone*), OR (“educational game”) AND (“education” OR “learning”) AND (“game”))) AND (“game”) AND (LIMIT-TO (DOCTYPE , “cp”) OR LIMIT-TO (DOCTYPE , “ar”)) AND (LIMIT-TO (SUBJAREA , “COMP”)) AND (LIMIT-TO (PUBYEAR , 2022) OR (PUBYEAR , 2021) (PUBYEAR , 2020) OR (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMITTO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT	• Search in all fields • Full text available • Search in all publication dates • 56 initial results
IEEE Xplore	Title:(((“preschool level” OR “young children” OR “early childhood”) AND ((game-based learning*) OR ((digital game-based learning*) AND ((tablet apps*) OR((smartphone*), OR (“educational game”) AND (“education” OR “learning”) AND (“game”))) OR Abstract: (((“young children” OR “preschool level”) AND ((learning applications*) OR ((“impacts” OR “outcomes” OR “engagement” OR “learning” OR “effects”))) Filters Applied: Journals and Conferences 2010 – 2022	• Search in the fields ‘‘Title’’, ‘‘abstract’’ or ‘‘author-specified keywords’’ • Search in all publication dates • 121 initial results
Springer	Title: (((“preschool level” OR “young children” OR “early childhood”) AND ((game-based learning*) OR ((digital game-based learning*) AND ((tablet apps*) OR((smartphone*), OR (“educational game”) AND (“education” OR “learning”) AND (“game”))) OR Abstract: (((“young children” OR “preschool level”) AND ((learning applications*) OR ((“impacts” OR “outcomes” OR “engagement” OR “learning” OR “effects”))) Filters Applied: Journals and Conferences 2010 – 2022	• Search in the field ‘‘Abstract’’ • Search for articles • Search in all publication dates • 45 initial results
Scopus	TITLE-ABS-KEY: (((“preschool level” OR “young children” OR “early childhood”) AND ((game-based learning*) OR ((digital game-based learning*)) AND ((tablet apps*) OR(smartphone*), OR (“educational game”) AND (“education” OR “learning”) AND (“game”))) AND (“game”) AND (LIMIT-TO (DOCTYPE, “cp”) OR LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (SUBJAREA , “COMP”)) AND (LIMIT-TO (PUBYEAR , 2022) OR (PUBYEAR , 2021) (PUBYEAR, 2020) OR (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMITTO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT	• Search in all fields • Full text available • Search in all publication dates • 130 initial results
Wiley Online Library	Title, abstract, keywords:(((“preschool level” OR “young children” OR “early childhood”) AND ((game-based learning*) OR ((digital game-based learning*) AND ((tablet apps*) OR((smartphone*), OR (“educational game”) AND (“education” OR “learning”) AND (“game”))) AND (“game”) Filters: 2010-2022 Research articles	• Search in the fields ‘‘Title’’, ‘‘abstract specified keywords’’ • Search in all publication dates • 140 initial results

Fig. 2 Search string used on each database

"training" was included. The following words were applied in Fig. 2 a total of 37 relevant articles were collected and categorized.

Screening of papers for inclusion and exclusion

In this step authors performed the screening of the papers obtained in the previous steps, to exclude those that are not considered relevant to answer the research questions. Figure 3 shows how to extract the result of preliminary studies. (Fig. 3).

The collection of magazines and internet sites have been searched from Web of Science, ERIC, JSTOR, ESCBO, Science Direct, IEEE Xplore, Springer, Scopus, and Wiley. It is noteworthy that the Google Scholar search engine has also been used to cover more research (Table 1).

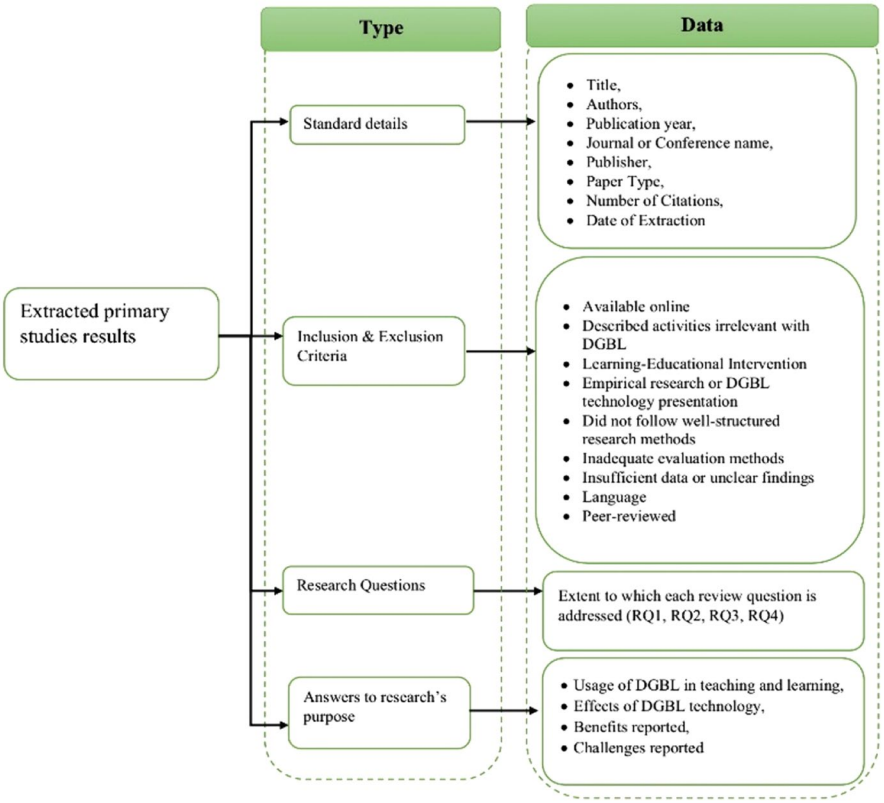

Fig. 3 Extracted the result of preliminary studies

Table 1 Electronic databases

Identifier	Database	Number of identified papers	Number of papers meeting the criteria
ED1	Web of Science	135	5
ED2	Science Direct	250	8
ED3	ERIC	50	3
ED4	JSTOR	79	2
ED5	ESCBO	56	2
ED6	IEEE Xplore	121	5
ED7	Springer	45	7
ED8	Scopus	130	3
ED9	Wiley Online Library	140	2

Eligibility criteria

The exit and entry criteria related to the research questions, the general criteria for determining the time frame, and the type of studies were agreed upon. Table 2, and Fig. 4 show the search protocol followed for each database (Table 2, Fig. 4).

Table 2 Inclusion and Exclusion criteria of publication

Inclusion criteria	
IC1	Studies published between 2010 and 2021
IC2	Studies that describe the applications of frameworks at the preschool level
IC3	Studies that provide evidence of educational potential based on a research method
IC4	Articles are written in English
IC5	Studies that have discussed the advantages and disadvantages of digital games based on education at the preschool level
IC6	Studies that describe DGBL applications and consider and describe application models or adaptive learning processes with DGBL
IC7	Studies that have mentioned the use of DGBL at the preschool level
Exclusion criteria	
EC1	Studies that are not recognized as articles in various journals. As a sign of the chapter of books and reviews and dialogue
EC2	Studies that have referred to "DGBL" but talked about a topic unrelated to digital game-based learning, or used the term "game-based learning" but addressed a topic unrelated to DGBL
EC3	Studies that did not provide sufficient data to calculate the effect of DGBL and there are no conclusive findings from their qualitative data
EC4	Studies structured from research methods such as; articles have not followed an experimental and non-experimental case study
EC5	Studies not written in English
EC6	Studies published before 2010 or after the third quarter of 2021

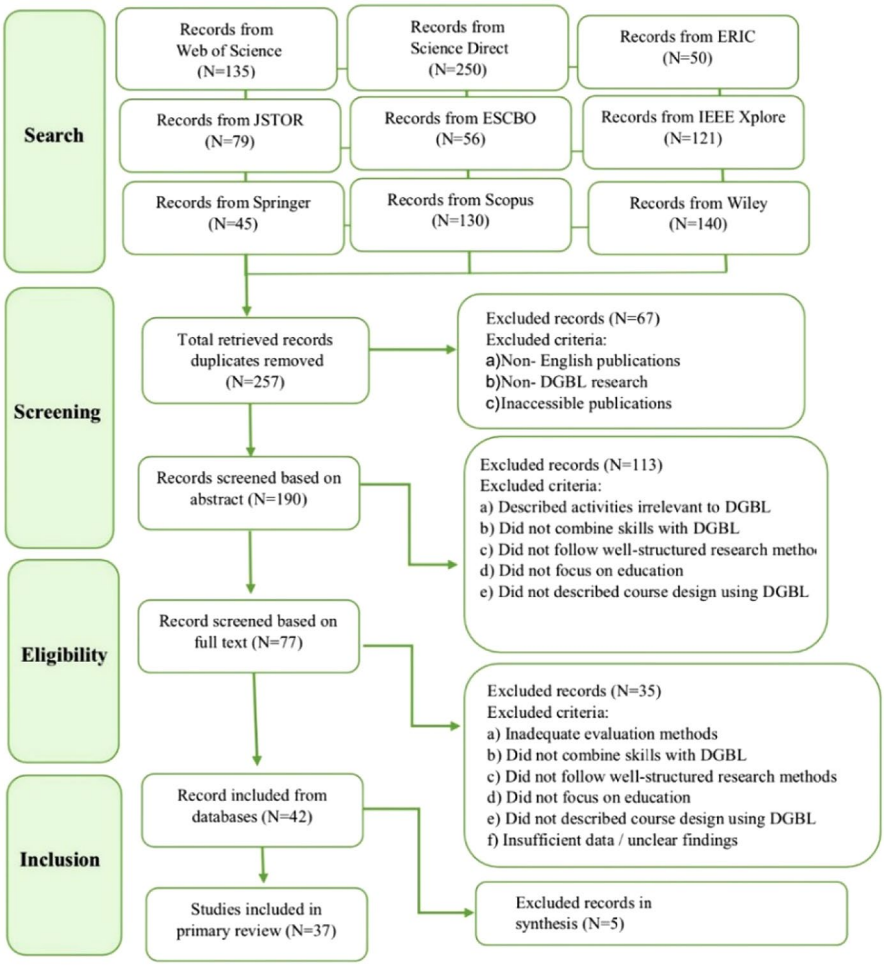

Fig. 4 Flowchart of paper selection for analysis

First, the year of publication was limited between 2010 and 2021 due to the increasing number of researches in this field during these years. The years before 2010 were not considered due to the small number of studies. In the second stage, the age of "childhood education" of the participants was selected, which was presented as an option in the database. This option was also added as a phrase in the keyword search. All types of articles such as surveys, reports, concept papers, and literature reviews were removed.

Articles are included in the main sources if they include published empirical studies and valid scientific and practical journals that are considered as indicative of the quality of publications with the number of citations. The number of eligible articles was reduced to 37 after screening and removing duplicates using keyword search. The titles and abstracts of the selected articles were reviewed. Articles that

did not qualify were not selected and returned. In the next step, a detailed review of each study according to its subject and content was considered. Therefore, articles with irrelevant content were also removed. The authors reviewed articles that used devices such as iPads, touchscreen tablets, smartphones, and digital systems. Thus, articles focusing on the impact of intelligent robots were removed. Also, from the materials of other cases, only articles that were evaluated in the school environment were examined. Therefore, articles focusing on family status online were removed. Finally, the authors considered a total of 37 articles suitable for review and analysis in this review (Table 2, Fig. 4).

Since the authors searched the databases on each publication date and not in a particular range, they first found the review in 2010 (Nikiforidou & Pange, 2010a) (Fig. 5). However, the analysis of the data shows that there has been a large increase in the number of publications after 2015. Based on the analysis of the data (Table 1), it is important to mention that most of the studies were published between 2019 and 2021($n=28$). DGBL technology is a new approach and trend in teaching courses, while the selected distribution of works in the figure shows the growing interest in using DGBL in teaching for demonstrating reinforcement of students' concepts and learning (Fig. 5).

Literature analysis of reviewed articles

Although the number of articles reviewed seemed limited, the analysis of recent studies shows that the trend toward the publication of DGBL studies has increased due to the spread of COVID-19 pandemic disease and online learning. These results indicate that DGBL is a new phenomenon, emerging and research and studies in its field are in their infancy. The coding scheme of the reviewed articles, as mentioned, includes a program with the main criteria for each article. The following are:

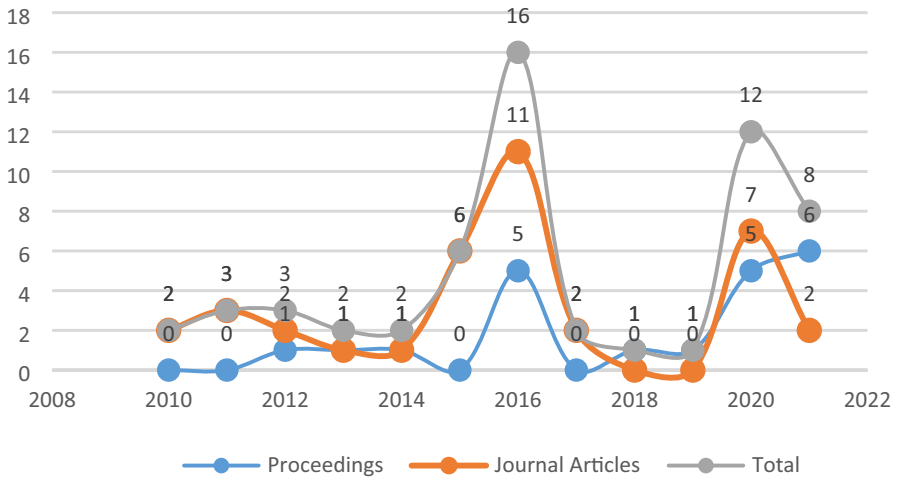

Fig. 5 Distribution of publications per papers per year

(a) The method and approach of educational design have been implemented.
(b) Features and elements of DGBL technology tested.
(c) Theoretical foundations based on theories and theories of contemporary learning are used and followed in the article.
(d) Educational design template that has been used to improve the learning experience.

Figure 6 shows a coding scheme used during the data extraction of the article selection process, which is based on the articles in the Liberati et al., (2009) guidelines and related articles (Liberati et al., 2009). The first author of the study

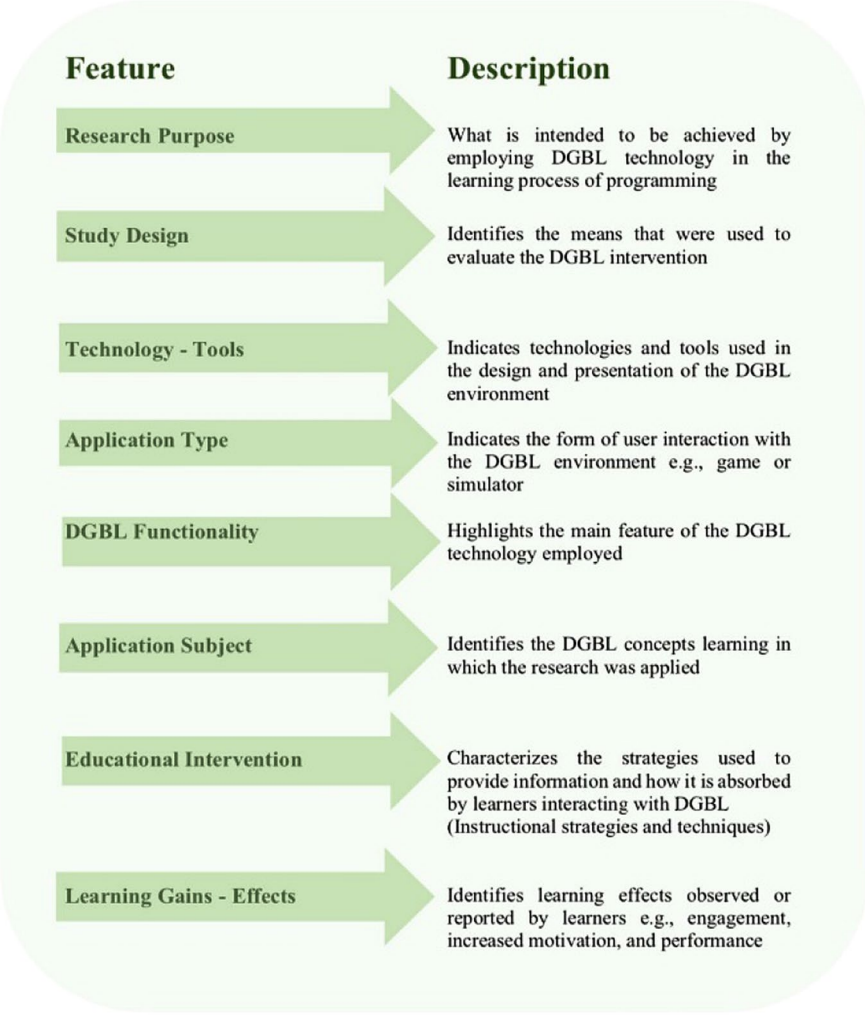

Fig. 6 Coding scheme of the reviewed paper

undertook all content analysis. The data were confirmed by three other authors who are experienced researchers in informatics and education. The fourth author is in charge of screening, and the other two authors have reviewed and approved general decisions with the first author based on pre-written selection rules. NVivo data collection and content analysis tool were used to perform content analysis from reviewed studies to process and analyze data and evaluate and create reliability in the results (Fig. 6).

Research purpose articles' Coding

Several articles (37) that met the inclusion criteria in this article were coded after a complete previous review. These studies and results and their multifunctional effects were categorized. Each article used in this study was selected based on the following criteria for inclusion in the study;

1. An appropriateness of the research design to address the main and secondary questions of the present article.
2. Appropriateness of research methods, analysis of study results.
3. Quality and any research questions about the study.
4. Alignment of study findings with current research questions. According to the above criteria, each article received a higher score by having more criteria.

Study designs' coding

The articles included in the current systematic review are subdivided;

(a) Coding of each research based on the design and type of method used in each study, such as the actual experimental design, quasi-experimental design, comparative study or qualitative research design, and the like.
(b) The evaluation of the collected studies was analyzed according to the design of the methods used in each research.
(c) Presenting the most important findings, results, and evaluations performed in each research.

Technology tools, application type, DGBL functionally and subject

Applications were classified according to the following;

(a) The purpose of the game and whether this game is originally designed to combine entertainment with learning or not.
(b) the educational topic/topic that each game deals with, for example; Science, mathematics, language, and so on.
(c) Platform/computing devices on which users have run the game, such as video consoles, personal computers, smartphones, and tablets, etc.

DGBL education intervention & learning gains-effects

Due to the focus of this study on the impact of DGBL on the preschool level, the following categories were used to analyze recent studies:

(a) Focus on DGBL output that leads to positive results in issues such as learning and skills (Acquisition of knowledge and comprehension in children).
(b) Psychological issues and assessment processes that have a positive impact on children's learning for a particular goal.
(c) The effect of DGBL on the range of learning topics in the game and the use of a particular game is examined.

Results

After searching the database of online digital libraries, scientific journals were found according to the search terms. Then duplicates were removed and so on with 257 jobs continued. In the next step, the title, abstract, and keywords were considered. At this stage, 190 items were selected. In the third stage, based on the degree of conformity in the field of title, the abstract and full text of articles based on the objectives of this research were examined. At this stage, the number of eligible articles was reduced to 42. In the next stage, by applying the exclusion criteria, 5 more works were removed and 37 articles were considered for the data extraction stage. A summary of digital game-based teaching and learning methods as well as the results and most important observations for each reviewed study is shown in Table 3.

Study design

Table 4 lists the method used in the study articles. The main goal of the games in this category also included learning objectives. From the 37 studies, the majority of studies (27) reported quantitative data, 24.3% studies reported quasi-experimental designs, 8.1% on RCT (Randomized Controlled Trial) designs, 24.3% reported survey designs, and 16.2% reported correlation designs. The result indicates that the majority of the studies 73.0% (27 papers) consisted of 'empirical studies' and quantitative data, while only 27.0% (10 papers) reported on qualitative data. The results in quantitative data showed a considerable focus on quasi-experimental designs.

Learning theories are applied in DGBL studies

Table 5 contains the classification of learning theories for game-based learning and offers one selected study as an example. According to Table 5, constructivism 40% (15 papers), constitutes the most popular theory followed by cognitive

Table 3 General overview of related DGBL studies in preschool level

Paper ID	Research Purpose/DGBL intervention	Study results and observations	References
A1	To investigate whether preschoolers could learn a fundamental math concept of learning from technology	Interactivity contributed to better performance and understanding of mathematics in DGBL and may support learning in specific contexts in early childhood	Aladé et al. (2016)
A2	To examine shifts in young children's learning progression levels with interaction virtual manipulative mathematics apps	It is possible to document evidence of shifts in children's learning progressions while they are interacting with mathematics apps on touch-screen devices	Watts et al. (2016)
A3	To examine the ability of young children to learn how to solve a problem on a touch-screen device	Children learn how to solve problems from interactive media	Huber et al. (2016)
A4	To investigate a tablet computer curriculum designed to improve at-risk preschoolers' mathematics performance	There was a significant and sizable effect on the mathematics posttest for Math Shelf students (Cohen's d ¼ 1.09, $p < 0.001$)	Schacter & Jo (2016)
A5	To examine whether the iPad with a Vygotskian social development approach can improve science learning	Children improved science learning abilities as a consequence of the iPad instruction	Lee & Tu (2016)
A6	To introduce and examine a new platform, called "EnPlein", for the kinesthetic practice of phonological skills by preschool children	Children who worked with the platform showed improvements in their phonological	Goffredo et al. (2016)
A7	To investigate SAMI a Software to introduce music learning in preschool education	Individual interaction and autonomous learning on mobile devices, and providing audio materials for sound discrimination and tone identification	Paule-Ruiz et al. (2017)
A8	-To investigate the application's acceptance and its impact on children motivation for learning writing Cyrillic letters	Children are highly motivated to learn writing Cyrillic	Duh et al. (2017)

Table 3 (continued)

Paper ID	Research Purpose/DGBL intervention	Study results and observations	References
A9	To investigate cognitive capabilities and pedagogical benefits have for preschoolers in using technology	The game context acts as a motivator that scaffolds more mature cognitive capabilities in young children than they exhibit during a no contextual standardized test	Axelsson et al. (2016)
A10	To implement the GIGL approach to improve the learning performance and motor skills	Improving both learning performance and motor skills to a greater extent compared with the traditional activity GBL approach	Hsiao & Chen, 2016)
A11	To evaluate the effectiveness of the freeware videogame “The Number Race"	“The Number Race” fostered mathematical learning	Sella et al. (2016)
A12	To examine common interaction techniques in mobile applications for young children	Increasing the similarity between symbol and referent, can make children more successful app users	Hiniker et al. (2016)
A13	To investigate the schemes that children develop in their interactions with the software	Children canrelate the schemes enacted to the development of number sense with their fingers	Baccaglini-Frank & Maracci (2015)
A14	To enhance the development of lexical knowledge and language awareness with DGBL	The importance of well-designed materials that support a child-centered learning model	Sylla et al. (2015)
A15	To examine how two main levels of executive control, attentional and action control in young children	Expressions and the need for scaffolds were predicted by attentional control	van de Sande et al. (2015)
A16	To understand how children could learn through the engagement process in mobile apps	Three prominent conditions of children’s learning engagement: collective sensory experience, emotional expression, and verbal expression	Noorhidawati et al. (2015)
A17	To investigate young children whether be able to reason about and reflect upon the actions, and enjoy an educational game	Preschoolers were capable of reasoning and reflecting and interested and engaged in this kind of game that involves instructing a digital tutee	Haake et al. (2015)

Table 3 (continued)

Paper ID	Research Purpose/DGBL intervention	Study results and observations	References
A18	To verify and compare the effects of two types of training on early numerical skills: a domain-general precursor, a domain-specific precursor	The early numeracy intervention specifically improved early numeracy abilities in preschool children	Passolunghi & Costa (2016)
A19	To provide an evaluation of children learning experience of multi-touch flash memory games	Children had an average learning experience with the game	Hui et al. (2014)
A20	To investigate the effects of digitized presentations of narratives that include oral text as well as multimedia information sources	Adding certain information to electronic storybooks, animated, music and sound, pictures, can facilitate multimedia learning, especially in children at-risk for language or reading difficulty	Bus et al. (2015)
A21	To investigate MOT abilities using the game in a non-experimental setting for children	Children as young can play independently in a non-research setting	Ryokai et al. (2013)
A22	To examine the effects of the computer-based intervention Living Letters among young children	The need for early remedial computer programs	Van der Kooy-Hofland et al. (2012)
A23	To investigate the effects of implementing a computer game that integrates the prediction-observation-explanation (POE) strategy	Experimental group significantly outperformed their counterparts in the concepts regarding	Hsu et al. (2011)
A24	To present a tangible user interface for an AR game	High levels of motivation, curiosity, collaborative behaviors, and interactions among kindergarten children	Campos & Pessanha (2011)
A25	To investigate whether DGBL apps can improve creativity skills	DGBLs affect students' ability to develop creative skills as well as provide for deep, insightful learning	Behnamnia et al. (2020)
A26	To investigate the feasibility of using PiktoMir in teaching elements	A natural textless environment that gradually introduces important programming concepts	Rogozhkina & Kushnirenko (2011)

Table 3 (continued)

Paper ID	Research Purpose/DGBL intervention	Study results and observations	References
A27	To investigate an interactive edutainment system for the children	Children interacted with their peers through discussions and sharing ideas	Karime et al. (2012)
A28	To assess children's prior knowledge and skills concerning a particular subject area in software	Not only the design but also the content, the process, and the purpose of preschool software should be taken into consideration when implementing pedagogical software	Nikiforidou & Pange (2010b)
A29	To investigate "Shoes and Squares" app in conditions of the unequal likelihood of events	In the 1st trial of both Conditions children gave 56.6% correct predictions, in the 2nd trial they gave 52.6% and in the 3rd trial 59.3%. There seems to be a learning effect	Nikiforidou & Pange (2010a)
A30	A novel application which through storytelling attempts to improve the understanding of students with respect to online risks	Application makes students to deliberate on the online activities and alter their attitudes	Lazarinis et al. (2020)
A31	To develop a set of design principles that informed the production of a YouTube video	Lead to better early learning experience	Neumann & Herodotou (2020)
A32	To investigate whether frequent MTSD user preschoolers exhibit different attentional and socio-cognitive skills compared to non-users	Playing with a fast digital game eliminated the advantage of selective attention over divided attention observed in the non-digital and slow digital game conditions	Konok et al. (2021)
A33	To investigate how young children, interact with Digital Education Games	The difference in the learning effect between the digital and cardboard game was insignificant, that the children's interaction strategies varied significantly with their achievement level	Nizam & Law (2021)
A34	To analyze how the use of digital resources contributes to improving cognitive flexibility, inhibitory control and basic math skills	Significant improvements and shorter reaction time in the two groups that received the intervention	Peralbo-Uzquiano et al. (2020)

Table 3 (continued)

Paper ID	Research Purpose/DGBL intervention	Study results and observations	References
A35	To investigate the influences of teaching approaches to enhance problem-solving skills and computational thinking abilities	Increasing preschool children's learning behaviors as well as enhance their learning interests and computational thinking abilities	Lin et al. (2020a, b)
A36	To evaluate how young children use and interact with mobile applications	Game access, active engagement with the activities, and the social speech that is generated from playing the game	Crescenzi-Lanna (2020)
A37	To investigate an Android based serious gaming App for Thinking Computational in a playful way	Students find the App well-structured and help them to understand the basics of programming	Utesch Aladé et al. (2020)

Table 4 Study design via primary purpose of game

Study design	Total	Percentage (%)
Qualitative	10	27.0
Correlational	6	16.2
Quasi-experimental	9	24.3
RCT	3	8.1
Survey	9	24.3

Table 5 Number of included articles by learning theories applied for DGBL studies

Learning Theories	Total	Percentage (%)
Constructivism	15	40.5
Constructionism	3	8.1
Activity theory	4	10.8
Experiential & generative learning	2	5.4
Flow theory	2	5.4
Cognitive theory	11	29.7

Table 6 Identified papers according to subject area

Subject Area	Number of Papers	Percentage (%)
Computing	1	2.7
Entertainment	2	5.4
General Knowledge	9	24.3
Health	1	2.7
Language	7	18.9
Mathematics	11	29.7
Music	2	5.4
Personal Development	1	2.7
STEM	3	8.1

theory 29.7% (11 papers). Other learning theories that are less popular may constitute a valuable field for future research.

Table 6 lists the subject disciplines that are used in the studies and games. Most games are in the fields of mathematics 29.7% (11 papers), general knowledge 24.3% (9 papers), and language 18.9% (7 papers), while the lowest tendency items are in geography, history and social issues. It should be noted that selected and repeated topics (mathematics, language and general knowledge) fall under education articles due to the researchers' tendency to choose these items.

Table 7 Game genre classification according to the study design

Game genre	Total	Percentage (%)
Animated tutorial	7	18.9
Generic	3	8.1
Puzzle	2	5.4
Role-playing	1	2.7
Simulation	2	5.4
Sports	2	5.4
Strategy	2	5.4
Virtual world	3	8.1
Serious game	15	40.5

Game design and platform

Table 7 shows the game genre in related articles and in the current review that was considerably varied. Classification of the game genre was done based on the Hertz System (1997) (Herz, 1997). According to Table 7, in recent studies, the most game genre is serious game with 40.5%, while other genres such as platform and racing, action, and adventure were ignored.

The investigation of the selected 37 papers shows that most studies include more than one game design element. This category is based on the research of Deterding (2011). Deterding et al. (2011). According to Deterding (2011) the reason of using more than one game design element for designing games could be due to the fact that the audience is more attracted to the game (Deterding et al., 2011). Table 8 shows the distribution of all the game elements. Among these elements; interactivity, challenge, collaboration, communication, clear goals, feedback, role-playing, and complexity are the most popular.

The existing studies and statistical data reveal that a variety of operating systems support games for preschoolers. The data also show that the most popular operating system for game support is mobile or smart phones, tablets or

Table 8 Elements of Game design implemented in DGBL study

Elements of Game design	Number of references
Collaboration/Competition/Interactivity/Social/Communication	**30**
Role-playing/Narrative/Coordination and agility (Motor skills)	6
Scaffold/Immediate/Immersion	2
Exploration/Discovery	2
Complexity/Challenge/Curiosity	12
Strategy/Clear goals/Rules	5
Control/feedback/Memory assessment/Rewards/failure	16
Self-expression/Explanation	3

Table 9 Using platform according to the game purpose

Instructional settings and devices used in DGBL	Number of studies	Percentage (%)
Smartphones	10	27.0
Tablet	23	62.0
Computer (laptop/desktop)	3	8.1
Motion-sensing input devices (e.g., Microsoft Kinect)	2	5.4

multi-touch systems 89.0% (23 papers) as shown in Table 9. The results of the table show that in most studies, smartphones or tablets have been used. It seems that the main reason for using more tablets and phones compared to computers (PCs) is to create movements for children while playing DGBL. The PC leads children to sit in a boring environment for a long time without any movement. On the other hand, using a mobile phone or tablet for teachers to evaluate children and use it in different environments outside the classroom or a scientific trip seems easier. Hence, DGBL technology in terms of creation and development can be called a cost-effective learning environment.

Table 10 demonstrates that the most popular game design used in the literature for preschool age is 2D 48.6% (18 papers). Furthermore, this tendency of single-player application types forms the highest percentage 75.6% (28 papers) of the selected studies, which indicates that in these games, there is the least amount of attention to encourage young children to cooperate and collaborate as shown in Table 11. This observation can also be made in regard to the entertainment games.

Discussion

Based on the analysis of the findings of 37 articles in this section, an attempt has been made to answer the questions of this research (Table 3).

Table 10 Game design according to the game purpose

Game design	Total	Percentage (%)
2D	18	48.6
3D	10	27.0
AR (Augmented Reality)	4	10.8

Table 11 Game type according to the game purpose

Game type	Total	Percentage (%)
Single-player	28	75.6
Massively multiplayer online games	2	5.4
Classroom multiplayer games	7	18.9

Table 12 General overview of measurements used in related DGBL studies

Study design	Number of studies
Motivation, Engagement	16
Satisfaction, Enjoyment, Usability	16
Pedagogical aspects/Better learning performance and/or learning gains	13
Student soft skills /activity	13

Effects of the inclusion of DGBL in early childhood education (RQ1)

According to recent studies and evaluations on DGBL in preschool, it seems that DGBL has had a positive effect on children's learning. Table 12 refers to this positive effect to some extent. Based on Table 6 shows the measurement of experimental/empirical studies and the most common results for use in 37 selected articles. Most of them measured students' "Motivation, Engagement" ($n=16$) and "Satisfaction, Enjoyment, Usability" and user experience concepts ($n=16$) through DGBL activities. In addition, "Pedagogical aspects/Better learning performance and/or learning gains" aspects in many cases ($n=13$), as well as "Student soft skills /activity" such as creativity and critical thinking ($n=13$), were measured.

Engagement and experience of children in DGBL

In most studies, the results show that students enjoyed DGBL technology, and their experiences and learning increased (Table 13). For example, ($n=17$) used DGBL as a fun, all-encompassing fun way to help students learn (A1, A2). In addition to young children's satisfaction and enjoyment of DGBL while learning, a positive view of DGBL usability was also observed in the studies (A5, A8, A19). For example, students established a positive visual interaction with the DGBL in order to learn mathematics (A4, A11, A34). Similarly, studies such as the use of DGBL as a positive and effective technology in fostering creativity have been researched and the results are very promising (A25). In another study (A26), DGBL was introduced as a technology for better learning efficiency for children experiencing virtual

Table 13 Effect of inclusion DGBL

Achievable extend	References	Percentage (%)
Engagement, fun/enjoyable intervention	22	59.4
Motivation impacts, games	14	37.8
Learning gains	13	35.1
Collaboration	9	24.3
Creativity	5	13.5
Direct feedback	3	8.1

play environments such as a natural environment outside of school. Other studies have reported the use of DGBL as beneficial for young children and high levels of satisfaction. They stated that the use of DGBL technology allows teachers to present complex topics in a way that is more understandable to children. Children use DGBL technology to better understand subjects (A28, A26 & A35).

Motivation and impact of DGBL

As expected, DGBL digital games have been used as a medium in several learning interventions ($n=14$). DGBL can bring many different elements and approaches to motivate children, such as; Interactive scenarios, narration and control of players. For example, in several studies (A12, A13, A27, A33 & A36), children interacted with some specific issues using the DGBL game. DGBL games are also motivating for young children (A8, A24). For example, in research (A24), children used a combination of real objects and a DGBL game to create and solve challenges in a play environment. In addition to increasing young children's motivation to play and continue playing, DGBLs also increase children's critical thinking skills (A3, A25, A35).

In addition, the use of DGBL helps children overcome play challenges in early childhood by using concepts in play. Rewarding games creates and increases motivation and reduces the fear of learning (A8, A24, A29). Learning-based games can also allow children to learn the basics well without putting pressure on them to stress. These games simplify lesson concepts and introduce a visually appealing environment in which young children are able to acquire knowledge and achieve the open goals of a stress-free play program (A7, A8, A10, A11, A14, A16, A19, A25).

Learning gains and pedagogical aspects

The most important part of digital games is the focus on learning, gaining knowledge, knowledge, behavior, and new skills. As mentioned, DGBL games potentially increase children's motivation and participation. Therefore, these games also increase the amount of learning based on the increase in motivation in young children. Many studies ($n=13$) have provided evidence of the great achievements of DGBL use in children in terms of development and performance in thinking skills. In the study (A10), young students compared mistakes with traditional classroom games and found that children who used DGBL made fewer mistakes and their performance was proven. In another study (A25), they used DGBL to examine the effect of effectiveness on learning enhancement, creativity, and critical thinking. In another study (A10), children were divided into two groups. One group was traditionally taught through a teacher and the other group was taught through DGBL programs. The results of learning in both groups show that the level of acceptance and understanding of the curriculum is higher in children who have used DGBL games to teach with the teacher. Perception of knowledge and content was similarly significantly improved in another case of studies in young children (A14, A28). In some cases, the ability to understand the logical connection between ideas and critical

thinking through DGBL was also enhanced (A25, A27). In another study, young children who used DGBL performed better in terms of logical calculation, critical thinking, and problem-solving skills (A3, A35). Transitional thinking in another example where children used AR coding activities to shape the formation of a complex problem into simpler parts (A24). On the other hand, fun learning and scaffolding through DGBL challenges can be very useful for young children to better understand thinking and arithmetic (A9, A17). Finally, it can be argued that DGBL technology brings lesson concepts to young children more effectively and reduces teachers' efforts to enhance children's learning with other peripherals.

Collaborative and creative environment

In addition, the study found evidence that DGBL can increase and enhance children's cooperation, social and communication skills, and creativity. For example, in one study (A28), children began to work together to develop a concept in a small group of other young children. This method somehow develops an active learning experience. Children work together in the DGBL game to enhance the process of acquiring knowledge, insight, and content during the game, and this situation makes their group play more enjoyable. In another study(A28), the game was based on a participatory learning scenario. Or in another case (A25), DGBL is also associated with children's creativity. For example, the extent to which children develop creativity when using DGBL games has been examined. The results of this study show that DGBL helps young children to be more creative.

Another effect of DGBL is the socialization of children, which is accompanied by children asking a friend or teacher to solve challenges in the DGBL game. Combining young children of different genders in different classes or levels of thinking creates a learning environment. Social interactions through children's activities at DGBL may make the dimensions of collaboration among children more interactive, cooperative or competitive. Several articles have been reported to have positive effects on social co-operation in children when using DGBL (A5, A25 & A36). Therefore, DGBL environment has a high potential to strengthen children's social skills and thus can increase motivation and learning achievements. However, DGBL technology can help develop educational systems with different learning contexts.

Teachers' access to activities and feedback

On the other hand, other positives mentioned in DGBL games by the research report are direct feedback and mastery of ranking scaffolding with process index such as score, high level, badge, and so on. In one study, children received quick feedback on a virtual screen when they started working in a DGBL environment (A28). Another benefit of receiving direct feedback on DGBL games is that it helps students close their mistakes and see, or even make fewer mistakes. For example, children used the tablet for their games. When the game was replayed, it was observed that the children made fewer mistakes (A1, A31). In another study (A8), direct feedback helped children to learn the concepts of the alphabet more easily, and in the same study,

DGBL, as a teacher present in the digital environment, highlighted the aspect of controlling children's learning activity during direct feedback on games (A15, A34).

DGBL approaches can also affect the role of the teacher. DGBL, for example, (A9) provides teachers with more useful insights into practicing with each child during the learning process. In another study (A26), the DGBL also provides the teacher with an adjustable system for determining the level of the child, allowing teachers to adjust the game according to their educational needs. Therefore, it can be said that DGBL by providing feedback enables children with any level of knowledge to increase their understanding of the content and learning process and supports children's performance by creating interest and motivation. DGBL impresses children and encourages them to continue learning by creating interactive communication through feedback.

Children introduction with DGBL environment (RQ2)

DGBL technology can bring immersive learning experiences to young children. Using the virtual world of the digital gaming environment, children easily get acquainted with the real world and gain the necessary knowledge to face the real world around them (A28, A14). AR technology in DGBL games can be mentioned. With a device such as a mobile phone or tablet and activating its camera by students and parents, students can see the physical world on the screen, which is enhanced by virtual 3D objects, and communicate with the real world with this mental image (A24). Depending on the type of activity, children can explore and interact with objects from different perspectives. In summary, empirical research provides valuable insights into the elements that children interact with in a DGBL-based environment.

This research provided concepts that pave the way for further research and action. In addition, the opinion of experts, teachers, doctors, and knowledgeable people seem to be very important. These knowledgeable and expert people can examine children's behavior and feedback in early childhood and suggest appropriate actions for the further development of DGBL games. Experts can also be researchers and educators who can help digital content designers with enough information and psychology of children's behavior. Therefore, a specialized hybrid DGBL design is essential for development. Educators who provide designs for how to interact and create content for young children, then DGBL designers need to be able to develop high-quality learning content and engineers who can program that content to what it takes to design a DGBL.

Learning concepts and process of DGBL (RQ3)

The development of children's learning outcomes from the beginning of use and the end of activity with DGBL was examined in a comparative manner. In addition, learning processes (cognitive and educational) were also examined and the factors that affect the learning process are mentioned.

Pedagogical process

The results of recent studies show a positive effect of DGBL on related behaviors and emotions, focusing on knowledge acquisition, content comprehension, and increased motivation in early childhood. Three Bloom revision classifications based on the measurement of outcome types were considered in this study. A first category is a group of studies on the known simple mechanisms of DGBL that affect children. This mechanism increases children's understanding of content and memory. The second category includes a group of researchers that focus on cognitive processes and the application of DGBL. The third category includes some studies that focus on the evaluation and development of DGBL in preschool children. The highest category is in the first category, which focuses on remembering and understanding DGBL content in preschool children.

Table 14 presents the number of articles that shows the different learning and behavioral outcome and impact. These result show that the studies are most focused on knowledge acquisition and content understanding 40.5% (15 papers), and on perceptual and cognitive 27.0% (10 papers). The other cases are affective and motivational 24.3% (9 papers), behavior change 5.4% (3 papers), and social and soft skill outcomes 2.7% (1 papers). Therefore, most efficacy studies of preschoolers are found in the area of perceptual and cognitive and knowledge acquisition and content understanding. Furthermore, it seems obvious that only few entertainment games are used for learning purposes at the preschool level.

Cognitive load and mental method

As mentioned earlier, the potential for children to learn in a DGBL environment is high. Mental methods and the development of mental abilities need to be combined with computational challenges that combine physical and virtual in the DGBL environment (Winslow, 1996). The reviewed articles present the following; DGBL learning outcomes, cognitive outcomes, and emotional outcomes such as attitudes or beliefs. A number of articles have suggested that DGBL has the potential to help students find ways to learn ($n = 17$). Studies have also shown that DGBL is enjoyable and exciting for children.

Table 14 Learning outcomes according to study design

Learning outcomes	Total	Percentage (%)
Affective and motivational	9	24.3
Behavior change	2	5.4
Knowledge acquisition/Content understanding	15	40.5
Perceptual and cognitive	10	27.0
Social/soft skill outcomes	1	2.7

DGBL as a medium with children

Most of the research-based digital education and games presented in this review are intended for the education or potential use of children. This is because DGBL and studies of these games will help in the long run of school education. DGBL can help young children develop and learn curiosity about answering their questions. On the other hand, by focusing on the specific design of DGBL, the cognitive load that is applied to working memory and children during the learning process can be applied more effectively to the learning outcomes of learning in the DGBL environment in children. What should be paid more attention to the creators of educational technology is how the children's minds work. According to Cook's (2006) and Mine's (1995) theory, how children's minds function in terms of the cognitive impact on visual learning in education in the DGBL environment should be considered (Cook, 2006; Mine, 1995). Because the use of DGBL is being promoted more widely among children today. Therefore, clear content is necessary to better understand and enhance children's learning. Extensive research should be done on how and when this necessary content emerges, and this research can have a positive impact on the educational and information technology community.

Challenges and future direction (RQ4)

The findings of this systematic literature review may be useful to various stakeholders; Students, educators, policymakers, and curriculum designers, child psychologists. Recent research shows that there is still no clear vision of how technologies such as DGBL can be integrated into the learning process safely for young children (Martín-Gutiérrez et al., 2017). There are several different levels at which a young child can communicate in a virtual DGBL game environment (Martín-Gutiérrez et al., 2017) and the DGBL program can have positive effects. These positive effects motivate and delight young children and at the same time can increase their understanding of learning concepts. As mentioned earlier, DGBL can increase the following among young children; Motivation, collaboration, creativity, critical thinking, learning satisfaction by keeping content in working memory (Jesionkowska et al., 2020). However, there is a long way to go to see how effective DGBL is in young children. As a first step, the use of DGBL in the education system of young children can be considered as a regular curriculum and not just as a program activity.

Designing and creating educational content in DGBL, on the other hand, seems like a complicated process, as the goal is not just to create a digital game in a virtual environment, but also to create an effective learning tool for young children (Liao et al., 2019). Therefore, more research is needed with DGBL technology. In particular, decision-making on how to create DGBL-based visual environments and communications is needed to help children create knowledge and discover tools and tools to measure whether children are really creating new knowledge (Beserra et al., 2019). Recent research shows that there are barriers to the use of technology at the preschool level, such as a lack of facilities, devices, or software (Yang et al., 2018).

Future research, on the other hand, should focus on creating more engaging designs and scenarios that are appropriate for preschool-level learning. The impact of cognitive load, content perception, and motivation on how to include DGBL in educating children according to special needs or gender should also be considered (Castillo, 2019). Considering all the above, how to design the inclusion of DGBL and examine the participation of its use in the combined education of young children should be given more attention and focus (Haataja et al., 2019; Sun et al., 2018).

Thus, visual representations may lead to better understanding and participation for early childhood. In several case studies, determining the appropriate results and analysis in the game has been mentioned, however, it is not clear how the DGBL performance can be increased on the performance motivation of young students (Barzilai & Blau, 2014; Chen & Law, 2016; Haataja et al., 2019). Many studies have suggested that what helps children develop their level of knowledge and make it easier for children to consider educational issues are key factors such as the ease of use of DGBL, the simplicity and clarity of the visual content used (Dukuzumuremyi & Siklander, 2018; Muhonen et al., 2016; Van de Pol et al., 2010). Another important aspect of teachers' familiarity in using this technology is receiving the necessary information and knowledge in using DGBL for combined education at the preschool level.

On the other hand, increasing motivation is possible not only by the attractive atmosphere of DGBL but also by teachers by encouraging children to learn knowledge (Muhonen et al., 2016; Tropper et al., 2015). Therefore, with an overview of recent research trends, it can be said that DGBL has gradually become a popular technology for combination education. Recent research from DGBL has been introduced as an efficient, highly stimulating, and powerful technique to increase motivation, content understanding, insight, and knowledge, enhancing learning concepts at the preschool level. Hence, DGBL has great potential to help educate young children. These games develop children's participation and motivation.

Limitations of DGBL in educational settings

Table 15 shows the limitations of DGBL digital games in the training environment. The greatest limitation in studies indicates that teachers need to become more familiar with DGBL technology. Teachers can plan to configure DGBL programs based on knowledge and child level when they are not familiar with these technologies (24.3%). So, the existence of an interdisciplinary program is felt. On the other hand, if DGBL programs do not evaluate the child properly, they can create a challenge above or below the child's level of knowledge and make the child frustrated or tired. Another limitation of the course is the emphasis and encouragement of children on their independent individual skills in critical thinking and creativity and problem-solving (21.6%). Hence, to provide a comprehensive analysis of the impact of DGBL games and children's learning, it is necessary to design an educational plan. There is also a lack of a learning plan or framework for early childhood (24.3%). Overconcentration of children and cyberspace have been reported as other limitations and may occur because children's learning curves have grown moderately. Short-term assessment periods to assess children's performance while using DGBL in studies

Table 15 Limitations of DGBL in educational settings

Limitations of DGBL in educational settings	Number of studies	Percentage (%)
Teachers cannot manipulate the same system for different educational subjects (lack of interdisciplinary programs)	10	24.3
Students paid too much attention to virtual information (novelty factor)	4	10.8
Teachers need to develop additional learning material exclusive to learning activity needs	3	8.1
Complex DGBL systems may have a modest learning curve	3	8.1
Too short periods of assessment to measure student learning performance	2	5.4
Lack of pedagogy scheme	7	18.9
Lack of model or framework of learning for preschooler	8	21.6

indicate that there may be statistical errors. long-term evaluation is needed to correct this error and increase the accuracy of statistics. On the other hand, teachers in DGBL games need additional educational items limited to childhood education. DGBL educational content should be understandable to young children and aim to focus on education and stay in their active minds (Makar et al., 2015; Muhonen et al., 2016). More research is needed on the development of DGBL with a level of content similar to early childhood so that teachers can easily use this technology to transfer their knowledge to children. Therefore, designers and professionals must focus on the design and experience of childhood education principles before making major advances in DGBL.

Additional factors

Different views have been offered on what factors are effective in creating a good educational digital game, yet those theories and views have mostly remained untested (Binkley et al., 2014). Most multiple and diverse learning theories have yet to be evaluated. Also, the subject areas have not been selected and worked, which is repeated training in articles in three areas of mathematics, language, and general knowledge. Hence, this concern constitutes the issue of repeated training in these areas; mathematics, language, and general knowledge. These areas are frequently addressed in education articles, possibly due to their popularity among educationalists (Binkley et al., 2014). However, the other disciplines are neglected such as; 21st Century social and practical skills for children which can prepare them for the future modern society (Aladé et al., 2016). This paper has found little empirical evidence for the claim of gender. Most researchers have used gender as an add-on variable, while they have not reasoned for it (without arguing why). In addition, the data obtained is low for western society or the eastern society variable effect on learning outcomes. Thus, for this variable more research is needed (Nikiforidou & Pange, 2010b; Noorhidawati et al., 2015).

In addition, the survey identifies some recommendations for future research in DGBL for preschoolers. Most empirical tests focused on the overall impact of DGBL

as compared to traditional training methods (Cascales et al., 2013). Also, new theories and digital game designs should be tested empirically. New experimental results of such tests will help designers and educators choose and design improved educational games. If the existing theories are not followed up with experimental tests, and they are not subsequently refined and expanded, the effectiveness and popularity of the games cannot be guaranteed and most remain contemplative due to the lack of empirical evidence. Due to the recent research trends and the increase of new educational approaches compared to traditional approaches, more research is needed with the randomized controlled trial (RTC) method as well as more comparative studies. This type of study (RTC) can be of great help to psychological studies in preschool children (Hui et al., 2014; Passolunghi & Costa, 2016; Sella et al., 2016; Van der Kooy-Hofland et al., 2012). On the other hand, longitudinal studies to evaluate educational games based on education are very few and the focus on further studies in this area is felt (Goldstein, 1968). In addition, prior works on the role of educational media in early learning have focused on a wide variety of topics, like early literacy prosocial skill acquisition and adoption of healthy behaviors (Aladé et al., 2016).

Limitations-threads to the validity

A more comprehensive investigation may also include databases of scientific literature, for example, Google scholar or the IET Electronic Library and others. Although the number of selected papers analyzed in this research was compatibly low, the sampling procedures and implemented measures were effective.

There may be studies that are not included in our selected articles. Given that a number of studies may have been overlooked in the search process, there may be studies that are not included in this study. Although the authors of this article have repeatedly reviewed the collected studies, the search process is based on a human process with human error, so important information may not have been considered.

Conclusion

This article provides a regular review of the literature, analysis of the state of the art in DGBL digital games. Hence, the purpose of this study is to present the latest developments and trends and through the review of experimental research related to the use of digital games based on early childhood education at the preschool level from 2 to 6 years of age. To ensure a consistent literature review, the present study is based on the proposed systematic review method. This review analyzes 37 articles in this area. In this paper, PRISMA's principles analysis of studies on the characteristics of DGBL technology has been used. The classification focuses on four areas: the objectives of current studies, the impact of technology use on children's learning, learning theories, and assessment methods in DGBL applications. DGBL seems to be a very promising technology to facilitate learning in the education of young children. The results of this study show that the use of DGBL can have an active effect on strengthening thinking skills and learning in childhood. The results of this

research can be effective for designing DGBL technology training. Due to the interest of children in acquiring game skills with DGBL and the increasing number of digital game environments based on teaching in the classroom, the use of DGBL technology also seems comprehensive, attractive, and necessary. This article may enable readers with different interests to advance their knowledge of this new and important field of DGBL in the education of young children and will be helpful to future generations of the DGBL learning environment.

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Declarations

Conflict of interest All authors declare that they have no conflict of interest. Also, all authors have participated in (a) conception and design, or analysis and interpretation of the data; (b) drafting the article or revising it critically for important intellectual content; and (c) approval of the final version. The following authors have affiliations with organizations with a direct or indirect financial interest in the subject matter discussed in the manuscript.

Ethical Declaration statement This material is the authors' own original work, which has not been previously published elsewhere. The paper is not currently being considered for publication elsewhere. The paper reflects the authors' own research and analysis in a truthful and complete manner. The paper properly credits the meaningful contributions of co-authors and co-researchers. The results are appropriately placed in the context of prior and existing research. All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference. All authors have been personally and actively involved in substantial work leading to the paper and will take public responsibility for its content.

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