



THE IMPACT OF GAME-BASED LEARNING ON COGNITIVE DEVELOPMENT IN EARLY CHILDHOOD: A REVIEW OF THE LITERATURE

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ABSTRACT

This study aims to investigate the impact of game-based learning on cognitive development in early childhood through a literature review. Game-based learning has become a major focus in early childhood education because of its potential to stimulate children's cognitive development. Through a comprehensive literature review, this article describes various findings from previous research that reveal the impact of game-based learning on cognitive abilities such as problem-solving, critical thinking skills, conceptual understanding, and flexible thinking abilities in early childhood. These findings provide insight into how this learning approach can influence children's cognitive development at an early stage in their lives. Practical implications and future research directions are also discussed in this article. Thus, this article provides a better understanding of the importance of integrating play-based learning in early childhood education curricula to improve children's cognitive development.

Keywords: *Game-based Learning, Cognitive, Childhood, Systematic Review*

1. INTRODUCTION

Game-based learning has been considered an engaging teaching approach to promote student learning and motivation (Hussein et al., 2019). The GBL environment can help children, instructors, and game designers to create a friendly learning environment (Tang, 2020). According to various research results, the reason children play games is that games are fun, exciting, and offer challenges in solving problems (Dalton & Devitt, 2019; Gerkushenko & Gerkushenko, 2014; Godwin et al., 2015; Mouws & Bleumers, 2015). Many prominent gaming experts have even put forward the view that gaming has great potential to revolutionize the world of education, driven by its wide prevalence and strong motivational power (Gee, 2003; Prensky, 2008; Squire & Jenkins, 2003).

The literature on early childhood education (ECE) and GBL emphasizes that educational digital games, when designed and used in pedagogically appropriate ways, can aid learning (Edwards, 2013; Hatherly et al., 2009), creativity (Edwards, 2013; Zevenbergen & Logan, 2008), cognitive development (Divjak & Tomić, 2011; Doliopoulou & Rizou, 2012; Fessakis et al., 2013; Koivisto et al., 2011; Lieberman et al., 2009; Manesis, 2018; VerenIkIna et al., 2010; Yien et al., 2011), social interaction (Doliopoulou & Rizou, 2012; Lieberman et al., 2009; Manesis, 2018), higher order thinking (Hatherly et al., 2009; Manesis, 2018; Yien et al., 2011), critical abilities (Allsop et al., 2013; Lonigan et al., 2003; Manesis, 2018), problem solving (Allsop et al., 2013; Fessakis et al., 2013; Yien et al., 2011), memory (Allsop et al., 2013; Divjak & Tomić, 2011; Hatherly et al., 2009; Koivisto et al., 2011; Manesis, 2018; Zevenbergen & Logan, 2008) in young children. Currently, the implementation of GBL into PAUD is also an important issue to support teacher professional development (Altun, 2019). A literature review states that the adoption and use of ICT and digital games in the teaching and learning process is usually influenced by teacher confidence in integrating GBL in the classroom, teacher beliefs and attitudes towards GBL, teacher competence and skills in using technology (Blackwell et al., 2013; Hew & Brush, 2007; Ihmeideh, 2009; Nikolopoulou et al., 2019).

In recent years, there has been an increase in the use of online educational games in society and schools. However, this has also raised concerns among families regarding uncertainty regarding its negative impact on children (Konok et al., 2021). For example, some experts believe that such educational games can increase the risk of addiction, increase the level of aggressiveness and reduce motor abilities. Therefore, many researchers emphasize the importance of conducting further research to clarify how digital games affect children and what factors influence this (Lazarinis et al., 2020).



A number of literature reviews have attempted to analyze and summarize the knowledge accumulated in the field of game-based learning (GBL) to provide guidance for the development of this field. These reviews examine GBL from various perspectives. Some focus on GBL outcomes (Hainey et al., 2016; Qian & Clark, 2016; So & Seo, 2018; Tan et al., 2017; Tokac et al., 2019; Wouters & Van Oostendorp, 2013). Other studies focus on specific levels of education, such as K-12 (Hainey et al., 2016; So & Seo, 2018), higher education (Subhash & Cudney, 2018; Tan et al., 2017) and early childhood education (Garcia, 2020; Lamrani & Abdelwahed, 2020; Tang, 2020; Zapata-Cáceres et al., 2021). Several reviews also explore game design elements that can contribute positively to learning outcomes (Ke, 2016; Subhash & Cudney, 2018). Additionally, there are also reviews targeting specific study domains such as language (Despeisse, 2018; Hung et al., 2016), mathematics (Tokac et al., 2019), and health care (Gentry et al., 2019; Ghoman et al., 2020; Tan et al., 2017).

In an increasingly advanced digital era, game-based learning (GBL) has become one of the most innovative and interesting learning methods. This method uses games as a tool to help students understand concepts and subject matter more interestingly and interactively. However, although much research has been conducted to explore the effectiveness of GBL in general education contexts, there is a significant lack of research regarding the implementation of GBL in early childhood. This paper aims to analyze the impact and benefits of game-based learning on children's cognitive development. This research is a systematic literature review, which means that this research will collect and analyze previous studies that have been conducted on GBL and children's cognitive development. By conducting a systematic review, this paper will try to answer important questions. It is hoped that the results of this analysis will provide new insights into how GBL can be used effectively in early childhood education. Thus, this paper can help educators and parents in designing learning programs that support their children's cognitive development. In addition, the results of this analysis can also provide a basis for further research on the use of GBL in early childhood education.

According to the research conducted in this paper, 66 studies relevant to the research topic were selected and systematically evaluated using the PRISMA analysis method (Liberati et al., 2009). This research explores the impact of game-based learning factors on children's learning. The five categories investigated in this study are;

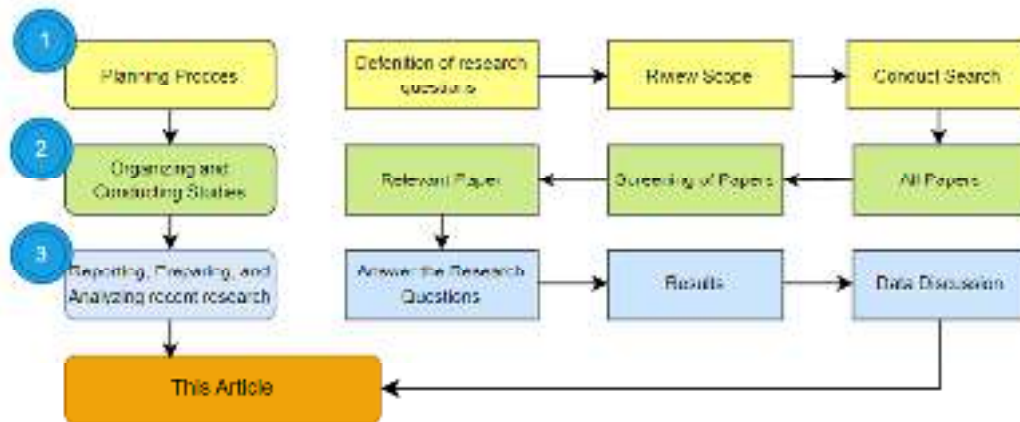
- 1) What are the annual publication trends in the field of game-based learning for early childhood from 2015-2023?
- 2) Who are the top 10 most influential writers in the field of game-based learning for early childhood based on their citations from 2015-2023?
- 3) What are the documents based on the research subject of game-based learning in early childhood education from 2015 to 2023?
- 4) What are the benefits of game-based learning research in early childhood education from 2015 to 2023?
- 5) The effect of game-based learning on children's cognitive development?

2. METHODS

The authors of this study have applied a systematic analysis approach and PRISMA review to gain the latest understanding of developments and current research surrounding play-based learning (GBL) at the preschool level (Moher, 2009).



In this paper, the research and review steps include the stages illustrated in Figure 1.



- 1) Planning process; Collection of journals and internet sites, exit and entry criteria for research, and expression of analysis and review steps.
- 2) Organize and conduct studies; Selected articles are analyzed, then the data is encrypted.
- 3) Reporting, compiling, and analyzing the latest research to understand the current status of game-based learning (GBL) in early childhood.

3. RESULTS & DISCUSSION

The application of Game-Based Learning (GBL) to early childhood has had a significant impact on their cognitive development. GBL is an effective educational tool for improving children's executive function, which can help in developing important cognitive and social skills (Liu et al., 2022) and is effective for improving the motivation and academic outcomes of young children (Paul, 2022). Through the use of games specifically designed for educational purposes, children not only actively learn new concepts, but also improve their overall cognitive skills. For example, in games designed to teach letters and numbers, children can develop their visual and auditory processing abilities by recognizing the characters and sounds associated with each letter or number. These digital game-based learning environments show the potential to increase students' interest and confidence in learning mathematics, as well as providing teachers with useful tools to help children with diverse mathematics learning needs (Thai et al., 2022). Additionally, challenging games like puzzles or memory games can also help in improving children's problem-solving abilities and short-term memory.

Game-based learning, especially the use of digital games, can be used as an effective tool to support learning and skill development for children with intellectual disabilities (Dhiyaneshwari, 2023). Apart from that, GBL also encourages children to develop critical and strategic thinking skills. The use of DGBL in early childhood education can have a positive impact on children's learning and thinking skills (Behnamnia et al., 2023). In challenging game situations, they are invited to plan their steps carefully, considering the consequences of each decision they make. This not only improves their ability to solve games but also transfers these critical thinking skills into everyday life, helping them make better decisions and solve problems more effectively. Thus, implementing GBL not only provides a fun learning experience for children but also significantly improves their overall cognitive development. The aim of this research is to look at game-based learning in the cognitive development of early childhood from 2015 to 2023. These findings are discussed in more detail in the following section.



Q1. What are the annual publication trends in the field of game-based learning for early childhood from 2015-2023?

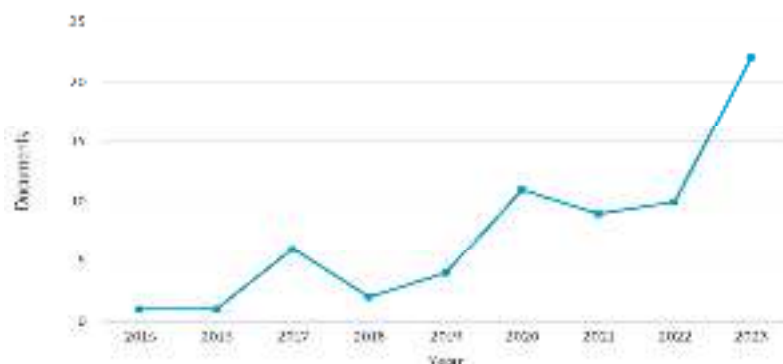


Figure 2. Game-based learning trend graph for early childhood

A total of 66 documents were selected from the SCOPUS (meta) database, all of which were research articles. Analysis of Game-Based Learning (GBL) research trends in early childhood shows a significant growth pattern from 2015 to 2023. In 2015 and 2016, the number of articles published was still low, with only one article for each year. However, starting in 2017, there was a quite sharp increase, with the number of articles published reaching six that year. This growth trend continued into 2018, albeit in slightly lower numbers, with two articles published.

In 2019, there was another increase in the number of articles published, reaching four articles. However, a significant increase occurred in 2020, when the number of published articles increased to eleven, indicating a continued increase in interest in research related to GBL in early childhood. This strong growth trend continued in 2021, with nine articles published. In 2022, the number of published articles reached ten, indicating continued interest in this research. The most striking trend occurred in 2023, when the number of articles published jumped drastically to twenty-two. This reflects increasing recognition of the importance of GBL in early childhood education and increasing interest in exploring its potential.

In conclusion, GBL research trends in early childhood show a significant increase from 2015 to 2023, with the number of publications increasing consistently. This reflects the growing interest in exploring the potential of GBL as an effective educational tool for early childhood. Although there are fluctuations in the number of publications from year to year, general trends indicate that GBL research in early childhood continues to be a relevant and interesting topic for researchers in the field of education.

Furthermore, the distribution of countries with the highest number of published articles about game-based learning for early childhood can be seen in Figure 3.

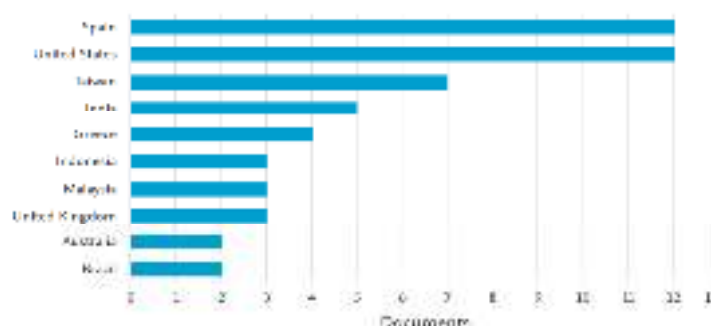


Figure 3. Distribution of Game-based Learning Publications for Early Childhood

Analysis of game-based learning research in early childhood shows that this topic has become a significant research focus in various countries around the world. From the data provided, it can be seen that



developed countries such as Spain and the United States have a high level of research activity with 12 articles each. This reflects the importance of early childhood education in these countries and awareness of the potential of games in enhancing learning in the early stages of life. In addition, countries such as Taiwan, India, and Greece are also involved in this research with a significant number of articles, indicating global attention to the development of effective learning methods for early childhood. However, there are also countries with lower research contributions such as Indonesia, Malaysia, and Australia. This could reflect challenges in resource access or different research priorities in these countries. In conclusion, research on game-based learning in early childhood is an important topic globally, with developed and developing countries alike contributing to developing our understanding of the role of games in children's education.

Q2. Who are the top 10 most influential writers in the field of game-based learning for early childhood based on their citations from 2015-2023?

Based on the 66 documents analyzed, there are the top 10 most influential authors in the field of game-based learning for early childhood based on their citations. More details can be seen in Table 1 below.

Table 1. Top 10 most influential authors

Authors	Title	Year	Cited
Manesis D.	Using a gesture interactive game-based learning approach to improve preschool children's learning performance and motor skills	2016	67
McBride C.; Smith A.; Kalir J.H.	Intrinsic motivation of Chinese learning in predicting online learning self-efficacy and flow experience relevant to students' learning progress	2017	53
González-González C.S.; Del Río N.G.;	Cognitive science in the field: A preschool intervention durably enhances intuitive but not formal mathematics	2017	48
Wilton K.S.; Murphy K.M.; Mahmud A.; Azam S.;	Introducing fundamental object-oriented programming concepts in preschool education within the context of physical science courses	2018	46
Rodríguez-Ferrer J.M.; Manzano-León A.; Aguilar-Parra J.M.	Critically Reviewing GraphoGame Across the World: Recommendations and Cautions for Research and Implementation of Computer-Assisted Instruction for Word-Reading Acquisition	2020	45
Bang H.J.; Li L.; Flynn K.	Does "Measure Up!" measure up? Evaluation of an iPad app to teach preschoolers measurement concepts	2020	24
Jaramillo-Alcázar A.; Arias J.; Alborno I	Games for Teaching Mathematics in Nigeria: What Happens to Pupils' Engagement and Traditional Classroom Dynamics?	2019	21
Espigares-Gámez M.J.; Fernández-Oliveras A.;	Game-based learning and gamification to improve skills in early years education	2020	21
Sarfaty L.; Ben-Eliyahu A.	Video games in the classrooms: Implications of a disruptive innovation to develop the Multiple Intelligences; [Videojuegos en las aulas: Implicaciones de una innovación disruptiva para desarrollar las Inteligencias Múltiples]	2015	20
Magalhães L.F.; Alves R.B.; Cunha L.R.C.	Music learning in preschool with mobile devices	2017	19

Some articles received a significant number of citations, indicating great interest by researchers in the topic. Articles such as "Using a gesture interactive Game-based Learning Approach to Improve Preschool Children's learning performance and Motor Skills" received 67 citations and "Intrinsic Motivation of Chinese



Learning in predicting online Learning Self-efficacy and flow experience relevant to Students' learning progress ” got 53 citations shows the importance of the topic in the academic community.

Q3. What are the documents based on the research subject of game-based learning in early childhood education from 2015 to 2023?

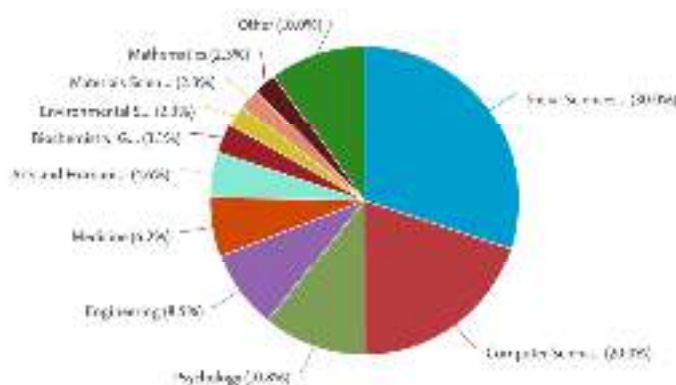


Figure 3. Documents Based on Research Subjects

The data above shows that social sciences have the largest share in related research, reaching 30% of the total articles compiled. This reflects the importance of understanding social and contextual aspects in implementing game-based learning in early childhood education. Furthermore, computer science has a significant contribution with 20%, showing the importance of developing technology and platforms to support game-based learning. The discipline of psychology also has a fairly large share of 10.8%, emphasizing the importance of understanding the cognitive, emotional, and behavioral aspects of children in using games as a learning tool.

Engineering, although not as big as social sciences and computer science, still makes a significant contribution with 8.5%. This reflects an effort to develop technology and design that supports the effectiveness of game-based learning. The medical discipline also made a decent contribution with 6.2%, indicating an interest in understanding the health and child development implications of gaming use in educational contexts. Meanwhile, the disciplines of arts and humanities, biochemistry, genetics, molecular biology, environmental science, materials science, and mathematics make smaller, but still important, contributions in enriching cross-disciplinary understanding of game-based learning in early childhood.

In conclusion, research on game-based learning for early childhood involves varied contributions from various scientific disciplines, emphasizing the importance of cross-disciplinary approaches in understanding and optimizing the use of games as effective learning tools. This confirms that a holistic and collaborative approach from various fields of science is very important in developing best practices in early childhood education through game-based learning.

Q4. What are the benefits of game-based learning research in early childhood education from 2015 to 2023?

Based on the results of a study of 66 articles, there are many benefits shown by game-based learning in early childhood, including:

1) Improved Learning

The research results show that the use of GBL can improve the learning process of early childhood in various contexts, including learning mathematics, language, and science concepts. The use of technology in the form of games can increase children's interest and involvement in their learning process.

2) Cognitive Stimulation



Game-based learning (GBL) can stimulate children's cognitive development, including critical thinking abilities, problem-solving abilities, and creative abilities. The various games and activities in GBL are designed to stimulate various aspects of children's cognitive development.

3) Child-Centered Learning

GBL enables child-centered learning, where the learning experience is personalized according to the child's individual needs and interests. This allows children to learn in a fun and supportive environment.

4) Development of Social and Emotional Skills

Several studies highlight that the use of GBL can also help in the development of children's social and emotional skills, such as cooperation, emotion management, and conflict resolution. Games are often designed to promote social interaction and teamwork.

Q5. The influence of game-based learning on children's cognitive development?

Through the analysis of these articles, it can be concluded that game-based learning (GBL) has great potential to improve the cognitive development of early childhood. GBL can improve learning and learning experiences, both for children and for their educators. The use of GBL can have a positive impact on children's cognitive development, including increased learning motivation, autonomous learning, and understanding of mathematical and language concepts. This shows the importance of integrating technology and innovative approaches in teaching to improve the quality of early childhood education up to the basic education level.

A systematic review shows that GBL can have a positive effect on children's learning, especially in strengthening thinking and learning skills. Additionally, the use of technology, games, and other innovative learning approaches can improve learning outcomes and student engagement in a variety of educational contexts, from early childhood education to higher education. However, to maximize the benefits, it is necessary to pay attention to factors such as teacher support, availability of equipment, child involvement, and adaptation of the curriculum to meet individual learning needs.

4. CONCLUSION

Based on an analysis of various articles regarding the use of game-based learning (GBL) in the cognitive development of early childhood, it can be concluded that this approach has great potential to improve learning in the early stages of children's development. Research results show that GBL can strengthen thinking and learning skills in young children, as well as increase learning motivation and understanding of mathematical and language concepts. Therefore, the use of GBL in early childhood education environments can be an effective strategy in developing their cognitive potential. The first recommendation is the need to integrate technology and innovation in teaching in early childhood education environments. Teachers and educators need to pay attention to the latest technological developments and use them creatively in designing interesting and interactive learning experiences for children. By utilizing GBL, teachers can create a stimulating and enjoyable learning environment for children, thereby increasing their interest and involvement in the learning process.

The second recommendation is the importance of training and support for educators in implementing GBL in the classroom. This training may include an understanding of GBL concepts, utilization of related tools and applications, and effective teaching strategies in the GBL context. In this way, educators will be better prepared to face challenges and maximize the learning potential that can be obtained through this approach. The third recommendation is that there is a need for further in-depth research regarding the effectiveness and implementation of GBL in various early childhood education contexts. This research can cover aspects such as long-term influences on children's cognitive development, curriculum adaptation to meet individual needs, and the role of parents in supporting the use of GBL at home.

The use of game-based learning has great potential to improve the cognitive development of early childhood through interactive, fun, and effective learning. With the right support from educators, technology, and ongoing research, GBL can be an effective solution in improving the quality of early childhood education and preparing them to face future developmental challenges.



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