

Trend and research of Lego and Minecraft as learning media to realize 4th SDGs

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Abstract. The SDGs emphasize quality education. Lego and Minecraft can stimulate students' 21st-century skills. This research aims to identify trends and contributions of Lego and Minecraft in education. The study utilized bibliometric analysis to evaluate publications. Data was collected from Scopus and analyzed using VosViewer software. Over the past decade, research on Lego and Minecraft in education has been more stable, with a peak in 2017 due to its popularity. Minecraft research increased from 2013 to 2019 but declined in 2020. Lego and Minecraft education research was published in conference papers with Springer as publisher. The United States and Germany are the most productive countries with top ten sources, with 90% focusing on computer science. The top eleven subjects significantly impact education by developing systems, online courses, and digital media. Lego and Minecraft research uses quan-qual-mix studies to explore their application in education. They strongly relate to STEM education, digital learning, 21st-century skills, and game-based learning. Combining Lego and Minecraft with technologies can increase computational thinking, creative-critical thinking, collaboration, and engineering skills. Future studies must employ one or more keywords, and work with Google Scholar and Web of Science data for in-depth analysis.

1 Introduction

The United Nations set 17 SDGs and 169 targets that emphasize the importance of quality education in achieving these goals [1]. There needs to be more quality education, particularly in numeracy, literacy, mathematical science, and technology. So, the government must increase the quality of curricula, teacher training, and learning environments [2]. Implementing digital learning media in education can improve quality education and create a promising framework for sustainable development education. Hsiao [3] states that implementing digital learning media—robot education—in schools can reach the fourth goal of the SDGs. According to the fourth SDG, Quality Education, the right to quality education directly impacts the world's human resources and future

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human prosperity. In contrast, persistent inequality and inadequate education can keep children trapped in poverty and immobility for generations without a comparable and quality education [4].

Lego has developed educational tools for many instructional activities that stimulate play and creativity in students [5]. It helps students develop their cognitive-creative skills and improve their language and literacy skills [6]. Lego is used by governments worldwide, including Peru, Singapore, and the United States [7]. In addition, another type of digital learning media is game education, one of the most popular video games [8]. Minecraft is advantageous for gaming, simulation, and education because it fosters creativity and responsiveness [9]. Over the past ten years, Minecraft has progressively become a part of game education in humanities and sciences research [10-12].

This research elaborated on the trends and research of Lego and Minecraft in education to identify and compare its research, which can help researchers in future studies.

- Regarding research characteristics and features, what was the location, type of documents, sources, and authors of Lego and Minecraft education research?
- In terms of application, what were the dominant disciplines, and how are the contributions and differences between Lego and Minecraft education research?

2 Methods

Bibliometric is a statistical technique used to assess and quantify publications in a specific research field, reducing objectivity and potential bias [13, 14]. It helps researchers understand structure, patterns, and trends in research activities in various disciplines [15, 16].

2.1 Resources

The data were collected from the Scopus database with broader coverage in social science than WoS [17].

2.2 Data collection

The data were collected on August 28, 2023. The three steps of bibliometric analysis include keyword selection, refining, export data, and analysis data. In this research, authors selected two keywords, "Lego" and "Minecraft". In refining steps, authors limited the data by scope and publication year. The timespan covered the range from January 2013 to December 2022. As a result, 597 documents relevant to Lego education research and 136 documents to Minecraft education research. Each data is downloaded in .ris and .csv format.

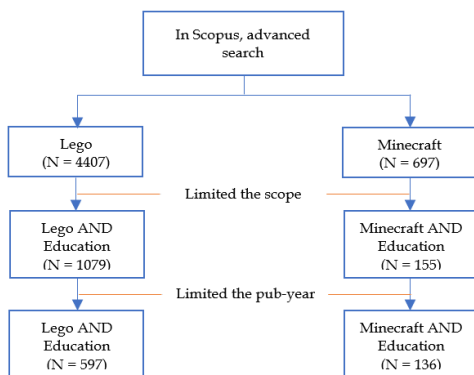


Fig. 1. Research map

2.3 Data analysis

The data was analyzed through VosViewer software to get the relationship among authors, documents, and keywords [18, 19]. The year of publication, country, affiliation, language, and other information were analyzed from the .csv file using Microsoft Excel. Microsoft Excel results were used to solve RQ 1 and VosViewer to solve RQ2 [20].

3 Results and discussion

3.1 Research characteristics and features

3.1.1 Year-wise distribution

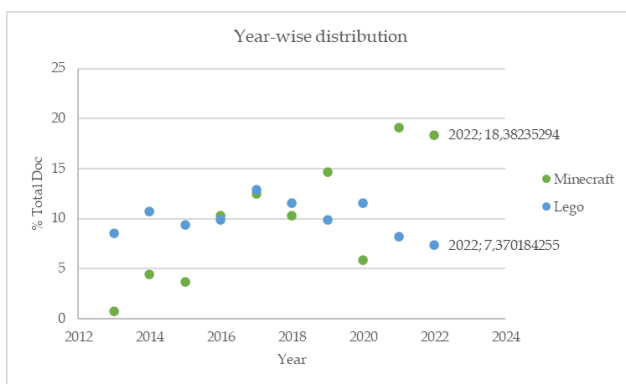


Fig. 2. The year-wise distribution of Lego-Minecraft education research

The Figure 2 shows research trends in Lego and Minecraft education over the last decade. There is more research on Lego than on Minecraft. The Lego research tends to be stable from 2013 to 2016, with the highest peak in 2017 (77 documents). Lego has been very popular since 1932 and was the most influential brand in the world in 2017 [21]. From 2018 to 2020, the publication percentage is the same as from 2013 to 2016.

In addition, Minecraft research increased from 2013 to 2019, declined in 2020, and increased from 2021 to 2022. The productive year was 2021, with 26 documents. The Lego research trend has declined in the last two years because of the Covid-19 pandemic. There was a change in the learning system that made students unable to meet to build Lego together. However, the pandemic helped Minecraft become successful and popular. Microsoft made the Minecraft education edition as an effort to assist students who are not able to return to school.

3.1.2 The most productive affiliation and region

Table 1 shows four public universities in Spain that participated in Lego Education. On the other hand, Tufts University gives the United States the first place of publications in Lego Education. Tufts University has Tufts CEEO with many exciting services and programs for educators. In addition, Aalborg University also participated in Lego and Minecraft Education and gave Denmark the third productive region. Denmark was a Lego block-maker in 1932. Minecraft was made in Sweden with two public universities producing five documents.

Table 1. Top five productive affiliation

Affiliation	Region	Total Doc	
		Lego	Minecraft
Tufts University	United States	12	-
Aalborg University	Denmark	6	8
Chalmers University of Technology	Sweden	6	-
Univerzita Komenskeho v Bratislave	Slovakia		
Universidad del Pals Vasco	Spain	5	-
ITMO University	Rusia		
Arizona State University	United States		
Goteborgs Universitet	Sweden		
Universidad de Salamanca	Spain		
Universidad Politecnica de Madrid	Spain		
Universidad Nacional de Edcacion a Distancia	Spain		
Central Connecticut State University	United States	-	4
Universitetet I Oslo	Norway		
Waseda University	Japan		

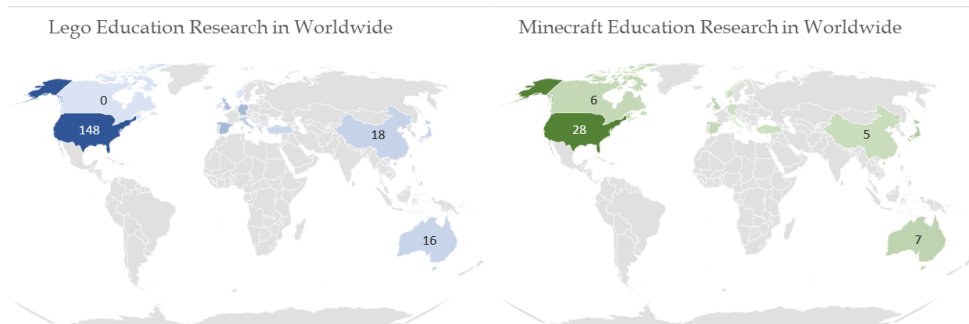


Fig. 3. The most productive region in Lego education research (left) and Minecraft education research (right)

Based on Figure 3, eight regions participated in Lego and Minecraft education research. The United States has a dark color (green and blue), which means the United States is the most productive region and has published 148 documents in Lego Education research and 28 research documents in Minecraft education. Italy and Greece have the last rank in Minecraft education. Canada and Norway in Lego Education.

3.1.3 Type of Research Documents

Half the document types in Lego and Minecraft education research are conference papers. Many international conferences have been held over the last decades (Table 2). The article takes second place in the research document on Minecraft education (200 documents; 33.5%) and Lego education (39 documents; 28.6%). The article was published in 39 journals not included in the top ten sources. The Education and Information Technologies journal was the most published article. Four types get less than 3%, such as review, note, book, and editorial. There is Lego education research published in an editorial. Minecraft has three types that have 0,7%, such as notes (SA Pharmaceutical Journal), books (The Music Technology Cookbook: Ready-made recipes for the classroom), and editorials (Interactive Learning Environments).

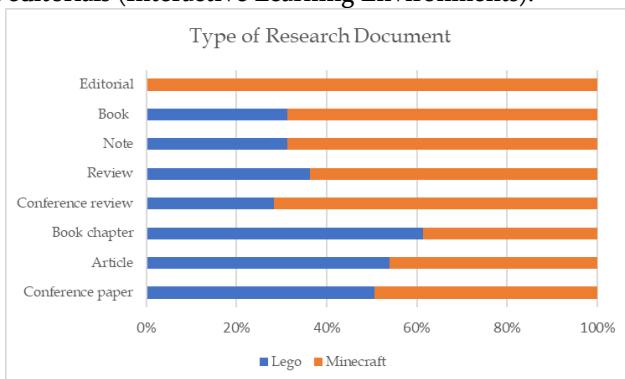


Fig. 4. Document types

According to Table 2, the top ten sources were published in Springer (3 sources), the association for Computing Machinery (2 sources), and another publisher. Springer has three sources with the highest H-index: Lecture notes in computer science (446), Communications in computer and information science (62), and Advances in intelligent systems and computing (58). The second highest H-index is the ACM international conference proceeding series published by the association for Computing Machinery. Advances in intelligent systems and computing and ASEE annual conference and exposition conference proceedings is the most productive source that published 32 Lego education research documents and Proceedings of the European Conference on game-based learning in Minecraft education research. According to Figure 3, the United States and Germany are the most productive countries with the top ten sources. 90% of sources are concrete in computer science scope.

Table 2. The top ten productive source

Source	Publisher	Subject Area	Country	H-Index	Total Doc	
					Lego	Minecraft
Advances in intelligent systems and computing (book)	Springer	Computer Science and Engineering	Germany	58	32	-
ASEE annual conference and exposition conference proceedings	American Society for Engineering Education	Computer Science and Engineering	United States	26	32	3
ACM international conference proceeding series	Association for Computing Machinery	Computer Science	United States	137	24	3
Proceedings of the European conference on game-based learning	Dechema e. V.	Computer Science, Engineering, and Social Sciences	Germany	16	-	16
Lecture notes in computer science	Springer	Computer Science and Mathematics	Germany	446	22	4
Ceur workshop proceedings	CEUR-WS	Computer Science	United States	62	8	7
IEEE global engineering education conference educon	IEE Computer Society	Decision Sciences, Engineering, and Social Sciences	United States	30	20	3
Proceedings-frontiers in education conference	Institute of Electrical and Electronics Engineers Inc.	Computer Science and Social Sciences	United States	45	9	3

Source	Publisher	Subject Area	Country	H-Index	Total Doc	
					Lego	Minecraft
Communications in computer and information science	Springer	Computer Science and Mathematics	Germany	62	9	-
Annual conference on innovation and technology in computer science education	Association for Computer Machinery	MBA and Social Sciences	United States	32	8	-

3.1.4 The top productive authors

Table 3 describes the top ten authors, the number of papers, the author’s affiliation, and region. 80% of Lego-education researchers have the same total documents. Salto from Waseda University, Japan, and Hanghoi from Aalborg University, Denmark, are the researchers who have published many papers about Minecraft. Related to Figure 3, US researchers were dominant in Lego research. Although, Japan’s researchers were dominant in Minecraft education.

Table 3. Top ten productive author

Lego Education				Minecraft Education			
Name	Affiliation	Region	Total	Name	Affiliation	Region	Total
Veselovska, M.	Comenius University	Slovakia	5	Salto, D.	Waseda University	Japan	5
Tobarra, L.	Spanish University for Distance Education	Spain	5	Hanghoj, T.	Aalborg University	Denmark	5
Ros, S.	Universidad Nacional de Educación a Distancia	Spain	5	Washlzaki, H.	Waseda University	Japan	4
Rogers, C.	Tufts University	United States	5	Fukazawa, Y.	Waseda University	Japan	4
Ludi, S.	University of North Texas	United States	5	Yi, S.	University of Illinois	United States	3
Kurkovsky, S.	Central Connecticut State University	United States	5	Morch, A. I.	University of Oslo	Norway	3
Castro, M.	Spanish University for Distance Education	Spain	5	Lane, H. C.	University of Illinois	United States	3
Albo-Canals, J.	Lighthouse-DIG	United States	5	Yamazaki, T.	Astrax Lab	Japan	2

Lego Education				Minecraft Education			
Name	Affiliation	Region	Total	Name	Affiliation	Region	Total
Pastor, R.	Spanish University for Distance Education	Spain	4	Winter, V.	University of Nebraska	United States	2
Mayerova, K.	Comenius University	Slovakia	4	White, J.	Kyoto University	Japan	2

3.2 Application of Lego and Minecraft in education research

3.2.1 Subject area

Eleven top subjects in Lego-Minecraft research and six were included in the top source’s scope. It is related to Table 2; computer science, social science, engineering, mathematics, MBA, and decision science were dominant in this research. Computer science was dominated by Lego and Minecraft education. Computer science significantly impacts education by developing systems, online courses, and digital media. Research has often influenced disciplines like artificial intelligence, science, STEAM, and engineering. Computer science is considered closer to mathematics than many scientific disciplines. Computational social science uses computer science theories to contribute to social sciences, while social computing explores the intersection of social behavior and computational systems.

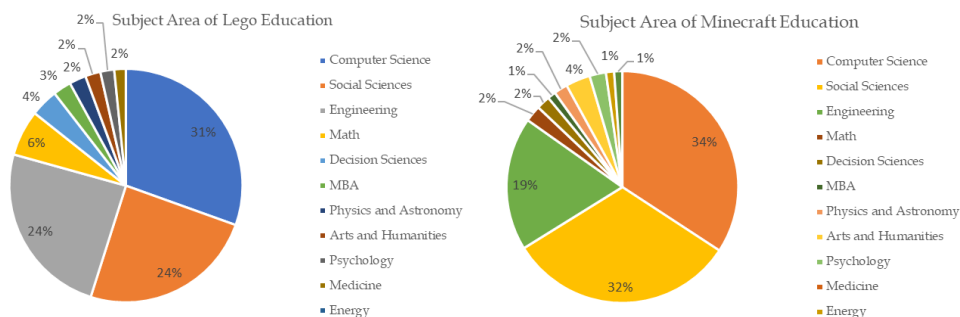


Fig. 5. Top subject area

3.2.2 Application Lego and Minecraft

The keywords in Lego and Minecraft research have similar forms, research methods, participants, and scope. According to Figures 6 and 7, Lego and Minecraft research used questionnaires, and interview studies to explore how Lego and Minecraft applied in education research: influence, participation, perspective, and awareness of students during learning [22-23]. Lego and Minecraft strongly relate to STEM education, digital learning, 21st-century skills, and game-based learning. Lego is related to robot education, and Minecraft is related to virtual game/world. Lego and Minecraft usually combine with

STEM education to increase computational thinking, creative-critical thinking, collaboration, and engineering skills. The realization of 4th SDGs also closely links to STEM education. It also strives to create and offer responses to global problems. Technology like Minecraft or Lego integrating robot education, AI, and VR is taking hold and is influencing all facets of our daily lives. Technology prompts a shift in STEM education, focusing on sustainable teaching that incorporates environmental understanding, morals, ethics, practical life skills, digital components, problem-solving, critical thinking, creativity, teamwork, and communication.

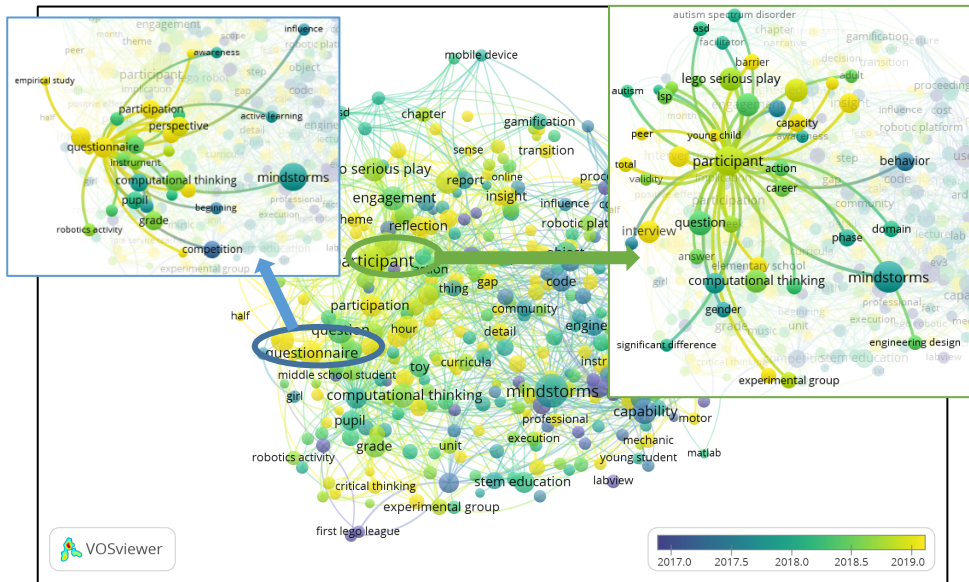


Fig. 6. Visualisation of Lego Education

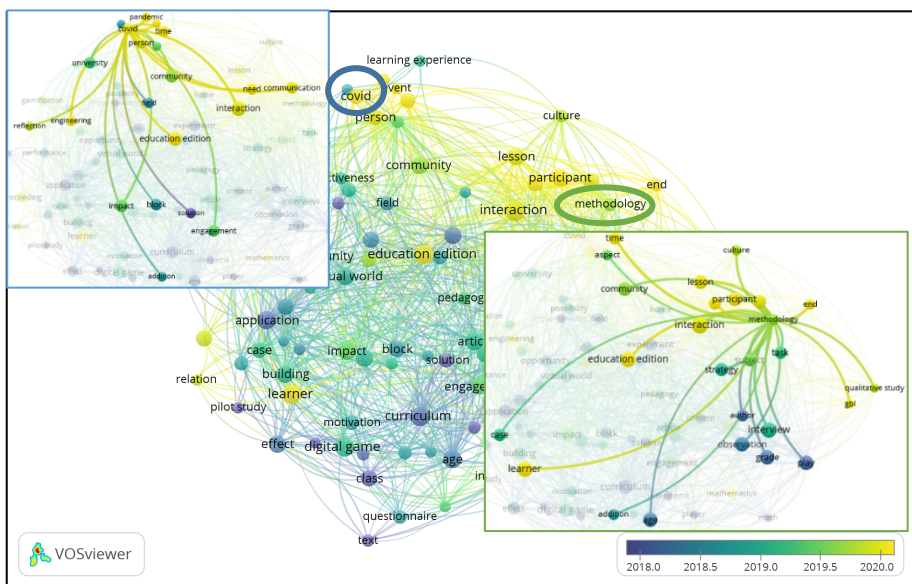


Fig. 7. Visualisation of Minecraft Education

Lego and Minecraft usually have other devices to develop quality learning activities like AR, VR, and system software. Lego and Minecraft have the difference in their year publication. In Figure 6, authors do not find the Covid or pandemic keyword, but this keyword was found in Figure 7 and linked to “solution”. It is related to Figure 2; there are significant publications on Minecraft education during the pandemic. Microsoft made the education edition as an effort to assist the students who are not able to return to school. In Minecraft Education, there are SDGs challenges in several themes (Government and Politics; Climate and Environment; Service Learning) so students can discover SDGs while creating a virtual world. The literature review about Lego and Minecraft education is in Table 4.

Table 4. The literature review about Lego-Minecraft Education

Category	Minecraft	Lego
Technology/ device	<ul style="list-style-type: none"> - GIS [24] - Python and JavaScript [26] - 3D printers [28] - Kodu [30] - AI and Metaverse [32] 	<ul style="list-style-type: none"> - AR [25] - Arduino and Microcontrollers [27] - Robot [29] - VR [31] - 3D Printed [33] - Matlab [34]
Skills	Collaborative, problem-solving, and creative-critical thinking [30]	Problem-solving, creative-critical thinking, collaboration, communication [35, 36]
How to Use	Using block by block to build digital world	Using groups of bricks in a variety of colors and sizes to build prototype.
Education Major	STEM	STEAM and medicine
Learning activities	<ul style="list-style-type: none"> - Collaborative learning [37] - Group-based learning [39] - Game-based learning [41] - PjBL [43] - PBL - Simulation [46] 	<ul style="list-style-type: none"> - Game-based learning [38] - Robot education [40] - PjBL - PBL [42] - Demonstration [44] - Workshop [45] - Blended learning [47]
Product	<ul style="list-style-type: none"> - Minecraft extension [48] - Minecraft Earth and MineCraft-Urban Planning [24] - Minecraft Education [51] 	<ul style="list-style-type: none"> - More To Math kit - STEAM Park and My XL World [49] - Coding Express - StoryTales [50] - BricQ Motion and Spike Prime Set [6] - Lego Exoskeleton [52]
Participant	<ul style="list-style-type: none"> - Primary students [53] - Secondary students [55] - Pre-service teacher [37] - College students [59] - Teacher [61] 	<ul style="list-style-type: none"> - Pre-K/Kindergarten [54] - Primary [56] - Secondary [57] - College [58] - Pre-Service teacher [60]

Category	Minecraft	Lego
		- Teacher [62]
Methods	<ul style="list-style-type: none"> - Qualitative (Observation) - Quantitative (Questionnaire, Interview) - Descriptive (Case study) - Explorative - Experiment (Program Development) 	<ul style="list-style-type: none"> - Experimental design (System development, Quasi-experiment) - Mix methods (Participatory research) - Quantitative (Questionnaire/Survey, meta-analysis) - Descriptive (Phenomenology, Case study, systematic review) - Qualitative (Action research, Interview, Literature studies)

Many types of Lego (Table 5) are used in robotic education. Students learn to build the robots, use code, and use sensors to move them [63]. Lego and Minecraft are related to Bruner’s theory. Bruner's theory of learning uses the discovery method to construct knowledge and link new facts with previous information, which helps learners acquire knowledge from smaller components, building a more substantial base [64].

4 Conclusion

This research explores the role of Lego and Minecraft in education, focusing on their trends, applications, and contributions. The study found that Lego and Minecraft had a stable trend in education over the past decade, with a peak in 2017 due to their popularity. Minecraft research increased from 2013 to 2019 but declined in 2020. The research primarily consists of conference papers, with the top ten sources being Springer and the association for Computing Machinery. Lego and Minecraft research focuses on eleven top subjects, such as computer science, social science, engineering, mathematics, MBA, and decision science, and their impact on education through systems, online courses, and digital media. They strongly relate to STEM education, digital learning, 21st-century skills, digital technologies, and game-based learning. This research only used metadata from Scopus, so there are several articles not indexed. Future research can combine metadata from Web of Science, Science Direct, and Scopus. This study offers insights for further researchers and educators to advance virtual-game learning, promoting cooperation between universities and other affiliations for increased publications and reference information.

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