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Bibliometric Analysis of Game Research Trends in Elementary Learning and Self-Regulated Learning Skill

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Abstract: Self-regulated learning is a skill that is important to be taught to students because this skill is useful in their learning environment management to achieve the best learning outcomes. Thus, teaching this ability as early as possible is better, such as in elementary school. One alternative way to introduce and teach this skill is through games. This study aims to capture the relevant previous research landscape regarding the use of games in elementary school learning and for self-regulated learning from 2020 to 2023 using bibliometric analysis with the help of the VOSviewer application. The Scopus database was used to search for data with the keywords "games", "self-regulated learning", "elementary education," and "primary education," which were then refined to become 196 journal article publications. From the results of this analysis, it was found that the trend of publications about the use of games in learning had appeared in 2020, but about self-regulated learning, game-based learning, and elementary/primary education had only appeared in 2021. The research focus can be divided into four major topics, namely: (1) the use of game and game-based learning in primary education, (2) child development, and (3) the use of technology used in primary school education. Surprisingly, there hasn't been research on self-regulated learning in elementary education. Thus, further research and development on the topic can be done.

Keywords: games, elementary education, self-regulated learning, bibliometric analysis, VOSviewer

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Introduction

Self-regulation is the student's capacity to plan, direct, supervise their behavior and adapt to shifting circumstances (Diaz et al., 1990). Zimmerman (Schunk, 2012) states self-regulation as a cyclical process consisting of three processes; forethought phase, performance phase, and self-reflection phase. In line with *Kurikulum Merdeka Belajar*, the self-regulated learning skill becomes the topic of conversation, as the name suggests. Therefore, it becomes important to be able to introduce and guide students to be able to develop this ability.

Multimedia is one method by which students can cultivate this ability. Shank (2008) argues that using multimedia in effective learning is not only about using various media at once but utilizing the characteristics of each media to add to the learning experience. This multimedia can be utilized in training, games/tournaments in class, and discovery learning. After determining the goals or outcomes that students want to achieve, multimedia designers can use all the information about learning materials and environments in their development, including instructional design, graphic art, information architecture, usability skills, and time of use. It is in line with the development of technology. Learning by using media becomes something interesting to implement. It encourages teachers to be more inventive and creative in developing learning media to engage and motivate students during the teaching and learning process.

Video games are one type of multimedia. Sandford and Williamson (2005) state that using games in the educational context, as in the game-based approach, can support the teacher's aims, objectives, and planned results. Games can be built for various subjects, and the nature of games as interactive

media can encourage students to engage actively in the learning process. It is supported by the tendency of children to choose games so that they are motivated and encouraged to think and sharpen their imagination by the challenges presented in games (Hamlen, 2011). Primary school students are a group that enjoys exploration, play, and high curiosity. Thus, a teacher can guide students to find various learning styles that suit them, especially for students who are not suited to just books or who are bored with teacher lectures.

In theory, a game that allows students to manage how they learn can train students to develop their self-regulation skills. There are previous studies that try to develop self-regulation skills using media. Yu et al. (2022) in their research which focus on personalized online learning, the media used is Massively Open Online Courses (MOOC) for college students, while Alhalafawy and Zaki's research (2022) uses Digital Platform Based Gamification (DPBG) for high school students. However, so far, no game media has been devoted to improving elementary school students' self-regulation.

Based on the above description, researchers are interested in using bibliometric analysis to examine research on the use of games to enhance elementary school student's ability to self-regulate their learning. This study aims to identify trends in research on using games in elementary school learning and self-regulated learning.

Methods

This study employed a literature review with a bibliometric approach as its methodology. A literature review is a systematic, explicit, and reproducible method for identifying, evaluating, and synthesizing research results and ideas researchers and practitioners produce. Meanwhile, the bibliometric approach is an analytical approach to examine the development or evolution of the research domain, including topics and authors, based on the social, intellectual, and conceptual structure of scientific disciplines (Donthu et al., 2020). This analysis is generally used in quantitative studies sourced from journal papers, books, or other types of written communication (Heersmink et al., 2010). Fahimnia et al. (2015) introduced a five-step bibliometric analysis method. The five steps include defining search keywords, initial search results, refining the search results, initial data statistics, and data analysis.

Keywords used for data collection include "game", "self-regulated learning", and "primary education"/"elementary education". The combination of these keywords includes: (1) game and "primary education" or "elementary education", and (2) "self-regulated learning" and game. This literature review will investigate using educational games for self-directed learning in elementary school education.

Journal articles from the Scopus database were used for this literature review. Using keywords "article title, abstract, keywords", resulted in a total of 491 data. Table 1 shows the search results. In addition, search results are also stored in RIS and CSV formats to add important information from articles, including titles, authors' names and affiliations, abstracts, keywords, and references.

Table 1. Initial Keyword Search Result

No.	Search Keyword	Number of Articles
1.	Game and “elementary education” or “primary education.”	425
2.	“Self-regulated learning” and game	66
	Total	491

Refinement of the Search Results

From 491 data, further elimination was carried out. This study's entry data were open-access, English-language journal articles published between 2020 and 2023. From this, we found 134 articles that would be used for this research. Table 2 shows the search results. In addition, search results are also stored in RIS and CSV formats to add important information from articles, including titles, authors' names and affiliations, abstracts, keywords, and references.

Table 2. Refined Keyword Search Result

No.	Search Keyword	Number of Journal Articles
1.	Game AND "elementary education" OR "primary education."	115
2.	"Self-regulated learning" AND game	19
	Total	134

Initial Data Statistics

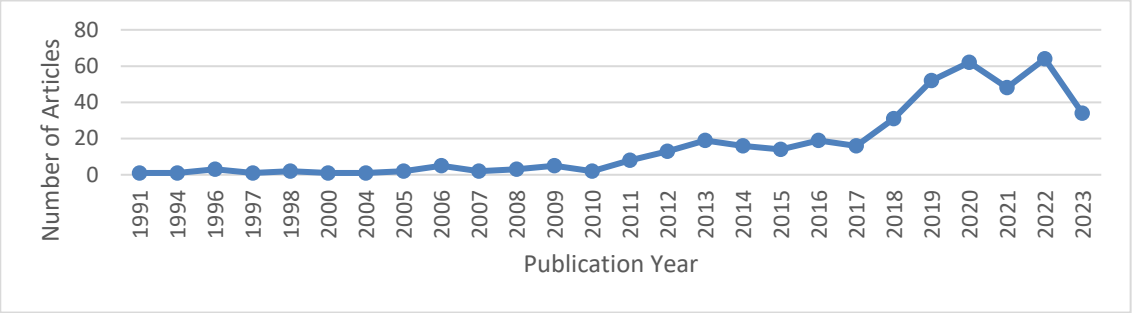

Figure 1. Graph Result of Number of Articles with "Games" and "Elementary Education"/"Primary Education" Database

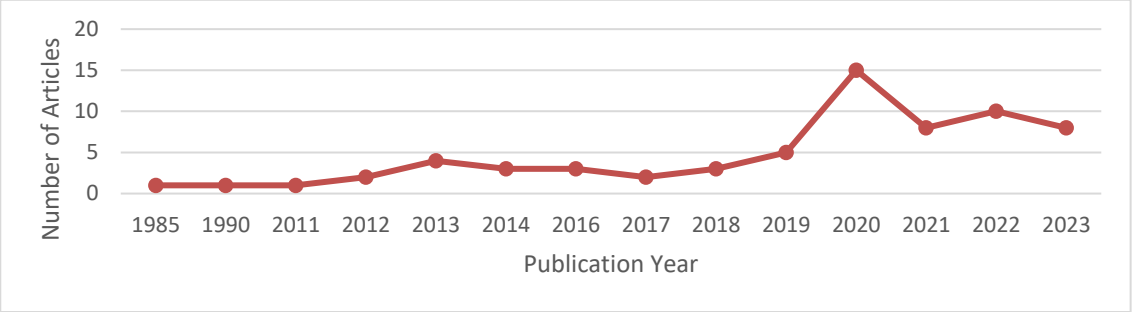

Figure 2. Graph Result of Number of Articles with "Games" and "Self-Regulated Learning" Databases

Figure 1 and Figure 2 show the number of developments in the publication of journal articles for games within the scope of elementary school learning and self-regulated learning. It was found that from a total of 491 filtered journal articles published in 249 journals, it was found that research on this topic found an increase in the 2010s. From the 134 filtered articles, it had 81 contributing journals, with the top 6 contributing 44 articles.

Preliminary statistics show that 5 of these 181 journals have published 154 articles, contributing 32.84%, as shown in Table 3.

Table 3. Top Six Journals with the Most Article Contribution

No.	Name of Journal	Number of Articles
1.	International Journal of Environmental Research and Public Health	15
2.	Sustainability Switzerland	7
3.	Education Sciences	6
4.	Journal Of Physical Education and Sport	6
5.	Computers And Education	5
6.	Frontiers In Psychology	5
	Total	44

Data Analysis

Bibliometric analysis for the keywords "game", "self-regulated learning", and "primary education"/"elementary education" then narrowed the search again for 2020 to 2023 from the Scopus database. It employs the VOSviewer application, software for making maps based on bibliographical data and visualizing and browsing the map. This study uses this application to analyze and visualize reference citations and keyword co-occurrence.

Results and Discussion

Citation and Country Analysis

Citation analysis was carried out to find the degree of connection between articles that have become data related to research on the use of games in learning for elementary school and self-directed learning since 2020 (since the Covid-19 pandemic). Further refinement was carried out from a total of 196 documents so that those who selected the articles cited them at least five times. From this, 66 articles were collected, which were successfully cited.

Table 4. Top Five Journal Article that Cited the Most

No.	Article Title	Amount Citation
1.	Immersive virtual reality as a tool to learn problem-solving skills	59
2.	The effects of two digital educational games on cognitive and non-cognitive math and reading outcomes	49
3.	An instructional design for online learning in vocational education according to a self-regulated learning framework for problem-solving during the covid-19 crisis	36
4.	Primary school students' perceptions of scaffolding in digital game-based learning in mathematics	25
5.	Can Academic Achievement in Primary School Students Be Improved Through Teacher Training on Emotional Intelligence as a Key Academic Competency?	24

From the ten articles that were cited the most shown in Table 4, it can be seen that research conducted by Araiza-Alba et al. (2021) entitled *Immersive virtual reality as a tool to learn problem-solving skills* has been cited as many as 59, being the most cited article in the articles that have been collected.

Country analysis was carried out to see the contribution of researchers from various countries concerning research on the use of games in learning, both for elementary school and self-regulated learning, since 2020 (since the COVID-19 pandemic). From 134 articles obtained from the Scopus database, it was found that 45 countries contributed.

Table 5. Top Six Country with the Most Contribution

No.	Country	Number Articles
1.	Spanish	58
2.	United Kingdom	10
3.	United States	8
4.	Netherlands	6
5.	Malaysia	5
6.	Slovakia	5

As shown in Table 5, Europe is the largest contributor of the six top countries with the most contributions, with four out of six countries from the continent. Of the four countries, Spain contributed the most, with 58 articles and the most citations within the scope of this research.

Indonesia also contributed to this database. There were four articles originating from Indonesia, shown in Table 6 as follows.

Table 6. Article Journal Published by Indonesian Writer

No.	Writer	Title	Amount Citation
1.	Fitriyana, N., Wiyarsi, A., Sugiyarto, K.H., Ikhsan, J.	The Influences of Hybrid Learning with Video Conference and "Chemondro-Game" on Students' Self-Efficacy, Self-Regulated Learning, and Achievement toward Chemistry	10
2.	Pinem, Y.A., Rahmawan, A.D.	Elements of digital media in vocabulary remote-learning achievement	0
3.	Suyanta, Wiludjeng, I., Jumadi, Astuti, S.R.D., Sari, A.R.P., Isa, I.M., Jafaar, R., Rahadian	Virtual Laboratory-Based Game Application: The Quality and Its Effects Towards Students' Motivation and Self-Regulated Learning	0
4.	Syawaluddin, A., Afriani Rachman, S., Khaerunnisa	Developing Snake Ladder Game Learning Media to Increase Students' Interest and Learning Outcomes on Social Studies in Elementary School	6

From four articles from Indonesia, the research conducted by Fitriyana et al. (2021) entitled *The Influences of Hybrid Learning with Video Conference and "Chemondro-Game" on Students' Self-Efficacy, Self-Regulated Learning, and Achievement toward Chemistry* has been cited as many as 10, being the most cited article from Indonesia in the articles that have been collected.

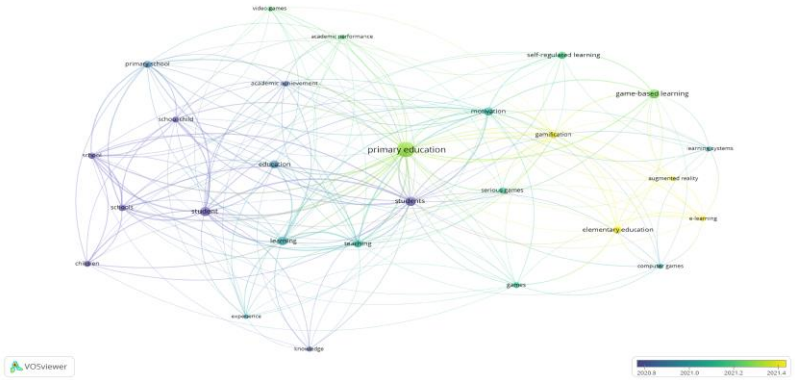

Figure 4. VOSviewer Overlay Visualization Result of Co-Occurences in Papers Published in Scopus Since 2020 with Keywords "game", "self-regulated learning", and "primary education"/"elementary education."

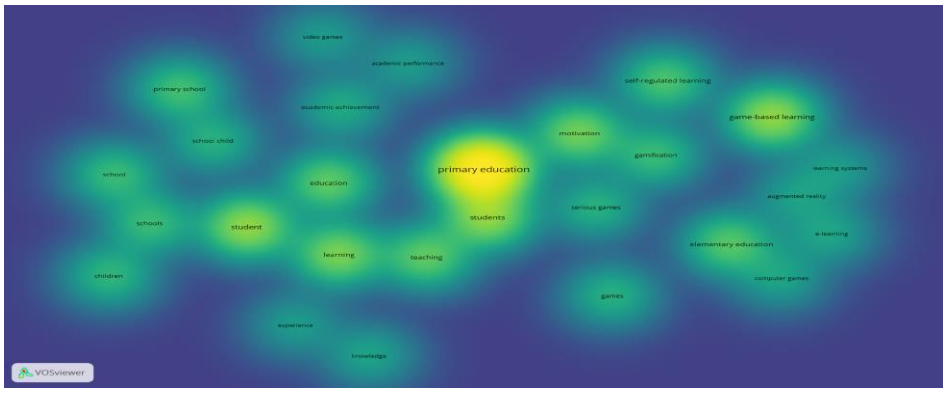

Figure 5. VOSviewer Density Visualization Result of Co-Occurences in Papers Published in Scopus Since 2020 with Keywords "game", "self-regulated learning", and "primary education"/"elementary

education."

Since 2020, trends in research publications on the use of games in education, both for elementary school and self-regulation. Figure 4 reveals that research on digital media or interactive learning has only emerged between 2020 and 2021, as indicated by the year of publication. Interestingly, research on serious games related to achievement in the academic field has emerged in 2020, even though not many. However, research on self-regulated learning and basic education will begin to emerge in 2021. In addition, when viewed from the density of research in Figure 5, it is found that research on primary education is in the yellow zone, so that can be interpreted that there has not been much research in this area. So, it can be a novelty if you want to research this field.

From 134 articles, after narrowing the first result, 878 keywords were found, and 52 keywords with a minimum number of occurrences of five were selected. After that, the keywords to be used are sorted once again, namely specializing in computer or electronic games, so that keywords related to physical games, health, and sports are not used and obtained a total of 31 interconnected keywords.

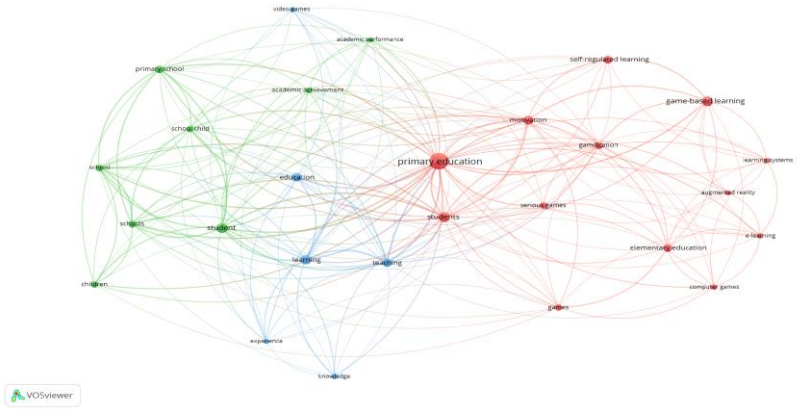

Figure 3. VOSviewer Network Visualization Result of Co-Occurences in Papers Published in Scopus since 2020 with keywords "game", "self-regulated learning", and "primary education"/"elementary education."

Figure 3 shows that in the discussion about games in learning when viewed from the distribution of clusters, there are links with various fields. The first cluster (red) grouped studies were conducted in primary education using games and game-based learning. It is found that games or game-based learning provide many advantages, such as improving mathematics learning outcomes using games, helping students with learning disabilities (such as dyscalculia) to learn without stress, increasing learning motivation, and others. The subjects covered in these studies can include math, geography, reading, languages, basic programming, and even music. The media used are virtual reality, board games, escape rooms, mobile games, and non-educational games such as *League of Legends*.

The second cluster (green) is about child development. Related to the first cluster (red), this cluster is about a primary school student's child development, whether it is about academic achievement, student health, behaviors, or cognitive development. Mobile phones were widely used in this research. They emphasized considerations that can be used for student development, such as learning methods (collaborative learning or gamification) and learning media (in this case, games).

The third cluster (blue) discusses the technology used in primary school education. It was found that in the adaptation of technology, the consideration is not only how to use it in learning or how to develop it based on the experience of the teacher who will be developing the learning tool but also the openness to the use of technology, especially games.

Something interesting is in the first cluster (red), the keyword ‘self-regulated learning’, despite being connected to other words like ‘academic performance’, ‘game-based learning’ and ‘serious g’, isn’t connected to ‘primary education’ nor ‘elementary education’. It means there hadn’t been thorough research about self-regulated learning skills in primary/elementary education, despite being an important skill, especially at this age.

The keyword "self-regulated learning" from the first cluster (red) is not related to "primary education", "elementary education", or "primary school". It opens the possibility of further research on

the connection between self-regulated learning with elementary education. However, as earlier research has shown, both "self-regulated learning" and "serious game" can be associated with "game-based learning," suggesting the possibility of new developments in video games for self-regulated learning that can improve academic accomplishment.

As seen in previous research, factors that needed to be considered in developing a video game for self-regulated learning: (1) the target student, whether the students have a disability or not, or when they even have access to said technology; (2) the subject as the center-theme of the video game. Most of the video games in this research are centered on school subjects, thus when developing a video game for self-regulated learning, while all subjects can be used (if we want to make a specific lesson), it is important to note the variables used in self-regulated learning; (3) the teacher's skill in developing the media, whether it is the teacher on their own or send to an out-school development team, it is the teacher job to make sure that the game will fit in the curriculum. While it is proven the usage of games can help, it is not widely known, especially from the common view that playing games is a waste of time. Thus, an open view is needed, and the teacher must do the convincing.

Conclusion

Research on games in elementary school learning as well as for self-regulated learning, has increased rapidly in 2020. Since 2020, several research can be grouped into three categories: (1) the use of game and game-based learning in primary education, (2) child development, and (3) the use of technology used in primary school education. While the research on games can relate to self-regulated learning and primary education, there hasn't been any research about the development of self-regulated learning skills in primary education, despite being an important skill to be taught at an early age. Thus, further research could be done on this topic, along with the development of the media, whether in games or others.

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