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SYSTEMATIC LITERATURE REVIEW: THE EFFECTIVENESS OF THE SELF-ORGANIZED LEARNING ENVIRONMENT (SOLE) MODEL IN SCIENCE EDUCATION

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Abstract

This study aimed to evaluate the effectiveness of the Self-Organized Learning Environment (SOLE) model in science education. The method used is a SLR based on the PRISMA guidelines, combined with a thematic approach. Data were analyzed from articles indexed in the Scopus and Sinta databases. The analysis results indicate a rising trend in the number of publications on the SOLE model, particularly in the field of chemistry, during the period from 2020 to 2024. Several frequently cited authors, including Sri Suciati and Dewi Sri Matovani, have made significant contributions to the development of this model. The main findings show that the implementation of the SOLE model effectively improves students' science learning outcomes, including concept comprehension, learning motivation, academic achievement, and metacognitive skills. Based on these results, this study provides a strong foundation for the development and implementation of the SOLE learning model across various educational levels.

Keywords: Effectiveness, Science Education, Learning Model, Self-organized Learning Environment

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INTRODUCTION

21st-century education demands innovation in teaching approaches, especially in Science Education. Students must have in-depth knowledge and complex skills such as critical thinking, creativity, collaboration, and communication (4C) (González-Salamanca et al., 2020; Häkkinen et al., 2017; Pardede, 2020; Redhana, 2019). Education aims to create an environment that develops students' potential holistically, encompassing spiritual, personality, and skills aspects that support social and professional life (Dewi, 2016; Judah et al., 2024; Nabukeera, 2018). However, the conventional teaching model, which places greater emphasis on lectures and question-and-answer sessions, has proven to be less effective in developing the mastery of 21st-century skills, commonly referred to as the 4Cs (critical thinking, creativity, collaboration, and communication) (Alaagib et al., 2019; Dzuhri et al., 2025; Suniati et al., 2013).

Therefore, a more participatory and technology-based approach is needed. One approach is to use the Self-Organized Learning Environment (SOLE), which Sugata Mitra first introduced in 1999. This model enables students to engage in self-directed learning using technology and the Internet while collaborating to complete tasks. The SOLE model is designed to foster critical thinking, creativity, and problem-solving abilities, which are highly relevant in Science Education (Suciati, 2021).

The implementation of SOLE offers advantages in enhancing learning independence, reading skills, creativity, computer literacy, interpersonal skills, and self-confidence. Several previous studies have shown that the SOLE model is effective in improving critical thinking skills (Niode et al., 2022; Setyorini et al., 2022), earning independence (Firdaus et al., 2021), and learning motivation (Satriani et al., 2022).

Until now, no Systematic Literature Review (SLR) has comprehensively discussed the implementation of the SOLE model in Science Education. Most previous studies have focused more on other models, such as Somatic Auditory Visual Intellectual (SAVI), Problem-Based Learning (PBL), Brain-Based Learning (BBL), and Discovery Learning, without exploring the advantages of SOLE. Therefore, there is still a research gap that needs to be addressed.

This study aims to evaluate the effectiveness of the SOLE model in Science Education using a SLR methodology. The study provides a comprehensive understanding of the strengths, limitations, and potential development of the SOLE model, particularly in improving concept comprehension, learning motivation, academic achievement, and students' metacognitive skills. Furthermore, this study contributes to the development of more effective and relevant technology-based learning strategies in the modern era.

METHOD

Research Questions (RQ)

We formulated specific research questions (RQs) to evaluate the effectiveness of the model in science education: RQ 1: What is the pattern of time distribution and the growth rate of publications? RQ 2: Which field of study is most dominant as the starting point for research in this theme? RQ 3: Which articles are categorized as the most-cited documents globally? RQ 4: Has the SOLE model been proven effective in Science Education based on the analysis of articles published between 2020 and 2024?

Article Search and Inclusion Criteria

This research method is a systematic literature review. We adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which include four steps: identification, screening, eligibility, and inclusion (Selçuk, 2019).

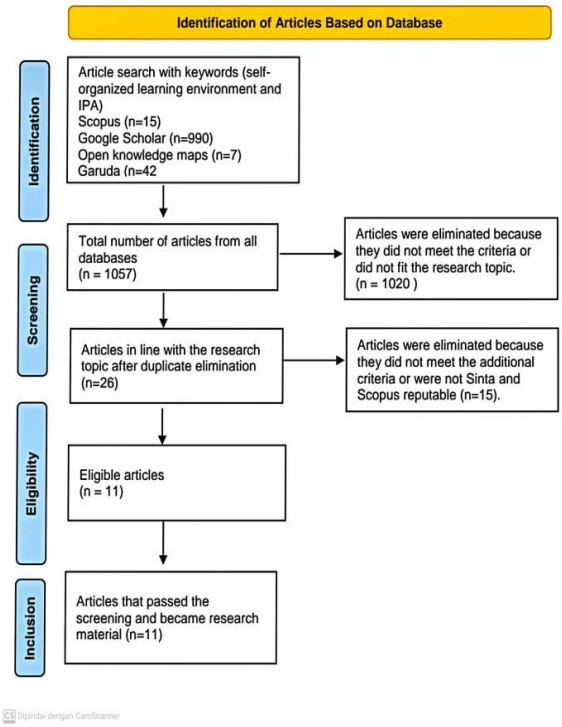

Figure 1. PRISMA flow diagram

The article search in this study was conducted using different keywords for each database. In Scopus, the search relied solely on the keyword "Self Organized Learning Environment"

without adding any other keywords. On the other hand, in Google Scholar, Garuda, and Open Knowledge Maps, the search was performed using a combination of the keywords "Self Organized Learning Environment" and "IPA" to obtain articles more relevant to the focus of this research.

Figure 1 shows that the article search for this study was focused on the keyword "Self-Organized Learning Environment (SOLE) AND IPA" and conducted in four main sources: Google Scholar (990 articles), Scopus (15 articles), Garuda (45 articles), and Open Knowledge Maps (7 articles). This process resulted in an initial total of 1,057 articles, which were then screened based on the established criteria.

Subsequently, 1,020 articles were eliminated because they did not meet the initial selection criteria. The reasons for elimination included misalignment with the research topic: many articles, although using relevant keywords, did not discuss the application of the Self-Organized Learning Environment (SOLE) model in Science Education, which is the primary focus of this research. Additionally, 11 duplicate articles were removed to ensure the authenticity and quality of the articles used in the study.

After the duplication removal process, 26 selected articles remained. However, 15 articles were excluded from further screening because they were not indexed in trusted databases such as Sinta and Scopus, which ensure publication quality. Finally, 11 articles were selected to be used as the primary materials for this study.

RESULTS AND DISCUSSION

Temporal Distribution

Figure 2 shows the number of articles listed in four databases, Scopus, Google Scholar, Open Knowledge Maps, and Garuda, from 2020 to 2024. Based on Figure 2, The trend of publications on the SOLE model for Science Education in the four databases reached its peak in 2023. However, this cannot be used as a basis to conclude that publications in the previous years were low, as this research only focuses on articles relevant to the studied topic and includes only those indexed in Sinta and Scopus. There may be other publications discussing different learning models or in the form of books, conference papers, and similar materials. A similar situation could occur in 2024, given that the number of publications in that year is already close to the publication count in 2023.

The rising number of publications on the SOLE model for Science Education in four different databases can be analyzed through several factors. First, the development of research in education and the growing attention to self-directed and collaborative learning have encouraged researchers to explore innovative learning models such as SOLE (Akbar et al., 2023).

Second, the demand for curricula and educational policies that support 21st-century skills has driven the adoption and exploration of learning models like SOLE (Bedir, 2019; Chusna et al., 2024). Technological advancements that facilitate access to information have also contributed to accelerating scientific article publications (Fiorillo & Mehta, 2024; Lukman, 2016). Furthermore, the COVID-19 pandemic, which led to the shift to remote learning, made the SOLE model, which is flexible and accessible online, even more relevant (Joice Ester Raranta, 2022; Marlina, 2021). These factors and the increasing availability of scientific publication platforms explain why the number of articles on SOLE in databases such as Scopus, Google Scholar, Open Knowledge Maps, and Garuda increased, particularly in 2023.

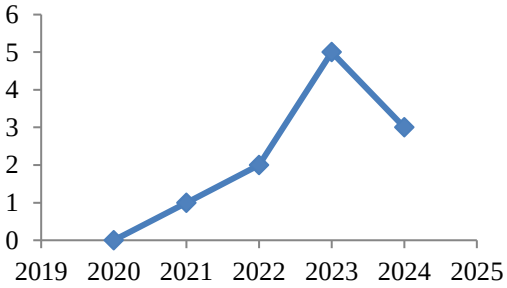

Figure 2. Documents based on year

Field of Study

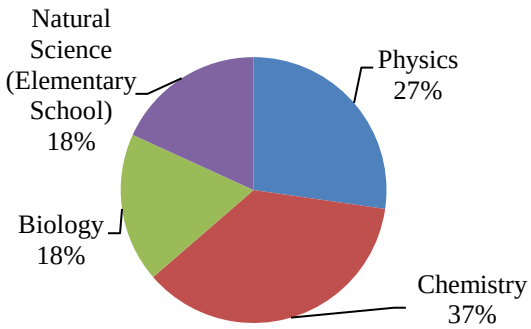

Figure 3. Field of study

Figure 3 shows the percentage of the fields of study of articles published in four databases: Scopus, Google Scholar, Open Knowledge Maps, and Garuda. It can be seen that the dominant field of study is chemistry, with a percentage of 37%. Chemistry became the main focus of research on

the SOLE model during the 2020-2024 period because it effectively teaches complex concepts such as colloidal systems, polymers, and other chemical substances and materials. (Budyaningsih & Fikroh, 2023; Kurnia & Ikhsan, 2023; Matovani et al., 2022; Suciati, 2021).

Furthermore, SOLE fosters 21st-century competencies such as problem-solving, creative thinking, and communication while encouraging student learning independence (Fikri, 2022). This model allows students to organize their learning methods, enhancing their understanding of polymer material and other chemistry concepts. Its relevance to the Merdeka Curriculum further strengthens its innovative value in exploring the material. On the other hand, physics accounts for 27%, biology 18%, and natural science (elementary school) 18%. The percentage of fields of study in the research on the SOLE model suggests that there are still significant opportunities for further research, especially in the areas of biology and natural science (elementary school), which have rarely been studied and developed through SOLE-based learning.

Most Cited Articles Globally

Table 1. Most cited articles globally

No	Title	Author	Journal	Year	Citation
1	The Use of the Self-Organized Learning Environment (SOLE) Model to Enhance Understanding of Polymer Materials	Sri Suciati	Ideguru;Jurnal Karya Ilmiah	2021	27
2	The Impact Of The Sole (Self-Organized Learning Environment) Approach Utilizing Quizizz Media On Concept Mastery	Dewi Sri Matovani, Siti Istiningsih1 , Baiq Niswathul Khair	Journal of Classroom Action Research	2022	13
3	Impact Of Self-Regulated Learning Environment (Sole) Pedagogy on Various Aspects of Students' Metacognitive Abilities in Science Subjects	Hodi Tsamago, Anass Bayaga	Heliyon	2023	6
4	The Self-Organized Learning Environments (SOLE) Model, Based On Blended Learning, Improves Student Independence And Cognitive Learning Outcomes In Acid-Base Topics.	Ika Budyaningsih, Retno Aliyatul Fikroh	Jurnal Penelitian Pendidikan IPA	2023	6

Table 1 presents data on the most globally cited documents. It shows that there are two dominant articles, one of which is titled The Application of the Self-Organized Learning Environment (SOLE) Model to Enhance Understanding of Polymer Material (Suciati, 2021). The Impact of the Self-Organized Learning Environment (SOLE) Model Using Quizizz Media on Understanding Concepts (Matovani et al., 2022).

Suciati (2021) said this study is frequently cited because it discusses applying the SOLE model in remote learning during the COVID-19 pandemic. The SOLE model encourages students to learn independently by searching for information online. The results showed a significant improvement in students' understanding of polymer material and classical mastery. This model effectively addresses the weaknesses of traditional learning methods, such as tasks not being completed independently, and has proven effective in science education, making it an important reference in the development of online learning.

Mantovani et al. (2022) also confirmed this study is widely referenced because it demonstrated the significant impact of implementing the SOLE model using Quizizz media on the conceptual understanding of science in 5th-grade students. Using a quasi-experimental design and t-test analysis, this study compared the pre-test and post-test results of the experimental and control groups. The findings indicate that applying the Quizizz-based SOLE model significantly improved students' understanding, as evidenced by higher post-test scores in the experimental group. This research provides strong evidence that using technology in learning can improve student learning outcomes, making it an important reference in education.

Result of Article Analysis

Table 2. Results of article analysis

No	Title	Author	Year	Quality of the Article	Result
1	Impact Of Self-Regulated Learning Environment (SOLE) Pedagogy on Various Aspects of Students' Metacognitive Abilities in Science Subjects	Hodi Tsamago & Anass Bayaga	2023	Q1	There were 155 participants in four groups (two urban and two rural) for this quasi-experimental study. The Metacognitive Self-Assessment Scale (MSAS) questionnaire was utilized for data collection, while descriptive statistics (mean and effect size) and inferential statistics (t-test) were applied for analysis. The findings showed that SOLE pedagogy improved metacognitive skills in general, with empathy for others showing the greatest improvement when compared to other domains. According to the research findings, SOLE pedagogy can promote the growth of comprehensive metacognitive abilities and build a nurturing learning atmosphere.
2	The Effect of the Self-organized Learning Environment (SOLE) Model Using Quizizz Media on Concept Comprehension	Dewi Sri Matovani, Sitiistiningsih, Baiq Niswathul Khair	2021	Sinta 4	The data collection method employed was testing. The results revealed a pre-test score of 60.5 for the experimental group and 67.0 for the control group. In contrast, the post-test scores improved to 84.0 for the experimental group and 78.5 for the control group. The results suggest that integrating Quizizz media with the SOLE teaching approach influences the understanding of fifth-grade students at SD 44 Ampenan. The t-test results show that the calculated t-value (1.463) is greater than the critical t-value (2.024) at a 5% significance level, meaning that the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted, signaling a significant effect of the SOLE learning model on students' conceptual understanding of science.
3	The impact of the Self-	Yoni Kurnia &	2023	Sinta 2	With an effective contribution

No	Title	Author	Year	Quality of the Article	Result
	Organized Learning Environment (SOLE) model on students' scientific attitude and cognitive learning outcomes on the theme of colloids in senior high school (SMA/MA).	Jaslin Ikhsan			of 11.6% with a moderate category, the results showed a significant value of 0.00 < 0.05, which indicates that the SOLE learning paradigm has an impact on cognitive learning outcomes and student scientific attitudes. The contribution to the scientific attitude variable is 4.6% (small category), while the contribution to cognitive learning outcomes is 7.7% (small category).
4	The Effect of the Self-Organized Learning Environment (SOLE) Model Assisted by Animation Video Media on Science Learning Outcomes in Class V SD Inpres Pattallassang	Nur Afifah, Irmawanty, Anisa	2024	Sinta 5	Data analysis on the implementation of the SOLE learning approach enhanced with animation video media for science learning outcomes in 5th grade at SD Inpres Pattallassang shows a significant effect. The hypothesis test results, with a Sig. (2-tailed) value of 0.025 indicates that H_0 is rejected because of the Sig. (2-tailed) value is smaller than α (0.025 < 0.05).
5	The Effect of the SOLE Learning Model Assisted by Audio-Visual Media in Improving Motivation and Science Learning Achievement in Class III	Shinta Kurnia Sari & Erwin	2022	Sinta 5	The study results show that t-calculated = -17.6635 < t-table = 2.1788 at α = 0.05, which means that H_0 is rejected and H_1 is accepted. This indicates that the use of the SOLE (Self-Organized Learning Environment) learning model with audio-visual media has a significant impact on enhancing the motivation and learning outcomes of third-grade students.
6	The Application of the Self-Organized Learning Environment (SOLE) Model to Enhance Understanding of Polymer Material	Sri Suciati	2021	Sinta 3	The study results show that implementing the Self-Organized Learning Environment (SOLE) model can improve students' understanding of polymer material in class X RPL at SMK Negeri 1 Sanden. The percentage of classical mastery increased from 57.89% in cycle I to 73.68% in cycle II, which has met the research success indicator.

No	Title	Author	Year	Quality of the Article	Result
7	The impact of the SOLE (Self-Organized Learning Environment) model using the Quizizz application on the science learning outcomes of fifth-grade students.	Petrus William Chan1, Rien Anitra, Evinna Cinda Hendriana	2024	Sinta 4	The study's results, which used parametric statistical analysis with a t-test, indicate that the t-value exceeds the critical t-value in the post-test results. This suggests that the impact of the SOLE learning model with the Quizizz application on students' cognitive learning outcomes is moderate, as shown by the average N-Gain of 0.5.
8	The influence of the SOLE learning model on the environmental literacy of high school students	Ade Suryanda, Nurmasari Sartono, Reyhanah	2023	Sinta 3	The study's results show that environmental literacy among students in both classes was comparable before implementing the learning model. The SOLE learning model had a significant and effective influence on students' environmental literacy, whereas the Discovery Learning model demonstrated lower effectiveness.
9	The Effect Of The STAD Type Cooperative Model And The Self-Organized Learning Environment (SOLE) Model On Knowledge Competence In Relation To Learning Independence On Dynamic Fluid Material.	Ahmad Fauzi, Pujayanto, and Adi Setiawan	2023	Sinta 2	This finding indicates that the impact of the STAD cooperative learning model with the Sigil module and the self-organized learning environment (SOLE) approach influences students' learning experiences and knowledge competency is not significantly different. However, the impact of students' learning independence category on knowledge competency varied. In addition, this study showed that learning independence and the learning model did not interact in influencing knowledge competency.
10	The Effect of the Implementation of the Self-Organized Learning Environment Model on Students' Learning Outcomes in Fluid Material for Class XI IPA 2	A. Asi1, D. G.E. Setiawan , R. Uloli	2024	Sinta 2	The study results show a significant improvement in students' learning outcomes after implementing the SOLE model. The average pre-test score was 23.48, while the average post-test score increased to 63.19. The t-test (paired sample t-test) showed a significance value of 0.000, smaller than 0.05. Thus, the alternative hypothesis (H1) is

No	Title	Author	Year	Quality of the Article	Result
					accepted. This suggests a notable difference between students' pre-test and post-test scores following the implementation of the SOLE model. Based on these results, implementing the Self-Organized Learning Environment (SOLE) model significantly improves students' learning outcomes in fluid material in class XI IPA 2.
11	The Self-Organized Learning Environment (Sole) Model, Utilizing Blended Learning, Enhances Student Independence And Cognitive Learning Outcomes In Acid-Base Topics	Ika Budyaningsih, Retno Aliyatul Fikroh	2023	Sinta 2	The research findings show that the SOLE learning model, which combines blended learning, influences students' independence in learning acid-base concepts, as indicated by the questionnaire results. However, the test results reveal that the blended learning-based SOLE model does not impact students' cognitive learning outcomes in acid-base topics.

The researcher successfully analyzed 11 relevant articles on the research topic using the SLR method following the PRISMA guidelines. Table 2 shows that the SOLE model has been proven to significantly impact student learning outcomes across different educational levels and learning materials. The SOLE pedagogy can develop students' metacognitive skills, including a more significant increase in empathy than other aspects (Tsamago & Bayaga, 2023).

Similarly, a study by Matovani and her team found that the SOLE model using Quizizz media can improve 5th-grade students' understanding of Science concepts, as evidenced by the significant t-test results (Matovani et al., 2022).

A separate study by Kurnia and Ikhsan demonstrates that the SOLE model positively influences students' scientific attitudes and intellectual learning outcomes in colloid topics at the high school level. However, its contribution remains relatively small (Kurnia & Ikhsan, 2023). A study conducted by Afifah also demonstrated that the use of animation video media in the SOLE model significantly impacts 5th-grade students' Science learning outcomes (Afifah et al., 2024).

Audio-visual media, as researched by Sari and Erwin, also significantly impacts student motivation and academic achievement in class III (Sari & Erwin, 2022). Implementing the SOLE model has also been shown to improve the understanding of polymer materials in vocational schools, as found in a study by Suciati. A significant increase was observed in the percentage of overall mastery between cycle I and cycle II (Suciati, 2021). Another study conducted showed that the SOLE model based on the Quizizz application had a moderate effect on science learning outcomes of fifth-grade elementary school students, with an average N-Gain of 0.5 (Chan et al., 2024). Another study also demonstrates the impact of the SOLE model on students' environmental literacy, stating that it is more effective than the Discovery Learning model (Suryanda et al., 2023). However, there is no substantial distinction between the effectiveness of the SOLE and STAD models in enhancing students' knowledge competence, although student learning independence plays a role in enhancing that competence (Setiawan et al., 2023).

Implementing the SOLE model on fluid material, as studied by Asi et al., significantly improves students' learning outcomes, with the

average post-test score much higher than the pre-test (Asi et al., 2024). Finally, although the blended learning-based SOLE model impacts students' learning independence in acid-base material. It is confirmed by the current study shows that this model does not affect students' cognitive learning outcomes (Budyaningsih & Fikroh, 2023).

These studies demonstrate that the SOLE model has been proven to improve students' academic performance effectively, including concept comprehension, motivation, achievement, and metacognitive skills. The effectiveness of this model may vary depending on the media used, the education level of the students, and the learning material being taught. Therefore, further research is needed to optimize the use of the SOLE model, considering supporting factors such as appropriate learning media and adaptation to students' needs.

Limitations of the Study

This study is limited by the availability of articles indexed in Scopus and Sinta, which may not fully represent all research on the SOLE model. Additionally, this study focuses only on publications from 2020 to 2024, and future research could benefit from a broader temporal scope. Another limitation is the limited exploration of how different learning materials or media impact the effectiveness of the SOLE model across various educational levels.

CONCLUSION AND SUGGESTIONS

Conclusion

Based on the results of this study, the implementation of the SOLE model has proven effective in improving Science education learning outcomes, particularly in the areas of concept comprehension, motivation, academic achievement, and students' metacognitive skills. Additionally, this study also reveals a significant trend of increasing publications related to the implementation of the SOLE model, particularly in the field of chemistry, during the period from 2020 to 2024.

Suggestions

Additional studies are suggested to improve the application of the SOLE model, considering supporting factors such as selecting appropriate learning media and adjusting to meet students' needs.

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