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The Effect of Self-Organized Learning Environment Implementation on Critical Thinking Skills and Digital Ethics: Systematic Literature Review

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A B S T R A C T

The purpose of this study was to examine the application of the Self-Organized Learning Environment (SOLE) model to the development of students' critical thinking skills and digital ethics. A literature search was conducted through two databases, namely Scopus and Google Scholar, for the period 2021–2026. The selection process followed the PRISMA protocol, with the identification of 37 articles, screening based on title and abstract (n=28), and feasibility assessment resulting in 9 articles meeting the inclusion criteria. Inclusion criteria included: peer-reviewed journal articles in Indonesian or English, focusing on the implementation of SOLE in formal education contexts, and containing empirical data related to learning outcomes. The findings in this study are: 1) SOLE improves critical thinking skills because students are trained to search for information independently, analyze problems, and find solutions through group discussions. 2) The implementation of SOLE improves digital ethics through the habit of using technology wisely, the ability to evaluate information, and the responsible use of digital media. 3) There is a strong relevance between critical thinking and digital ethics in the implementation of SOLE, because critical thinking skills help students sort information appropriately, thus supporting the formation of responsible and ethical digital behavior.

1. Introduction

Education in the Learning Society 5.0 era is experiencing rapid development due to digitalization, which is transforming the global learning landscape. The skills needed to support education are increasingly diverse. Education in the Learning Society 5.0 era focuses on combining 21st-century skills with smart technology to improve the quality of human life and prepare students to be able to use technology to solve problems. The use of technology can be crucial, enabling students to achieve quality education and engaging them in lifelong learning. (Bleeker, 2019).

Although digital platforms can be used easily and quickly to access information, users must have technical and cognitive abilities that will help them to use them.. Shah et al., (2018) stated that some students rely too heavily on Google, Yahoo, and open sources to access the internet. To find information, students tend to use search engines to find instant answers without critically examining and understanding the material. The results of the 2022 PISA study showed that the literacy and critical thinking skills of 15-year-old Indonesian students remain low, ranking Indonesia 63rd out of 81 countries.

One of the fundamental goals of education is to develop critical thinking skills, especially in today's technological era. (Amalia et al., 2024). Developing critical thinking skills in adolescence will help you see your potential, analyze information intelligently, make accurate choices, and draw conclusions. (Novianti, 2020). The use of technology in the learning process has made information sources more accessible and complex. This situation has also triggered the emergence of a culture of "digital plagiarism," where students often copy information from unverified sources. This shows that technological mastery alone is not enough to equip students in learning; it must also be aligned with digital ethics so that the use of information remains based on academic honesty.

Therefore, a more participatory and technology-based learning model is needed to assist students in learning. One learning model that can be implemented is the use of an independent learning environment or Self-Organized Learning Environment (SOLE), first introduced by Sugata Mitra. The SOLE learning model (Self-Organized Learning Environments) emphasizes the independent learning process carried out by anyone who wishes to learn by utilizing the internet and their smart devices. (Rahayu, 2021). This SOLE learning model allows students to be directly involved in independent learning by utilizing technology and the internet to solve problems collaboratively. According to Suciati (2021) the SOLE model is designed to foster critical thinking, creativity, and problem-solving skills, which are highly relevant to Science Education.

Several previous studies have shown that the SOLE model can provide opportunities for student participation and increase the integration of technology in the educational process (Almalki, 2024), critical thinking skills (Niode et al., 2022), facilitating digital literacy skills (Dimyati et al., 2024) and student learning independence (Fariha & Amalia, 2021). Most research focuses solely on the implementation of SOLE on critical thinking skills and digital literacy, without addressing digital ethics. Therefore, there is still a research gap that needs to be addressed in the implementation of this learning model, which examines students' digital ethics. Therefore, in learning activities, integrating these two competencies within the SOLE model is expected to protect academic integrity while ensuring students have an accurate and accountable understanding of the material they learn.

2. Methodology

The method used in this study was a systematic literature review. The search guidelines used in this study were the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), which includes four steps: identification, information screening, eligibility review, and inclusion. (Selcuk, 2019). In the idea of Page et al., (2022) PRISMA is a guideline used to report systematic reviews systematically, transparently, and completely so that research results can be trusted and easily evaluated.

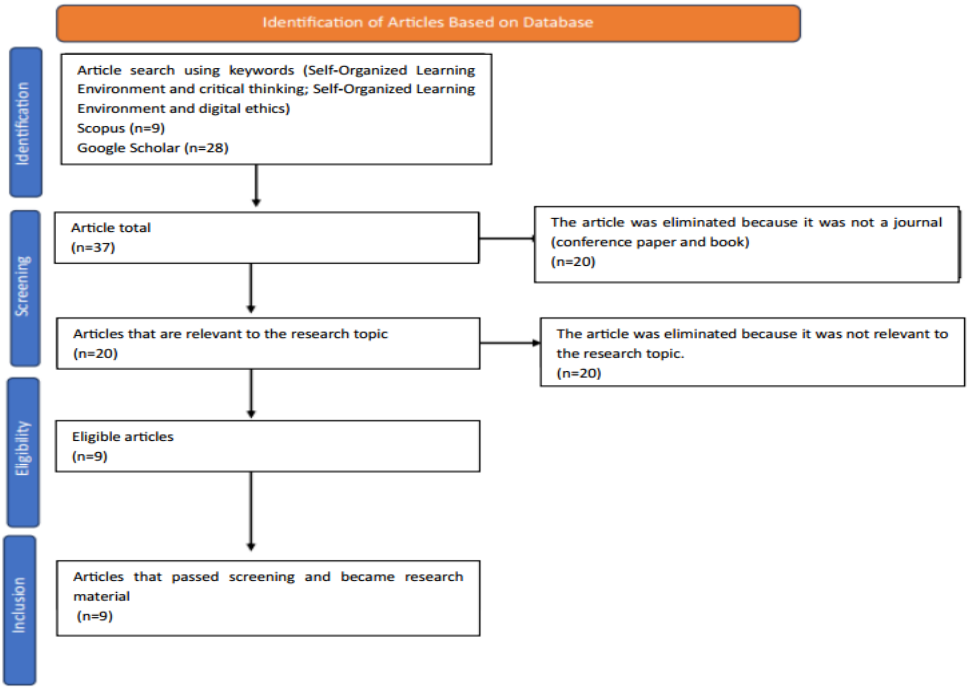


Figure 1. Prism Flowchart

Research Question

To strengthen the concept of thinking in the application of SOLE in science learning, the research questions are as follows: 1) How can the application of Self-Organized Learning Environment improve critical thinking skills? 2) How can the application of Self-Organized Learning Environment improve digital ethics? 3) What is the relevance of critical thinking and digital ethics in the application of Self-Organized Learning Environment?

Selection and Analysis Process

In this study, article searches were conducted using different keywords in each database. In the Scopus database, the search was conducted using the keyword "Self-Organized Learning Environment." A data search in the Google Scholar database was conducted using the keywords "Self-Organized Learning Environment" and "creative thinking" and "digital ethics" to find more relevant articles. The results of the Scopus search yielded 9 documents, and Google Scholar yielded 28 documents. Of the 37 documents obtained, documents were then filtered

for those irrelevant to research related to SOLE, creative thinking, and digital ethics, despite using specific keywords. To ensure the quality and relevance of the included studies, inclusion and exclusion criteria were systematically established, as presented in Table 1.

Tabel 1. Kriteris Inklusi dan Eksklusi

Criteria	Inclusion	Exclusion
Year of Publication	Articles published in the last 5 years	Books, theses, proceedings, and articles published more than 5 years ago
Publication access type	Articles that are available and open access	Articles that are not available and cannot be accessed
Discussion Topics	Articles discussing self-organized learning environments, critical thinking, digital literacy, and digital ethics	Articles that are not relevant to the research focus.
Metode Penelitian	Articles that use quantitative, qualitative, or SLR methods that examine related variables	Opinion articles, non-empirical essays, or articles without a clear methodological design

The criteria in Table 1 were systematically applied to ensure only relevant studies were included. Inclusion criteria emphasized recent empirical research (2021-2026) addressing the application of self-organized learning environments to critical thinking skills and digital ethics. Meanwhile, exclusion criteria filtered out non-empirical studies and publications without full-text access. Of the initial 37 articles, the selection process yielded nine articles that met the requirements.

3. Results and Discussion

Network Visualization

In Figure 2 there is a network visualization that can be used to show the relationship between research concepts that focus on Self-Organized Learning Environment (SOLE), Digital Ethics, and Creative Thinking. Based on the mapping conducted in the VOS viewer, three main clusters are identified. The first cluster focuses on the learning environment and information, linked to the Self-Organized Learning Environment (SOLE), indicated in blue. This cluster demonstrates that a learning environment that provides access to information is the primary basis for learning, fostering independent learning processes in the implementation of the SOLE. The second cluster encompasses the SOLE, effectiveness, and creative thinking, indicated in green. This cluster demonstrates that previous researchers have tended to associate SOLE with increased learning effectiveness and the development of creative skills.

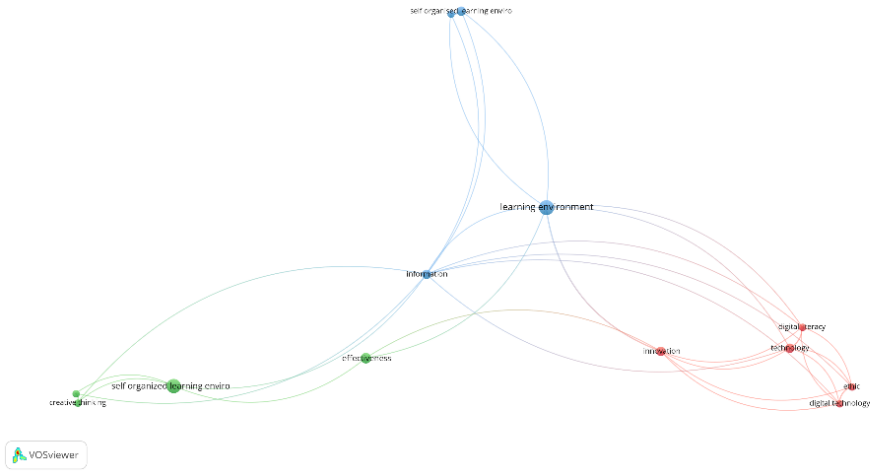


Figure 2. Network Visualization

However, the existing visualizations do not yet include critical thinking, the focus of this study, as it is part of higher-order thinking skills. Cluster 3 presents visualizations covering digital literacy, technology, innovation, and ethics, indicated in red. This cluster emphasizes that the development of digital literacy cannot be separated from the ethical aspects of technology use. Therefore, when ethics are properly implemented, the use and retrieval of digital information can be accounted for. Overall, the inter-cluster relationships demonstrate interrelated concepts that support the implementation of the SOLE model in learning, thereby facilitating learning. The learning environment serves as a bridge connecting SOLE with digital literacy and ethics. However, in networking visualization, there is a research gap, namely the development of critical thinking. Most researchers still focus on developing and enhancing students' creative skills in learning.

Overlay Visualization

To provide a clearer picture of the development of research trends based on the year of publication, an overlay visualization is presented in Figure 5 as follows.

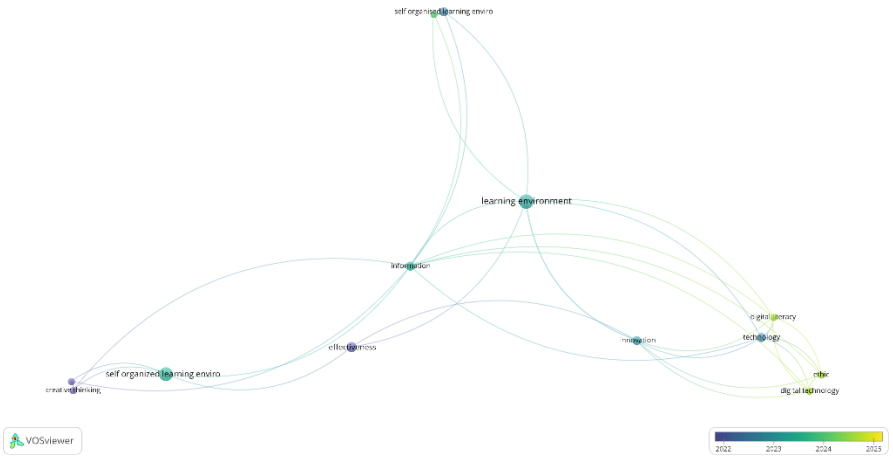


Figure 3. Overlay Visualization

Figure 3 shows the development of research trends based on publication year. In the image, purple depicts older research, covering the years 2022-2023, while green and yellow depict more recent research, published between 2023 and 2025. In the older research period, the focus was on learning environments, information, and effectiveness, indicating early research efforts and understanding of the SOLE model. Meanwhile, the 2023-2025 period shows many new topics associated with SOLE learning, such as digital literacy, technology, and digital ethics. This indicates increasing attention to the SOLE model, which is moving toward contextual implementation and can be combined with research on critical thinking skills.

Density Visualization

To show the level of emergence and development of relevant research topics over time, the results of the density visualization are presented in Figure 6 as follows.

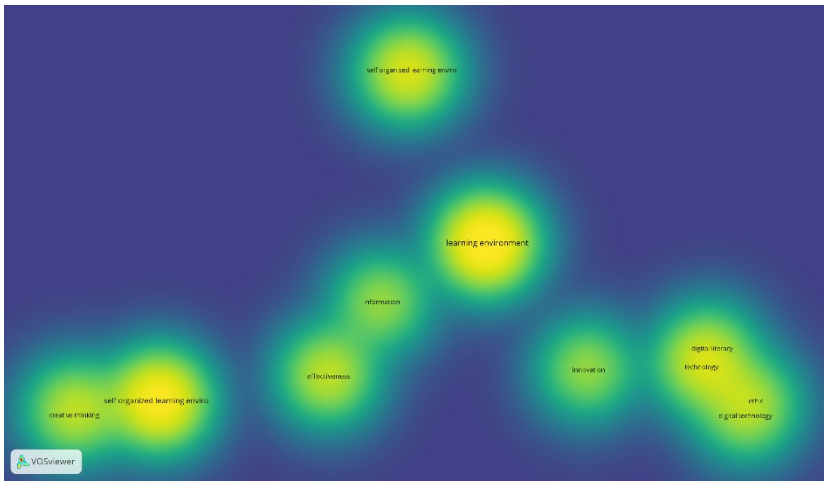


Figure 4. Density Visualization

Figure 4 presents a density visualization showing the development of relevant research topics over time. In the figure, light colors indicate that the topic was recently published. There are three main focuses in the visualization: the learning environment, which serves as the center of connectivity; SOLE, which is the focus of research related to effectiveness and creative thinking skills; and digital literacy and ethics, which are the latest research trends. However, upon closer inspection, the main focus of this research is related to the concept of critical thinking, which has not yet appeared in the visualization, thus providing a gap for further research.

Article Analysis Results

The characteristics and main findings of the reviewed articles are systematically summarized in Table 2.

Table 2. Analysis Results

Author and Year	Title	Method	Main Findings	Relevance
(H. Tsamago & Bayaga, 2023)	The effect of Self-organized learning environments (SOLEs) pedagogy on the different aspects of learners' metacognitive skills in the Physical Sciences classroom	Quasi-experimental with non-equivalent control group design; using MSAS instrument; data analysis with descriptive statistics t-test	SOLEs improves all aspects of students' metacognitive skills (Self awareness, respect to others, empathy, problem solving), with the greatest improvement in the aspect of empathy towards others.	Supporting SOLE in science learning because it can improve students' metacognitive and social interaction skills, which are important for collaboration-based learning and critical thinking.
(Almalki, 2024)	Exploring Students' Perspectives on the Implementation of a Self-Organised Learning Environment: SOLE via Mobile Devices	Critical Participatory Action Research (CPAR); data from interviews, focus groups, and reflective journals	Mobile learning-based SOLE increases engagement, collaboration, and enjoyment of learning. SOLE implementation helps with material retention and comprehension, and encourages evaluation of ideas before publication. However, challenges such as unreliable information and technical constraints exist.	Relevant for technology-based learning (e-learning/mobile learning) because it shows that SOLE is effective in increasing students' collaboration and critical thinking by providing guidance in digital ethics in evaluating information before sharing and avoiding misinformation.
(H. Tsamago & Bayaga, 2023b)	SOLE Pedagogy as a Conduit to Learners' Metacognitive Skills and Conceptual Understanding in STEM	Quasi-experimental (pre-test & post-test, control vs. experimental)	Sole significantly improves metacognitive abilities (Self-awareness, self-evaluation) and conceptual understanding.	SOLE enhances independent and collaborative learning through problem solving and independent exploration.
(Putri, et al., 2025)	Systematic Literature Review: The Effectiveness of	Systematic Literature Review (PRISMA)	SOLE improves conceptual understanding, learning	improve 4C skills

	SOLE Model in Science Education		motivation, academic achievement, and metacognitive skills.	
(Firdaus & Mutmainah, 2022)	Self-Organized Learning Environment (SOLE) Learning in Sketch Subjects	Descriptive qualitative (observation, interviews, documentation)	The implementation of SOLE improved the quality of students' work (45% very good, 41% good)	Students actively build independent concepts and actively seek information.
(Rizal et al., 2022)	Creative Thinking and Process Science Skill: Self-Organized Learning Environment on Watershed Conservation Material	*Quasi experiment (Post-test only control group design)*	SOLE has a significant effect on creative thinking (sig 0.001 < 0.05) and science process skills (sig 0.000 < 0.05). Students are more active in searching for information via the internet and generating solution ideas.	SOLE is a powerful technology-based learning model and independent investigation (Big Question, Investigation, Review). It involves investigation, group discussion, prediction, and problem-solving.
(Dewi et al., 2025)	Improving Students' Critical Thinking Skills through the PhET-Assisted SOLE Model	*Quasi experiment (Nonequivalent control group design, pre-test, post-test, uji N-Gain*	There was an increase in students' critical thinking skills with an N-Gain value of 0.58 (moderate category). Improvements occurred across almost all critical thinking indicators.	The implementation of SOLE assisted by PhET technology can strengthen digital-based collaborative independent learning.
(Wedasuwari et al., 2025)	Digital Literacy-Based SOLE Learning Model for Improving Student Learning Outcomes and Activeness	Quantitative (pretest-posttest/experiment)	The digital literacy-based SOLE model has been proven to improve learning outcomes and student activeness in the learning process.	SOLE was developed with the integration of digital literacy so that learning is more independent by improving digital ethics in the ability to select information, use

				sources wisely, and be responsible in the use of technology.
(Dimyati et al., 2024)	Development of E-Modules for Media & Educational Technology Based on Self-Organized Learning Environment Oriented to Digital Literacy	Research and Development (R&D)	The SOLE-based e-module developed is capable of improving digital literacy.	The implementation of SOLE in modules can encourage technology-based learning. In digital ethics, this includes the wise use of technology, information selection, and digital responsibility.

At this stage, researchers analyzed nine articles relevant to the research topic using the PRISMA guidelines. Table 2 shows that implementing SOLE in learning can improve students' critical thinking skills and is expected to foster digital ethics as children engage in digital literacy. Based on the journals reviewed, implementing the SOLE model in learning has a fairly consistent effect on improving student abilities, despite using different methods and focuses. Research by Rizal (2022) The SOLE model significantly influences creative thinking skills and science processes which have been analyzed through t-tests, students are more active in searching for information via the internet and generating solution ideas. Tsamago & Bayaga (2023) conveyed the idea that SOLE encourages students to engage in independent problem-solving and exploration. Firdaus & Mutmainah (2022) stated that the implementation of SOLE can build the concept of independence and active information seeking by students. Furthermore, other studies have shown that SOLE pedagogy has been shown to have a positive impact on increasing empathy. (Tsamago, 2024). Melalui paparan hasil temuan beberapa penelitian tersebut menunjukkan bahwa penerapan SOLE mendorong munculnya kemampuan menghasilkan ide, pemecahan masalah, eksplorasi mandiri, aktif mencari informasi, dan peningkatan empati.

Almalki (2024) stated that it was found that SOLE was effective in increasing collaboration and critical thinking of students by providing guidance in digital ethics in evaluating information before sharing and avoiding misinformation. SOLE is also said to be a teaching method that can encourage the application of 4C skills, namely Critical Thinking, Collaboration, Communication, and Creativity (Putri, et al., 2025). In the context of improving critical thinking skills, learning was found to demonstrate almost all critical thinking indicators after implementing SOLE with the assistance of PhET technology. This improvement in students' critical thinking skills is crucial in the learning process because it can influence students' mindsets regarding information seeking and problem-solving.

Dimyati et al., (2024) showed that integrating SOLE into e-module learning can facilitate digital literacy skills. In line with this idea, Wedasuwari et al. (2025) conveyed that the digital literacy-based SOLE model has been proven to improve student learning outcomes and activeness in the learning process. The implementation of SOLE in modules can encourage technology-based learning. In digital ethics, this includes the wise use of technology, information selection, and digital responsibility. Digital literacy is a crucial skill for shaping how individuals learn, think, and behave in the digital world. Research shows an increase in digital literacy, with the e-module's practicality reaching 97.5%, indicating that SOLE is highly suitable for implementation in technology-based learning.

The use of information and communication technology (ICT) in learning also significantly contributes to the creation of interactive learning and supports 21st-century skills. Research conducted by Azizah et al. (2026) shows that ICT integration in learning can increase student engagement, support independent learning, and strengthen critical thinking and creativity in the digital age. Student involvement in learning through group discussions, training students to express opinions, analyze information, develop arguments, and respect the views of others, significantly improves students' critical thinking skills.(Musoffa et al., 2025). These activities align with the characteristics of SOLE, which emphasize collaboration, exploration, and active learning. Through interaction between students in digital information searches, students not only gain knowledge but also learn to communicate ethically and responsibly. Learning that connects science, technology, the environment, and everyday life makes it easier for students to understand concepts contextually and connect learning to real-world problems (Yanti & Suyanta, 2025).

Currently, a visible impact is a decline in the authenticity of individual thinking due to a tendency to rely on technology for instant answers. This is highly relevant when linked to the SOLE model. With good digital literacy, the use of technology such as AI can be directed more wisely to support learning and prevent the decline in critical thinking skills. Yusnidah (2025) stated that self-efficacy and digital literacy have a positive and significant relationship with independent learning. This aligns with SOLE learning, which emphasizes independent learning and critical thinking skills. Fredika et al. (2026) stated that strengthening digital ethics is a crucial aspect of technology-based learning. This includes awareness of responsible technology use, the ability to verify information, avoid the spread of hoaxes, and foster ethical behavior in the digital world. Therefore, implementing SOLE integration in learning not only has the potential to improve students' critical thinking skills but also fosters awareness of digital ethics in the wise and responsible use of technology.

4. Conclusion

Based on a review of nine articles, it was found that the implementation of the Self-Organized Learning Environment (SOLE) model consistently impacts two main aspects: critical thinking and students' digital literacy ethics. In terms of social

skills, SOLE encourages collaboration, communication, empathy, and cooperation among students in problem-solving. These social skills ultimately shape critical thinking skills, enabling students to more actively analyze information, solve problems, and generate ideas independently. Meanwhile, in terms of improving digital literacy ethics, students are able to use technology more wisely through the process of searching, selecting, and evaluating digital information. This new research finding demonstrates that these skills are integrated in SOLE-based learning.These findings also address three research questions. First, the implementation of SOLE has been shown to improve critical thinking skills because students are trained to independently search for information, analyze problems, and find solutions through group discussions. Second, the implementation of SOLE can also improve digital ethics by fostering the habit of wisely using technology, the ability to evaluate information, and responsible use of digital media. Third, there is a strong relevance between critical thinking and digital ethics in the implementation of SOLE, because critical thinking skills help students sort information appropriately, thus supporting the formation of responsible and ethical digital behavior. Based on this, teachers can integrate SOLE-based learning with the reinforcement of digital ethics in learning so that the learning process does not only focus on mastering concepts but also on character development in the digital era. Teachers can provide space for students to search for information independently via the internet, guide students in evaluating the accuracy of information, cite reference sources, and use technology wisely and responsibly.

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