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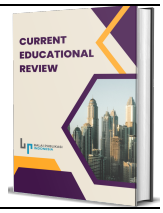

Systematic Review of the STEAM-Integrated 5E Learning Cycle Model to Improve Concept Mastery and Creative Thinking in Science Learning for Students

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Abstract: This study aims to examine the development trend of science e-modules based on the 5E learning cycle model integrated with STEAM, reviewed from the aspects of concept mastery and creative thinking skills, to improve junior high school students' learning outcomes. This approach is relevant in facing the challenges of education in the era of globalization and the industrial revolution 4.0, which requires students to have critical and creative thinking skills. Research data were collected through bibliometric analysis of 1,000 documents indexed by Google Scholar in the period 2015–2024. The results of the analysis show that the research trend has increased significantly since 2020, with a dominance of publications in the form of articles and edited books. The main keywords that are often used include technology, student, and science learning. The application of the 5E model integrated with STEAM is not only effective in improving concept mastery but can also motivate students through digital-based learning. This study provides a foundation for the development of more innovative and relevant learning resources, and supports the implementation of technology-based learning strategies in the classroom.

Keywords: Concept mastery; Creative thinking; Learning cycle model; STEAM

Introduction

Science education today faces a major challenge to not only focus on mastering concepts, but also on developing creative thinking skills. Creative thinking skills are considered very important in the era of globalization and the industrial revolution 4.0 because this ability helps students to innovate, solve problems effectively, and adapt quickly to change (Yuliati et al., 2018). According to Guilford (1950), creative thinking includes the ability to generate new ideas that are original, flexible, and contextual. Therefore, science education must be designed to support the development of these abilities.

One of the innovative approaches proposed to achieve these goals is the implementation of the 5E Learning Cycle learning model integrated with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach. The 5E learning model, first introduced by Bybee et al. (2014), consists of five stages: Engage, Explore, Explain, Elaborate, and Evaluate. These stages are designed to encourage active learning, build conceptual understanding, and create meaningful learning experiences. When integrated with the STEAM approach, the 5E model provides opportunities for students to understand abstract concepts through cross-disciplinary perspectives, thereby encouraging critical and creative thinking skills (Yakman et al., 2012).

The STEAM approach not only relies on scientific and technological aspects, but also emphasizes arts as an important element in developing student creativity (Rahmawati, 2024). Research shows that integrating STEAM into education can increase learning motivation, interest in science, and the ability to solve problems

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innovatively (Herro et al., 2018). For example, students involved in STEAM-based projects tend to be more skilled at connecting theory to practice, generating new solutions, and working collaboratively.

In addition, the systematic application of the 5E model has been proven effective in improving students' conceptual mastery. Research by Rizki et al. (2023) shows that this approach can help students understand complex science materials, such as renewable energy, through more structured and exploratory learning. By involving students in an active learning process from the early stages (Engage) to reflection and assessment (Evaluate), the 5E model allows students to internalize concepts deeply and develop higher-order thinking skills.

With the growing literature on STEAM-based learning and the 5E model, it is important to conduct a systematic review to identify trends, challenges, and effectiveness of both approaches in science education. This review will not only provide a strong empirical foundation but also contribute to developing innovative, relevant, and impactful learning practices for students.

Furthermore, this study is expected to provide practical recommendations for educators in designing and implementing learning strategies that support students' mastery of concepts and creative thinking skills. For example, research by Çorlu (2012) emphasized the importance of cross-disciplinary collaboration to produce innovative solutions in STEAM education. By integrating the 5E model, this approach can be further strengthened, as it provides a systematic framework for exploration and problem solving.

Science education that combines the 5E Learning Cycle model with the STEAM approach has great potential in preparing a creative, innovative, and adaptive young generation to the challenges of the times. In this context, it is important for researchers and educators to continue to explore and evaluate the effectiveness of this approach through in-depth empirical research, so that science education can continue to develop in accordance with the needs of the era of globalization and the industrial revolution 4.0.

With the growing literature on STEAM-based learning and the 5E model, it is important to conduct a systematic review to identify trends, challenges, and effectiveness of these approaches in science education. Through this systematic review, it is hoped that a strong empirical basis can be found for developing more innovative, relevant, and impactful learning practices for students.

Method

This study uses descriptive and analytical methods that aim to understand and describe research trends on the 5E learning cycle model integrated with STEAM in improving concept mastery and creative thinking skills. Data in this study were collected from information sources indexed by Google Scholar, with the help of analysis tools such as Publish or Perish and Dimension.ai for data search. The keywords used are related to research trends on the 5E learning cycle model to improve students' concept mastery and creative thinking.

In this study, the analysis was conducted on 1,000 documents that have been indexed by Google Scholar between 2015-2024. The Google Scholar database was chosen as a place to search for documents because Google Scholar applies consistent standards in selecting documents to be included in its index and Google Scholar displays more documents compared to other top databases, especially research in the field of education (Munandar et al., 2023). Then to filter the data that has been collected through Publish or Perish, the researcher uses selected reporting items as a guideline for systematic review and meta-analysis.

Result and Discussion

This study aims to describe research trends that use the 5E learning cycle model with STEAM to improve students' conceptual mastery and creative thinking in the period 2015 to 2024. Based on trend analysis of publication data collected through Google Scholar from 2015 to 2024, it can be seen that research using the 5E learning cycle model with STEAM to improve conceptual mastery and creative thinking has experienced a significant increase, especially from 2021 to 2023.

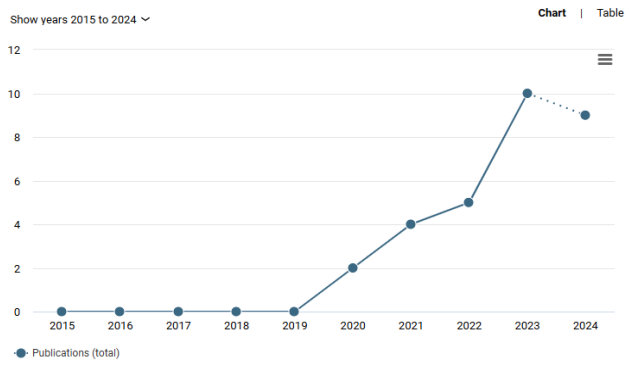

Figure 1. Trends in systematic review of the integrated STEAM 5E learning cycle model to improve students' mastery of science concepts and creative thinking

Figure 1 shows that the research trend on the Integrated 5E Learning Cycle Model STEAM to improve students' conceptual mastery and creative thinking skills fluctuated between 2015 and 2024. The increase in the research trend occurred in 2020, 2021, 2022, and 2023. So that in 2024 interesting research is needed that is relevant to this topic. In 2015 to 2019, there were 0 publications related to the development of the 5E

learning cycle model with STEAM to improve conceptual mastery and creative thinking, which then increased to 2 publications in 2020. This increase in the research trend provides deeper insight into the development of the 5E learning cycle model with STEAM and problem-solving strategies related to conceptual mastery and creative thinking skills.

Table 1. Trends in the 5E Integrated STEAM Learning Cycle Model to Improve Students' Mastery of Concepts and Creative Thinking Skills

Publication Type	Publications
Article	18
Edits Book	12

Based on Table 1, it is known that there are more than 2 types of publications that discuss 5E-STEAM-based science e-modules to improve students' mastery of concepts and creative thinking in the period 2015 to 2024. There are 18 documents in the form of articles and 12 documents in the form of edited books. Research trends show that the most common type of publication is in the form of books that are articles, compared to the type of publication that has been edited (edited book). According to O'Neil-Henry (2013), an edited book is a book that is compiled through an editing process and contains a collection of chapters or essays written by various authors with the coordination of one or more editors. The role of the editor includes collecting, selecting, editing, and uniting these writings in one main theme or topic. This type of book is designed to present various points of view, compile research or information that focuses on one theme, support the development of science, and encourage collaboration in the academic world (Creswell, 2017).

Table 2. Top 10 Sources of Titles Trending 5E-STEAM-Based Science E-Modules to Improve Students' Concept Mastery and Creative Thinking

Name	Publications	Citations	Cites/years
Advances in Social Science, Education and Humanities	10	9	0.90
Advances in Engineering Research	1	0	-
Indonesian Science Education Journal	1	6	6.00
Journal of Physics Education	1	0	-
Journal of Education and Teaching	1	0	-
JINoP (Journal of Learning Innovation)	1	2	2.00
Obsession Journal Early Childhood Education Journal	1	1	1.00
Journal of Educational Research and Development	1	1	1.00
Journal of Community Service for Master of Science Education	1	4	4.00
Social Humanities and Educational Studies (SHES)	1	0	-

Table 2 shows that the most published research source related to the development trend of science e-modules based on the 5E learning cycle model integrated with STEAM in terms of concept mastery and creative thinking to improve students' science learning outcomes is Advances in Engineering Research, with a total of 10 publications, 9 citations, and an average citation of 0.90. The journals in Table 2 show that the publications made are 1 publication, and an average of 1 citation, with an average citation also of 1.00. However, some journals do not have citations and the average citation or is equal to 0. Table 3 presents information regarding the 5E-STEAM e-module trends to improve students' concept mastery and creative thinking, which is often referred to by other researchers on this topic.

Table 3. Top 10 Quotes about 5E-STEAM E-Module Trends to Enhance Students' Concept Mastery and Creative Thinking in 2015-2024

Mean	Year	Author	Title
33.50	2022	Eroğlu et al. (2022)	The effect of 5E-based STEM education on academic achievement, scientific creativity, and views on the nature of science
2.50	2022	Wiriani et al. (2022)	The impact of the 5E learning cycle model based on the STEM approach on scientific attitudes and science learning outcomes
12.67	2021	Anggraeni et al. (2021)	The analysis of the development of the 5E-STEAM learning model to improve critical thinking skills in natural science lessons
1.67	2015	Çiğdemoğlu et al. (2015)	Context-based lessons with 5E model to promote conceptual understanding of chemical reactions and energy concepts
6.00	2022	Aköz et al. (2022)	A course content designed in accordance with the 5E teaching model within the scope of STEM learning approach in environmental education course: My smart
15.50	2022	Koyunlu Ünlü et al. (2022)	A systematic review of 5E model in science education: proposing a skill-based STEM instructional model within the 21st century skills
9.00	2022	Amiruddin et al. (2022)	Analysis of the Application of the Steam Approach to Learning in Indonesia: Contributions to physics education

1.00	2021	(Priawasana et al., 2021)	Development of Learning Cycle 5E Oriented Learning Tools to Critical Thinking Skills and Creative Thinking
8.00	2023	Varoglu et al. (2023)	Effect of 5E learning cycle assisted with concept maps on conceptual understanding
-	2024	Respasari et al. (2024)	The Effect of The Learning Cycle 5e Model On Mastery of Concepts and Creative Thinking Students On Renewable Energy Materials At SMAN 1 Gerung.

Table 3 shows that research on the development of Science E-Modules based on the 5E learning cycle model integrated with STEAM in terms of concept mastery and creative thinking to improve students' science learning outcomes has been cited by other researchers. For example, a study entitled " The effect of 5E-based STEM education on academic achievement, scientific creativity, and views on the nature of science " has been cited 33.5 times per year. Furthermore, a study entitled "The impact of the 5E learning cycle model based on the STEM approach on scientific attitudes and science learning outcomes" received 2.5 times per year, and "The analysis of the development of the 5E-STEAM learning model to improve critical thinking skills in natural science lessons" was cited an average of 12.67 times per year. This data is in line with the research trend of developing science e-modules based on the 5E learning cycle model integrated with STEAM in terms of concept mastery that continues to be cited from 2015 to 2024. The articles that are used as references for this research often discuss terms related to critical thinking skills and student learning outcomes.

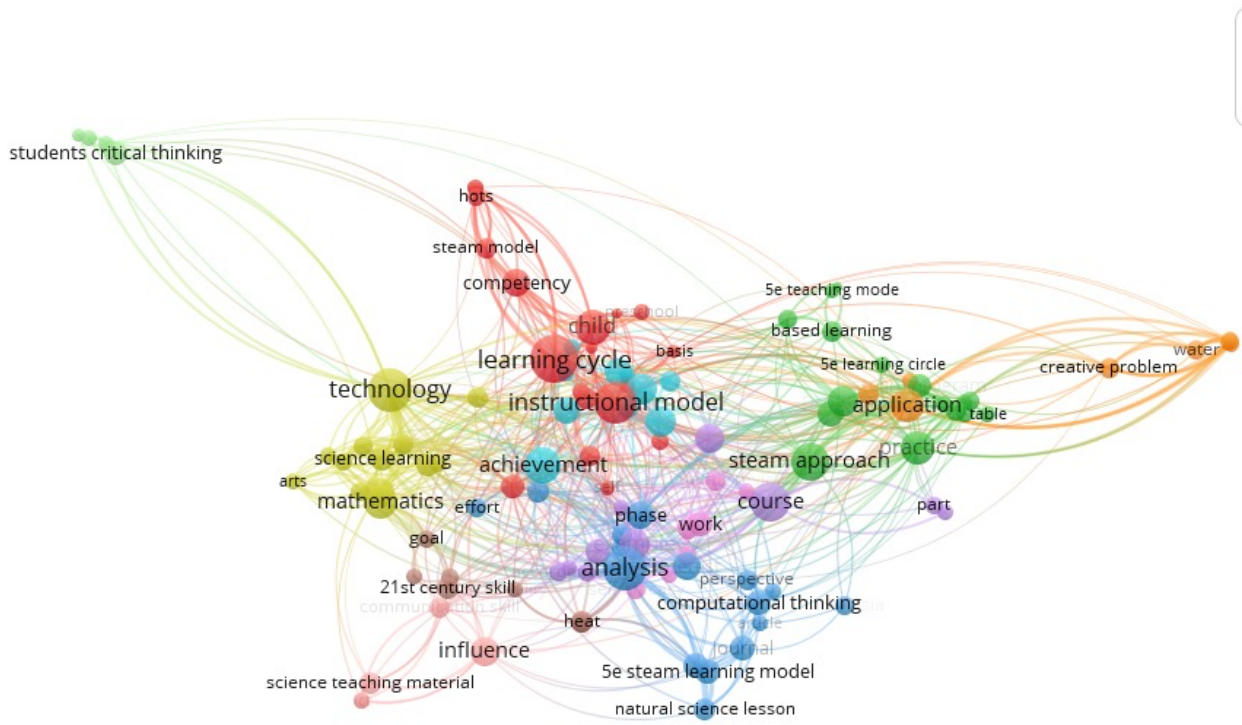

Figure 2. Overly visualization of the science e-module based on the 5E learning cycle model integrated with STEAM Reviewed from the concept mastery and creative thinking of students

Figure 2 shows the trend of keywords related to the research on the development of science e-modules based on the 5E learning cycle model integrated with STEAM in terms of concept mastery and creative thinking to improve students' science learning outcomes in Google Scholar indexed journals from 2015 to 2024. The trend of article writing themes related to the development of science e-modules based on the 5E learning cycle model integrated with STEAM in terms of concept mastery, which is seen from the concept mastery and creative thinking to improve students' learning outcomes in junior high schools from the oldest to the newest year is marked by the themes of purple, blue, turquoise, light green, and yellow. In 2022, the keywords that are widely used by researchers are learning cycle, instructional model, application, and others. In 2023, the keywords that appear most are technology, student, science learning and others.

Research on the development of science e-modules based on the 5E learning cycle model integrated with STEAM in terms of concept mastery, concept mastery and creative thinking in terms of improving student learning outcomes in junior high schools is one of the areas of research that has experienced rapid

development in recent years is the development of science e-modules based on the 5E learning cycle model integrated with STEAM in terms of concept mastery and creative thinking to improve student science learning outcomes through density visualization. Figure 4 displays a visualization of the density of research themes, where bright yellow indicates themes that are widely researched. The brighter the color of the theme, the higher the frequency of research conducted. Conversely, dimmer colors indicate that the theme is rarely the focus of research (Muttaqin, 2024). Themes with bright colors indicate research topics that are often the focus of researchers. Conversely, themes with dark colors reflect topics that rarely receive attention in research. This condition indicates that these keywords can be used as a reference for further research.

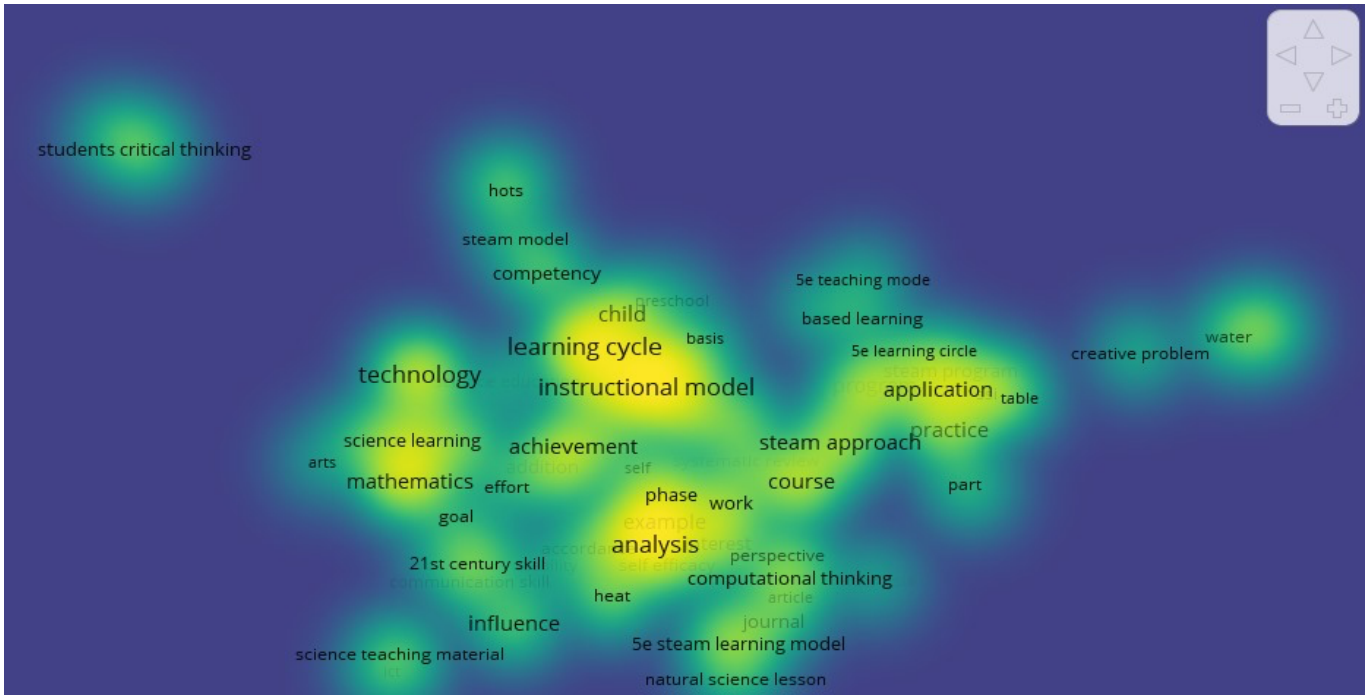

Figure 3. Density visualization in science e-module based on integrated STEAM 5E learning cycle model reviewed from students' concept mastery and creative thinking

Research on the development of science e-modules based on the 5E learning cycle model integrated with STEAM, reviewed from the aspect of concept mastery and creative thinking skills, has its own importance in improving junior high school students' learning outcomes. This kind of research has the potential to add digital learning resources that can be accessed by students anytime and anywhere. In addition, the 5E learning cycle model which is specifically designed to strengthen students' concept mastery and creative thinking skills can be an alternative effective learning approach in the classroom. Learning integrated with digital technology can also increase students' learning motivation, which is ultimately expected to be able to encourage the achievement of better learning outcomes.

Conclusion

Research on the development of science e-modules based on the 5E learning cycle model integrated with STEAM, viewed from the aspect of concept mastery and creative thinking skills, has its own importance in improving junior high school students' learning outcomes. This kind of research has the potential to add digital learning resources that can be accessed by students anytime and anywhere. In addition, the 5E learning cycle model which is specifically designed to strengthen students' concept mastery and creative thinking skills can be an alternative effective learning approach in the classroom. Learning integrated with digital technology can also increase students' learning motivation, which is ultimately expected to be able to encourage the achievement of better learning outcomes.

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No conflict interest.

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