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Effectiveness of the STEAM based SETS Learning Model to Increase Student's Scientific Literacy in Science Learning

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Abstrak

Tujuan penelitian ini adalah untuk mengetahui efektivitas pembelajaran SETS berbasis STEAM untuk meningkatkan literasi sains siswa dalam pembelajaran IPA. Jenis penelitia ini adalah penelitian meta-analisis pengumpulan data melalui analisis 11 jurnal nasional dan internasional yang terbit tahun 2021-2024. Teknik pengambilan sampel data melalui teknik purposive sampling. Kriteria inklusi dalam penelitian ini adalah penelitian diakses melalui database google scholar; ERIC, Sciencedirect dan Wiley, penelitian terkait model SETS berbasis STEAM untuk meningkatkan literasi sains siswa dalam pembelajaran IPA, Penelitian harus terindeks SINTA, Scopus dan WOS dan penelitian memiliki data yang lengkap untuk menghitung effect size. Kata kunci pencarian data yaitu model pembelajaran SETS, STEAM, Literasi sains dan pembelajaran IPA. Proses penyeleksian data melalui metode PRISMA. Analisis data adalah analisis kuantitatif dengan bantuan aplikasi Microsoft Excel. Hasil penelitian menyimpulkan bahwa model pembelajaran SETS berbasis STEM berpengaruh singnifikan terhadap kemampuan literasi sains siswa dengan nilai rata-rata effect size (ES= 0.834) kategori effect size tinggi. Temuan memberikan informasi penting bahwa mode pembelajaran STEM berbasis STEM efektif untuk meningkatkan literasi sains siswa dalam pembelajaran IPA dengan N-gain = 0.41.

Kata Kunci: *Pembelajaran SETS, STEAM, Literasi Sains, Meta-analysis*

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Abstract

The purpose of this study was to determine the effectiveness of STEAM-based SETS learning to improve students' science literacy in science learning. This type of research is a meta-analysis *of data collection through the analysis of 11 national and international journals published in 2021-2024. Data sampling techniques through purposive sampling techniques. The inclusion criteria in this study are research accessed through the google scholar database; ERIC, Sciencedirect and Wiley, research related to the STEAM-based SETS model to improve students' science literacy in science learning, Research must be indexed by SINTA, Scopus and WOS and research has complete data to calculate effect size. Data search keywords are SETS learning models, STEAM, Science literacy and Science learning. Data selection process through PRISMA method. Data analysis is quantitative analysis with the help of Microsoft Excel application. The results concluded that the STEM-based SETS learning model had a significant effect on students' science literacy skills with an average value of effect size (ES= 0.834) in the high effect size category. The findings provide important information that STEM-based STEM learning modes are effective for improving students' science literacy in science learning with N-gain = 0.41.*

Keywords: *SETS Learning, STEAM, Science Literacy, Meta-analysis*

Introduction

Science literacy is a crucial aspect of Natural Science learning that equips students with the ability to understand, analyze, and use scientific information in everyday life (Stylos et al., 2023;Rudolph, 2024). Understanding science literacy is not only limited to knowledge of scientific facts, but also involves the ability to think critically, solve problems, and make decisions based on scientific evidence (Elfira et al., 2023; Nurtamam et al., 2023). In the context of science learning, integrating science literacy helps students develop a deeper understanding of scientific concepts, while applying them in real situations, which ultimately increases their adaptability and innovation amid the development of science and technology (Maghfiroh et al., 2023; Quimada et al., 2023; Aina et al., 2023).

Science literacy in science learning requires a holistic and interactive approach, where students are not only recipients of information, but also as active actors in the learning process (Georgiou, 2023; Aruta, 2023). Teachers play an important role in creating a supportive learning environment, through learning methods that encourage students to ask questions, conduct scientific investigations, and collaborate in solving problems (Socrates et al., 2023; Utomo et al., 2023; Luciana et al., 2023). Thus, science literacy-based science learning not only increases students' understanding of scientific concepts, but also shapes students' character who are critical, creative, and able to adapt to change, which is an important competency in the 21st century (Chakravartty, 2023; Kumar et al., 2023).

In fact, student literacy in science learning is still relatively low (Ichsan et al., 2023). This can be seen from the PISA score in 2018 conducted by the OECD, the science literacy ability of Indonesian students obtained a score of 396, ranked 71 out of 78 participating countries (Zulyusri et al., 2023; Supriyadi et al., 2022; Solissa et al., 2023; Razak et al., 2021). Furthermore, the results of the 2015 TIMSS Survey showed students' critical thinking skills in science and mathematics obtained a score of 397 lower than the average International score of 500 (Rahman et al., 2023; Suharyat et al., 2022). The low ability of science literacy is also influenced by the ability of teachers to apply inappropriate learning models in encouraging students' science literacy skills (Torres, 2021; Kumar et al., 2023; Hejnová, 2024). Furthermore, students' ability to solve and analyze problems in learning is relatively low (Azis &; Nugraha, 2021; Nurhayati et al., 2024; Parno et al., 2024). Therefore, there is a need for a learning model that can encourage students' science literacy skills in learning.

The SETS learning model is one of the learning models that can encourage students' science literacy (Kumar et al., 2024; Nisa et al., 2021). The SETS learning model is a Science Environment Technology Society (SETS) learning model integrating scientific concepts with relevant environmental, technological, and social issues in learning. This approach aims to help students understand the interrelationships between science, the environment, technology, and society holistically (Hardianti et al., 2021). With a focus on real experience and practical application, SETS enables students to develop a deeper understanding of how science and technology impact the environment and society and how those impacts can be positively addressed or utilized (Zhong et al., 2021). Through observation, experimentation, and discussion, students not only learn about scientific concepts, but also become aware of their responsibilities as environmentally and socially concerned citizens of the world.

The SETS learning model also encourages students to develop critical, creative, and collaborative thinking skills (Yuniastuti, 2015). By exploring various complex issues related to science, environment, technology, and society, students are invited to question, analyze, and find solutions to existing challenges. This enables them to become independent and innovative learners who are ready to face the changes and challenges of the modern era (Amanda et al., 2018); Zahra et al., 2019). In addition, through collaboration with fellow students and various stakeholders, students also learn to appreciate diversity of opinions and understand the importance of cooperation in achieving common goals. Thus, the SETS model not only develops an understanding of scientific concepts, but also shapes the character of students who are responsive, insightful, and ready to contribute to building a sustainable future for all.

The learning model can be linked to the STEAM approach. STEAM (Science, Technology, Engineering, Arts, and Mathematics) is a holistic educational innovation, combining exact disciplines with art to enrich the teaching and learning process (Quigley et al., 2017). By integrating art into STEM foundations, STEAM encourages students to think creatively and critically, allowing them to explore complex concepts in more innovative and multidimensional ways (Zayyinah et al., 2022; Chujitarom &; Piriyasurawong, 2018); . This approach not only enhances students' understanding of the subject matter, but also prepares them with essential skills needed in the 21st-century job market, such as problem-solving, collaboration, and communication (Jr & Morales, 2019; Putra et al., 2023; Luciana et al., 2023). Through STEAM, education becomes more inclusive, engaging, and relevant, helping students to develop a love of lifelong learning and encouraging students to become innovative thinkers and problem solvers of the future (Ridwan &; Rahmawati, 2017; Huang, 2020).

Previous research by Devi et al., (2018) The implementation of the SETS learning model can develop students' cognitive abilities in learning. Research by Kadir et al., (2019) The SETS learning model has a positive influence on student motivation and interest in learning. Next (Zahra et al., 2019) explaining the SETS learning model can encourage students' science process skills in learning. The number of studies related to the SETS learning model has not found a size effect on the STEM-based SETS learning model.

Therefore, this study aims at the effectiveness of STEAM-based SETS learning to improve students' science literacy in science learning.

Methods

This type of research is meta-anaslisis research. Meta-analysis is a type of research that collects and analyzes previously relevant research that can be analyzed quantitatively to arrive at a conclusion (Korayem et al., 2024; Solehuddin et al., 2023; Suparman et al., 2021; Oktarina et al., 2021; Weldeab et al., 2024). This research data comes from an analysis of 11 national and international journals published in 2021-2024. Data sampling techniques through purposive sampling techniques. The inclusion criteria in this study are research accessed through the google scholar database; ERIC, Sciencedirect and Wiley, research related to the STEAM-based SETS model to improve students' science literacy in science learning, Research must be indexed by SINTA, Scopus and WOS and research has complete data to calculate effect size. Data search keywords are SETS learning models, STEAM, Science literacy and Science learning. Data selection process through PRISMA method. Data analysis is quantitative analysis with the help of Microsoft Excel application. Furthermore, the calculation of the effect size value can be seen in Table 1.

Table 1. Formula for calculating the Effect Size value

Statistical Data	Formula
Average value on one group	$ES = \frac{\bar{x}_{post} - \bar{x}_{pre}}{SD_{pre}}$
Average scores in each group	$ES = \frac{\bar{x}_{Exsperiment} - \bar{x}_{Control}}{SD_{Control}}$
Mean and Standard deviation values in each group (two groups of postes-pretest)	$ES = (\frac{(\bar{x}_{post} - \bar{x}_{pre})_E - (\bar{x}_{post} - \bar{x}_{pre})_c}{SD_{preC} + SD_{preE} + SD_{postC}}$
Chi square	$ES = \frac{2r}{\sqrt{1-r^2}}$; r= $\sqrt{\frac{x^2}{n}}$
t-count	$ES = t\sqrt{\frac{1}{n_{experiment}} + \frac{1}{n_{Control}}}$
P-Value	SPSS

Source : Becker & Park Dalam (Khoiri, 2019; Hidayatullah & Wulan, 2022)

Furthermore, for the effect size value criteria related to the influence of the STEAM-based SETS learning model to improve students' science literacy in science learning based on the effect size value criteria (Cohen et al., 2007) i.e. 0.0 ≤ES≤ 0.2 effect size low criteria; 0.2 ≤ES≤ 0.8 medium effect size criteria; and ES ≥0.8 High effect size criteria.

Result and Discussion

Based on the results of searching for data sources through google scholar; ERIC, Sciencedirect and Wiley related to the effect of STEAM-based SETS learning models to improve students' science literacy in science learning obtained 229 studies. Furthermore, the research was selected using the PRISMA method (figure 1) obtained 11 studies that had met the inclusion criteria that had been determined. Furthermore, data that have met the inclusion criteria are calculated effect size values which can be seen in Table 2.

Table 1. Value of Effect Size 11 Research

Research Code	Year	Journal Index	Effect Size Value	Criterion
P1	2023	SINTA	1.17	High
P2	2023	SINTA	0.61	Medium
P3	2021	Scopus	1.44	High
P4	2024	SINTA	0.59	Medium
P5	2024	SINTA	0.40	Medium
P6	2024	Scopus	0.89	High
P7	2022	Scopus	1.19	High
P8	2021	Scopus	1.25	High
P9	2023	SINTA	0.92	High
P10	2024	WOS	0.78	Medium
P11	2023	SINTA	0.32	Medium
Average Effect Size value			**0.869**	**High**

Based on Table 1, the effect size value of 11 studies analyzed the highest effect size was 1.44 and the lowest effect size value was 0.32. Furthermore, the average effect size value is 0.869 with high effect size criteria. The results of this study conclude that the STEM-based SETS learning model has a significant influence on students' science literacy in learning. The results of the study are in line with (Ulfah, 2020) application of the SETS learning model in encouraging science literacy skills in science learning. The results of this study are also supported by (Hardianti et al., 2021) The STEAM-based SETS learning model is effective for improving students' science literacy in learning.

In this study, the STEAM approach is applied to provide a new dimension in SETS learning, by emphasizing creativity and innovation through the integration of art. Art, in this context, is not only a medium of expression, but also as a tool to understand scientific concepts more deeply (Rachmadiarti, 2023). It is hoped that through this approach, students can develop their critical and creative thinking, in addition to increasing their understanding of the science concepts taught. significant improvement in students' science literacy in the group receiving STEAM-based SETS learning compared to the control group. This improvement is not only seen in aspects of knowledge and application, but also in the scientific attitude of students. This indicates that the integration of SETS and STEAM can be an effective approach to improving science literacy, which is important to prepare students for the challenges of the globalization era (Julianto, 2022).

This research underscores the importance of integrating SETS (Science, Environment, Technology, and Society) approaches based on STEAM (Science, Technology, Engineering, Arts, and Mathematics) in science learning, with the main aim of improving students' science literacy (Yıldırım, 2023). Science literacy, which includes understanding concepts, applications of knowledge, and scientific attitudes, is a crucial component of science education that aims to prepare students to be able to interact effectively and responsibly in a society based on knowledge and technology (Walag &; Fajardo, 2022). Through STEAM-based SETS learning, students are invited to explore science concepts in a broader context, integrate knowledge and skills from different disciplines and apply them in real situations related to the environment, technology, and society.

In the context of this study, STEAM-based SETS learning is applied through learning activities designed to encourage students to think critically, collaborate, and innovate (Santosa et al., 2023). The activities are designed to not only strengthen understanding of science concepts, but also to develop important skills such as problem solving, communication, and creativity. This approach encourages students to make connections between the knowledge they gain and the world around them, increase their awareness of environmental and social issues, and strengthen their understanding of how science is applied in everyday life (Mahlianurrahman et al., 2023).

STEAM-based SETS learning contributes significantly to the improvement of students' science literacy, which is characterized by increasing students' ability to understand science concepts, apply knowledge in new contexts, and develop a positive scientific attitude (Yoon et al., 2023; Kristiyanto et al., 2020). These findings confirm that an interdisciplinary approach, which blends aspects of SETS within the STEAM framework, can provide a new dimension in science learning, making it more relevant, engaging, and effective in equipping students with the skills and knowledge needed to succeed in the 21st century (Suharyat , et al., 2022; Sigit, 2022). This demonstrates the importance of science education that not only focuses on factual knowledge, but also on the development of students' intellectual and social competencies, preparing them to become informed and responsible global citizens (Edelen et al., 2023; Mou, 2020).

Furthermore, size effect analysis to determine the effectiveness of the STEAM-based SETS learning model to improve students' science literacy in science learning can be seen in Table 3.

Table 3. Size Effect Effectiveness of SETS learning model based on STEAM > Science Literacy

Effect Size Value	N-gain	Crieria
0.86	0.41	High

Table 3. Explaining the results of the effect analysis, size effectiveness obtained an ES value = 0.86 and N-gain of 0.41 with high criteria. The results show that the STEAM-based SETS learning model is effective for improving students' science literacy in science learning. The implementation of STEAM-based SETS is expected to improve students' science literacy, which includes the ability to understand scientific concepts, apply science knowledge in everyday life, and develop a positive scientific attitude. The learning process is designed to encourage students not only to be passive recipients of information, but also as active participants involved in the learning process through exploration, experimentation, and reflection. This is expected to deepen students' understanding of science concepts and develop critical thinking skills and creativity (Piila &; Salmi, 2021). This improvement covers various aspects of science literacy, from conceptual understanding to applicative abilities and scientific attitudes.

Students involved in this learning demonstrate increased ability in relating science concepts to real situations, solving problems with a scientific approach, and developing a deeper understanding of science's impact on the environment and society. Furthermore, STEAM-based SETS learning encourages collaboration and communication between students, an important aspect that strengthens social skills and the ability to work in teams. This learning process also allows students to explore multiple perspectives and approach problems in more creative and innovative ways (Kristanto, 2023). Thus, this learning not only improves science literacy but also develops other important competencies that students need to contribute effectively in society.

Conclusion

From this study, it can be concluded that the STEM-based SETS learning model has a significant effect on students' science literacy skills with an average value of effect size (ES= 0.869) high effect size criteria. The findings provide important information that STEM-based STEM learning modes are effective for improving students' science literacy in science learning with N-gain = 0.41. This model deepens the understanding of science concepts and can develop students' critical and creative skills, as well as encourage them to apply knowledge in a broader, multidisciplinary context. This approach successfully creates a holistic learning experience, increases students' awareness of environmental and social issues, and prepares them with essential skills for the future, affirming the importance of science education that is interactive, innovative, and relevant to the challenges of the 21st century.

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