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The Effectiveness of SAVI Learning Model Based on Flipped Classroom on Children's Problem Solving Ability

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Abstract
This study aims to determine the effectiveness of the flipped classroom-based SAVI learning model on children's problem-solving skills. This research is a type of meta-analysis research. The eligibility criteria in this study are: a) the research must be published in 2022-2024; b) this research was obtained through the Google Scholar database; Mendeley; ScienceDirect; and Wiley; c) the research must be relevant; d) the research must have complete data to calculate the effect size value; and the sample size > 30 participants. The data in this meta-analysis is analyzed with the help of JASP and Microsoft Excel applications. The results of the analysis of 19 effect sizes concluded that the summary effect size value ($d = 1.077$; $z = 8.172$; $p < 0.001$) of the effect size category was strong. These findings show that the application of the effectiveness model of the flipped classroom-based SAVI learning model has a positive influence on children's problem-solving skills

Keywords: *SAVI Model; Effect Size; Flipped Classroom; Problem Solving*

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Introduction

Problem-solving skills are one of the core competencies that children must have in facing the challenges of the Industrial Revolution 4.0 and 5.0 (Wantu et al., 2024; Uluk et al., 2024). In this era, the rapid development of technology such as artificial intelligence, the internet of things, and automation has created new complexities in various aspects of life, both in the economic, social, and educational fields (Asnur et al., 2024; Khairani Wijaya et al., 2023). This situation requires children to be able to critically analyze problems, find innovative solutions, and adapt quickly to changes (Juhanaini et al., 2024). Problem-solving skills are not only relevant in the context of work, but also play an important role in everyday life, where children are expected to be able to make the right decisions amidst abundant and often unstructured information. Thus, this ability is not only a provision to face today's challenges, but also to create new opportunities in the future (Baybayan & Cabanes, 2024; Alyusfitri et al., 2024; Nugraheni et al., 2024).

In the context of the Industrial Revolution 5.0 which prioritizes the integration of technology and human values, problem-solving skills are increasingly prominent as an important aspect (Rusmawati et al., 2023). This revolution emphasizes the importance of solutions that are not only technologically efficient but also have a positive social and environmental impact. Therefore, the ability to solve problems creatively, collaboratively, and value-based is essential (Kasmini et al., 2024). Education plays a key role in equipping the younger generation with these skills, especially through interactive, innovative, and contextual learning approaches. A learning model that encourages students to be actively involved in the process of problem identification, solution exploration, and data-driven decision-making can be an effective strategy to produce children who are competent and ready to face challenges in this era (Aminah, 2024; Yasa et al., 2024).

Furthermore, problem-solving skills not only focus on finding practical solutions, but also emphasize the importance of critical and creative thinking (Mardiyah & Sunarsi, 2024). Individuals are expected to be able to explore various alternative solutions, evaluate their impacts, and make effective and ethical decisions. With good problem-solving skills, one can adapt quickly in a dynamic environment, especially in the face of global challenges such as technological, economic, and social changes.

In addition, the Framework for 21st Century Learning places problem-solving skills as an integral part of the collaborative and contextual learning process. Problem-solving not only involves individuals personally but also encourages collaboration between individuals to find innovative and sustainable solutions (Zulkifli et al., 2022; Zulyusri et al., 2023). This is relevant to the needs of the modern world of work which increasingly prioritizes multidisciplinary teams to overcome complex problems (Herlambang et al., 2024). In the context of education, the development of problem-solving skills can be integrated through project-based learning approaches, group discussions, and real-world simulations. This approach allows students to hone their critical thinking, communication, and collaboration skills, all of which are essential elements in preparing them to become competent and responsible global citizens in the 21st century (Rusmawati et al., 2023).

Problem-solving skills have a very important relevance in basic education as they become the main foundation for advanced learning and effective decision-making (Bachtiar et al., 2023; Ichsan et al., 2023). At this stage, students are in a critical period of cognitive development, where logical, analytical, and creative thinking skills begin to form. By integrating problem-solving into basic learning, students can be trained to independently identify problems, analyze relevant information, and formulate appropriate solutions (Ali et al., 2024). This process not only helps them understand academic concepts in depth, but also equips them with essential life skills, such as critical thinking and making decisions based on rational considerations (Fischer & Beyer, 2024). As a foundation for advanced learning, these skills enable students to be more adaptive in facing the more complex educational challenges of the future, while preparing them to become individuals capable of facing real-world problems with a strategic and solution-oriented approach (Natalina & Hidayah, 2024; Fung & Deng, 2024).

One of the fundamental problems in learning in the modern era is the lack of effective methods to develop students' problem-solving skills (Ramadhani et al., 2019). Many schools still rely on the traditional, one-way approach to learning, where teachers are the main center of learning, while students are only passive recipients of information. Methods like this often do not provide room for students to develop the critical, creative, and analytical thinking skills

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needed in the problem-solving process (Ergene & Karaboğaz, 2024; Ma et al., 2024). What's more, traditional learning often fails to accommodate the diversity of students' learning styles, so some students are unable to absorb information optimally (Dermentzi, 2024). This condition indicates an urgent need to implement a more innovative, inclusive, and focused learning model on the development of 21st century skills, including problem-solving skills.

The SAVI (Somatic, Auditory, Visual, Intellectual) learning model based on Flipped Classroom offers a potential solution to overcome this problem (Riana et al., 2020). This approach integrates different learning styles by building an active and well-rounded learning experience. With Flipped Classroom-based learning, students can learn material independently through digital media before class sessions, so that time in class can be used for interactive and applicative activities (Khairani Wijaya et al., 2023; Putri, 2023). This model also provides opportunities for students to actively participate in problem exploration and creative solution development through learning experiences that suit their learning style. However, the effectiveness of the integration of the SAVI and Flipped Classroom models in improving children's problem-solving skills still requires empirical proof (Baybayan & Cabanes, 2024; Alyusfitri et al., 2024). This study aims to answer these challenges by evaluating the extent to which this learning model can provide better results than traditional approaches, as well as how its implementation can be optimized in the context of basic education (Kasmini et al., 2024; Samadi et al., 2024; Wantu et al., 2024; Luciana et al., 2024; Dewanto et al., 2023).

Research by Gunawan et al. (2022) revealed that Flipped Classroom-based learning allows students to learn material independently before class sessions, so they are better prepared to participate in interactive and applicable classroom activities. Another study by Rahmawati and Pratama (2023) emphasizes that the effective use of SAVI Flipped Classroom-based model can encourage students to think critically and creatively in facing learning challenges. This study shows that through a combination of independent learning outside the classroom and collaborative activities in the classroom, students are able to identify problems more systematically and come up with innovative solutions. research from Suryani et al. (2024), which tested the effectiveness of Flipped Classroom-based SAVI in science subjects at the primary education level. The results showed that students who learned using this model showed an increase in the ability to understand problems, explore alternative solutions, and make decisions based on valid data.

Meta-analysis of the effectiveness of SAVI (Somatic, Auditory, Visual, Intellectual) and Flipped Classroom learning models individually has been widely conducted, but research that specifically evaluates the combination of the two in the context of children's problem-solving abilities is still very limited. Most of the existing meta-analysis studies only focus on the effectiveness of Flipped Classroom as a digital learning model or SAVI as a multisensory approach without integrating the two approaches. In addition, there have not been many meta-analysis studies exploring its impact on students at the primary education level, especially in measuring specific skills such as problem-solving abilities. Furthermore, previous studies have often lacked in detail in analyzing moderation factors, such as student age, learning subjects, or evaluation methods, which may affect the effectiveness of SAVI and Flipped Classroom integration. Based on this, this study aims to determine the effectiveness of the flipped classroom-based SAVI learning model on children's problem-solving skills by meta-analysis.

Methodology

This study uses a meta-analysis approach to determine the the effectiveness of the flipped classroom-based SAVI learning model on children's problem-solving skills. Meta-analysis is a research approach that evaluates previous research statistically to reach a conclusion (Tamur et al., 2020; Badawi et al., 2023; Nurtamam et al., 2023; Zulyusri et al., 2023). The meta-analysis research procedure can be seen in Figure 1.

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Figure 1. Stages in Meta-analysis ((Borenstein et al., 2007)

Eligibility Criteria

In the process of searching for data through the Google Scholar, ScienceDirect, Wiley, ERIC, ProQuest, Fronteins and Web of Science databases, the research must meet several inclusion criteria, namely a) the research must be published in 2022-2024; b) this research was obtained through the Google Scholar database; Mendeley; ScienceDirect; and Wiley; c) the research must be relevant; d) the research must have complete data to calculate the effect size value; and the sample size > 30 participants.. From the data search, 19 studies were obtained that met the inclusion criteria published in 2022-2024 which can be seen in Table 2.

Data Collection

To obtain valid research data related to the effectiveness of the flipped classroom-based SAVI learning model on children's problem-solving skills collected from Google Scholar, ScienceDirect, Wiley, ERIC, ProQuest, Fronteins and Web of Science databases and frontenists. The keywords for data search are " SAVI Model", The Effect of the Flipped Classroom-based SAVI Model on Children's Problem-Solving Ability", "Flipped Classroom", "Problem-Solving Ability in Children".

Statistical Analysis

Data analysis in this study calculates the effect size value of each study analyzed. The effect size value in this study is to calculate the effect of the to the effectiveness of the flipped classroom-based SAVI learning model on children's problem-solving skills. According to (Borenstein et al., 2007) The stages of data analysis in the meta-analysis can be seen in (Figure 1.). Furthermore, the criteria for the effect size value in the study can be seen in Table 1.

Table 1. Category Effect Size Value

Effect Size	Category
0.0≤ES≤ 0.2	Low
0.2≤ES≤ 0.8	Medium
ES≥ 0.8	High

Source: (Borenstein et al., 2007; Bachtiar et al., 2023; Tamur et al., 2020)

Result and Discussion

Based on the results of data search through the database, 19 studies/articles met the inclusion criteria. The effect size and error standard can be seen in Table 2. Based on Table 2, the effect size value of the 19 studies ranged from 0.39 to 2.92. According to Borenstein et al., (2007) Of the 19 effect sizes, 7 studies had medium criteria effect sizes and 12 studies had high criteria effect size values. Furthermore, 19 studies were analyzed to determine an estimation model to calculate the mean effect size. The analysis of the fixed and random effect model estimation models can be seen in Table 3.

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Table 2. Effect Size and Standard Error Every Research

Code Journal	Years	Effect Size	Standard Error
AT 1	2022	1.34	0.30
AT 2	2023	0.97	0.32
AT 3	2023	0.56	0.28
AT 4	2024	2.08	0.45
AT 5	2024	1.60	0.40
AT 6	2024	1.30	0.39
AT 7	2023	0.68	0.39
AT 8	2022	0.91	0.33
AT 9	2024	0.77	0.30
AT 10	2024	0.61	0.29
AT 11	2024	0.59	0.21
AT 12	2024	0.36	0.17
AT 13	2022	0.48	0.20
AT 14	2022	0.88	0.29
AT 15	2024	1.26	0.39
AT 16	2022	1.73	0.40
AT 17	2023	1.69	0.42
AT 18	2024	2.92	0.58
AT 19	2024	1.70	0.40

Table 3. Fixed and Random effect

	Q	df	p
Omnibus test of Coefficients Model	72.923	1	< 0.001
Test of Residual Heterogeneity	113.034	23	< 0.001

Based on Table 3, a Q value of 113.043 was obtained higher than the value of 72.923 with a coefficient interval of 95% and a p value of 0.001 <. The findings can be concluded that the value of 24 effect sizes analyzed is heterogeneously distributed. Therefore, the model used to calculate the mean effect size is a random effect model. Furthermore, checking publication bias through funnel plot analysis and Rosenthal fail safe N (FSN) test (Tamur et al., 2020; Badawi et al., 2022; Ichsan et al., 2023b; Borenstein et al., 2007; Abdullah et al., 2024). The results of checking publication bias with funnel plot can be seen in Figure 2.

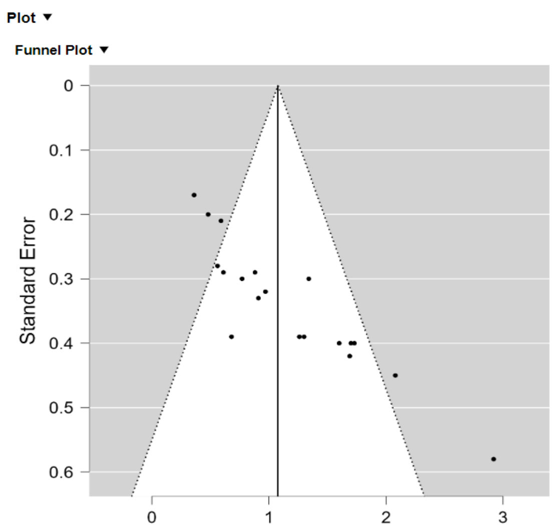

Figure 2. Funnel Plot

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Based on Figure 2, the analysis of the funnel plot is not yet known whether it is symmetrical or asymmetrical, so it is necessary to conduct a Rosenthal Fail Safe N (FSN) test. The results of the Rosenthal Fail Safe N calculation can be seen in Table 4.

Tabel 4. Fail Safe N

File Drawer Analysis			
	Fail Safe N	Target Significance	Observed Significance
Rosenthal	1395	0.050	< 0.001

Based on Table 4, the Fail Safe N value of 1395 is greater than the value of 5k + 10 = 5(19) + 10 = 105, so it can be concluded that the analysis of 19 effect sizes in this data is not biased by publication and can be scientifically accounted for. Next, calculate the p-value to test the hypothesis through the random effect model. The results of the summary effect model analysis with the random effect model can be seen in Table 5.

Table 5. Summary/ Mean Effect Size

Coefficient						
	Effect Size	Standard Error	z	p	95 % Coefficient Interval	
					Lower	Upper
Intercept	1.077	0.132	8.172	< 0.01	0.819	1.335

Based on Table 5, the results of the analysis with the random effect model obtained a lower limit value of 0.819 and an upper limit of 1.335 and a mean effect size value of 1.077. The effect size category in this study is included in the high category. Furthermore, the results of the Z test to determine the significance were obtained at 8.172 and the p-value < 0.01, so it can be concluded that the application of an ethno-physics-based problem-based learning model can improve students' 21st-century thinking skills compared to conventional models. The SAVI (Somatic, Auditory, Visual, Intellectual) model, which accommodates a variety of children's learning styles, as well as the Flipped Classroom, which utilizes technology to facilitate independent learning, are seen as complementary approaches. This study aims to evaluate the combined effectiveness of these two models in improving problem-solving skills in children, with the hope that it can make a significant contribution to the development of more effective learning strategies (Amin et al., 2024).

The SAVI model integrates four elements of deep learning, namely somatic, auditory, visual, and intellectual, to meet the needs of various children's learning styles (Khairani Wijaya et al., 2023). Each element plays an important role in creating a more holistic and well-rounded learning experience. By incorporating somatic elements, children can learn through physical activity and movement, while auditory and visual elements facilitate learning through hearing and vision. On the other hand, Flipped Classroom changes the traditional learning structure by providing learning materials first through digital media, allowing children to study basic concepts outside the classroom (Ngo, 2024; Alyusfitri et al., 2024). The time in class is then utilized for discussions, problem-solving, and interactive activities that encourage the direct application of the concepts learned. The combination of these two models is expected to accelerate the learning process and improve problem-solving skills in children (Dementjeva, 2024; Oktarina et al., 2021).

The success of learning is not only determined by the mastery of the material, but also by the level of involvement and active participation of children in the learning process. SAVI' Flipped Classroom-based model allows children to be more actively involved in the learning process, especially in solving given problems (Baybayan & Cabanes, 2024). Through this model, children are given the opportunity to learn independently before meeting with the

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teacher, who is then facilitated to discuss, work together, and think critically in class sessions (Kasmini et al., 2024). This approach encourages children to be more responsible for their learning process, develop independence, and train them in solving problems in a more applicative and contextual way. In this case, activity-based learning that integrates SAVI is able to develop sharper and more relevant problem-solving skills in real life. Problem-solving capabilities involve a complex process that includes analysis, synthesis, and evaluation to find the right solution(Yasa et al., 2024; Mardiyah & Sunarsi, 2024). By combining the SAVI and Flipped Classroom models, children are given the opportunity to develop these skills through a more holistic and integrated approach. Based on previous research, children who learn through the Flipped Classroom model tend to understand complex concepts more easily because they can learn the material independently first, so they are better prepared to discuss and solve problems in class (Nurtamam et al., 2023). With SAVI elements, children with different learning styles—whether kinesthetic, auditory, visual, or intellectual—can more easily absorb and apply concepts in a variety of contexts, strengthening their problem-solving process.

Although the initial results show great potential from the combination of the Flipped Classroom-based SAVI model, the implementation of this model is not without its challenges. One of the main challenges is the readiness of students to access and utilize technology for independent learning(Nisa, 2024). Not all students have the same digital skills or adequate access to technological devices. In addition, the role of the teacher as a facilitator in class sessions is very important to ensure that group discussions and activities can take place effectively, so that problem-solving skills can be developed optimally(Solo et al., 2024). Therefore, the challenge of designing and managing technology-based learning and providing adequate support for children is an important aspect that needs to be considered in the implementation of this model. The combination of the SAVI and Flipped Classroom models has the potential to significantly improve students' problem-solving skills. This model opens up opportunities for the development of more innovative learning methods that are in line with the needs of education in the 21st century, which demand the mastery of critical skills such as analytical and creative thinking(Komarudin et al., 2024). By utilizing technology and a more personalized approach, this model also provides a more inclusive and responsive learning experience to students' diverse learning styles (Karaismailoglu & Yildirim, 2023). The implications of these findings are an encouragement for educators and policymakers to better integrate technology in learning, as well as design curricula that enable students to develop skills relevant to the challenges of an ever-evolving world.

Conclusion

From the results of this meta-analysis, it can be concluded that the application of the effectiveness model of the flipped classroom-based SAVI learning model has a positive influence on the problem-solving ability of children with a value of summary effect size ($d = 1{,}077$; $z = 8{,}172$; $p < 0.001$) of the strong effect size category. The integration of the multisensory elements of the SAVI model, which involves physical, auditory, visual, and intellectual activities, with a self-paced learning approach through Flipped Classroom, enriches students' learning experience and allows them to be more active in processing information and applying problem-solving skills in a more practical context. The implication of these findings is that educators need to consider using a combination of these models to optimize learning in the classroom, particularly in developing 21st century skills such as critical and creative thinking. The application of this model is expected to encourage more inclusive learning, be responsive to students' diverse learning styles, and increase students' readiness to face increasingly complex global challenges, which require effective problem-solving skills.

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