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Meta-analysis of the STEM Based Think Pair Share (TPS) Model on Students 21st Century Thinking Abilities in Indonesia

Ahmad Zain Sarnoto[1*], Sri Tuti Rahmawati[2], Sisi Yulianti[3], Eri Mardiani[4], Normansyah[5]
[1]Universitas PTIQ Jakarta, Indonesia
[2]Institut Ilmu Al-Quran (IIQ) Jakarta, Indonesia
[3] Universitas Andalas, Indonesia
[4] Universitas Nasional, Indonesia
[5] Universitas Asahan, Indonesia
*Corresponding email:ahmadzain@ptiq.ac.id

Abstract

The purpose of this study was to determine the effect of STEM-based Think Pair Share (TPS) model on students' 21st century thinking skills in Indonesia. This type of research is meta-analysis research. The sources in the meta-analysis came from 15 national and international journals published in 2021-2024. The inclusion criteria in the research are that the research must be indexed by SINTA, Scopus and Web of Science, the research must be experimental or quasi-experimental related to the STEM-based Think Pair Share (TPS) model on students' 21st century thinking skills; Research data obtained through google scholar, Mendeley, Sciencedirect and ERIC, Research must be open access, and research must have complete data to calculate the effect size value. The sampling technique is purposive samling. Data analysis in this study is quantitative statistical analysis by calculating the effect size value with the help of the OpenMEE application. The results concluded that the STEM-based Think Pair Share (TPS) model had a significant effect on students' 21st century thinking skills in Indonesia with a high influence category with an average effect size value (ES = 0.952). This finding provides important information for teachers in implementing this model to encourage students' 21st century thinking skills in Indonesia.

Keywords: TPS Model, STEM, Effect Size, 21st Century Thinking, Meta-analysis

Introduction

The importance of 21st Century Thinking Skills for Students in Indonesia cannot be underestimated (Zulyusri et al., 2023; Miterianifa et al., 2021). In the midst of globalisation and rapid technological development, the ability to think critically, creatively, collaboratively and communicatively is the main key in facing future challenges (Ongardwanich et al., 2015; Razak et al., 2021; Elfira et al., 2023). Students who have 21st century thinking skills tend to be better prepared to deal with various changes that occur in the surrounding environment, both

in terms of academics and daily life (Zainil et al., 2023). In addition, 21st century thinking skills also help students to be more adaptive to the various changes and challenges that occur in the digital era. With this ability, students can more easily adjust to the ever-changing development of technology and information. They are also able to create innovative solutions in dealing with various complex problems, both at school and in society (Rehman, 2023; Zulkifli et al., 2022; Sarnoto, 2024).

Not only that, 21st century thinking skills also help students to be more competitive in the world of work. Critical and creative thinking skills, as well as the ability to work collaboratively and communicatively, are added values that are highly valued by industry (Rushiana et al., 2023); Rahman et al., 2023; Pramasdyahsari et al., 2023). Thus, investing in the development of 21st century thinking skills for students in Indonesia will provide long-term benefits for the advancement of education as well as the country's overall development (Suryono et al., 2023). The development of 21st century thinking skills also has a positive impact on Indonesia's overall social and economic progress. Students who possess these skills are expected to become agents of change who are able to create new innovations that can improve the quality of life of society. Therefore, it is important for education in Indonesia to continue to develop learning methods that encourage the development of 21st century thinking skills so that students can be ready for a challenging future (Boari et al., 2023).

The achievements of STEM education in Indonesia have shown positive developments in recent years, especially with the increase in the number of study programmes and educational institutions offering education in STEM fields (Rahman et al., 2023). The Indonesian government has also given greater attention to STEM education through various policies and programmes, such as the Vocational Education programme and the School Literacy Movement. However, the main challenge faced in achieving STEM education in Indonesia is the availability of skilled and qualified human resources in STEM fields. The lack of qualified teachers and educators in STEM fields is one of the main obstacles in the effort to improve the quality of STEM education in Indonesia (Ichsan et al., 2023; Widodo et al., 2024).

In addition, the lack of adequate educational facilities and infrastructure is also a serious challenge in achieving STEM education in Indonesia. Many schools in remote or rural areas still lack laboratory facilities and equipment to support STEM learning. This makes it difficult for students in these areas to develop their skills and interests in STEM (Vennix et al., 2023). Therefore, there is a need for greater efforts from the government, educational institutions and society as a whole to improve access and quality of STEM education in Indonesia, so as to create a young generation that is ready to face challenges in the digital era and globalisation (Hong et al., 2023).

The Think Pair Share (TPS) model is an active learning model that encourages students to think critically and collaborate in solving problems (Bella & Islami, 2023; Ragil et al., 2023). This model involves students in paired discussions (think pair) to consider various points of view before sharing their thoughts with the group or class (share). In the context of STEM (Science, Technology, Engineering, and Mathematics) learning, the use of TPS Model can help

students to understand complex concepts and apply them in real situation (Ultimate, 2023) . Through paired discussions, students can develop critical and creative thinking skills, as well as improve their communication and collaboration skills in solving complex problems in STEM fields. The application of TPS Model in STEM learning can also increase students' interest and motivation towards the subject. By actively involving students in the learning process, the TPS Model helps to create an interactive and fun learning atmosphere (Zaidah &; Hidayatulloh, 2024). In addition, the TPS Model can also help teachers to monitor students' understanding of learning materials in more detail through interactions that occur in paired discussions. Thus, the introduction of the TPS Model in the context of STEM learning is expected to make a positive contribution to improving the quality of learning and student achievement in STEM fields (Li &; Tu, 2024).

STEM-based Think Pair Share (TPS) model on students' 21st century thinking skills in Indonesia, a review of recent literature is key to understanding the framework and methodology used in this study (Sayekti &; Siagian, 2024). The state of the art of this research involved an in-depth review of recent studies that have been conducted previously, with a focus on the effect of the TPS Model on key aspects of 21st century thinking skills, such as creativity, critical thinking, collaborative thinking, and communicative thinking (Fitriani et al., 2024). Through a comprehensive analysis of the current literature, this meta-analysis aims to provide a deeper understanding of the effectiveness of the TPS Model in improving students' thinking skills in Indonesia in the context of STEM education. Through a comprehensive meta-analysis of current literature, this research is expected to make a significant contribution in improving our understanding of the importance of the TPS Model in developing students' 21st century thinking skills in Indonesia.

Research Methods

The research method in this meta-analysis will involve systematic steps to collect and analyse data from previous studies relevant to the effect of STEM-based Think Pair Share (TPS) Model on students' 21st century thinking skills in Indonesia. First, the researcher will conduct a comprehensive literature search using scientific databases such as Google Scholar, ERIC, Mendeley and science direct using keywords relevant to the research topic. After that, we will select the studies based on the inclusion and exclusion criteria, such as the studies must be conducted in Indonesia, use the TPS Model in STEM learning, and provide sufficient data to be analysed.

Once the studies that fulfil the inclusion criteria are selected, the researcher will extract relevant data from each study, such as sample size, research design, outcomes related to 21st century thinking skills, and analysis methods used. This data will then be synthesised using the statistical method of meta-analysis, which will allow the researcher to combine and analyse the results of the studies as a whole. This analysis will produce an estimate of the effect of the TPS Model on students' 21st century thinking skills in Indonesia, as well as identify factors that influence the variability of results between studies. This method is expected to provide a more

comprehensive understanding of the effectiveness of the TPS Model in improving students' 21st century thinking skills in Indonesia. Data analysis was quantitative statistical analysis by calculating the effect size value with the help of the OpenMEE application. Furthermore, the effect size criteria for research can be seen in Table 1.

Table 1. Effect Size (ES) Value Criteria

Effect Size Value	Criterion
0.0≤ES≤ 0.20	Low
0.20≤ES≤ 0.80	Medium
ES≥ 0.80	High

Source:(Cohen et al., 2007)

Result and Discussion

From the results of searching data sources through Google Scholar, Mendeley, Sciencedirect and ERIC related to the influence of the STEM-based Think Pair Share (TPS) model on the thinking skills of 21st century students in Indonesia obtained 198 studies, but the research was selected based on predetermined inclusion criteria, 15 research journals met the inclusion criteria. Research that has met the inclusion criteria is calculated for its effect size value which can be seen in Table 2.

Table 2. Value of Effect Size 15 Research Journal

Journal Code	Year	Index	Effect Size	Effect Size Criteria
H1	2021	Sinta	0.87	High
H2	2023	Sinta	0.66	Medium
H3	2023	Scopus	0.95	High
H4	2023	Scopus	1.18	High
H5	2024	Scopus	1.42	High
H6	2023	Sinta	0.92	High
H7	2022	Sinta	0.43	Medium
H8	2023	Scopus	1.53	High
H9	2022	Sinta	0.41	Medium
H10	2022	Sinta	0.33	Medium
H11	2021	Scopus	1.78	High
H12	2021	Sinta	0.62	Medium
H13	2023	Scopus	0.96	High
H14	2024	Sinta	1.07	High
H15	2023	Scopus	1.15	High
Average value of effect size			0.952	High

Based on Table 2, the results of effect size value analysis from 15 journals obtained the highest effect size value of 1.78 and the lowest effect size of 0.33. Furthermore, according to Cohen et al., (2007) Of the 15 journals analyzed for effect size value, five studies (n = 5) had medium effect size criteria and ten studies (n = 10) had high effect size criteria. Not only that, the average value of the overall effect size of 0.952 categoru is high. These results conclude that the STEM-based Think Pair Share (TPS) model has a significant influence on the 21st century thinking skills of students in Indonesia. The results of this study are in line with (Ramdhani et al., 2024) The implementation of the Think Pair Share (TPS) model affects students' creative thinking ability in learning.

The use of the TPS Model has proven effective in improving students' critical, creative, collaborative, and communicative thinking skills. These results are consistent with active learning theory that emphasizes the importance of social interaction and reflection in learning (Warpala et al.,, 2023). In addition, factors that influence the effectiveness of the TPS Model in improving the thinking skills of 21st century students in Indonesia. One factor that plays an important role is the quality of TPS Model implementation in learning (Silva et al., 2022). Successful studies show that good implementation, including selection of relevant topics, clear guidance for students, and deep reflection, has a greater impact on improving students' thinking skills.

Furthermore, the discussion also includes the practical and theoretical implications of the findings of this meta-analysis. In practical terms, these findings can be the basis for the development of STEM learning programs in Indonesia that are more effective and relevant to the demands of 21st century thinking skills (Sumiati et al., 2013). Meanwhile, theoretically, these findings support the concept of active learning that emphasizes the importance of student involvement in the learning process to achieve broader learning goals (Setiadi et al., 2020). Meta-analysis shows the effectiveness of the TPS Model in improving the thinking skills of 21st century students in Indonesia, there are still some shortcomings in research that need attention. One is the lack of variation in study design and study sample size, which can affect the generalizability of findings. Therefore, future research may expand the scope of studies with more variation in research design and sample size to reinforce these findings.

This meta-analysis makes a significant contribution to the understanding of the effectiveness of the TPS Model in improving the thinking skills of 21st century students in Indonesia. These results provide a solid foundation for the development of more effective and relevant STEM learning programs with the demands of the times (Marhaeni et al., 2022). By strengthening the use of the TPS Model in STEM learning, it is expected to improve the quality of education and student readiness to face future challenges (Naim et al., 2020). This l model can be a guide for teachers and policy makers in designing effective STEM learning programs that are relevant to the needs of students in Indonesia. By strengthening the use of the TPS Model in STEM learning, it is expected to improve the quality of education and student readiness to face challenges in the era of globalization and technology (Oktarina et al., 2021; Putra et al., 2023; Sarnoto et al., 2023).

Conclusion

From the results of this meta-analysis, it can be concluded that the STEM-based Think Pair Share (TPS) model has a significant influence on the thinking skills of 21st century students in Indonesia with a high influence category with an average value of effect size (ES = 0.952). These findings provide important information for teachers in implementing this model to encourage students' 21st century thinking skills in Indonesia. The use of the TPS Model has proven effective in improving students' critical, creative, collaborative, and communicative thinking skills.

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