Does Ethnoscience Based Problem Based Learning Model Improve Student's Creative Thinking Skill in Chemistry Learning? Meta-analysis

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Abstract: Many studies on ethnoscience-based problem-based learning models have an impact on students' thinking skills. The purpose of this study is to determine the effectiveness of ethnoscience-based problem-based learning to improve students' creative thinking skills in chemistry learning. This study used a meta-analysis method. Data in the study was obtained through the databases ERIC, Researchgate, ScienceDirect and google scholar. The criteria for data eligibility are 1) publications must be indexed by SINTA, Scopus and Google Scholar, 2) research related to ethnoscience-based problem-based learning models, 3) research published in 2018-2023, and 4) research must have complete data to calculate the value of effect size. Statistical analysis with the help of JASP application version 0.8.5. The results of the effect size analysis of the study with the random effect model showed a significant influence of ethnoscience-based problem-based learning models to improve students' creative thinking skills ($z = 7,189$; $p < 0.001$; 95% CI [0.816; 1.345]). Furthermore, the influence of ethnoscience-based problem-based learning models on creative thinking skills in strong criteria ($rRE = 0.944$). This research provides important information for applying ethnoscience-based problem-based learning models in schools

Keywords: Chemistry learning; Creative thinking; Effect size; Ethnoscience; Problem based learning

Introduction

Creative thinking skills are important abilities that must be developed in students in this modern era (Hidayanti et al., 2018; Syafrial et al., 2022). Creative thinking enables students to generate new ideas, innovative solutions, and more effective problem solving (Rahman et al., 2023; Simkova et al., 2021; Ardiansah & Zulfiani, 2023). In addition, creative thinking skills help students to become more adaptive to changes and challenges that continue to evolve in everyday life (Kristanto, 2023). Creative thinking skills not only contribute to students' intellectual development, but also prepare students for a more successful future (Widiana & Jampel, 2016; Ernawati et al., 2022). Students who have the ability to think creatively tend to be more independent in finding

solutions to problems faced (Rosen & Stoe, 2021), as well as being able to see opportunities where others might not see them (Kartikasari et al., 2022). Therefore, it is important for teachers to provide opportunities for students to practice and develop creative thinking skills in chemistry learning.

But in fact, students' creative thinking skills in chemistry learning are still relatively low (Nasution et al., 2023; Suwendra et al., 2023; Liliawati et al., 2020). In teacher learning activities, there is less active student involvement so that the learning atmosphere seems less attractive (Herdiawan & Langitasari, 2019; Nuswowati & Taufiq, 2015). Next, the survey results *Programme Internationale for Student Assesment* (PISA) In 2018, Indonesian students' science literacy was relatively low, only obtaining a score of 396, ranked 71 out of 78 countries (Suharyat et al. 2023; Utomo et al., 2023;

Zulyusri et al., 2023; Suryono et al., 2023). The lace of students' creative thinking skills in chemistry learning is also because teachers only train students to memorize it does not encourage students to think creatively (Wilis et al., 2023; Syafitri et al., 2022). Furthermore, the learning model used does not encourage students' creative thinking skills in learning. Therefore, there is a need for an effective learning model to encourage students' creative thinking skills.

Problem-based learning is a learning model that is very effective in promoting deep understanding and development of students' creative solving and thinking skills (Amanda et al., 2022; Rahman et al., 2023; Fradila et al., 2022; Amin et al., 2023). Problem-based learning models are faced with real-world problems or scenarios that require them to identify, analyze, and find solutions to those problems (Utomo et al., 2023; Poonputta & Prasitnok, 2022). This problem-based learning combines aspects of active learning with relevant contexts and encourages students to become independent and critical learners (Sebatana & Dudu, 2022; Aristin et al., 2023; Treepob et al., 2023).

In addition, problem-based learning connects learning with real-life contexts (Duman, 2023), so that students can see the relevance of the subject matter to their daily lives. It helps students to better understand and internalize the concepts learned (Amaral & Fregni, 2021). Problem-based learning models can also increase student motivation because they have more control over their own learning and they feel involved in the learning process (Muzana et al., 2021; Jos & Costa, 2022). By using problem-based learning models, teachers can prepare students for real-world challenges and help them develop skills they will use throughout their lives (Kasuga et al., 2022).

Furthermore, ethnoscience-based problem-based learning models help students in identifying and learning their local wisdom. Ethnoscience learning can stimulate students' interest and participation in science by relating scientific concepts to their own cultural experiences and contexts (Herdiawan & Langitasari, 2019; Dewi et al., 2021). Ethnoscience-based learning makes learning more relevant and meaningful for students (Santosa et al., 2023), as well as helping them feel more involved in the learning process (Winarto et al., 2022). In addition, this approach can also help break stereotypes and biases in science by highlighting the contribution of different cultural groups in the development of science. Sudarmin et al. (2023) Ethnoscience-based learning can boost students' 21st-century skills.

In ethnoscience learning, students are invited to understand how the values, beliefs, and cultural practices of certain communities can influence scientific perceptions and practices. This helps students to understand that science is not a neutral entity, but always forms in complex social and cultural contexts (Sumarni et al., 2017). Through ethnoscience learning, students can develop a deeper understanding of the relationship between science and culture, as well as appreciate the diversity of knowledge and perspectives across world societies.

Previous research into problem-based learning models provides significant insight into students' creative thinking skills (Wartono et al., 2018; Khairunnisa et al., 2022; Kardoyo et al., 2019; Wenno et al., 2021). Furthermore, research by Rahayu et al. (2023) and Sania et al. (2022), Ethnoscience-based problem-based learning models can improve creative and critical thinking skills in learning. However, many studies on problem-based learning models have not found effeck size of all research in chemistry learning. Therefore, it is necessary to conduct a meta-analysis of ethnoscience-based problem-based learning in chemistry learning. Based on this, this study aims to determine the effectiveness of ethnoscience-based problem-based learning to improve students' creative thinking skills in chemistry learning.

Method

Research Design

This research is a type of quantitative research with a meta-analysis approach. Meta-analysis is a type of research that collects and analyzes primary research that can be analyzed quantitatively (Joseph, 2023; Razak, 2021; Öztop, 2023). This study is to determine the effect size of ethnoscience-based problem-based learning models to improve students' creative thinking skills in chemistry learning. Furthermore, this meta-analysis aims to summarize and draw an in-depth conclusion of a study by calculating the effect size statistically (Hidayah, 2023). According to Borenstein et al. (2009) The meta-analysis research procedure can be seen in Figure 1.
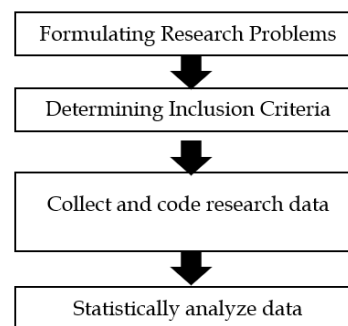

Figure 1. Meta-analysis procedure

Eligibility Criteria

The eligibility criteria are research obtained from the ERIC, Reseearcgate, ScienceDirect and Google Scholar databases, publications must be indexed by

SINTA and Scopus, research related to ethnoscience-based problem-based learning models, research published in 2018-2023, research must have r, t and f values, research comes from national and international journals that are open access, research at the junior high school education level, High School and Higher Education (PT) and research must be experimental methods of ethnoscience-based problem-based learning models in experimental classes and conventional in control classes. Furthermore, data coding is carried out by paying attention to research characteristics consisting of study codes, publication years, r, t and f values, education levels and journal indexes. The results of data coding can be seen in Table 1.

Table 1. Data Coding

Study Code	Year	r	t	F	Education level	Index
L1	2023	0.612			Senior High School	Sinta3
L2	2021	0.412			Senior High School	Feel 2
L3	2022			43.113	Junior High School	Scopus Q3
L4	2021	0.396			Junior High School	Scopus Q4
L5	2019	0.429			Senior High School	Scopus 2
L6	2020	0.314			Senior High School	Sinta 3
L7	2020	0.582			Senior High School	Sinta 4
L8	2022	0.465			Senior High School	Sinta 4
L9	2020	0.608			Senior High School	Sinta 2
L10	2021		7.124		Senior High School	Scopus Q2
L11	2018		3.160		Senior High School	Scopus Q2
L12	2020	0.591			Senior High School	Scopus Q4
L13	2023		10.182		Senior High School	Sinta 5
L14	2023			56.140	Senior High School	Sinta 3
L15	2020	0.577			Senior High School	Sinta 2
L16	2023		6.459		Senior High School	Sinta 2
L17	2021		4.210		College	Scopus Q1
L18	2022	0.442			College	Sinta 3
L19	2021			92.167	Junior High School	Sinta 5
L20	2022	0.329			Senior High School	Sinta 2
L21	2023			34.016	Senior High School	Scopus Q3

Research Procedure

Table 2. Effect Size Value Criteria

Value	Criteria Effect Size
< 0 +/-1	Weak
< 0.30	Modest
< 0.50	Moderate
< 0.80	Strong
≥ 0.80	Very Strong

According to Hidayah (2023) the procedure in this meta-analysis consists of 1) formulating and searching for articles according to the research topic, 2) selecting research according to inclusion criteria, 3) coding data, 4) converting F values into r and t values and converting t values to r, 5) testing data heterogeneity, 6) checking publication bias, 7) conducting normality tests, 8) Calculate the average value and standard error, 9) Calculate the summary effect size value and create data visualization with forest plot, 10) check publication bias with funnel plot, eggers test and trim and fill method. Statistical analysis of data with JASP 0.8.5 application. Furthermore, the effect size criteria are guided by the criteria (Cohen et al. 2020) can be seen Table 2.

Result and Discussion

Result

Based on the analysis of articles related to ethnoscience-based problem-based learning models on students' creative thinking skills in chemistry learning, 892 articles were obtained. From these data, researchers selected in accordance with the established inclusion criteria, 21 studies were reviewed. The first analysis tested the heterogeneity of the 21 articles analyzed. The results of the heterogeneity test can be seen in Tables 3 and 4.

Table 3. The Heterogeneity Test Result

	Q	df	P
Omnibus test of Model Coefficients	63.201	1	< 0.001
Test of Residual Heterogeneity	534.145	20	< 0.001

Note: *p value are approximate*

Table 4. The Residual Heterogeneity

	Estimates	Lower bound	Upper bound
t^2	0.513	0.328	8.056
T	0.426	0.556	0.914
I^2 (%)	95.410	92.014	97.212
H^2	22.910	17.972	25.663

Tables 3 and 4, describe the heterogeneity test results of 21 heterogeneously distributed articles. With a p value of < 0.001; Q = 63,201; τ^2 or τ and I^2 (%) of 95.410 is almost close to 100%. The next step is to calculate the summary effect size or mean effect size. The results of the summary effect size calculation can be seen in Table 5.

Table 5. The Result of the Summary Effect Size Test

	Estimated	Standard Error	with	p	Lower bound	Upper bound
Intercept	0.944	0.320	7.189	< 0.001	0.816	1.345

Table 5, explaining p values < 0.001, there is an influence of ethnoscience-based problem-based learning models on students' creative thinking skills in chemistry learning. This effect is a strong criterion based on Cohen's (2020) effect size with a standard error of 0.320 [0.816; 1.345]. Moreover. The summary effect sizes of the 21 articles are also depicted with the forest plot in Figure 2.
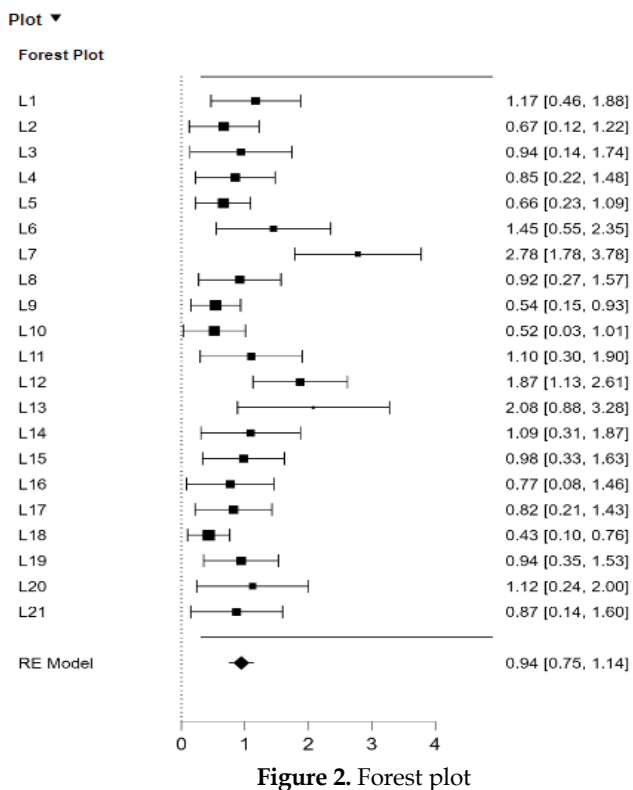

Figure 2. Forest plot

Figure 2, describing the 21 articles analyzed exerted a significant influence. The trend of the correlation value can be seen in the size of the point and its direction. The final step checks the publication bias of 21 funnel flot articles, Egger's Test and Rosenthal Fails Safe N. 21 articles checked for publication bias with funnel plot in Figure 3.
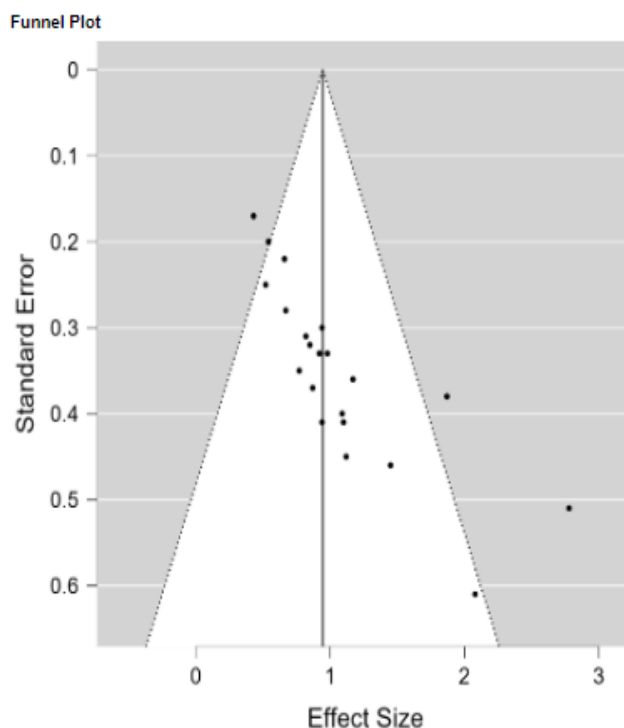

Figure 3. Funnel plot

Based on figure 3, the analysis of the szie effect with the funnel plot is difficult to know whether the curve is symmetrical or asymmetrical because there are points reviewed outside the curve. Therefore, it is necessary to carry out further tests, namely Egger's test. Egger's test results can be seen in Table 6.

Table 6. Egger's Test Results

	z	p
Six	1.230	0.173

Table 6, Egger's test result value p-value = 0.173 > 0.05. This means that the analysis of 21 effect sizes is distributed symmetrically on the funnel plot curve. In addition, from the analysis of the funnel plot, there is no publication bias. To increase the validity related to publication bias of the 21 articles analyzed, the Rosenthal Fail Safe N test was carried out.

Table 7. Rosenthal Fail Safe N Test Results

	Failsafe N	Target Significance	Observed Significance
Rosenthal	2140	0.050	< 0.001

Table 7, describes the Roenthal Fail Safe N test result of 2140. Next, the Rosental test result of the Safe N file was compared with a value of 5k + 10 = 5 (21) + 10 = 115. From Rosental Fail Safe N 2140 test value with sig value. 0.050 and p value < 0.001. Thus, the Rosenthal fail Safe N value > 5k + 10, so the research in the meta-analysis of 21 articles did not contain any publication bias.

Discussion

Based on 21 articles included in the meta-analysis are heterogeneously distributed. Therefore, these results explain that it may happen that there may be other variables that have a significant impact on the correlation of ethnoscience-based problem-based learning models on students' creative thinking skills in chemistry learning. Furthermore, if in the heterogeneity test a study shows insignificant results, it is stated that the study is homogeneous and must adjust the effect size model used for statistical analysis (Susanti et al., 2020; Juand et al., 2021). In meta-analysis research, heterogeneity tests are very important as prerequisite tests for subsequent statistical analyses (Chamdani et al., 2022; Diah et al., 2022; Suryono et al., 2023).

Furthermore, based on the results of the summary effect size test obtained a value (rRE = 0.944), it can be concluded that the ethnoscience-based problem-based learning model has a significant effect on students' creative thinking skills with strong influence categories. In the analysis of 21 effect sizes with forest plots that all studies have a significant influence. These results are in line with (United, 2017; Sihaloho et al., 2017) The application of the problem-based elarning model has a significant influence on students' creative and critical thinking skills in chemistry learning. These results are supported by research (Rodibyani, 2019; Ulger, 2018) said the ethnoscience-based problem-based learning model in developing students' creative thinking skills in learning chemistry. Ethnoscience-based problem-based learning model students can learn more actively and creatively according to their living environment (Wahyuni et al., 2023; Hikmawati et al., 2021; Sania et al., 2022).

The ethnoscience-based Problem Based Learning (PBL) model is a learning model that combines ethnographic and scientific aspects to improve students' creative thinking skills in chemistry learning (Letter et al., 2023). In this context, students are presented with challenges or problems relevant to their culture and environment, which they then investigate using a scientific approach. This ethnoscience-based problem-based learning model provides opportunities for students to understand the relationship between science and their own culture (Yuliana et al., 2021; Qori et al., 2020), as well as encouraging them to think creatively in finding innovative solutions. Through ethnoscience-based problem-based learning, students can develop creative thinking skills to solve complex problems that are closely related to their cultural reality (Pratama, 2023).

Furthermore, ethnoscience-based problem-based learning can also develop students' critical and analytical thinking skills (Dewi et al., 2021). In this model students must collect data, analyze information, and make conclusions based on their own research (Amanda et al., 2022; Santosa, 2021). This not only helps them understand science concepts more deeply, but also trains their ability to question, design experiments, and find evidence-based solutions Playing Chess (2020). Thus, ethnoscience-based problem-based learning not only produces students who have a better understanding of science and culture that can be applied in chemistry learning (Aristin et al., 2023), but also students who have strong creative, critical, and analytical thinking skills (Tanjung et al., 2022). In addition, thinking skills are very important for to provide new ideas or ideas in chemistry learning.

Conclusion

Based on this study, it can be concluded that there is a significant influence of ethnoscience-based problem-based learning models to improve students' creative thinking skills (z = 7,189; p < 0.001; 95% CI [0.816; 1.345]). Furthermore, the influence of ethnoscience-based problem-based learning models on creative thinking skills in high criteria (rRE = 0.944). This research provides important information for applying ethnoscience-based problem-based learning models in schools. The application of ethnoscience-based problem-based learning models is effective in developing students' creative thinking skills in chemistry learning. This model allows students to learn more actively and independently to implement local wisdom in the chemistry learning process.

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