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RESEARCH ARTICLE

EFFECTS OF ETHNO PJBL ON CREATIVE THINKING SKILLS AND LEARNING OUTCOMES IN SCIENCE LEARNING: A META-ANALYSIS

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Abstract

Creative thinking skills are important 21st century skills that can significantly improve learning outcomes. However, research results show that creative thinking skills and student learning outcomes are still low. The Project-Based Learning (PjBL) model and ethnoscience integration have been applied by many researchers as a solution, with varying results. Therefore, further analysis is needed to determine the effect of the PjBL model and ethnoscience integration in science learning on improving creative thinking skills and student learning outcomes. The method in this study is the meta-analysis method. Data were obtained from 25 articles that met the research criteria. The results showed that the PjBL model significantly improved students' creative thinking skills with a Very High category. In addition, the PjBL model also had a positive impact on student learning outcomes with an average effect size of the medium category. Analysis based on subjects showed that the PjBL model was most effective in physics learning, followed by biology, and the lowest in chemistry. Based on the level of education, the highest effect size is in high school (Very High), followed by elementary school (Moderate), college (Moderate), and junior high school (Moderate). The integration of ethnoscience in PjBL provides a relevant and interesting local cultural context, making learning more meaningful for students. This study provides guidance for educators in choosing and implementing effective learning models to improve creative thinking skills and student learning outcomes in science learning.

Introduction:-

The progress of a nation depends on education. Education is an effort to improve, strengthen, and idealize every human capacity and ability(Amroni et al., 2024). Education in the 21st century has undergone real changes, which have contributed to highlighting the necessity of this century for humanity to meet changing needs and expectations(Issa &Khataibeh, 2021). Following the pattern of 21st century education, students need resilience in facing difficulties and being able to turn these difficulties into challenges and opportunities in achieving goals(Pradnyani& Wibawa, 2023). Education is required to prepare a generation that is able to master skills

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according to the demands of the 21st century or what is called the 4C skills, namely critical thinking, communication, collaboration, and creativity(Herlita et al., 2023). Therefore, the education system needs to be adapted to ensure that students can develop these skills effectively and relevantly to the demands of the times.

Creative thinking skills are one of the crucial competencies that students must master. This statement is supported by the opinions ofErnawati et al (2023) and Hanifah et al (2020)who stated that creative thinking skills are important skills because they make humans more flexible, open, and adaptable to various situations and problems in life. The large role of creative thinking skills makes world researchers always explore things that are closely related to creative thinking skills(Daryanes& Putra, 2022).This makes the Indonesian Government facilitate the development of creative thinking skills in the national education system through various policies and programs(Handayani et al., 2021).With good creative thinking skills, a person will have a fast way of thinking, be superior in thinking and finding solutions to the problems they face(Wijayati et al., 2019).

Natural Sciences (IPA) is a field of study that systematically studies the natural environment. Creative thinking needs to be developed in science learning so that students can practice finding alternative solutions to problems in science learning(Fasha &Ruqoyyah, 2020).Creative thinking skills allow students to use new approaches to solving problems, innovations, and discoveries(Darmuki et al., 2022). By thinking creatively, students not only memorize scientific facts, but also understand concepts in depth and are able to apply them in different contexts. This increases student engagement and motivation in learning, which in turn contributes to the achievement of better learning outcomes.

Based on the results of the analysis and literature review studies, it was found that students' learning outcomes and creative thinking skills are problems that often occur in science learning. Various studies have shown that students' creative thinking skills in science learning are low(Wibowo & Ahmad, 2023; Muchsin& Mariati, 2020; Auliyah et al., 2021; Praptama et al., 2023; Sarah et al., 2023; Suciati et al., 2023). The reason is that in general creative thinking is not trained by teachers. Most students only pay attention and take notes on what the teacher says. Teachers still think that creative thinking is not important in the learning process. This can be seen from the frequency with which teachers give tests using routine questions rather than questions that contain problem solving(Selvira&Heffi, 2022).Various studies also show that student learning outcomes in science learning are still low(Amelia et al., 2021; Astra, 2023; Namira et al., 2024; Susilawati et al., 2022).

One effective way to develop creative thinking skills and student learning outcomes is to use a learning model that actively involves students in thinking(Eka et al., 2024). Conventional teaching methods are considered less able to develop students' thinking skills effectively(Alawi & Soh, 2019). If learning does not apply the right learning model, then learning outcomes will be less than optimal(Rahardjanto et al., 2019). It is important for educators to choose and apply learning models that can stimulate students' active involvement in the teaching and learning process. Thus, students not only understand the material more deeply but are also able to apply that knowledge in various contexts.

The solution that can be applied is to use a project-based learning model or Project-Based Learning (PjBL). Project-based learning can improve students' skills needed to meet the global community, especially for communication, cooperation, creativity, and especially critical thinking(Issa &Khataibeh, 2021). The results of severalrelated research shows that the PjBL learning model is able to improve students' skills because it can encourage students to be active in learning, able to solve problems, be more creative, have empathy, and be able to work together in groups(Darmuki et al., 2022; Firda& Sunarti, 2022; Fuldiaratman&Ekaputra, 2023; Putri et al., 2023).PjBL provides opportunities for students to be more active in learning, because they are encouraged to ask questions, investigate, explain, and interact with problems. Furthermore, students are asked to create and present products from the results of the investigation(Mursid et al., 2022).

Science and ethnoscience are a unity that when combined will make it easier for us to learn them, especially through the PjBL model. The PjBL model provides opportunities for students to apply science knowledge in the context of local culture, making it more relevant and interesting. Cultural diversity in Indonesia in relation to science learning is an interesting value for the learning process(Fanani et al., 2023). In a society that has a diverse culture, so that local wisdom about nature does not become extinct, noble values need to be instilled and socialized to students through the learning process(Novitasari et al., 2023).Thus, science learning becomes more contextual and meaningful, helping students develop their thinking skills.

Many previous researchers have applied the PjBL learning model and integrated ethnoscience into learning. The results of these studies show different variations. Based on these diverse research results, further analysis is needed to draw conclusions about the influence of the PjBL learning model and ethnoscience integration in science learning. This reason is the basis for conducting a meta-analysis study, where the formulation of the research problem is how the use of the PjBL learning model and ethnoscience integration affects students' learning outcomes and creative thinking skills in terms of subjects and levels of education.

The purpose of this study is to see how much influence the use of the PjBL learning model has on learning outcomes and creative thinking skills, viewed from the subject and level of education. This study is expected to provide clearer guidance for educators in choosing and implementing the most effective learning model. In addition, this study also aims to identify factors that can influence the effectiveness of integrated PjBL and ethnoscience learning in various contexts. This study is expected to provide clearer guidance for educators in choosing and implementing the most effective learning model to improve creative thinking skills and student learning outcomes in the context of science learning integrated with local wisdom.

Methods:-

This study uses a meta-analysis method. The meta-analysis method is a study conducted by summarizing, reviewing and analyzing data from several studies with similar problems(sanuaka et al., 2022). With this method, research can provide a more comprehensive picture of the relationship between these variables. The data used is secondary data, where secondary data is data obtained from the results of previous studies without having to conduct research in the field. There are two dependent variables used in this study, namely learning outcomes and creative thinking skills. While the moderator variable is based on subjects and levels of education.

Data collection in the study was conducted by searching a number of articles via Google Scholar, with the keywords "PjBL learning model", "Ethnoscience" "Learning Outcomes" and "creative thinking skills". The results of the article search obtained 25 articles that met the established criteria. Inclusion criteria for selecting articles include: (1) articles in Indonesian or English, (2) published in the 2014-2024 period, (3) using experimental or quasi-experimental designs, (4) reporting statistical data needed for calculating effect size. The selected articles must also be primary research that has gone through a peer-review process. In addition, the article must focus on the application of the ethnoscience-based PjBL learning model and its impact on students' learning outcomes or creative thinking skills. Finally, the articles used in this meta-analysis must present fairly complete information regarding the research methodology, including sample size and data collection procedures.

The steps taken in this study are (1) selecting the topic to be studied, (2) collecting article data that matches the criteria of the selected topic, (3) finding the effect size value of each article, (4) determining the effect size category of each article, (5) grouping articles according to the moderator variables that have been determined, (6) drawing conclusions from the results of data processing. The data collection technique used is through coding, with data analysis techniques using the effect size technique. Effect size analysis was chosen because of its ability to measure the strength of the relationship between variables quantitatively. In addition, categorizing effect sizes helps in interpreting research results more easily and systematically. After calculating the effect size using the appropriate formula, the effect size is then categorized with the criteria listed in Table 1.

In detail, Meta-analysis begins with a systematic search and selection of articles relevant to the research topic, using predetermined inclusion and exclusion criteria. After the articles are selected, researchers extract important data from each study, including sample size, descriptive statistics, and relevant statistical test results. Researchers then calculate the effect size for each study, which is a standardized measure for comparing results between studies with different measurement scales. Furthermore, sensitivity analysis is performed to assess the impact of methodological decisions on the results of the meta-analysis and identify studies that may have a disproportionate influence. Finally, the results from all studies are statistically combined to produce an estimate of the overall effect, which is then interpreted and presented in the form of a forest plot or funnel plot for visualization of the meta-analysis results.

Table1:-Category Effect Size.

NO	ES	Category
1	$ES \leq 0.15$	Very Low
2	$0.15 < ES \leq 0.40$	Low

3	$0.40 < ES \leq 0.75$	Medium
4	$0.75 < ES \leq 1.10$	High
5	$ES > 1.10$	Very High

(Becker, 2011)

Result:-

As research data, 25 articles were selected based on the criteria set by the researcher. The mapping of the articles is summarized in Table 2 to identify the identity of the selected articles. Article analysis refers to the research objectives that focus on the use of the PjBL model and the integration of ethnoscience in science learning. Article selection is carried out through a systematic review process to ensure the relevance and quality of the research included in the meta-analysis. Each article is evaluated based on the research design, sample size, and suitability to the topic of PjBL and ethnoscience integration in science learning. The results of the analysis of these 25 articles are expected to provide a comprehensive picture of the effectiveness of the PjBL model integrated with ethnoscience in improving student learning outcomes in science subjects. The characteristics of each article related to the use of the PjBL learning model can be seen in Table 2.

Tabel 2:-Characteristics of Articles Related to the PjBL Learning Model.

Article Code	Title	Author	Subject	ES	Average ES	Category
K1	Improving Students' Creative Thinking Skills With Project Based Learning	(Nasution et al., 2021)	Biology	1.321	0.90725	High
K2	The Effect of Project Based Learning Model on Creative Thinking Ability	(Lavli & Efendi, 2024)	Biology	0.691		
K3	Implementation of PjBL-STEM to Improve Students' Creative Thinking Skills On Static Fluid Topic	(Saefullah et al., 2021)	Physics	3.051		
K4	The Influence of Project Based Learning Model on Creative Thinking Skills in Applied Physics Learning	(Umamah & Andi, 2019)	Physics	0.955		
K5	The Impact of Project-Based Learning (PjBL) Model on Secondary Students' Creative Thinking Skills	(Biazus&Mahtari, 2022)	Physics	4.403		
K6	The Influence of Project-based Learning Integrated STEAM on the Creative Thinking Skills	(Pramashela et al., 2023)	Biology	0.514		
K7	The Influence of Project-Based Learning Model on Students' Learning Outcomes in Reaction Rate Material	(Hanisa et al., 2023)	Chemistry	0.014		
K8	Project-based Model in Physics Learning: The Influence on Computational Thinking Skills on the Eleventh-Grade Natural Science Major Students	(Subekti et al., 2024)	Physics	0.269		
K9	The Effect of the Project-Based Learning (PjBL) Model based on an Integrated STEM Approach with Entrepreneurial Character on Students' Creative Thinking Ability	(Ananda et al., 2024)	Physics	0.711		
P1	The Effect Of Project Based Learning Model On Student's Learning Results In Cognitive Domain and Creative Thinking Ability On Material Of Temperature and Calorie	(Rahmi, 2023)	Physics	0.134		
P2	The Effect of Project-Based Learning through YouTube Presentations on	(Rozal et al., 2021)	Physics	0.131		

	English Learning Outcomes in Physics					
P3	Influence Of Physics Problem-Solving AbilityThrough The Project Based Learning TowardsVocational High School Students' LearningOutcomes	(Retno et al., 2019)	Physics	1.563		
P4	Improving Students' Scientific Literacy and Cognitive Learning Outcomes through Ethnoscience-Based PjBL Model	(Rusmansyah et al., 2023)	Chemistry	0.698		
P5	The Influence of Project Based Learning Model on Cognitive Learning Outcomes of Physics of High School Students	(Siahaan et al., 2023)	Physics	0.464		
P6	Effectiveness of Project Based Learning (PjBL) to Improve Natural Science Learning Outcomes Of Grade IV Students	(Turyati et al., 2020)	Biology	0.693		
P7	The Influence of Project-Based Learning of Chemical Products on High School Students' Understanding of Concepts and Science Process Skills	(Anggriani et al., 2019)	Chemistry	0.761		
P8	Project Based Learning Model on Elementary School Students' Science Process Skills and Creative Thinking Skills	(Apriansyah et al., 2024)	Physics	0.785		

Based on Table 2, it can be seen the mapping of articles and the acquisition of effect sizes for each article regarding the influence of the PjBL model on learning outcomes and students' creative thinking skills in science learning. The table explains the article code, author identity, subject, journal, effect size of each article and the categories obtained from the articles that have been analyzed. The article on the influence of the PjBL learning model on science learning outcomes is given the code "P" and the article on the influence of the PjBL learning model on creative thinking skills is given the code "K". The average effect size of the various articles obtained is 0.90725, with the category "High". This shows that overall, the PjBL learning model has a significant and positive impact on science learning.

Table3:- The Influence of the PjBL Model Based on the Dependent Variable.

Article Code	Dependent variable	ES	Average ES	Category
K1	Creative Thinking Skills	1.321	1.457	Very High
K2		0.691		
K3		3.051		
K4		0.955		
K5		4.403		
K6		0.514		
K7		0.014		
K8		0.269		
K9		0.711		
P1	Learning outcomes	0.134	0,71	Medium
P2		0.131		
P3		1.563		
P4		0.698		
P5		0.464		
P6		0.693		
P7		0.761		
P8		0.785		

Based on Table 3, it can be seen that the PjBL model has varying effects on the two dependent variables analyzed, namely Creative Thinking Skills and Learning Outcomes. For Creative Thinking Skills, the average effect size (ES) is 1.457 which is included in the "Very High" category. This high effect size value indicates that the PjBL model significantly improves students' creative thinking skills. This may be due to the PjBL approach that allows students to explore and develop their creative ideas through the projects they work on. On the other hand, for the Learning Outcomes variable, the average effect size obtained is 0.71 which is included in the "Moderate" category. However, this value still shows that PjBL has a positive impact on student learning outcomes, although not as strong as the impact on creative thinking skills. This could be because learning outcomes are influenced by various factors other than the learning methods used, such as students' academic background, motivation, and support from the learning environment.

Tabel 4:- The Influence of the PjBL Learning Model Based on Subjects.

Article Code	Subject	ES	Average ES	Category
K1	Biology	1,321	0.80475	High
K2		0.691		
K6		0.514		
P6		0.693		
K3	Physics	3.051	1.4265	High
K4		0.955		
K5		4.403		
P5		0.464		
K8		0.269		
K9		0.711		
P1		0.134		
P2		0.131		
P3		1.563		
P8		0.785		
P4	Chemistry	0.698	0.3875	Low
K7		0.014		
P7		0.761		

Based on Table 4, the analysis of the influence of the Project Based Learning (PBL) model on various subjects shows variations in its effectiveness. For Biology, the average effect size (ES) is 0.80475 which is included in the "High" category. This indicates that the application of PBL in Biology learning has a significant and positive impact. PBL in Biology may encourage students to be more active in the learning process, develop analytical skills, and improve conceptual understanding through projects relevant to Biology topics. In Physics, the average effect size is 1.4265 which is also included in the "High" category. This indicates that the PBL model is very effective in improving Physics learning. The greater effect on Physics compared to Biology may be due to the experimental and practical nature of Physics, where students can directly apply theories through practical projects. Thus, PBL helps students understand abstract physics concepts better through direct experience and experiments.

Meanwhile, for Chemistry, the average effect size only reached 0.3875, which is included in the "Low" category. The lower effectiveness of PjBL in Chemistry may be due to various factors, such as the complexity of chemical materials that require in-depth theoretical understanding before practical application. Projects in Chemistry may require closer supervision and more resources, which can be a challenge in implementing PjBL. Therefore, although PjBL can be applied in Chemistry learning, additional adjustments and support are needed to make it more effective. Overall, this table shows that the Project-Based Learning (PjBL) model has varying impacts depending on the subjects taught. More experimental and practical subjects such as Physics seem to benefit more from this approach compared to more theoretical subjects such as Chemistry. This emphasizes the importance of adjusting PjBL strategies to the characteristics of each subject to maximize its effectiveness in improving student learning outcomes.

Tabel 5:-The Influence of the PjBL Learning Model Based on Education Level.

Article Code	Educational level	ES	Average ES	Category
P6	SD	0.693	0.746	Medium
P8		0.785		

P7		0.761		
K2	SMP	0.691	0.412	Medium
P1		0.134		
K1	SMA	1.321	1.415	Very High
K3		3.051		
K5		4.403		
K6		0.514		
K7		0.014		
K8		0.269		
K9		0.711		
P3		1.563		
P4		0.698		
P5		0.464		
K4	College	0.955	0.543	Medium
P2		0.131		

Table 5 presents data on the effect of the PjBL learning model based on education level: SD (Elementary School), SMP (Junior High School), SMA (Senior High School), and University. Each education level has several articles analyzed with their respective ES values. The average ES value and effectiveness category for each education level are also calculated and listed, providing an overview of how effective PjBL is at each education level. At the elementary level, there were three articles analyzed with ES values of 0.693, 0.785, and 0.761, respectively. The average ES for the elementary level was 0.746, which is included in the "Moderate" category. This shows that the PjBL learning model is quite effective at the elementary level, with ES showing a moderate effect. The implementation of PjBL at the elementary level is likely to increase student engagement and motivation, which is very important for effective learning at an early age.

For the junior high school level, there were two articles analyzed with ES values of 0.691 and 0.134. The mean ES for junior high school level was 0.412, which also falls into the “Moderate” category. Although this mean is lower than that for elementary school level, it still shows that PjBL has a positive, albeit moderate, effect at the junior high school level. Possible challenges at this level include the adaptation of students who are transitioning from primary to secondary education, as well as the readiness of teachers to implement the PjBL method. At the senior high school level, there were nine articles with ES values ranging from 0.014 to 4.403. The mean ES for senior high school level was 1.415, which falls into the “Very High” category. This suggests that PjBL is very effective at the senior high school level. The large variation in ES values may reflect differences in the implementation of PjBL across school contexts. However, overall, this high effectiveness could be due to the ability of senior high school students to work more independently and handle more complex projects.

At the tertiary level, there were two articles analyzed with ES values of 0.955 and 0.131, respectively. The average ES for this level was 0.543, which is in the "Moderate" category. Although its effectiveness is not as strong as at the high school level, PjBL still shows a moderate positive effect in tertiary education. This effectiveness may be due to students who already have better analytical skills and project management skills, although the adaptation of PjBL in an academic context may require a more structured approach and be in accordance with the needs of higher education. Overall, this table shows that the PjBL learning model has varying levels of effectiveness depending on the level of education. High school shows the highest effectiveness, followed by elementary school, tertiary education, and junior high school. This difference indicates the importance of adjusting the implementation of PjBL according to the needs and characteristics of students at each level of education to achieve optimal results.

Tabel 6:- Characteristics of Ethnoscience Related Articles.

Article Code	Title	Author	Variabel	ES	Average ES	Category
EH1	The Effectiveness of Ethnoscience-Based PBL Model on Learning Outcomes	(Nuralita et al., 2020)	Learning Outcomes	0.745	0.981	High
EH2	The Effect of Ethnoscience Learning on the Development of Students' Cognitive and Affective Aspects in	(Hikmawati et al., 2024)		1.285		

	Junior High School					
EH3	The Effects of Ethnoscience Integrated STEM E-Book Application onStudent's Science Generic Skills inChemical Equilibrium Topic	(Azalia et al., 2020)		1.209		
EH4	The Effect of Project Based Learning with Ethnoscience Approach on Science Conceptual Understanding	(Ardianti& Raida, 2022)		0.685		
EK1	Ethno-STEM Integrated Project-Based Learning to Improve Students' Creative Thinking Skills	(Babalola &Keku, 2024)	Creative Thinking Skills	0.589	0.967	High
EK2	Development of Learning Modules Using an Ethnoscience-Based Project-Based Learning Model to Enhance Students' Collaboration, Critical Reasoning, and Creativity	(Fitriana et al., 2024)		0.343		
EK3	The Influence of the Integrated Project Based Learning Model of Ethnoscience on Students' Creative Thinking Skills in Science Subjects for Grade VII at SMPN 2 Pujut	(Wanggi et al., 2023)		0.795		
EK 4	The Influence of Project Based Learning (Pjbl) Learning Model on Creative Thinking Skills in Thematic Learning of Science Subject Content for Grade V Elementary School Students	(Febriyanti et al., 2021)		2.143		

Four articles in Table 6 examine the influence of ethnoscience on learning outcomes. These articles have varying Effect Size (ES) values: EH1 with ES 0.745, EH2 with ES 1.285, EH3 with ES 1.209, and EH4 with ES 0.685. The average ES for the learning outcome variable is 0.981, which is in the "High" category. This indicates that the ethnoscience approach significantly improves student learning outcomes. The use of ethnoscience in education appears to be effective in linking subject matter to students' cultural contexts, thereby increasing their understanding and engagement in the learning process.

The other four articles focused on creative thinking skills. These articles also showed variations in ES values: EK1 with ES 0.589, EK2 with ES 0.343, EK3 with ES 0.795, and EK4 with ES 2.143. The average ES for the creative thinking skills variable was 0.967, which was also in the "High" category. This suggests that the ethnoscience approach has a strong impact on improving students' creative thinking skills. This may be because ethnoscience encourages students to think more openly and innovatively through exploring scientific concepts related to their own culture.

Overall, Table 6 shows that the ethnoscience approach in education has a high effect on improving students' learning outcomes and creative thinking skills, with high ES averages for both variables. The implementation of ethnoscience seems to be successful in making learning more relevant and interesting for students, which in turn improves their learning outcomes and creative thinking skills. These findings support the wider application of the ethnoscience approach in the educational curriculum, to utilize its full potential in improving the quality of education.

Discussion:-

This study examines the effect of using the Project-Based Learning (PjBL) learning model and ethnoscience integration on students' learning outcomes and creative thinking skills in science learning. The PjBL model is known to be able to increase student involvement in the teaching and learning process by facilitating them to ask questions, investigate, explain, and interact with the problems they face. The application of this project-based learning model in science learning provides a new way for students to gain knowledge that is different from learning that only focuses on the contents of books and teacher explanations(Apriansyah et al., 2024). In line with this, PjBL is a model

recommended in the independent curriculum (Indriyani et al., 2023), which is designed to prepare students to face the challenges of the 21st century. This century, which is referred to as the century of openness or the century of globalization, requires every individual to have comprehensive abilities, namely abilities that are balanced between knowledge, skills, attitudes, and values in their lives(Asrizal et al., 2022). Thus, the use of the PjBL model and the integration of ethnoscience in science learning is expected to help students develop the abilities needed to face challenges in this era of globalization.

Previous research results revealed that the PjBL learning model has an effect on students' cognitive learning outcomes(Aska et al., 2022; Mursalim et al., 2023; Suryani et al., 2024). The knowledge gained through this cognitive learning process helps students develop thinking and problem-solving skills. The better the cognitive learning outcomes, the broader and deeper the knowledge possessed by students. The results of the study also showed that digital teaching materials integrated with the PjBL and ethnoscience learning models have a significant effect on students' creative thinking skills. The PjBL learning model has been shown to have a significant effect on students' creative thinking skills.

Recent studies have shown that PjBL encourages students to be actively involved in the learning process, allowing them to develop creative thinking skills more effectively than traditional learning methods(Wijayati et al., 2019). The PjBL model allows students to work on real projects that require practical application of concepts and skills. This helps students develop creative thinking skills, because they have to find solutions to problems faced in the project. Research conducted by various researchers shows that the PjBL learning model has a significant positive effect on students' creative thinking skills(Zhang et al., 2024).By using the Pjbl model, difficult problems and complex activities are prioritized to encourage students to be creative, manage work, and produce original products(Eliaumra et al., 2024; Heldisari, 2023).

The rapid development of science and technology has created contradictions in society regarding cultural values and science itself. Many cultural values of society are considered ancient and irrelevant to be applied in the modern world. On the other hand, ethnoscience is a study of communal knowledge and is a cultural heritage that needs to be researched and protected(Ariska et al., 2022). Integration of learning materials with local wisdom can serve to provide scientific knowledge to students(Verawati et al., 2022). The results of previous studies have shown that ethnoscience-based science learning can improve students' creative and critical thinking skills, thereby increasing students' cognitive learning achievements(Wirama et al., 2023)Through ethnoscience-based learning, students can make direct observations so that they can identify scientific questions and explain phenomena scientifically(Kumalasari et al., 2021).Combining materials with culture can increase knowledge about local wisdom(Sijabat et al., 2024).

Conclusion:-

Based on the results of the meta-analysis, it can be concluded that first, the PjBL model significantly improves students' creative thinking skills. The high average effect size indicates that this model is very effective in encouraging students to think creatively through the projects they work on. The PjBL model has a positive impact on student learning outcomes, although not as strong as its impact on creative thinking skills. This shows that the PjBL model can help students understand concepts more deeply and applicatively. Second, the effectiveness of the PjBL model varies by subject. This model is most effective in Physics learning, followed by Biology, and the lowest in Chemistry. This difference is likely due to the characteristics of each subject and the complexity of the material taught. Third, based on the level of education, the highest effect size is in high school (Very High), followed by elementary school (Medium), college (Medium), and junior high school (Medium), which indicates the need to adjust the implementation of PjBL according to the needs and characteristics of students at each level of education. The ethnoscience approach in education shows significant effectiveness in improving students' learning outcomes and creative thinking skills, with a high average Effect Size on both variables, indicating better relevance and engagement in learning through cultural context.

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