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# STEM-based PjBL Learning Model with Manggaraians Indigenous Science Content to Improve Science Literacy: is it Effective?

Yuliana Wahyu[1*], Ambros Leonangung Edu[1], Arnoldus Helmon[1]

[1] Elementary School Teacher Education, Catholic University of Saint Paul, Ruteng, Indonesia.

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Corresponding Author:
Yuliana Wahyu
yulianawahyu76@gmail.com

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**Abstract:** This study aims to develop the effectiveness of the STEM-based PjBL (Project-Based Learning) model which incorporates Manggarai indigenous knowledge content to increase scientific literacy in elementary school students. The target population of this study were elementary school students in Langke Rembong District, Manggarai Regency. The research follows the Borg & Gall model for research and development. Data collection included administering scientific literacy tests to assess students' knowledge, attitudes, and competencies related to original science content. To assess the effectiveness of the STEM-based PjBL model, an ANOVA test was used to compare the literacy level of science students who took innovative models with students who took conventional learning. The results of hypothesis testing show that the STEM-based PjBL model has proven effective in increasing scientific literacy in various dimensions, including students' content knowledge, contextual understanding, attitudes towards science, and competency in applying scientific concepts. Notably, after implementing the product trials, significant differences in scientific literacy were observed between students who were exposed to STEM-based PjBL-based models and those who followed conventional teaching methods. These findings underscore the potential of the STEM-based PjBL approach, combined with native Manggarai science content, as an effective means of increasing science literacy among elementary school students.

**Keywords:** Learning Model; Manggaraians Indigenous; Science Content; Science Literacy; STEM Based PjBL

## Introduction

Preparing a generation that has good scientific literacy skills is an urgent need that needs to be given serious attention today. In the context of national life, the literacy level of citizens is one indicator of the success and prosperity of a nation's society (Nofiana, 2017) ; Ogunkola, 2013). The level of science literacy of citizens correlates directly with their productivity which is characterized by the number of innovations produced (İleritürk, 2018).

Science literacy is the ability to understand the content and process of science and develop scientific attitudes to be applied in solving everyday problems and making accountable decisions (Aswirna, 2020), explain science issues rationally and data-based, evaluate and design science investigations and processes, and interpret data and evidence scientifically (OECD, 2017). Scientific literacy has a number of aspects such as skills, values, attitudes, understanding, competence, and knowledge of science needed for individuals to investigate, explain science phenomena, interpret data and make conclusions (Klucevsek, 2017). Aspects of science literacy, by PISA 2015 (OECD, 2017), are grouped into 4 interrelated aspects, namely contexts, knowledge, compitencies, and attitudes.

In relation to learning, science literacy is the main purpose of science education about scientific concepts and principles, scientific laws and theories, and inquiry skills. A large part of science literacy will be the

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experience and the key to success in Science Education. Science literacy is also understood as a way to engage and motivate learners effectively in science learning and working scientifically. Science literacy is inseparable from the nature of learning science itself which is related to the process, product, and scientific attitude of students.

On the other hand, the ability of science literacy and HOTS Indonesian students are still weak (Afriana et al., 2016). The fundamental thing is also seen from the results of the PISA survey, namely, in 2009 ranked 60 out of 65 countries, 2012 ranked 64 out of 65 countries, 2015 ranked 63 out of 72 countries, and 2018 62 out of 72 countries. The value of 2018 has decreased compared to the results of PISA 2015 (OECD, 2017). In general, the literacy ability of students from the aspects of content, process, and science context, is still weak where the achievement is only 45% for the content aspect, 52% for the process aspect, and 48% for the science context aspect (Widiyati et al., 2020). The low level of science literacy and scientific attitude is also experienced by most elementary schools in the Manggarai regency area. The results of Primary School Examinations for science/science subjects in Manggarai regency in recent years have not been satisfactory. The average US science subjects for the 2018/2019 school year were 69.12, the 2019/2020 school year was 72.62 and the 2020/2021 school year was 74.7. These data show that science learning achievement in elementary schools has not reached optimal results (us SD report Manggarai regency, 2020).

These problems occur due to various factors such as the selection of learning materials that are not appropriate, misconceptions, and learning that is not contextual (Fuadi et al., 2020). In addition, the selection of models and learning devices that do not give students the opportunity to apply the science process is also an important factor that causes students ' science literacy skills to be low (Naturasari et al., 2016).

Good literacy is inseparable from the application of the learning model applied in the learning process of science. One of the learning models that can improve science literacy is the STEM-based PjBL model. Students' science literacy skills can be improved by applying appropriate learning models such as the PjBL model because it is applied in interdisciplinary learning that involves different academic abilities and forms conceptual understanding through assimilation of different subject topics (Capraro et al., 2013). PjBL Model will be more effective if integrated with STEM approach (Syukri et al., 2021), STEM makes learning more meaningful through the systematic integration of knowledge, concepts, and skills (Tseng et al., 2013).

STEM is an interdisciplinary learning to learn academic concepts in a rigorous way that combines lessons on the real world in applying science, technology, engineering and mathematics in the context of relationships with schools, communities, work, and activities in the era of globalization (Brown et al., 2011; Sahin, 2015). Brown et al., 2011, defines STEM as a school-level metadiscipline in which science, technology, engineering and mathematics teachers teach in an integrated manner from each discipline material into a unified whole. Dugger defines STEM as a learning approach needed for the development of a 21st century society that relies heavily on technology. NRCdefines STEM into four parts namely; 1) science is the body of knowledge that has accumulated over time from a scientific examination that produces new knowledge. 2) technology is the whole system of people and organizations, knowledge, processes and devices that then create things and operate them. 3) Engineering is the body of knowledge about the design and creation of man-made objects and a process for solving problems. 4) mathematics is the study of patterns and relationships between the sum of numbers, and space.

Furthermore, Bybee (2013)stated that, STEM is the process of solving problems by using scientific concepts and mathematical concepts in creating or designing to produce a product called technology. The link between science, engineering, technology, and mathematics is that science provides a way or tool to estimate the behavior of objects or materials through scientific concepts that are used by engineering in solving practical problems that produce products called technology. Technology provides eyes and ears for science. This shows the close relationship in the four areas to be combined into a learning approach in learning science. STEM is a learning approach that accumulates knowledge of Science, Technology, Engineering, and mathematics, to solve problems in public life.

The STEM-based PjBL Model can develop the pedagogical competence of prospective teachers, can reach the affective and cognitive domains, in Science Learning, increase student interest, learning takes place happily without any pressure, and students can solve problems in learning science (Christensen et al., 2015; Manduca et al., 2017; Rose et al., 2017; Shahali et al., 2017;Williams et al., 2015). The application of STEM-based PjBL Model can encourage students to design, develop and utilize technology, hone cognitive, manipulative and affective skills, and apply knowledge (Permanasari, 2016). STEM can be supported by innovative learning models in the learning process to improve students' science literacy.

In addition to the selection of learning models, the selection of contextual science content is also important in improving students' scientific literacy skills (Rahayu, 2017). Contextual and meaningful science content and topics will encourage students to be actively involved in the learning process. Local indigenous science is one form of contextual science content that has the potential to improve students' science literacy (Hastuti et al., 2020) and make learning more meaningful (Handayani et al., 2018). However, local science has been largely ignored and not recognized in the science curriculum for many years. Similarly, Manggaraians indigenous science began to be forgotten by the people of Manggarai, Flores, NTT. Students in Manggarai are not familiar with Manggaraians indigenous sciencethere is no integration of Manggarai culture-based science content in schools.

So far, many studies have been conducted to uncover local knowledge based on Manggarai culture. However, no research has been conducted in order to revitalize Manggaraians indigenous science that is integrated into the classroom learning curriculum. In fact, this is important, in addition to making science learning more meaningful, it is also in order to revitalize Manggaraians indigenous science.

The use of this content is increasingly urgent, especially because Manggaraians indigenous science is already less known by students. The use of such content in science learning in the classroom will help revitalize Manggaraians indigenous science based on values and local wisdom of Manggarai culture. Thus, the STEM-based learning model of PjBL with manggaraians indigenous science content as a learning model in project-based science can train students to think critically and improve scientific literacy skills as a provision in having 21st century skills, making learning more meaningful and can revitalize Manggaraians indigenous science based on values and local wisdom of Manggarai culture. In this study, the developed PjBL model is a STEM-based PjBL syntax that contains Manggaraians indigenous science content. This learning model is offered as a solution to equip students with STEM literacy and science literacy.

This research introduces a novel approach to addressing the urgent need for improving science literacy skills among elementary school students. The key novelties of the research can be summarized as follows:

STEM-based PjBL Model: The research presents a unique integration of the Project-Based Learning (PjBL) model with a STEM (Science, Technology, Engineering, and Mathematics) approach. This innovative learning model aims to enhance science literacy by combining interdisciplinary learning with real-world applications, fostering students' problem-solving abilities and conceptual understanding.

Incorporation of Indigenous Science Content: In this study, Manggaraians indigenous science content is introduced into the STEM-based PjBL Model. By integrating local contextual science content, the research aims to make science learning more meaningful and relevant to the students, preserving and revitalizing the cultural knowledge of the Manggarai community.

Focus on Science Literacy Improvement: The research emphasizes science literacy as the primary goal of science education. By promoting students' abilities to understand scientific concepts, principles, and inquiry skills, the study seeks to equip them with essential 21st-century skills required for meaningful participation in society.

Addressing Low Science Literacy Levels: This research addresses the persistently low science literacy levels among Indonesian students, particularly those from the Manggarai region. By investigating the effectiveness of the STEM-based PjBL Model, the study aims to provide insights into improving science education outcomes.

Potential for Educational Reform: The findings from this research have the potential to contribute to educational reform and curriculum development. The integration of STEM-based PjBL with indigenous science content offers a promising avenue for enhancing science education practices and promoting local cultural knowledge in the classroom.

This research offers a novel approach to improving science literacy among elementary school students by introducing a STEM-based PjBL Model with Manggaraians indigenous science content. The study's findings have broader implications for science education and cultural preservation, aiming to empower students with critical thinking skills, 21st-century competencies, and a deeper appreciation of their local cultural heritage.

The purpose of this study was to determine: 1) the effectivity of the application of STEM-based PjBL model that had been developed in measuring the science literacy of elementary school students. 2) The excellences of experimental classes that learned with STEM-based PjBL models than control classes with conventional learning. 3) the difference in literacy between students who followed the STEM-based PjBL model and students who followed conventional learning in learning science.

The quality of science learning can be improved through the ability of literacy and good science literacy of learners. Science literacy is the main goal of science education about scientific concepts and principles, scientific laws and theories, and inquiry skills. A large part of science literacy will be the experience and the key to success in Science Education. Science literacy is regarded as a way to engage and motivate learners effectively in science learning and working scientifically (Saribas, 2015). According to Paul de Hurd, science literacy is a skill to understand science and its application to the needs of society. Science literacy is the understanding, use, and reflection of written text to achieve one's goals in developing knowledge and potential in participating in society. Science literacy is inseparable from the nature of learning science itself which is related to the process, product, and scientific attitude of students. Nasution stated that, literacy is a person's mastery of certain knowledge or skills in one subject, which is usually obtained from test scores given by teachers. Literacy is the ability or skills possessed by students. Good literacy is inseparable from the application of the learning model applied in the learning process of science. One of the learning models that can improve science literacy is the STEM-based PjBL model.

STEM is regarded as interdisciplinary learning to learn academic concepts in a rigorous manner that combines lessons on the real world in applying science, technology, engineering and mathematics in the context of relationships with schools, communities, work, and activities in the era of globalization (Brown et al., 2011; Sahin, 2015). Brown et al., (2011), defines STEM as a school-level metadiscipline in which science, technology, engineering and mathematics teachers teach in an integrated manner from each discipline material into a unified whole. Duggerdefines STEM as a learning approach needed for the development of a 21st century society that relies heavily on technology. NRCdefines STEM into four parts namely; 1) science is the body of knowledge that has accumulated over time from a scientific examination that produces new knowledge. 2) technology is the whole system of people and organizations, knowledge, processes and devices that then create things and operate them. 3) Engineering is the body of knowledge about the design and creation of man-made objects and a process for solving problems. 4) mathematics is the study of patterns and relationships between the sum of numbers, and space.

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## Method

This study aims to develop a STEM-based PjBL model with the content of Manggaraians indigenous science on the science literacy of elementary school students at Manggarai RegencyThe population of the study were elementary students at Langke Rembong District, Manggarai Regency, by using elementary students of SDK Ruteng 4 dan SDK Konggang as samples.Instrument trials were carried out at SDK Kawak. This type of research was research and development. This study developed a STEM-based PjBL learning model to improve science literacy and student retention. The development model in this study followed the design of Borg & Gall which consisted of 10 (ten) steps. The development procedure refered to the opinion of Borg & Gall which were implemented only 9 steps by reason of limited funds and time.

The process of internal assessment of the consistency of the contents of the scientific literacy test items involved 3 experts, each in the field of science and evaluation. In the critical table CVR about the description of science literacy and student learning retention was valid if it has a CVR $\geq$ 0.74. The results of the analysis of the validity of the literacy test item instrument were very valid (1.0 > 0.74) because CVR-hit >CVR-table with CVR-table = 0.74. Data analysis in this study used multivariate variance analysis with the help of SPSS 16.0. Data were collected through science literacy tests. The data were analyzed using the ANAVA test. The research Roadmap is outlined in Figure 1.

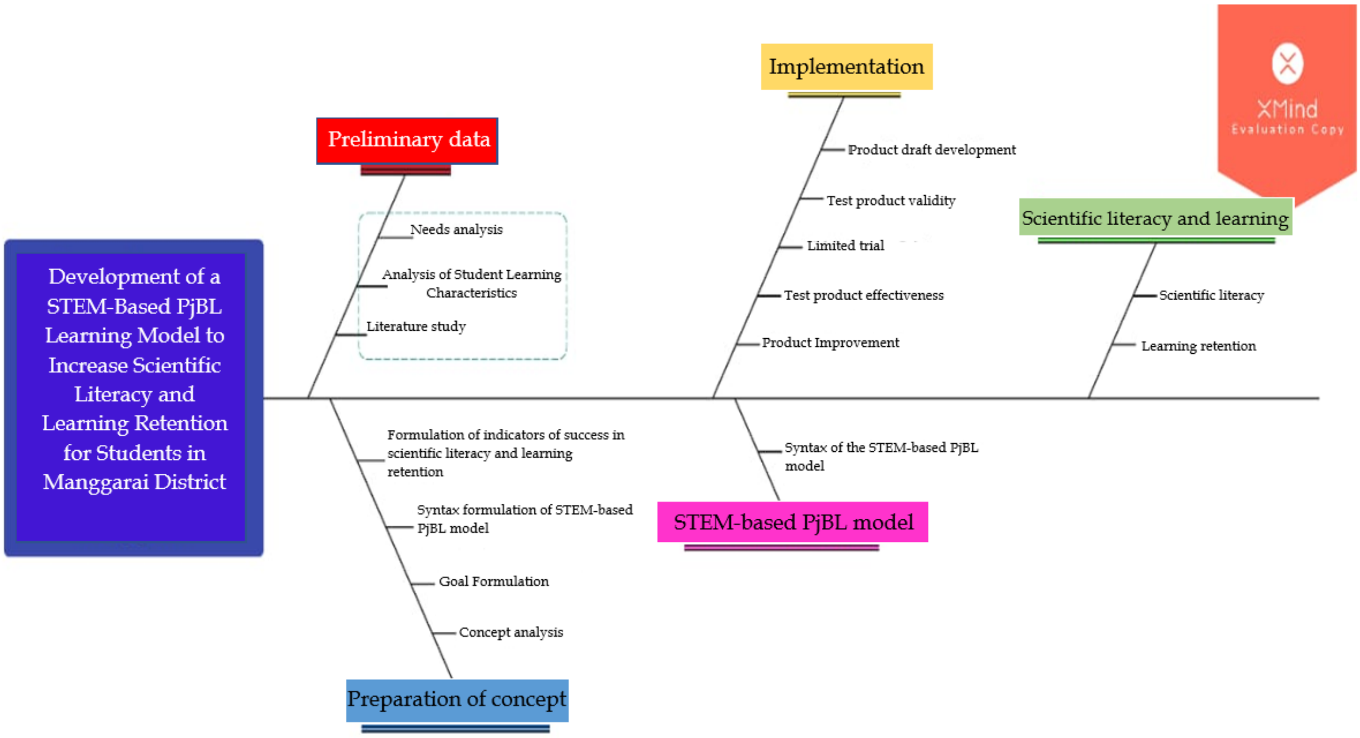


**Figure 1.** Road Map Research

## Result and Discussion

*PjBL Model developed in the study*

Referring to the learning achievement, namely science literacy and scientific attitude, the application of STEM in this study used PjBL learning steps from Sahin and collaborated with PBL model from Barrows & Myers cited by Sadia.PjBL design with 5 stages, namely: 1) Phase I (introduction), 2) Phase II (presentation of the problem), 3) Phase III (Follow-Up problem), 4) Phase IV (presentation), 5) Phase V (conclusion). PjBL learning stages in this study was developed and adapted to the STEM approach with the theme 8 in the fifth grade of elementary school is the environment. The concept of STEM-based learning is a learning approach that is accumulated from the knowledge of Science, Technology, Engineering, and mathematics, to solve problems in public life. STEM-based PjBL model developed can be seen in Table 1.

**Table 1.** Syntax of STEM-Based PjBL Model

| Stages | Learning Activities | Notes |
|---|---|---|
| Phase 1: Introduction<br>1. Student orientation on the problem<br>2. Define problems and ask questions | 1. Teachers focused students' attention in the classroom and convey learning objectives, motivate by asking contextual questions, and address issues related to the essential concepts discussed.<br>2. Students listened to the information provided and pay attention to questions from the teacher.<br>3. The teacher asked the students to form groups and the students form groups with each group consisting of 5-6 people. | Bringing out Science Indicators in STEM |
| Phase 2: Initiation and presentation of the problem (Starting New Problem)<br>1. Organizing students to study.<br>2. Presentation of problems related to learning topics.<br>3. Internalization of the problem.<br>4. Develop and use technology and design. | 1. The teacher conveyed information how to explore with the learning videos about the environment and the students listen to the information submitted by the teacher.<br>2. Students determine the group leader in order to guide exploration and investigation activities in group discussions.<br>3. The teacher gave problems to students related to the concept of material about the environment.<br>4. Students together with their group examined carefully the problems presented in the MFI. | Bringing out indicators Science, Technology, Engineering and Mathematics with the help of learning videos |

| Stages | Learning Activities | Notes |
|---|---|---|
| 5. Describe the product or performance that needs to be presented.<br>6. Presentation of learning tasks.<br>7. Develop reasoning and arguments based on the problems that have been presented.<br>8. Identification of learning sources and scheduling follow-up issues. | 5. Students investigated materials related to problems through visualization on learning videos and steps in MFIs.<br>6. The teacher accompanied the students during the investigation activities and the students analyze the problems presented.<br>7. Students provided a temporary answer (hypothesis) to the problem and connect facts or concepts that have been previously known by the students with the problems that exist in the MFI.<br>8. The teacher asked students to determine the necessary sources and design an investigation to resolve the problem | |
| Phase 3: Management (Implementation) and problem follow-up (problem follow-up)<br>1. Use a variety of resources and skills of critical thinking and creative thinking to solve the problem of discovery activities.<br>2. Interpret data and analyze, using mathematics and computational thinking or counting.<br>3. Construct explanations and design solutions.<br>4. Review and revise the problem solved if it has not achieved accurate results. | 1. Teachers guided students in finding the concept of the material through exploration in the learing videos.<br>2. Students collected data through investigative activities according to the design of the investigation that has been prepared.<br>3. Teachers reviewed every activity that students do<br>4. The student analyzed the data obtained in the investigation activity and makes conclusions related to the solution of the investigated problem.<br>5. Each member of the student group gave his opinion on each group activity.<br>6. Students with their groups exchanged opinions, discuss, clarify, and unite ideas and opinions.<br>7. Each group of students completed the MFI as a report on the results of the investigation | |
| Phase 4 Deliverables (presenting / delivering):<br>1. Presenting an opinion based on evidence<br>2. Obtaining, evaluating, and communicating information<br>3. Presentation of problem solving by group and class discussion | 1. The teacher guided and directed students in class discussions to discuss the problem solving of each group.<br>2. One of the students presented the results of the investigation and the results of the discussion in front of the class with the LCD and the other students took a look at the results of the investigation.<br>3. Groups that could not present could watch and provide input if there were different results of the investigation.<br>4. Students delivered a given problem solving by applying the concepts that have been found.<br>5. The teacher asked the students to collect the report of each group and the students collected the group report. | |
| Phase 5. Scientific assessment and conclusion (after the conclusion of the problem)<br>1. Sumlearning videosy and conclusion<br>2. Self-evaluation | 1. The teacher asked students to deduce the concept of the material studied based on the findings in previous activities.<br>2. Students deduced concepts based on findings in previous activities<br>3. Teachers gave tests to determine the ability of students to solve existing problems and students do the tests given individually<br>4. Students did self-evaluation | Bringing out science and Engineering Indicators in STEM |

(Modified from National Research Council Framework (Sahin, 2015) & Barrows & Myers)

*Data Description*

The data described in this study was science literacy as a result of the application of STEM-based PjBL model. A sumlearning videosy of the results of descriptive analysis of science literacy scores from the dimensions of content, context, competence, and science attitudes was described below.

*Description of Science Literacy Score of Students Who Followed Science Learning with STEM-based PjBL Model*

The results of the description analysis of the average score of each dimension of science literacy, namely scientific context, scientific knowledge, and scientific compitencies, were presented in Table 2.

**Table 2**. Average score of dimensions of science context (scientific context), scientific knowledge/content (knowledge), and competence (scientific competence)

| Dimensions | PjBL STEM | Conventional |
|---|---|---|
| Scientific Contexts | 25.19 | 12.56 |
| Scientific Knowledge | 25.46 | 15.16 |
| Scientific Compitencies | 25.38 | 12.06 |

Dimension of scientific attitude was measured using student performance observation sheet. A sumlearning videosy of the average scores of the scientific attitude dimension is presented in Table 3. the following.

**Table 3.** Recapitulation of The Results of Descriptive Analysis of Students' Science Literacy Scores Dimensions of Scientific Attitude

| Dimensions | PjBL STEM | Conventional |
|---|---|---|
| Science Interests | 83.49 | 80.1 |
| Conducting a science inquiry | 82.79 | 79.9 |
| Sensitivity and responsibility | 78.79 | 77.00 |

In sumlearning videosy, the average score for each scientific attitudesindicator was presented in the form of a histogram as shown in Figure 2.

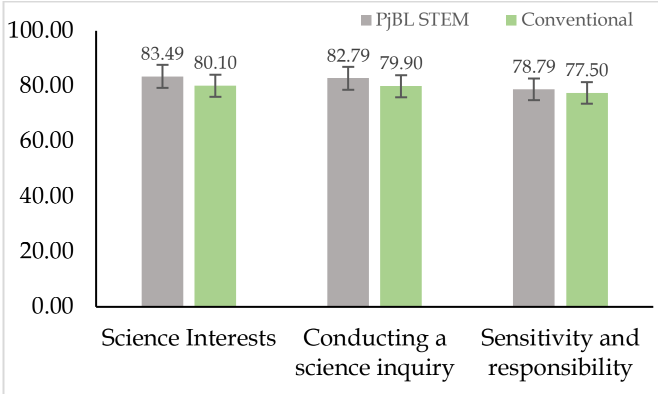


**Figure 3.** Average score of Dimension indicator of scientific Attitudes of students in learning science

Inferential statistical test results of differences in science literacy and literacy scores of students who follow the STEM-based PjBL model and students who follow conventional learning were presented in Table 4.

**Table 8.** Results of Different Tests of Scientific Literacy

| | | | | | | Multivariate Tests[b] |
|---|---|---|---|---|---|---|
| Effect | | Value | F | Hypothesis df | Error df | Sig. |
| Science Literacy | Pillai's Trace | 0.099 | 9.471[a] | 2.000 | 172.000 | 0.000 |
| | Wilks' Lambda | 0.901 | 9.471[a] | 2.000 | 172.000 | 0.000 |
| | Hotelling's Trace | 0.110 | 9.471[a] | 2.000 | 172.000 | 0.000 |
| | Roy's Largest Root | 0.110 | 9.471[a] | 2.000 | 172.000 | 0.000 |

The results of multivariate general linear analysis with the SPSS program on the variables of science literacy and science literacy showed a significance number < 0.001 with F = 9.471, meaning that there was a significant difference in science literacy and science literacy simultaneously between students who follow the STEM-based PjBL model with conventional learning.

The results of the test of between-subjects effected on the difference in science literacy between students who followed STEM-based PjBL learning and students who followed science learning with conventional learning, showed the value of F = 18.059 (p <0.05), then H0 was rejected, meaning that there was a significant difference in science literacy between students who follow science learning with STEM-based PjBL model and students who follow science learning with conventional learning. The results of the pairwise comparisons test showed that the average difference in student science literacy between the group of students who followed Science Learning with STEM-based PjBL model and the group of students who followed Science Learning with conventional learning was 2,314. This means that the science literacy of students who follow science learning with learning using the STEM-based PjBL model is significantly higher than the science literacy of students who follow science learning with conventional learning.

The results of the test of between-subjects effects on the difference in science literacy between students who followed learning using STEM-based PjBL model and students who followed science learning with conventional learning, showed the value of F = 12.953 (p <0.05), then H0 was rejected , meaning that there was a significant difference in science literacy between students who followed science learning with STEM-based PjBL model and students who followed science learning with conventional learning. The results of the pairwise comparisons test showed that the average difference in students' science literacy between the group of students who followed Science Learning with STEM-based PjBL model and the group of students who followed Science Learning with conventional learning was 1,874. This means that the science literacy of students who follow science learning with learning using the STEM-based PjBL model was significantly higher than the science literacy of students who follow science learning with conventional learning.

*Discussions*

The results of descriptive analysis of students' science literacy after learning science using STEM-based PjBL model increased the average score by going into the category of very good ifbeing compared to conventional learning. Comparison of the average value in each dimension of science literacy, namely scientific contexts, scientitific knowledge, and scientific compitencies had different scores. Based on the average score of each aspect of science literacy, the highest score was on the aspect of science competence. An aspect of science competence was the ability to use scientific evidence, identify scientific issues, and explain scientific phenomena. These indicators were contained in the instrument of science literacy questions that were closely related to aspects of students' science knowledge about understanding the concept of transportation systems in humans. The results of this study were in line with research conducted by Ismail, et al.which showed that, learning by using STEM-based PjBL model could improve science literacy from the aspect of context, content, competence, and attitude of science students.

The average score of science literacy in the aspect of scientific attitudes had a different score size for each indicator. From the scores obtained, students were more likely to be interested in science and did science inquiry compared to the attitude of responsibility and sensitivity to the environment. Science literacy meant understanding science and its application to the needs of society. Learning science through the use of STEM-based PjBL models showed active classes compared to the application of conventional learning. These results were supported by research conducted by (Rainey et al., 2019), which suggested that an active teaching environment with STEM positively impacted students ' science interests.Inquiry learning through the PjBL model integrated with STEM also had a significant impact on students ' positive attitudes towards science.

The results of the test of between-subjects' effects showed that there was a significant difference in science literacy between students who followed Science Learning with using STEM-based PjBL models than students who followed Science Learning with conventional learning. The science literacy of students who followed Science Learning with using the STEM-based PjBL model was significantly higher than the science literacy of students who followed Science Learning with conventional learning. The results of this study supported the results of research conducted by Learning videosgot & Kertler, the implementation of STEM in learning could support a quality curriculum, increase interest, and professional development of teachers. STEM made an important contribution in improving pedagogical skills in students as prospective teachers. STEM learning could improve understanding of concepts, conducted independent research, and could solve problems related to scientific literacy.

The findings of this study proved that learning using STEM-based PjBL models in Science Learning had a positive impact on students' scientific literacy. There was the positive influence of learning using STEM-based PjBL model on students' science literacy. Learning using STEM-based PjBL model was a learning process that required students to actively discover concepts through exploration activities using the help of learning videos.

The results of hypothesis testing on differences in science literacy between students who followed science learning with learning using STEM-based PjBL model and students who followed science learning with conventional learning indicated that, there were significant differences in science literacy between students who followed science learning with STEM-based PjBL model and students who follow science learning with conventional learning. The science literacy of students who followed Science Learning with learning using the STEM-based PjBL model was significantly higher than the science literacy of students who followed Science Learning with conventional learning.

The results of this study supported the results of research conducted by Griese, et al., , that entitled "Refining Questionnaire-based Assessment of STEM Students Learning Strategies" and concluded that, the use of STEM-based learning techniques design could be used as a pedagogical model in the professional development of teachers in prilearning videosy schools. Depending on the purpose of the individual study, it was advisable to create a questionnaire on the metacognition test. Previous assessment characteristics were separate from learning and technically irrelevant. The latent metacognitive location became apparent in the learning strategy and could be measured. Other forms of data used were interviews, videographed, group discussions, classroom observations, portfolios and could be made further research from the study.

The findings of this study proved that learning using STEM-based PjBL models in Science Learning had a positive impact on students' scientific literacy. The results of hypothesis testing on the difference in science literacy between students who followed science learning with learning using STEM-based PjBL model and students who followed science learning with conventional learning, showed that, there was a significant difference in science literacy between these groups.

STEM-based PjBL Model could improve students' literacy on procedural cognitive aspects and knowledge. The process of discovering science concepts involved activities in accordance with scientific steps or scientific processes. The results of this study supported the results of research conducted by Afriana et al. (2021), who concluded the application of STEM integrated PjBL could improve the results of science learning outcomes and science literacy. The STEM-based PjBL model that had been developed was very effective for developing students' careers, increasing interest in science, technology, mathematics, and science. Thus, Science Learning using STEM-based PjBL model could improve students ' science literacy.

The research findings indicate that the implementation of the STEM-based PjBL model with Manggaraians indigenous science content has a significant positive impact on improving science literacy among elementary school students. The results of the multivariate general linear analysis revealed a significant difference in science literacy and science literacy simultaneously between students who followed the STEM-based PjBL model and those who underwent conventional learning. This suggests that the innovative learning approach positively influenced various dimensions of science literacy, including students' content knowledge, contextual understanding, attitudes towards science, and competency in applying scientific concepts.

The significant difference in science literacy between the STEM-based PjBL model and conventional learning groups, as shown by the between-subjects effects test, highlights the effectiveness of the STEM-based PjBL model in fostering higher science literacy levels. The average difference in science literacy scores between the two groups further supports this finding. The STEM-based PjBL model group exhibited a significantly higher average science literacy score compared to the conventional learning group. This outcome implies that the STEM-based PjBL model effectively enhances students' grasp of scientific concepts and principles, as well as their ability to apply them to real-world situations.

The success of the STEM-based PjBL model in improving science literacy can be attributed to several factors. First, the integration of the PjBL approach fosters active student engagement and hands-on learning experiences (Hakimah, 2023). As students work on projects related to Manggaraians indigenous science content, they are encouraged to investigate, analyze, and solve problems collaboratively. This experiential learning process deepens their understanding of scientific concepts and nurtures their critical thinking and inquiry skills.

Second, the STEM approach facilitates interdisciplinary learning, enabling students to connect knowledge from various subjects to solve complex real-world challenges. By integrating science, technology, engineering, and mathematics, the model provides a holistic perspective that reflects the interconnected nature of these disciplines (Ortiz-Revilla et al., 2022). This interdisciplinary approach encourages students to explore different dimensions of science literacy, enhancing their ability to relate scientific knowledge to practical applications. Furthermore, the inclusion of Manggaraians indigenous science content makes science learning more meaningful and relevant to the students' cultural context. Incorporating local knowledge and practices fosters a sense of identity and belonging among students, which in turn positively influences their attitudes towards science. Students are more likely to be motivated and actively participate in learning when they recognize the significance of the content to their own lives.

The positive impact of the STEM-based PjBL model on science literacy aligns with previous research that highlights the effectiveness of project-based learning and STEM education in improving students' academic performance and problem-solving abilities (Hsieh et al., 2022). Additionally, studies have emphasized the significance of contextual science content in enhancing students' science literacy and interest in science. Moreover, the research findings shed light on the importance of revitalizing and preserving indigenous science knowledge. As observed in this study, Manggaraians indigenous science content, which was previously overlooked, proved to be a valuable resource for enhancing science literacy and cultural awareness. This finding resonates with literature emphasizing the importance of integrating local knowledge and culture into education to promote inclusivity and cultural preservation.

The significance of this research lies in its potential implications for educational reform and curriculum development. By demonstrating the effectiveness of the STEM-based PjBL model with indigenous science content, this study provides valuable insights for educators and policymakers seeking to improve science education practices. Implementing this innovative approach in science classrooms across different regions can contribute to the development of scientifically literate and culturally aware citizens. However, it is essential to acknowledge some limitations of this study. The research was conducted in a specific geographical context, focusing on Manggaraians indigenous science content and elementary school students in Langke Rembong District, Manggarai Regency. Therefore, the generalizability of the findings to other regions and educational levels requires further investigation.

Therefore, this research demonstrates the effectiveness of the STEM-based PjBL model with Manggaraians indigenous science content in improving science literacy among elementary school students. The integration of the PjBL approach, STEM education, and contextual indigenous science content creates a powerful learning environment that fosters students' scientific understanding, critical thinking, and problem-solving skills. Additionally, the research highlights the importance of preserving and revitalizing local knowledge and culture within the education system. By incorporating indigenous science content, educators can make science learning more meaningful and relevant while promoting cultural awareness among students. This study contributes to the growing body of research on innovative teaching and learning approaches, providing valuable insights for educational practices and curriculum development aimed at fostering scientifically literate and culturally aware citizens in the 21st century.

## Conclusion

Based on the results of hypothesis testing as described, it could be concluded that the STEM-based PjBL model in science learning affects students' scientific literacy. There were several findings, namely, the PjBL Model developed was very effective in improving students' science literacy in the dimensions of content / knowledge, context, competence, and student attitudes; there were significant differences in science literacy between students who follow science learning with the use of STEM-based learning videosmedia and students who follow conventional learning; and the use of STEM-based PjBL models was superior to conventional learning.

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### Conflicts of Interest

The authors declare no conflict of interest.

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