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Analysis of Mathematical Literacy viewed from Student Learning Independence in Problem-based Learning assisted by e-Modules with a Local Culture Themes

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Abstract: This research aims to describe students' mathematical literacy abilities through the application of a PBL (Problem-Based Learning) model assisted by an e-module with a culturally based Ethnomathematics approach to the topic of Systems of Linear Equations and Inequalities (SPLDV). The study focuses on students' self-directed learning. The research subjects consisted of 32 students from SMP Negeri 3 Pematang Siantar. The research employed a mixed-methods approach, combining qualitative and quantitative research. The design used in this study was exploratory mixed-methods. Students' self-directed learning levels were categorized into three groups: high, medium, and low. The research findings from the 32 students in the experimental group showed that 5 students had low self-directed learning, 19 students had medium self-directed learning, and 8 students had high self-directed learning. The implementation of the teaching methods went very well, with an average rating of 4.50. The average score for mathematical literacy reached the minimum passing score (70), which was 82.73, with a passing proportion of 87.50%. The interpretation of both qualitative and quantitative research results led to the conclusion that there is a relationship between students' self-directed learning and their mathematical literacy abilities when exposed to the PBL model with a culturally based Ethnomathematics approach. Specifically, students with low self-directed learning exhibited low mathematical literacy, and vice versa. The research results also indicated that the average mathematical literacy scores of the experimental group were better than those of the control group.

Keywords: mathematical literacy, pbl, self-directed learning, ethnomathematics, e-module, spldv.

Abstrak: *Penelitian ini bertujuan untuk mendeskripsikan kemampuan literasi matematis siswa melalui penerapan model PBL berbantuan e-modul dengan Pendekatan etnomatematika berbasis budaya lokal pada materi SPLDV ditinjau dari kemandirian belajar siswa. Subjek penelitiannya adalah 32 siswa SMP Negeri 3 Pematang Siantar. Jenis penelitian yang digunakan adalah penelitian campuran (kualitatif dan kuantitatif). Penelitian ini menggunakan desain campuran exploratory. Tingkat kemandirian belajar dikategorikan menjadi 3 yaitu tinggi, sedang dan rendah. Hasil penelitian dari 32 siswa pada kelas eksperimen terdapat 5 anak yang memiliki kemandirian rendah, 19 anak memiliki kemandirian sedang, dan 8 anak memiliki kemandirian tinggi. Keterlaksanaan pembelajaran berjalan dengan sangat baik dengan nilai rata-rata sebesar 4,50. Rata-rata nilai kemampuan literasi matematis mencapai KKM (70) yaitu 82,73 dengan proporsi ketuntasan mencapai 87,50%. Hasil interpretasi penelitian kualitatif dan kuantitatif dapat disimpulkan ada hubungan antara kemandirian belajar siswa dengan kemampuan literasi matematis siswa yang dikenai model pembelajaran PBL dengan pendekatan etnomatematika berbasis budaya lokal, yakni siswa yang memiliki kemandirian belajar rendah, kemampuan literasi matematisnya juga rendah, begitu sebaliknya. Hasil penelitian diperoleh rata-rata nilai kemampuan literasi matematis siswa pada kelas eksperimen lebih baik dari kelas control.*

Kata kunci: *literasi matematika, pbl, kemandirian belajar, etnomatematika, e-modul, spldv*

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▪ INTRODUCTION

Formal education has an important role in making the nation's life intelligent, in line with the ideals of the Indonesian nation as stated in the 1945 Constitution. This paragraph reflects the determination of the Indonesian people to educate and equalize education throughout Indonesia in order to achieve an intelligent national life. In the educational context, the subject of mathematics has a very important role. Rapid progress in science and technology in the Industrial Revolution 4.0 era, which involves the use of information and communication technology, cannot be separated from the contribution of mathematics. Mathematics is not only the main basis for the development of modern technology, but also influences many other scientific disciplines and plays a major role in improving human thinking abilities. However, the demands on students' abilities in mathematics are not only limited to numeracy skills. More than that, they must have the ability to think logically and critically in facing and solving various problems, especially those that are relevant to everyday life and can solve them independently.

The ability to learn independently is one of the psychomotor aspects that students must have. This is in line with what was stated in the 2013 curriculum. The 2013 curriculum emphasizes the competencies that students must have in learning mathematics, including the cognitive, affective and psychomotor (skills) domains. Independent learning is an activity that involves students realizing their desire to learn without external pressure in order to accept responsibility as students in facing learning challenges (Yantia & Surya, 2017). Learning independence is one of the factors that supports students' success in learning mathematics. In line with Edmondson et al (2012), students who learn independently effectively are more successful. Ali & Asrori (2010) stated that learning independence is a behavior that an individual has to take the initiative in doing all work with a sense of responsibility without depending on other people. Each student has different abilities so that each student has the independence to learn in different ways. Majid (2013) states that independent learning is a learning activity that aims to build individual initiative, independence and self-improvement. Learning independence is characterized by a person's self-awareness to learn accompanied by the knowledge they already have.

Knowles (1975) states that learning independence is a situation of self-learning, this refers to an individual's ability to take the initiative in identifying their own learning needs, the ability to determine their learning goals, the ability to determine the resources needed for learning, the ability to choose/use appropriate learning strategies. appropriately and evaluate learning outcomes with or without help from outsiders. In line with Merriam et al (2007), independent learning is a process where individuals are responsible for planning, continuing and evaluating their learning experiences. Since Premkumar et al (2018) stated that independent learning is a learning activity based on one's own initiative and students have the main responsibility for planning, implementing and evaluating efforts. Cazan & Schiopca (2014) stated that "openness" is the most important trait associated with independent learning.

Song & Hill (2007) stated that learning independence can be described from three perspectives: personal attributes, processes, and learning environment design characteristics. Raidal & Volet (2008) stated that in higher education, learning independence is an important goal to improve the quality of student learning and prepare students for the future. Loyens et al (2008) stated that learning independence is a design characteristic of a learning environment that fosters student control in learning activities.

According to Astuty (in Wijayanti, 2020) learning independence is a student's behavior in realizing his wishes or desires in a real way without depending on other people. Independent learning can occur if students have thoughts, feelings, strategies and student behavior that are oriented towards achieving goals. So it can be concluded that the aspect of independence is important to pay attention to in efforts to increase students' mathematical literacy. This is in line with Auliya et al (2021) who stated that independent learning will also affect students' mathematical literacy abilities. So in this research, mathematical literacy abilities will be viewed from students' learning independence, with indicators of learning independence, namely: Having the initiative to learn, Confidence in the learning process, Able to independently overcome learning difficulties, Responsible for completing learning thoroughly, Evaluate learning outcomes.

Mathematical literacy is defined as a person's ability to formulate, apply and interpret mathematics in various contexts, including the ability to reason mathematically and use concepts, procedures and facts to describe, explain or predict a phenomenon/event. The Center for Development and Empowerment of Mathematics Educators and Education Personnel (P4TK, 2011) defines that, "Mathematical literacy is a person's ability to formulate, apply and interpret mathematics in various contexts, including the ability to reason mathematically and use concepts, procedures and facts to describe , explain or predict phenomena/events". The definition of mathematical literacy does not just focus on knowledge in mathematics, but can use mathematical concepts in other fields, including aspects of daily life. From simple to complex things. In line with Sumirattana et al (2017), mathematical literacy refers to students' knowledge and ability to apply what they learn to their daily lives and understand situations related to mathematics lessons. In line with Oktiningrum & Hartono (2016) stated that mathematical literacy starts from realistic problems, which are categorized into context and content categories. The mathematics learning process has the potential to encourage increased students' mathematical literacy abilities (Gatabi et al, 2012) in line with Masjaya & Wardono (2018) who stated that mathematical literacy abilities can improve human resources.

From the definitions above, it can be concluded that mathematical literacy ability is a person's ability to analyze, formulate and examine various contexts mathematically by using concepts and procedures in solving mathematical problems that are closely related to everyday life.

Based on the results of a survey conducted by PISA (OECD, 2018), students' mathematical literacy abilities in Indonesia are still low. Indonesia is below the international average. Not only that, the majority of students can only solve problems below level 2 of the six levels of student mathematical ability developed by PISA to show students' cognitive abilities. Research conducted by Asmara & Rochmad (2017) showed that students with medium and high abilities could only solve questions at level 3, while students with low abilities could only solve questions at level 1. In line with the results of Wijaya's research (2016), it was stated that student literacy was still low, where students do not achieve three information literacy competencies, namely recognizing needed information, finding and evaluating the quality of information, and creating information effectively. There are many factors that may cause the low mathematics literacy of

Indonesian students; for example, students are not used to completing tasks such as PISA in their learning activities (Ahyan et al, 2014). In line with Novita et al (2012), students are accustomed to only acquiring and using formal mathematical knowledge in class and students' problem solving abilities are lacking for non-routine or high-level problems because most of the test items used in the learning process only focus on low-level tasks.

In line with this, based on the researcher's initial observations at SMP Negeri 3 Pematang Siantar which implemented the 2013 curriculum, in practice the learning carried out by several teachers at the school was still classified as teacher-oriented learning only. Students still tend to be passive, only receiving information from teachers and unable to learn independently if they have to be faced with authentic problems. This condition is a picture that shows one of the factors that results in students' low mathematical literacy. Indicators of students' mathematical literacy abilities in this research are: Communication, Mathematics, Representation, Reasoning and arguments, Designing strategies to solve problems, Use of symbols, formal and technical language, and use of operations, Use of mathematical tools. Give mathematical conclusions.

Problem based learning is a learning model that has been proven to improve students' mathematical literacy skills. PBL presents students with contextual problems that encourage them to learn more actively and independently. In this context, the ethnomathematics approach can also be used to connect mathematics learning with students' local culture, motivate students, and provide a more real context for the lesson material. This is in line with the mandate of the 2013 curriculum, namely that teachers are encouraged to implement learning using the PBL learning model. Tabun et al (2020) stated that students' mathematical literacy skills in PBL model learning are better than students in learning without a PBL model.

Pamungkas and Franita (2019) stated that learning mathematics using PBL can improve students' mathematical literacy skills. Pratiwi and Ramdhani (2017) stated that the increase in the mathematical literacy skills of students who studied using the problem based learning (PBL) learning model was significantly better than the increase in the mathematical literacy skills of students who received conventional learning. Herutomo et al (2020) stated that the PBL model with a realistic mathematical approach is effective in increasing students' mathematical literacy. Dinata (2022) stated that the application of the PBL model in the learning process for students experienced an increase in mathematical literacy skills, from the lowest 7.65% to the highest 48.27%, resulting in a very significant increase, namely 29.0138%. This is because in learning with the PBL model learning activities are student-centred. In line with Savery (2020), PBL includes student-centered learning for problem solving. In PBL learning there are two main outcomes, namely creative thinking and critical thinking (Chan, 2012).

Suciawati et al (2023) mention the application of the PBL model can improve students' mathematical literacy skills better than using conventional learning models. Yewa & Gohb (2016) stated that PBL is an effective teaching and learning model, especially when evaluated for long-term knowledge retention and implementation. Muharomah and Setiawan (2020) mentioned increasing the mathematical literacy skills of junior high school students who use PBL better than increasing students' mathematical literacy skills with conventional learning, achieving mathematical literacy skills for junior high school students using PBL better than achieving students' mathematical literacy skills with conventional learning, and students' attitudes towards learning using PBL positive. Ornawati et al (2023) mention the learning PBL can be used as a learning model that can be used to improve mathematical literacy skills.

Hidayat et al (2019) stated that there is a positive and significant relationship between mathematical disposition in implementing the PBL model and mathematical literacy abilities. This means that mathematical disposition when applying the PBL model can be used to predict the level of mathematical literacy skills in mathematics learning. And mathematical disposition when applying the PBL model has an influence of 37.8% on mathematical literacy abilities.

In the midst of current developments in educational technology, the educational curriculum also demands cultural involvement in learning at school with the aim that students can become a generation of character and are able to maintain and preserve culture as the basis of national character. It is important to instill cultural values in every individual from an early age, so that each individual is able to better understand, interpret and appreciate and realize the importance of cultural values in carrying out every life activity (Fajriyah, 2018). Sulistio et al (2020) stated that the mathematical literacy abilities of students who received a PBL model based on character and local culture were higher than students who received expository learning.

The bridge that connects mathematics learning with the daily lives of students in society who utilize culture as a learning medium is the ethnomathematics approach. Mogari (2014) states that the ethnomathematics approach is student-centered and activity-oriented.Mania & Alam (2021) states Ethnomathematics is not only fun and meaningful but also more concrete in students' minds. Concretely, students can see and discover traditional everyday foods and games that teachers can use as a medium for teaching mathematics. In carrying out their role, Verner et al (2013) stated that teachers were enthusiastic and fascinated by the learning approach through ethnomathematics.

Successful integration of cultural values in mathematics learning. In line with the results of research by Yuliani and Saragih (2015), culture-based mathematics learning can increase the effectiveness of mathematics learning in certain areas. Apart from that, Yusra and Saragih also mentioned that designing learning plans with cultural content can make students more able to relate culture to mathematics so that students feel the benefits of mathematics in everyday life (cited in Hutagalung, 2017). In line with Astalini et al (2019) stated that the use of e-modules in learning activities can train students' abilities and skills effectively. Based on the results of the N-gain analysis, the e-module developed is quite effective in improving students' learning abilities.

In this research, researchers used E-Module teaching materials oriented towards PBL learning with an ethnomathematics approach based on local culture. E-modules or electronic modules are modules in digital form, consisting of text, images, or both containing digital electronics material accompanied by simulations that can and are suitable for use in learning (Herawati & Muhtadi, 2018). Syahrial et al (2019) stated that the use of e-modules is effective in improving students' abilities and interests. Based on the research results of Pramana et al (2020), it is stated that PBL-based e-modules succeeded in achieving very good qualifications in each lesson content validity test, learning design validity test, learning media validity test, individual trials and small group trials. PBL-based e-modules are suitable for application in the learning process so that learning problems can be resolved properly.

Based on the description above, researchers will conduct research to overcome students' low mathematical literacy, namely by implementing a PBL learning model with a local culture-based ethnomathematics approach designed in the form of an e-module. In this research, students' mathematical literacy abilities will be reviewed based on student learning independence.

▪ METHOD

Participants

The population in this study was 8th grade students of SMP Negeri 3 Pematang Siantar for the 2022/2023 semester 1 academic year, totaling 11 classes. The research sample consisted of two classes, i.e the experimental class with 32 students and the control class with 32 students. The research sample was chosen randomly using the simple random sampling method. The experimental class will be taught using the Problem Based Learning (PBL) Model with an ethnomathematics approach based on local culture, while the control class will use the Conventional Model.

Research Design and Procedures

The research method used is mixed research methods. According to Sugiyono (2015), mix methods are a research method that combines two research methods at once, qualitative and quantitative, in a research activity, so that more comprehensive, valid, reliable and objective data will be obtained. The research design used in this research is exploratory mixed design (The Exploratory Sequential Design). There is a sequence in the research stages, starting from qualitative research and continuing with quantitative.This research consists of one independent variable, namely learning independence and one dependent variable, namely students' mathematical literacy abilities.

This research procedure was carried out in three stages. namely: planning stage, implementation stage, and data processing stage. The planning stage is carried out to look at the characteristics of the population, develop test equipment and instruments, and carry out analyzes of validity, reliability, level of difficulty and differentiating power of research instruments. The implementation stage includes pre-test, learning implementation and post-test of mathematical literacy skills. The data processing stage includes data processing and analysis as well as preparing research results reports. This research was conducted from 14 November 2022 to 2 December 2022.

At the initial stage, the experimental class was given a learning independence questionnaire with a classification of the level of learning independence into 3 categories, namely high, medium and low. From the results of the questionnaire, 2 samples of each student were taken (low, medium and high learning independence) to be interviewed regarding the results of the learning independence test. After the interview, quantitative research continued with the application of the PBL model assisted by e-modules with an ethnomathematics approach based on local culture in the experimental class while the control class used conventional learning, each with 4 direct face-to-face meetings with the lesson material System of Linear Equations in Two Variables (SPLDV). Next, a 5-question mathematical literacy ability test is given. Then the six students who had been interviewed previously were interviewed again regarding their mathematical literacy test results. Next, interpretation of the qualitative and quantitative research results is carried out to draw conclusions.

Instrument

The instrument in this research is an independence questionnaire consisting of 28 statement items, an interview guide and a mathematical literacy ability test consisting of 5 descriptive questions. An independence questionnaire was given to all experimental class students and a mathematical literacy ability test was given to all experimental class and control class students. The learning independence questionnaire is used to classify students based on the level of independence which is categorized into 3, namely, high, medium and low. The independence questionnaire consists of 28 statements which are arranged based on the learning independence grid. The independence instrument was prepared using a Likert scale with four answer choices, namely always, often, sometimes, never. The answer to each statement is given a score of 1-4. The indicators used in the independence questionnaire are presented in table 1. The twenty eight questionnaire statements were prepared based on indicators of independence. An example of an independence questionnaire is presented in Table 2.

Table 1. Learning independence indicator

No	Indicator
1	Have the Initiative to Learn
2	Believe in yourself
3	Able to independently overcome learning difficulties
4	Responsible for adapting learning completely
5	Evaluating Learning Outcomes

Table 2. Example learning independence questionnaire

No	Statement	Response			
	Indicator: Initiative to Learn	**SL**	**S**	**KD**	**TP**
1	I studied mathematics of my own free will				
2	I chose math practice questions of my own free will				
3	I did math practice questions of my own free will				
4	I did math practice questions because of school assignments				
5	I read mathematics books in the library of my own free will				

The mathematical literacy ability test instrument consists of five description questions. The questions used in this test use SPLDV material. The test instrument is prepared based on mathematical literacy indicators accompanied by an assessment rubric. The questionnaire and test instruments that had been prepared were then validated by one mathematics education lecturer at HKBP Nommensen University, Pematang Siantar and two mathematics teachers at SMP Negeri 3 Pematang Siantar. Next, instrument test calculations are carried out. This instrument is said to be usable if $r_{count}>r_{table}$ (Lestari &; Yudhanegara, 2018). The reliability results of the questionnaire and test instrument were 0.868 and 0.826 respectively and the validity was 4.5 and 4.46 in the valid category. This shows that the two instruments are declared valid and reliable.

Then, to obtain more accurate data, a trial of the test instrument was carried out to test the distinguishing power and level of difficulty on the seven questions on the mathematical literacy test. The results of the trial of the mathematical literacy ability test showed that the distinguishing power and level of difficulty were respectively for question number one 0.44 (very good) and 0.62 (medium); question number two 0.24 (medium) and 0.57 (medium); question number 3 obtained 0.08 (bad) and 0.17 (difficult); question number 4 obtained 0.22 (medium) and 0.58 (medium); question number 5 was obtained 0.09 (bad) and 0.15 (difficult)' question number seven was obtained 0.20 (medium) and 0.56 (medium).

Based on the description of the instrument test results above, it was obtained for questions number 3 and 5 that the discriminating power was poor and the level of difficulty was poor. Meanwhile, questions number 1, 2, 4, 6 and 7 meet the specified level of difficulty and distinguishing power. So the mathematical literacy ability test instrument for numbers 1, 2, 4, 6 and 7 is suitable for use to collect data.

Other learning tools used in the research were also tested for validity by 3 validators. The instrument validity values from the three validators are: syllabus: 4.5 (very good); RPP: 4.57 (very good); learning implementation observation sheet: 4.4 (very good); student response sheet: 4.72 (very good); interview sheet: 4.43 (very good); module: 4.54 (very good).

Data Analysis

Analysis of the results of the independence questionnaire is used to determine whether students' level of learning independence is low, medium or high. Meanwhile, the analysis of test results is carried out based on mathematical literacy indicators, namely Communication, Mathematization, Representation, Reasoning and arguments, Designing strategies to solve problems, Use of symbols, formal and technical language, and use of operations, Use of mathematical tools. Give mathematical conclusions.

The data analysis process is carried out through several stages, namely data reduction, data presentation, and drawing conclusions. At the data reduction stage, researchers analyzed the results of questionnaires and tests that had been carried out by students and then grouped them into three levels of learning independence, namely high, medium and low. Then, based on questionnaire analysis, six students were selected (2 students each from low, medium and high independence) for further analysis and interviews. Next, the PBL learning model was implemented with an ethnomathematics approach based on local culture in the experimental class and conventional learning in the control class, 4 meetings each with SPLDV material.

Next, a mathematical literacy ability test was given in the experimental class and control class, consisting of 5 questions in the form of descriptions. After obtaining the test results, the six students who had been interviewed previously were interviewed again regarding the test results obtained. At the data presentation stage, this was done by presenting the results of the analysis of mathematical literacy skills, independence questionnaires and interviews. Meanwhile, in the final stage (drawing conclusions) the researcher draws conclusions from the data that has been presented.

In this research, four hypotheses were tested. The first hypothesis states that the average literacy rate of students who use PBL learning with a local culture-based ethnomathematics approach reaches a minimum of 70. The second hypothesis states that the percentage of students who achieve a minimum of 70 in the class that uses PBL learning with a local culture-based ethnomathematics approach exceeds 75%. The third hypothesis states that there is an influence of student learning independence on students' mathematical literacy abilities. The fourth hypothesis states that students' mathematical literacy in terms of students' learning independence using the PBL model with a local culture-based ethnomathematics approach is better than conventional learning.

Before data analysis and hypothesis testing are carried out, prerequisite tests are first carried out, namely the normality test and the difference test in the initial data (pretest scores). Based on the results of the normality test using the Liliefors test, the initial data obtained were normally distributed and in the homogeneity test, the initial data were homogeneous so that in the difference test the t-test was used. From the results of the difference test, it was found that the average initial score of students' mathematical literacy abilities who were given the Problem Based Learning learning model with a local culture-based ethnomathematics approach was the same as the average initial score of students' mathematical literacy abilities who were given the conventional learning model.

Next is to provide a qualitative instrument, namely a learning independence questionnaire which is prepared using a Likert Scale with 28 statements consisting of positive and negative statements with indicators of learning independence, namely, has the initiative to learn, is self-confident, is able to independently overcome learning difficulties, responsible for adapting learning completely and evaluating learning outcomes. The answer choices from the independence questionnaire are Always, Often, Sometimes, and Never. For positive statements, Always worth 4, Often worth 3, Sometimes worth 2 and Never worth 1. For negative statements the opposite is true, namely Always worth 1, Often worth 2, Sometimes worth 3 and Never worth 4. Interpretation Learning independence scores can be seen in table 3.

Table 3. Interpretation of learning independence

Low	score < 37
Moderate	37 < score ≤ 73
High	score >73

Next, two samples of students from low, medium and high learning independence were taken for interviews. The next step is for the experimental class to be given SPLDV material with the help of an e-module with a PBL learning model with a local culture-based ethnomathematics approach, while for the control class it is used with a conventional learning model for 4 meetings each. After the learning activities for 4 meetings have been completed, the next step is to provide quantitative instruments, namely giving mathematical literacy ability test questions with a total of 5 descriptive questions. The indicators of mathematical literacy abilities in this research are: communication, mathematics, representation, reasoning and arguments, designing strategies to solve problems, use of symbols, formal and technical language, and use of operations, use of mathematical tools. give conclusions mathematically. After obtaining the results of the mathematical literacy test, it was followed by another interview with 2 students from each of the low, medium and high levels of independence that had previously been selected. Furthermore, interpretation of qualitative and quantitative research, as well as interpretation of qualitative and quantitative relationships.

▪ RESULT AND DISSCUSSION

Initial data on students' mathematical literacy abilities was obtained from the results of the pretest scores carried out before the learning action was given (at the beginning of the meeting). Recapitulation of initial score data on students' mathematical literacy abilities is presented in Table 4.

Table 4. Recapitulation of initial score data on students' mathematical literacy ability

Group	$\bar{x}$	s	Min	Max
Experiment	26.88	5.39	12.50	36.25
Control	26.02	5.98	15.00	36.25

From the table it can be seen that the average initial score for the mathematical literacy abilities of experimental class and control class students is only 0.86. The standard deviation for students in the control class is slightly higher than in the experimental class, this shows that the class following conventional learning has a more diverse distribution of initial mathematical literacy ability score data than the experimental class. The highest scores were obtained by students in the experimental class and in the control class, too. Meanwhile, the lowest scores were owned by students in the experimental class. Data on student learning independence is presented in table 5.

Table 5. Student learning independence in experimental group

Category	**Number**
High	8
Middle	19
Low	5

The table contains the results of the recapitulation of the learning independence questionnaire that was given to experimental class students. The level of learning independence is divided into three categories, namely low, medium and high. Of the 32 students in the experimental class, there were 5 children who had a low level of learning independence, 19 children had a medium level of learning independence, and 8 children had a high level of learning independence. Next, from each category, 2 children were selected for interviews related to the results of the learning independence questionnaire. After the interview, quantitative research continued with the application of the PBL model assisted by e-modules with an ethnomathematics approach based on local culture in the experimental class while the control class used conventional learning, each with 4 meetings. The results of observations of learning implementation are presented in table 6 below.

Table 6. Observation results of learning implementation

Observed activities	Mean score
Plannning	4.38
Implementation	4.5
Closing	4.63
Average	4.50

Based on table 6, it can be concluded that overall the implementation of learning went very well with an average value of 4.50. Next is given mathematical literacy ability test with 5 questions. The data analysis technique used consists of: prerequisite test; average thoroughness test one party proportion test; simple regression analysis; and comparative test of two samples. The recapitulation of post-test score data on students' mathematical literacy abilities is presented in Table 7 below.

Table 7. Recapitulation of final score on students' mathematical literacy

Group	$\bar{x}$	s	Min	Max
Experimental	82.73	10.59	61.25	97.50
Control	73.98	10.12	56.25	92.50

Based on Table 7, the average final score of mathematical literacy abilities of students who took part in PBL learning with a local culture-based ethnomathematics approach was higher than the average final score of mathematical literacy abilities of students who took part in conventional learning. The standard deviation of students who take part in PBL learning with a local culture-based ethnomathematics approach is also higher than the standard deviation of students who take part in conventional learning, meaning that the final score of students' mathematical literacy abilities who take PBL learning with a local culture-based ethnomathematics approach is more diverse than the final ability score. mathematical communication of students who follow conventional learning. The lowest scores were owned by students who took conventional classes. Meanwhile, the highest scores were obtained by students who took part in PBL learning with an ethnomathematics approach based on local culture.

Hypothesis 1: The average literacy of students who use PBL learning with a local culture-based ethnomathematics approach reaches a minimum of 70 Hypothesis 1 testing uses a one-side average test, with H_0 and H_1: H_0: $\bar{x} = \mu$ (the average analysis of students' mathematical literacy is the same as the minimum completeness criteria), H_1: $\bar{x} \neq \mu_0$ (the average analysis of students' mathematical literacy is not the same as the minimum completeness criteria). (Sukestiyarno, 2020). The calculation results are obtained in table 8.

Table 8. Interpretation of Hypothesis **1**

$-t_{\text{table}}$	t_{calc}	α
−1.697	6.70	5%

Based on the calculations results, it can be concluded that the average analysis of students' mathematical literacy is not the same as the minimum completeness criteria. with a significance level of α= 5%, so it can be concluded that the average analysis of students' mathematical literacy in learning using PBL with a local culture-based ethnomathematics approach is not the same as the minimum completeness criteria.

Hypothesis 2: The percentage of students who achieve a minimum completion score of 70 in classes subjected to PBL learning with a local culture-based ethnomathematics approach exceeds 75%. Test hypothesis 2 using a one-party proportion test, namely the left side, with H_0 and H_1: H_0: $\pi \leq 0.75$ (Percentage of completeness of students' mathematical literacy ability test results using the PBL learning model with a local culture-based ethnomathematics approach that achieved a minimum score less than or equal to 75%), H_1: $\pi > 75\%$ (Percentage of completeness of students' mathematical literacy ability test results using the PBL learning model with a local culture-based ethnomathematics approach which achieved a minimum score of more than 75%). (Masrukan, 2017). The calculation results are obtained in table 9.

Table 9. Interpretation of hypothesis 2

$-z_{table}$	z_{calc}	α
-0.1736	1.63	5%

Based on the calculation results above, the values obtained z_count=1.63 and -z_tabel=-0.1736 with a significance level of α=5%, so it can be concluded that the percentage of completeness of students' mathematical literacy ability test results using the PBL learning model with a local culture-based ethnomathematics approach achieved a minimum score of more than 75%.

Hypothesis 3: There is an influence of student learning independence on students' mathematical literacy abilities. Hypothesis three uses a regression test. H_0: $\beta_1 = 0$ (the equation is not linear or there is no relationship between student learning independence and the mathematical literacy abilities of students who are subjected to the PBL learning model with a local culture-based ethnomathematics approach). H_1: $\beta_1 \neq 0$ (the equation is linear, there is a relationship between student learning independence and the mathematical literacy abilities of students who are subjected to the PBL learning model with a local culture-based ethnomathematics approach). The regression test was carried out using SPSS using regression with a significance level of 5%, if the sig value is <5% then H_0 is rejected, conversely if the sig value is ≥ 5% then H_0 is accepted (Sukestiyarno, 2020). The Regression Test output is presented in table 10. From the output above, the value F = 31.033, sig = 0.000 is obtained. Sig = 0.000 = 0% < 0.05 means reject H_0 and accept H_1. So the equation is linear or x has a linear relationship to y or x has a positive effect on y. In other words, there is a relationship between student learning independence and the mathematical literacy abilities of students who are subjected to the PBL learning model with a local culture-based ethnomathematics approach.

Table 10. Regression test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-7.313	13.624		-.537	.595
	Mathematical Literacy	.910	.163	.713	5.571	.000

a. Dependent Variable: Kemandirian Belajar

Hypothesis 4: Students' mathematical literacy in terms of students' learning independence using the PBL model with a local culture-based ethnomathematics approach is better than conventional learning. Hypothesis 4 uses a one-sided t test to determine whether the mathematical literacy abilities of class VIII students using the PBL learning model with a local culture-based ethnomathematics approach are better than the control class. The average difference test with the t test is carried out if the data is normally distributed and homogeneous. The hypothesis is H_0: $\mu_1 \leq \mu_2$ (the average value of mathematical literacy abilities of students using the PBL learning model with a local culture-based ethnomathematics approach is not better than the average value of mathematical literacy abilities of control class students), H_0: $\mu_1 > \mu_2$ (the average mathematical literacy ability score of students using the PBL learning model with a local culture-based ethnomathematics approach is better than the average mathematical literacy ability score of control class students). The mean difference test was carried out with SPSS using the Independent-samples T-test with a significance level of 5%, if the sig. value ≥ 5% then H_0 is accepted, conversely if the sig. value < 5% then H_0 is rejected (Sukestiyarno, 2020). The average difference test output is presented in table 11.

Table 11. Mean difference test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Learning outcomes	Equal variances assumed	.724	.398	3.326	62	.001	8.75000	2.63070	3.49130	14.00870
	Equal variances not assumed			3.326	61.872	.001	8.75000	2.63070	3.49108	14.00892

The significance value of the Independent sample T-test is 0.001, less than 0.05, so$H0$ rejected. This indicates that the average mathematical literacy ability score of experimental class students is better than that of the control class. Based on the four hypothesis tests that have been carried out, it can be concluded that the application of the PBL model with an ethnomathematics approach based on local culture is effective in increasing students' mathematical literacy skills. The PBL model influences students' mathematical literacy abilities. So the PBL model with an ethnomathematics approach based on local culture can be a solution to improve students' mathematical literacy skills. Some opinions state that the PBL model can improve other mathematical abilities. Tabun et al (2020) stated that students' mathematical literacy skills in PBL model learning are better than students in learning without a PBL model. Pamungkas and Franita (2019) stated that learning mathematics using Problem Based Learning can improve students' mathematical literacy skills. Pratiwi and Ramdhani (2017) stated that the increase in the mathematical literacy skills of students who received the problem based learning (PBL) learning model was significantly better than the increase in the mathematical literacy skills of students who received regular learning.

Herutomo et al (2020) stated that the PBL model with a realistic mathematical approach is effective in increasing students' mathematical literacy. Dinata (2022) stated that the application of the PBL model in the learning process of students experienced an increase in mathematical literacy skills from the lowest of 7.65% to the highest of 48.27%, resulting in a very significant increase, namely 29.0138%. Suciawati et al (2023) stated that the problem-based model can improve students' mathematical literacy skills better when this learning model is applied, compared to using conventional learning models. Muharomah and Setiawan (2020) stated that increasing the mathematical literacy skills of junior high school students who use the Problem Based Learning learning model is better than increasing the mathematical literacy skills of students using conventional learning, achieving mathematical literacy skills of junior high school students who use the Problem Based Learning learning model is better than achievement of students' mathematical literacy skills with conventional learning, and students' attitudes towards learning using the positive Problem Based Learning model. Ornawati et al (2023) stated that the Problem Based Learning learning model can be used as a learning model that can be used to improve mathematical literacy skills.

Hidayat et al (2019) concluded that there is a positive and significant relationship between mathematical disposition in implementing PBL and mathematical literacy abilities. This means that mathematical disposition in implementing PBL can be used to predict the level of mathematical literacy ability in mathematics learning. And the mathematical disposition in implementing PBL has an influence of 37.8% on mathematical literacy abilities. Yanuarto and Qodariah (2020) stated that students with high learning independence in solving problems tend to be able to meet all indicators of mathematical literacy ability. Students with moderate learning independence are quite capable of meeting indicators of mathematical literacy abilities, namely formulating and using mathematical concepts, facts, procedures and reasoning. In the indicators of interpreting, applying and evaluating mathematics results, students with moderate learning independence are less able to correctly conclude the results obtained from the problems given. Meanwhile, students with low learning independence tend not to be able to meet all indicators of mathematical literacy abilities.

The implementation of learning is analyzed based on observations made by teachers of researchers to assess how learning takes place. The results of the observations are then summarized in a learning implementation observation sheet. The observed activities consist of 3 main parts, namely the planning stage (preliminary activities), implementation (core activities), and closing activities. Each stage has several indicators to be assessed by observers. Based on the research results, it is known that at the first to third meetings overall learning was carried out very well with an average score of 4.50.

The first learning meeting using the Problem Based Learning (PBL) model with an ethnomathematics approach based on local culture was in the very good category with an average score of 4.54. Every learning activity can be carried out well, even though they are still in the stage of recognizing student characteristics, the students look enthusiastic and enthusiastic in participating in learning activities. At the second meeting, the learning that took place was also in the very good category, this was shown by the average score on the learning implementation observation sheet of 4.45. During the second meeting, the researchers had a better understanding of the student's character when studying, so it was easier to condition the class. At the second meeting, the tutor's role became more active because they knew what was expected from their role as a tutor. Learning goes according to a predetermined plan. At the third meeting, learning took place more conducively, students already understood their respective roles. The researcher has completely controlled the class and students. The average value of observations by observers is 4.50, which means it is in the very good category. Likewise, at the fourth meeting the enthusiasm and enthusiasm of the students increased. The average value of observations by observers is also in the very good category, namely 4.52.

Students generally respond positively to learning that uses the PBL model with an ethnomathematics approach based on local culture. A positive response shows that students are interested and happy to use the learning components used, and feel updated with the learning components used (Simanjutak & Imelda, 2018). Students are also interested in repeating learning in the next lesson. In the aspect of students' attitudes towards learning mathematics, the indicator of interest in mathematics lessons received a positive response, this shows that the participants have an interest in mathematics lessons, although there are some students who do not show the same thing. Students are well aware that studying mathematics is very useful in everyday life, this can be seen from the very positive response to the indicator of knowing the benefits of studying mathematics.

Student responses are also seen based on aspects of students' attitudes towards learning using the PBL model with an ethnomathematics approach based on local culture. Students respond positively to mathematics learning using the PBL model with an ethnomathematics approach based on local culture. Students stated that the learning carried out was different from usual learning, it could make them happy, interested in mathematics lessons, and more motivated to learn mathematics.

Students also responded positively to indicators of the benefits of participating in mathematics learning using the PBL model with an ethnomathematics approach based on local culture. Learning like this can make it easier for students to understand the material, understand the application of mathematics in everyday life, be able to express opinions, and be able to discuss with friends. The learning process does not make students stressed and tense in learning, making them not lazy to pay attention to the material, making it easier for students to understand the material. In accordance with the opinion of Yuliani and Saragih (2015), culture-based mathematics learning can increase the effectiveness of mathematics learning in certain areas.

The analysis of mathematical literacy is reviewed based on learning independence, namely, a) subjects with low learning independence are generally unable to fulfill the stages of the PBL learning model, namely the orientation stage, organizing stage, guiding investigations, developing and presenting work results, analyzing and evaluating the problem solving process. b) subjects with moderate learning independence can generally fulfill several stages of PBL learning, namely the orientation stage, organizing stage, guiding investigations. Meanwhile, the stages of developing and presenting work results, analyzing and evaluating the problem solving process cannot be fulfilled properly by the subject. c) subjects with high independence can fulfill the PBL stages well, namely the orientation stage, organizing stage, guiding investigations, developing and presenting work results, analyzing and evaluating the problem solving process.

▪ CONCLUSION

Based on the results of the research and discussion, it was concluded that student learning independence is directly proportional to students' mathematical literacy abilities. Students with low learning independence generally cannot fulfill the stages of the PBL learning model, which means their mathematical literacy abilities are also low. Subjects with moderate learning independence can generally fulfill several stages of PBL learning, which means their mathematical literacy abilities are still relatively moderate. Subjects with high independence can fulfill the PBL stages well, which means their mathematical literacy abilities are also high. The Problem Based Learning (PBL) learning model with an ethnomathematics approach can improve mathematical literacy skills.

The model of students' mathematical literacy skills in classes that uses the Problem Based Learning Model assisted by modules with an ethnomathematics approach based on local culture can be used as an alternative learning model applied to students. Students with different categories of independence have different mathematical literacy abilities, therefore teachers need to provide more motivation and attention to students with low independence, so that they can solve problems well. There is a need for further research on the extent to which independence affects students' mathematical literacy abilities.

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