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Cultural Fusion in Mathematical Literacy: Enhancing Skills through Pisa-Equivalent Questions with Traditional Elements

Vera Dewi Susanti[1], Yohannes Leonardus Sukestiyarno[2]*, Iqbal Kharisudin[3], Arief Agoestanto[4]

Abstract

This research explores integrating traditional cultural elements into PISA-equivalent mathematics questions to improve students' mathematical literacy. Increasing cultural understanding and appreciation is essential in the educational environment. This research aims to foster deeper connections between students' cultural backgrounds and mathematics learning by incorporating traditional elements from various cultures into mathematics assessments. This type of research is research and development. The research results show that the questions developed are practically valid and ready to be tested. Findings show that incorporating traditional elements into math problems positively impacts students' engagement and understanding of math concepts.

Keywords: *Cultural Fusion, Mathematical Literacy, PISA-Equivalent Question, Traditional Element*

Introduction

Minister of Education and Culture Nadiem Makarim, in 2021, changed the national exam to a National Assessment. This National Assessment will consist of three parts: minimum competency assessment, character survey, and learning environment survey. The National Assessment marks a paradigm shift in educational evaluation. Improving the education evaluation system is part of the Merdeka Belajar policy, whose main aim is to encourage improvements in the quality of learning and student learning outcomes. Mathematical literacy is one aspect of the minimum competency assessment, part of the National Assessment benchmarks. Therefore, mathematical literacy skills are an essential ability for every student to have.

Good mathematical literacy skills are one of the goals to be achieved in mathematics because literacy and achievement are interrelated to support learning (Brock et al., 2018; Cameron et al., 2019; Schmitt et al., 2017). Mathematical literacy is the ability of an individual to identify and formulate (Oktiningrum et al., 2016), using and interpreting mathematics in different contexts, including the ability to think mathematically and use concepts, procedures, and facts as tools to describe, explain and predict phenomena or events (Niss & Jablonka, 2020; OECD, 2013). This means that mathematical literacy can also help individuals recognize the role of mathematics in the real world and as a basis for consideration and decision-making needed by society.

According to PISA (OECD, 2019), mathematical literacy is student activity in formulating,

[1] Universitas Negeri Semarang, Indonesia, 0000-0002-8195-3481, Email: veras3mathedu@students.unnes.ac.id
[2] Universitas Negeri Semarang, Indonesia, 0000-0003-2377-5872
* Corresponding Author: Email: sukestiyarno@gmail.com
[3] Universitas Negeri Semarang, Indonesia, 0000-0002-1156-4974, Email: iqbalkharisudin@mail.unnes.ac.id
[4] Universitas Negeri Semarang, Indonesia, 0000-0001-8070-200X, Email: arief.mat@mail.unnes.ac.id

using, and interpreting different contexts to solve problems. According to Umbara and Suryadi, (2019), mathematical literacy includes thinking and reasoning, argumentation, communication, modeling, posing and solving representative problems, using language and symbolism, formal and technical operations, and assistive devices. Meanwhile, Kusuma et al., (2022) classify mathematical literacy as interpreting, applying, and evaluating mathematical results, using concepts, facts, procedures, and mathematical reasoning, and formulating situations mathematically. In contrast, Cheema (2018) categorizes mathematical literacy activities by identifying questions, explaining scientifically (communication), and using scientific evidence. This is because mathematical knowledge is essential for students to understand mathematics and not only to master its content but also to use arguments, concepts, facts, and mathematical tools to solve everyday problems. It is also essential to do so, requiring students to communicate their problems. They face and explain mathematical concepts (Cameron et al., 2019; Fointuna, 2021; OECD, 2016). From several definitions by experts, mathematical literacy is the ability of students to identify, interpret, and use symbolic operations, concepts, procedures, and mathematical reasoning to formulate and apply mathematics in solving problems and evaluating mathematical results.

According to PISA (OECD, 2019) mathematical literacy is student activity in formulating, using, and interpreting in different contexts to solve different problems. According to Umbara & Suryadi, (2019), mathematical literacy includes thinking and reasoning, argumentation, communication, modeling, posing, and solving representative problems, using language and symbolic, formal, and technical operations, and using assistive devices. Meanwhile, Kusuma et al., (2022) classify mathematical literacy with activities of interpreting, applying, and evaluating mathematical results, using concepts, facts, procedures, and mathematical reasoning, and formulating situations mathematically. In contrast, Cheema, (2018) categorizes mathematical literacy activities by identifying questions, explaining scientifically (communication), and using scientific evidence. This is because mathematical knowledge is very important for students to understand mathematics, and not only to master its content, but also to use arguments, concepts, facts, and mathematical tools to solve everyday problems. It is also very important to do so, which means it requires students to communicate their problems. they face and explain mathematical concepts (Cameron et al., 2019; Fointuna, 2021; OECD, 2016).

PISA-based questions are important to familiarize students with contextual problems in everyday life that can be solved mathematically and improve students' literacy skills skills (Noviarsyh Dasaprawira et al., 2019). In addition, PISA requires students to have high-level thinking skills and incorporate students' knowledge in solving a mathematical problem (Oktiningrum et al., 2016). The importance of mathematical literacy is contained in PISA questions because it is needed to deal with issues in life (Efriani et al., 2019). Students' literacy skills through the PISA model questions have three main characteristics: content, context, and competence. Content is material taught in schools as target assessment items, context is a problem or situation in everyday life, and competence is the ability to formulate, use, and interpret mathematics in solving problems (Ahyan et al., 2014).

Indonesian students' mathematics proficiency PISA results ranked 63rd out of 69 countries in 2015 and 74th out of 79 countries in 2018. According to her three recent surveys, Indonesia is still in the bottom ten. This shows that Indonesian mathematics knowledge is deficient. Various studies from various school levels also show that students' mathematical literacy is at a low level (Julie et al., 2017; Kurniawati & Mahmudi, 2019; Rohman et al., 2019; Setiani et al., 2018; Wijayanti et al., 2018). Kamaliyah et al., (2013) found that Indonesian students need help

solving problems that require the ability to learn, reason, and communicate effectively and to solve and interpret problems in various situations. In addition, students are accustomed to developing formal math skills in class, which prevents weaker students from working on problem-based problems such as her PISA problem Novita et al., (2012). Consistent with the statements of Novita and Putra (2016), students are constantly presented with non-routine problems and formal knowledge in class, leaving them needing more mathematical knowledge.

Students will quickly understand the context of the PISA questions through cultural development to make students familiar with PISA standards so that they can increase their mathematics scores at the OECD (Noviarsyh Dasaprawira et al., 2019). The use of culture in learning mathematics has yet to be widely carried out, even though mathematics is realized due to human activities, one of which is culture (Supiyati et al., 2019). The use of culture in schools has yet to apply questions about culture in everyday life. This is based on Noviarsyh Dasaprawira et al. (2019) research, which states that the teacher gives more objective and descriptive questions. Students cannot develop their ideas if the teacher often gives assignments as routine questions in students' math books (Baber, 2011; Wood, 2012). Applying this cultural aspect helps ensure the questions are accessible and understandable to students from various cultural backgrounds. Apart from that, adding elements of local culture, customs, and traditions can form the character that gives the identity of a nation (Mahira et al., 2023).

Researchers used the Indonesian context to familiarize students with PISA standard questions and improve math scores at the OECD level. Several researchers have developed problems like PISA by using contexts in Indonesia, such as the context of COVID-19 (PISACOMAT) (Nusantara et al., 2021) and several Asian Games matches in Indonesia (Nizar et al., 2018; Nusantara et al., 2021; Permatasari et al., 2018; Yansen et al., 2019). In this research, the problems developed incorporate elements of traditional culture in mathematical problems equivalent to PISA to increase students' mathematical literacy and support respect for cultural heritage. It is intended to explore the potential for integrating cultural elements into mathematics problems, to strengthen students' understanding of mathematical concepts, and to build deeper bonds between mathematics learning and students' cultural heritage. It is hoped that this research can provide new insights for educators, curriculum developers, and education stakeholders to create a more inclusive and culturally meaningful approach to learning mathematics and improve the quality of teaching and learning that encourages expected achievement by measuring, analyzing, interpreting, and using performance student data to identify learning need (Mohd Khalid et al., 2023).

Research Methods

This type of research is research and development with a 4-D development model, namely define, design, develop, and disseminate, which refers to the flow of learning device development (Thiagarajan & Semmel, 1974). This 4-D development model is modified into 3-D to define, design, and develop the stages. Based on the development model used in this study, the development procedure implemented was (1) Define: the researcher conducted an initial analysis and learning objectives. (2) Design: The researchers designed traditional cultural-based forms of math questions on the material of multilevel rows and flat shapes to measure students' mathematical literacy. This design is based on the level of mathematical literacy according to PISA and on the essential competencies of multilevel sequences and flat shapes. (3) Develop: This step will produce valid and quality draft questions.

This research was conducted at SMA Kyai Ageng Basyariyah Madiun Indonesia with research subjects in class X. The research instruments used in this study were student response questionnaires, draft questions, and validation sheets. The validation sheet was submitted to two validators: the mathematics teacher and the Mathematics Education lecturer. Student response questionnaire sheets were handed over to students when the trial was completed. The draft question is a math problem on the material of graded sequences and flat shapes for class X based on traditional culture to measure students' mathematical literacy. The questions developed amounted to 6 description questions, which refer to 6 levels of aspects of students' mathematical literacy. Every aspect of the level of mathematical literacy is applied to each item. Data analysis techniques implemented in this study are as follows:

Content Validity

The researcher consulted with experts to evaluate each expression in the developed measuring instrument in terms of the content of the scale or terms of suitability and evaluated each expression according to the opinion of the experts (Rubio, D. M., Berg-Weger, M., Tebb, S. S., Lee, E. S., & Rauch, 2003; Sürücü & Maslakçi, 2020). Validity data was obtained from validation instruments submitted to the validators: three mathematics education lecturers and one mathematics teacher. In obtaining objective results in the calculations that must be carried out to determine content validity, the quality and number of experts have significant importance (Ayre & Scally, 2014). Aiken (1980) formulated a formula to calculate the content validity coefficient with the following formula.

$$V = \frac{\sum s}{[n(c-1)]}$$

In this study, it is said to be valid if the minimum value of v > 0.4 or in the medium category.

Empirical Validity

This empirical validity was carried out using the SPSS tool to determine each item's validity. The results of the calculation of count are compared with rtable at the 95% confidence level, the product can be said to be valid if the results of rcount ≥ rtable.

Reliability

Reliability is the consistency of the questions as a reliable test instrument. Calculating reliability using the alpha formula (Sukestiyarno, 2020) is the following formula.

$$r_{11} = \left[\frac{k}{k-1}\right]\left[1 - \frac{\sum S_b^2}{S_t^2}\right]$$

In this study, it is said to be reliable if the minimum value of r11 is > 0.4.

Practicality

Practicality is obtained by examining student responses based on student response questionnaire instruments. The practicality category is based on student responses.

Table 1: Practicality.

Value	Category
1,0 ≤ x < 1,5	Negative
1,5 ≤ x < 2,5	Negative Tendency
2,5 ≤ x < 3,5	Positive Tendency
3,5 ≤ x < 4,0	Positive

Mathematical Literacy

Analysis of students' mathematical literacy was carried out by looking at the results of trials to measure the level of mathematical literacy achieved by students based on the scores obtained when working on mathematical literacy questions. Table 2 below determines the criteria for students' mathematical literacy scores.

Table 2: Mathematical Literacy.

Score	Category
$80 \leq x \leq 100$	Very high
$60 \leq x < 80$	Tall
$40 \leq x < 60$	Enough
$20 \leq x < 40$	Low
$0 \leq x < 20$	Very low

Findings / Results

This development research uses the development model proposed by Thiagarajan, Semmel & Semmel, namely the 3D development model or define, design, and develop. The development procedure of the development model is as follows.

Define

Preliminary analysis was carried out through interviews with one of the students of SMA Kyai Ageng Basyariyah Madiun Indonesia; it is known that this school implements the Merdeka Curriculum and the material studied by students in class X this even semester is flat shapes and multilevel rows and flat shapes. In this interview, it can also be seen that most students do not know about the cultures that exist in Indonesia. Based on this problem, the researcher is interested in developing math problems in the material of graded rows and flat shapes for class X based on traditional culture to measure students' mathematical literacy.

Traditional culture is expected to help students to know more about various cultures in Indonesia. In addition, the questions are also likely to measure students' mathematical literacy. Mathematical literacy has six levels: level one is the lowest, and level six is the highest. Interviews were also conducted with one of the mathematics teachers, who found that students had different abilities, and the teacher often gave routine questions so that if given additional questions, students had difficulty working on these questions.

At the define stage, it was concluded that students have different abilities, and the teacher often gives routine questions so that if given additional questions, students need help when working on these questions, especially students with low cognitive abilities. In addition, many students still don't know much about traditional culture in Indonesia and don't associate many math problems with elements of traditional culture. Mathematics literacy achievement data also shows that Indonesia's literacy is still relatively low. This is the basis for research on the development of mathematical problems within the context of traditional Indonesian culture to measure mathematical literacy.

Design

The grid preparation in developing this question is adjusted to the Competency Achievement

Indicators on multilevel rows and flat shapes and aspects of mathematical literacy according to PISA. The draft I product development consists of covers, work instructions, Competency Achievement Indicators, levels of mathematical literacy aspects, question grids, multilevel questions, flat shapes based on traditional culture, and solutions. The following presents sample design questions from elements of batik and regional dances.

The grid preparation in developing this question is adjusted to the Competency Achievement Indicators on multilevel rows and flat shapes and aspects of mathematical literacy according to PISA. The draft I product development consists of covers, work instructions, Competency Achievement Indicators, levels of mathematical literacy aspects, question grids, multilevel questions, flat shapes based on traditional culture, and solutions. The following presents sample design questions from elements of batik and regional dances.

n = 1 n = 2 n =3

Figure 1: Tambal Batik.

"Tambal" batik is a typical batik from Central Java, Indonesia, which means "Tambal" (repairing). This can be interpreted as the journey of life, where humans must improve themselves towards a better physical and mental life. In making the "Tambal" batik, one cloth measuring $4cm^2$ requires two triangular batik motifs, as shown in Figure 1. Then, a cloth measuring 8 cm^2 requires eight pieces of triangular batik motifs. If n indicates the number of batik motifs in a triangular shape, then the number of triangular batik motifs = $2n^2$, and the area of the cloth = 4n. Suppose the fabric needed is more comprehensive with the same triangular batik motif as the previous pattern. Which of the number of triangular batik motifs or the area of the cloth is increasing faster? Explain your answer!

Figure 2: Remo Dance.

The Remo Dance is a dance welcoming guests from East Java, Indonesia. This dance can be performed by one person or a group of dancers. At the celebration of the Independence Day of the Republic of Indonesia on August 17, 2023, the arrival of the regent was greeted with a Remo dance consisting of five people forming an isosceles triangle, as in Figure 2. It is known that the height of the front dancers is 150 cm, and the height of the back dancers is 5 cm taller

than the height of the front dancer. The distance between adjacent dancers is 100m. If the stage is widened by 1 meter on each side, what minimum space is provided so the dancers do not collide? What is the ratio of the shortest to tallest dancers?

Develop

The draft I was revised according to expert validator suggestions as follows.

1. The cover of the question development product is given nuances of batik culture and regional dances.
2. Addition of Competency Achievement Indicators and aspects of mathematical literacy level.
3. The questions are more adapted to aspects of mathematical literacy.

Validity

Draft II that has been produced is given to five experts. Expert validators at this stage were three Mathematics Education lecturers and two high school mathematics teachers. The recapitulation of product assessments from expert validators can be seen in Table 3 below.

Table 3: Results of Content Validation.

Question	Average	Criteria
1	0,672	Valid
2	0,714	Valid
3	0,563	Valid
4	0,692	Valid
5	0,556	Valid
6	0,481	Valid

Based on Table 3, the average score for each question from all aspects meets the valid criteria with a high category, and overall, the average validation result is 0.614 so that the product can be tested in the field, but small improvements are still needed based on criticism and suggestions from the validator.

The following is an overview of the results of the revised Draft II of the product based on criticism and suggestions from expert validators.

1. The images presented are not clear.
2. Adding information from pictures so that children know Indonesian culture.

After the revision was carried out by the suggestions for improvement from the two validators, product development questions were produced, categorized as valid, and could fulfill the requirements for conducting product trials.

Empirical validity

At this stage, trials are implemented in class X SMA Kyai Ageng Basyariyah Madiun Indonesia. The analysis results regarding the validity of each item with a r_{table} of 0.355 are in Table 4 below.

Table 4: Empirical Validation Results.

Question	Average	Criteria
1	0,612	Valid
2	0,545	Valid
3	0,489	Valid
4	0,791	Valid

5	0,513	Valid
6	0,608	Valid

Based on Table 4, the results of the rcount in each question are higher than the rtable with a 95% confidence level with a total of 124 students. The problem is empirically valid.

Reliability

Based on the calculation results, the data obtained is r11 = 0.753, so it can be known that reliability is within the high category.

According to Hair JR et al. (2010), the product being developed must be tested for validity and reliability after the product conformity requirements have been met. The validity results show that the average validation result is 0.614, so the product can be tested in the field. However, minor improvements are still needed based on criticism and suggestions from the validator. Empirical validity also shows that the validity of each item is more than the r table of 0.355. Theoretically valid can be seen from the results of the validator's assessment, where almost all validators stated that the questions were reasonable based on content, construct, and language. As for the valid criteria, based on the analysis of the item items and the analysis of the item items, the reliability calculation results obtained data r11 = 0.753 so that reliability can be known. This also corresponds to the reliability of the test instrument fulfilling the reliability, and the results of the construct reliability coefficient are more significant than 0.70 (Gefen et al., 2000; Viladrich et al., 2017). Reliability testing is necessary because it refers to stability and consistency across measurement instruments (Huck, 2011; Miyejav et al., 2023). If the product is valid and reliable, it can proceed to the next stage: product testing.

Practicality

Questionnaires were given to 45 students at the trial stage. Student response questionnaires were given after students completed multilevel questions and flat shapes based on traditional culture. The results of the student response analysis are described in Table 5 below.

Table 5: Practical Results.

No	Criteria	Average	Practical value	Category
1	The questions are based on the material for stepped sequences and flat shapes studied in class X.	3,572	89,3%	Positive
2	The questions presented are easy to do.	2,483	62,4%	Tend Positive
3	The questions given do not contain double meanings (ambiguous).	3,516	87,9%	Positive
4	The questions given have elements of Indonesian culture.	3,674	92,6%	Positive
5	I am challenged to do the questions given.	3,152	71,2%	Tend Positive

Practical results show more positive responses to the development of math problems based on Indonesian traditional culture. Two statements tend to be positive, namely, the indicators that the questions given are easy to work on and students are challenged to work on the questions given. The questions developed are questions that have a difficulty level equivalent to PISA so more questions require understanding and reasoning so that students need to be habituated and motivated to be challenged to solve problems when given questions.

Mathematical Literacy

Table 6 below shows the results of measuring the mathematical literacy of Class X students at SMA Kyai Ageng Basyariyah Madiun Indonesia.

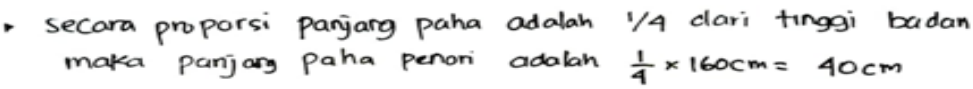
Table 6: Mathematical Literacy Results.

Information	Level					
	1	2	3	4	5	6
Score	93,356	89,865	72,423	38,192	24,563	3,184
Criteria	Very high	Very high	High	Low	Low	Very low
Average	53,56					
Criteria	Enough					

Based on Table 6, the measurement of the mathematical literacy of Class X students at SMA Kyai Ageng Basyariyah Madiun Indonesia, the average student's mathematical literacy is included in the "Enough" criteria.

Levels 4, 5, and 6 questions show that students still struggle solving problems. This is due to students' lack of reasoning in understanding the questions that have been presented.

In proportion, the length of the thigh is ¼ of the body height, so the size of the dancer's thigh is ¼ x 160 cm = 40 cm.



In the student's answer, the student argues that the length of the human thigh is ¼ of the body's height. It is not based on solid references. The problems presented do not mention this as the basis for working on the questions. Solving mathematical problems must be mathematical and conceptualized clearly, not making conjectures or arguments without being based on accurate information. This shows that students have not involved reasoning and argumentation properly in designing problem-solving strategies. This strategy is presented in the form of precise mathematization. Communication skills have also been well involved in selecting and identifying problem-solving elements. Even though the student's answer sheet has not yet received a total score, he has engaged some basic mathematical skills in completing it. Another ability that is observed is the involvement of critical thinking processes. In this case, the student has reached the assessment stage, which includes selecting relevant information/concepts/ideas, connecting between the information/codes/concepts, linking with relevant information/codes/concepts, and connecting with previous problems. Based on this, it can be concluded that the questions developed have potential effects involving reasoning and argumentation, designing strategies, representation, and critical thinking for students.

Conclusion

Based on the results of research on the development of math questions in the material of multilevel rows and flat shapes for class X based on traditional culture in mathematical literacy through 3D model development research or define, design, and develop with activities in the form of validation and product trials in the field. The product of developing traditional math-based questions to measure students' mathematical literacy is valid with a score of 0.614 and empirically valid. The reliability value shows r11 = 0.607, so the questions are reliable. The

student response questionnaire showed a positive response for math literacy quite enough.

The limitation of this research is that the trial was only carried out in class X in one school, only one question was developed at each level of mathematical literacy specifically for material on tiered rows and flat figures, traditional culture was taken from regional dances and batik, and the research was developed in only three stages, namely define, design, and develop.

In future research, a more comprehensive trial is needed involving more schools and a variety of questions both in the field of mathematics or other subjects related to more diverse traditional cultures, considering that many regional cultures have not been explored, such as traditional houses, traditional clothing, typical food and It is hoped that further research can be developed to 4D (define, design, develop and disseminate).

Based on the research results, the advice given in this research is that teachers should use PISA model questions with a traditional cultural context as an alternative to measure students' mathematical literacy and increase students' knowledge regarding conventional culture, which needs to be remembered. Meanwhile, students should be able to independently utilize PISA model questions with a traditional cultural context to evaluate their abilities to continue improving their learning outcomes.

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