TIRTAMATH: Jurnal Penelitian dan Pengajaran Matematika
Volume 6 Nomor 1 Tahun 2024
ISSN 2885-9890 (print) | ISSN 2720-9083 (online)
https://jurnal.untirta.ac.id/index.php/Tirtamath/index

Development of mathematical literacy instruments using batik Banten context for junior high school students

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Article History:
Received: May 08, 2024
Revised: June 03, 2024
Accepted: June 20, 2024

Keywords:
Banten Batik; Instrument; Mathematical Literacy.

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Abstract: This research aims to develop and see the potential impact of a valid and reliable mathematical literacy instrument using the Banten Batik context for junior high school students. The subjects of this research were junior high school students at SMPN 7 Serang City. This research uses the Research and Development (R&D) Plomp model which consists of 5 stages, namely self evaluation, expert reviews, one to one, small group, and field test. This research produced eight mathematical literacy instruments using the Banten Batik context which correspond to the level of mathematical literacy according to PISA and are valid and reliable. The instrument developed has a potential impact seen from students' ability to: (1) use basic algorithms, formulas and procedures, (2) follow instructions that have been given, (3) explain an operation and respond in a simple systematic form, (4) demonstrate understanding basics about functional relationships, (5) interpreting and using representations, (6) solving problems with undefined models obtained from reasoning abilities, (7) designing procedures through combining mathematical knowledge that is not stated explicitly in the problem, (8) mastering symbolic mathematical operations and formal and can explain the reasons for decision making in relation to the initial solution and problem.

INTRODUCTION

World civilization has entered the 21st century where the skills needed to be able to adapt and be able to compete in this century are also developing. One of the basic literacy skills needed to adapt and compete in the 21st century is mathematical literacy skills(Habibi & Suparman, 2020).

Mathematical literacy ability is the ability where a person can formulate, use, interpret mathematical concepts, procedures and facts in various contexts including the context of everyday life.(Sari, 2015). Even though mathematical literacy skills are a very important ability for a person to have, in reality students in Indonesia still have very few mathematical literacy skills. This is evident based on the assessment of mathematical literacy abilities through PISA (Program for International Student Assessment) held by the OECD (Organization for Economic Cooperation and Development) in 2022 which stated that there was a decline in the mathematical literacy abilities of Indonesian students which can be seen

from the decreasing average score to 366 in the mathematics category(OECD, 2023). Seeing this ironic fact, it is necessary to increase mathematical literacy skills in Indonesia.

One of the reasons why mathematical literacy skills in Indonesia are still low is that the way it is presented is still monotonous from abstract to concrete concepts and does not present contextual problems that exist in everyday life so that mathematics does not appear to be related to everyday life.(Kehi et al., 2019). On the other hand, mathematical literacy skills are very necessary in everyday life because mathematical literacy skills are the ability to use, formulate and interpret mathematical knowledge concepts in everyday life so it is important to present contextual problems in mathematics learning with the aim of growing the ability to interpret and formulate related mathematical knowledge with the context of problems in everyday life(Nurkamilah et al., 2018).

One of the contextual problems that can be presented in mathematics learning in an effort to improve mathematical literacy skills is the local cultural context (Mahpudin & Yuliati, 2019). This is supported by the results of research conducted by Kehi, Zaenuri, and Waluya (2019) which states that mathematics learning that uses a cultural context is easier to understand because it combines daily activities with mathematics learning. The results of this research are also in line with the results of research conducted by Mahpudin and Yuliati (2019) which stated that students will better understand the relationship between mathematics and their daily activities. if mathematics learning is wrapped in a cultural context. Furthermore, Fajriyah's (2018) research stated that learning mathematics which is linked to the cultural context can help students build mathematical knowledge based on their own cultural environment. This makes it easier for students to understand mathematical concepts because they are linked to something close to them. One of the cultural products that is close to students is batik.

Batik is one of the local cultures that can be presented and linked to mathematics learning because it is close to students' daily lives. Batik is a typical Indonesian patterned cloth resulting from the thoughts and expressions of the artists who created it(Safira et al., 2021). Banten Batik is an example of batik that has a typical Banten regional pattern. The style contains the philosophy of the Banten sultanate because the history of Banten cannot be separated from the history of the various sultanates that were once established in Banten. The patterns on Banten Batik can be presented in mathematics learning as a context for real problems that are close to students' daily lives.

Based on the background that has been described, this research aims to develop a mathematical literacy instrument using the Banten Batik context for junior high school students that is reliable and reliable and looks at the potential impact of the instrument developed.

METHOD

Approaches and types of research

The research method used in this research is Research and Development (R&D) using the Plomp model. The Plomp model has five stages, namely the self-evaluation stage, expert reviews, one-to-one, small group, and field test. This research refers to the article entitled Mathematics Literacy Task on Number Pattern Using Bengkulu Context for Junior High

School Students written by Susanta, Sumardi, Susanto, and Retnawati (2023) as well as an article entitled Developing PISA-like Math Problems in The Content of Space and Shape Through The Context of Historical Buildings written by Aini, Zulkardi Putri and Yaniawati (2022).

Location and Research Subjects

This research was conducted at SMPN 7 Serang City. The research subjects in this study were 6 students for the one to one stage, 12 students who had low, medium and high mathematics abilities for the small group stage, and 164 students for the field test stage.

RESULTS AND DISCUSSION

Research result

1. Self evaluation stage

   This stage begins with conducting a literature study regarding the PISA instrument which is used as a reference through the 2012 and 2022 PISA digital books as well as three articles regarding the development of the PISA instrument. Next, data was collected by conducting an interview with Nadia as one of the Banten Batik craftsmen since 2020 in Serang City, precisely on Jl. Bhayangkara, Cipocok Jaya, Serang City, Banten Province to obtain actual data about Banten Batik which will be used as context for the instrument to be developed. The results of the literature study and field study obtained a mathematical literacy instrument in the form of a first prototype.
2. Expert reviews stage

   After the first mathematical literacy instrument prototype has been created, the next step is to carry out validation to see whether the instrument created is valid using the Aiken index. The following are the results of the validation of the mathematical literacy instrument:

Table 1. Validation Results

No.	Aspect	Value	Interpretation
1.	Content	0,82	Valid
2.	Language	0,81	Valid
3.	Construct	0,81	Valid

The validator's comments and suggestions were used as improvement notes for the second instrument prototype. The validator comments and suggestions are listed in the table below:

Table 2. Validator Comments and Suggestions

No.	Validator	Comments dan Suggestions
1.	Dr. Novaliyosi, M.Pd. (lecturer in the mathematics	Instructions for question number 6 are clarified, provide

No.	Validator	Comments dan Suggestions
	education department at UNTIRTA)	information on using a piece of paper
2	Andi Siti Aminah, S.Pd., Gr. (mathematics teacher at SMPN 7 Serang City)	Correct the answer key number 7
3.	Wulan Sari Silvana Dewi, S.Pd., Gr., (mathematics teacher at SMPN 7 Serang City)	The questions as a whole are in accordance with the PISA question requirements. Contains mathematical literacy skills and is made interesting and contextual using Banten batik. Question number 1 is explained as what percentage of the number of pink and black rhombus shapes. Improve the writing order

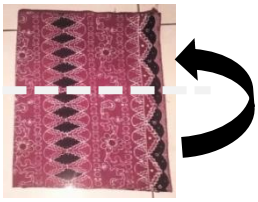
Based on validator 1's suggestion, the instructions for question number 6 were clarified, information for using a piece of paper was added to the instructions. Therefore, improvements to question number 6 are shown in the following bold text:

Check out the steps of batik cloth creation below!

Here are the instructions for making a book cover from batik cloth:

1. Prepare a piece of batik cloth measuring 65 cm x 27 cm.
2. Fold the fabric in half sideways **from right to left** as shown by the dotted lines in the image below.

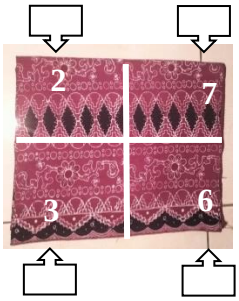
3. Fold the fabric in half **from bottom to top** as shown by the dotted line in the image below.



4. Cut the bottom as shown by the dotted line in the image below

The result of the fabric that has been cut and numbered can be seen in the picture below (the white line indicates the point where the fabric was cut).

Show the pages behind pages 2, 3, 6, and 7 by writing the page numbers 1, 4, 5, and 8 in the empty boxes below! **Explain your answer!**



Notes: Use a piece of paper instead of batik cloth for the trial!

Based on validator comments, there are 2 answer keys to question number 7 that need to be corrected. Therefore, the answer key for question number 7 has been revised as shown in the following bold text:

Yes. Proof:

Since the mould is only 20 cm x 15 cm, and the fabric to be printed is 40 cm x 40 cm, it is necessary to calculate the area first.

Area of canting stamp: 20 cm x 15 cm = 300 cm

The area of the handkerchief fabric you want to make: 40 cm x 40 cm = 1600 cm

$\frac{\text{Area of canting cap}}{\text{Area of handkerchiefs}} = \frac{1600\text{ cm}}{300\text{ cm}} = 5{,}3$ cm (rounded to 5 cm)

Number of black coloured rhombuses: 4 x 5 = 20

Number of pink coloured rhombuses: 8 x 5 = 40

Number of blue coloured rhombuses: 12 x 5 = 60

The total number of rhombuses is 120

So the percentage of  **is** $\frac{20}{120} x\ 100 = 16.67\%$

Based on validator 3's comments, there are words that need to be corrected according to the rules in questions number 1, 4, and 7. Therefore, improvements to questions number 1, 4, and 7 are shown in the following bold text:

Question number 1

Look at the picture and paragraph below to answer the questions correctly!

One of the techniques in batik is the stamp technique. Batik made with this technique is called stamped batik. Batik cap is made using a canting cap made of

copper. The picture above is an example of a canting cap mould measuring 20 cm x 15 cm.

Based on the information above, what is the **percentage** of the number of buildings  and buildings  on the canting cap mould? Explain your answer!

Question number 4

Look at the picture and paragraph below to answer the questions correctly!

One of the techniques in batik is the stamp technique. Batik made with this technique is called stamped batik. Batik cap is made using a canting cap made of copper. The picture above is an example of a canting cap mould measuring 20 cm x 15 cm.

Based on the information above, if Andi stamped 3 times consecutively sideways on a cloth using the mould, what is the **percentage** of the number of buildings  and buildings  on the canting cap mould? Explain your answer!

Question number 7

Look at the picture and paragraph below to answer the questions correctly!

One of the techniques in batik is the stamp technique. Batik made with this technique is called stamped batik. Batik cap is made using a canting cap made of copper. The picture above is an example of a canting cap mould measuring 20 cm x 15 cm.

Based on the information above, if you want to make a handkerchief measuring 40 cm x 40 cm with the motif as in the picture with the stamp technique, is the **percentage** of the building  less than 60%? Explain your answer!

3. One to one stage

The one to one stage was carried out on 6 students in grades 7 and 8 who were members of the extracurricular math club at SMPN 7 Serang City on March 5 2024. The second instrument prototype was given to the six students to work on. One student works on one number except for continuous instrument numbers such as numbers 1, 4 and 7. Because these three numbers have continuous questions, all three numbers are worked on

by one student. After students work on the instrument, each student will be interviewed one by one to see whether they understand the question so they can answer the question and whether the images or stimuli provided are clear enough. Here are the answers from some of the students interviewed:

Student S*: Yes ma'am*
Researcher*: Do you understand the question?*
Student S*: Understand ma'am*
Researcher*: Can you answer the questions?*
Student S*: I was confused ma'am because I didn't know the meaning of digits*
Researcher*: Is the picture shown clear?*
Student N*: Yes ma'am*
Researcher*: Do you understand the question?*
Student N*: Understand ma'am*
Researcher*: Can you answer the questions?*
Student N*: At first I couldn't answer question number 6 if I just imagined it so I used paper because the instructions still made me confused.*

The results of student interviews at the one to one stage were used as improvement notes for the third instrument prototype. Based on interviews from student S, the word digit in the answer choice for question number 3 is confusing. Therefore, improvements to question number 3 are indicated by the following bold text:

Look at the information below to answer the questions correctly!

Batik Motif Sabakingking prima material	Batik Motif Kawangsan prisima material	Batik Motif Pasulaman satin material
		
175.000	275.000	600.000

Nia totalled the three prices of the fabrics using a calculator and the result she got was:

510.000

Nia's answer on the calculator was wrong. She made a mistake. Which mistake did she make? Explain your answer!

A. Nia enters one of the prices repeatedly twice
B. Nia forgot to enter one of the prices
C. Nia did not enter the last **number** of one of the prices
D. Nia subtracted one of the prices

4. Small group stage

The small group stage was carried out on 12 students in grades 7 and 8 who were members of the extracurricular math club at SMPN 7 Kota Serang on March 21 2024. These twelve students were not among the 6 students in the one to one stage. The twelve students were randomly selected with different abilities from low, average and high according to the criteria for achieving learning goals set by the school. The selected students will work on a third instrument prototype. Two students will work on the same number except for continuous instrument numbers such as numbers 1, 4 and 7. Because these three numbers have continuous questions, there are two students each working on these three numbers. After students work on the instrument, each student will be interviewed one by one to see whether they understand the question so they can answer the question and whether the images or stimuli provided are clear enough. Here are the answers from some of the students interviewed:

Researcher: *Is the picture shown clear?*
Student A: *Yes ma'am*
Researcher: *Do you understand the question?*
Student A: *I understand question number 2 but I'm confused about how much fabric to measure*
Researcher: *Can you answer the questions?*
Student A: *At first I couldn't, ma'am, because I was confused about how much fabric to measure, but after asking you, I could*
Researcher: *Is the picture shown clear?*
Student I: *Yes ma'am*
Researcher: *Do you understand the question?*
Student I: *Understand but you have to read it again to find the question because there are so many sentences*
Researcher: *Can you answer the questions?*
Student I: *Yes, ma'am*
Researcher: *Is the picture shown clear?*
Student N: *Yes ma'am*
Researcher: *Do you understand the question?*
Student N: *Understand ma'am*
Researcher: *Can you answer the questions?*
Student N: *I was confused about what to do to answer question number 6 but after repeatedly following the instructions I could*

The results of student interviews at the small group stage were used as improvement notes for the fourth instrument prototype. Twelve students in the small group stage were again given the same questions on April 29 2024 to test the reliability of the instrument. Student A who at the small group stage worked on questions number 1, 4 and 7 will also work on the same questions during the reliability testing and so on until the 12th student. An instrument is said to be reliable if the student's answers before the reliability test and after the reliability test have a correlation seen from the score obtained by the student. The correlation between the answers is calculated using Pearson correlation. The correlation between students' answers is as follows:

Table 1. Reliability Test

n	16
r	0,85
Correlation	High

5. Field Test Stage

The field test stage was carried out on 165 students. At this stage students are given the fourth prototype literacy instrument. All students in one class will work on one instrument number except for continuous instrument numbers such as numbers 1, 4 and 7. Because these three numbers have continuous questions, there is one class where each student works on all three numbers. Based on Susanta et al (2023), assessment is categorized into high criteria if the student's response is complete and correct, medium criteria if it is incomplete/low level, and low criteria if the response indicates not doing inductive thinking. The number of answers from students who have worked on the instrument is in the following table:

Table 2. Percentage of Student Responses to the Instruments Developed

Question Number (Level)	Explanation of mathematical literacy levels	Number of students working	High Criteria (Percentage)	Medium Criteria (Percentage)	Low Criteria (Percentage)
1 (1a)	Students can answer questions with simple context using basic algorithms, formulas and procedures to solve problems	27	24 (88%)	2 (8%)	1 (4%)
2 (1b)	Students can carry out simple calculations following the instructions given in the form of tables or graphs clearly	32	18 (56%)	12 (38%)	2 (6%)
3 (1c)	Students are able to follow instructions that explain one operation and respond in a very short and simple systematic form	30	18 (60%)	10 (33%)	2 (7%)
4 (2)	Students demonstrate a basic understanding of functional relationships as well as devise simple strategies to solve problems	27	16 (59%)	6 (22%)	5 (19%)
5 (3)	Students can interpret and use representations based on information and reason directly	33	26 (79%)	6 (18%)	1 (3%)
6 (4)	Students can solve problems with undefined models obtained from reasoning skills	17	4 (24%)	8 (47%)	5 (29%)
7 (5)	Students can solve problems by designing procedures through combining mathematical knowledge that is not stated explicitly in problems for complex situations	27	10 (37%)	10 (37%)	7 (26%)
8 (6)	Students have mastery of symbolic and formal mathematical operations and can explain the reasons for making decisions regarding solutions and initial problems	26	3 (11%)	14 (54%)	9 (35%)

Discussion

The results of this research indicate that the instrument developed has a potential impact on developing students' mathematical literacy skills. This capability supports the goals of an independent curriculum which was created to adapt and compete in the 21st century in Indonesia. For example, in instrument number 4, students are asked to formulate the shape of a batik stamp print and then calculate the percentage of flat shapes from the batik motif to answer the question. Through this instrument students are asked to use various strategies to solve problems(Dinarti et al., 2023).

Doing assignments in learning can improve students' mathematical knowledge and mathematical literacy skills(Rachmawati et al., 2021). The instruments developed support aspects of mathematical literacy as well as levels of mathematical thinking through students' problem solving processes (Baroroh et al., 2019). Rimma Nyman Research (2016) shows that learning tasks can be interesting if they use the right context. Banten batik is the appropriate context for use in the mathematical literacy instrument developed in this research(Safira et al., 2021).

The use of local cultural context in this research has an impact on student literacy. Apart from that, this context also helps students in developing problem-solving strategies. This is in accordance with what Mahpudin and Yuliati said (2019) in his research that using the local cultural context as a problem in mathematics assignments makes students learn more meaningfully. Contexts related to everyday life can stimulate students' creativity and critical thinking abilities, as can be seen from how students create problem-solving strategies through the activity of observing stimuli to obtain information. Activities working on real-world context-based instruments can develop students' literacy skills. This is important to help students explore ideas and mathematical thinking abilities(Widjaja, 2013). The use of images as stimuli in the instruments developed also supports students' literacy skills. This is in accordance with the research results Hoogland et al., (2018) that pictures can help students get visual information to understand problems.

CONCLUSIONS

This development research produced 8 (eight) mathematical literacy instruments using the Banten Batik context which correspond to the level of mathematical literacy according to PISA. This instrument has been tested for validity using the Aiken index of 0.82, where this value can be said to be valid. The reliability of the instrument was developed using the test-retest method which produced a value of 0.85 so it can be said to have a high correlation, which means the instrument is reliable..

The potential impact of the instrument being developed is high on the process: (1) using basic algorithms, formulas and procedures to solve problems, (2) following instructions that have been given in the form of tables or graphs clearly, (3) explaining one operation and responding in a very short and simple systematic form (4) demonstrate a basic understanding of functional relationships and design simple strategies for solving problems, and (5) interpret and use representations based on information and direct reasoning. The potential impact of the instrument being developed is classified as moderate in the process of: (1) solving problems with undefined models obtained from reasoning skills, (2) designing procedures through

combining mathematical knowledge that is not stated explicitly in problems for complex situations, and (3) have mastery of symbolic and formal mathematical operations and can explain the reasons for decision making in relation to the initial solution and problem. The context used in this instrument is only limited to Banten Batik. Therefore, the suggestion for further research is to expand the boundaries of using context in instruments because instruments that use local cultural contexts contribute as a learning resource in improving mathematical literacy skills in Indonesia, one of which is facing the PISA test.

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