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Jambi *Batik* Pattern: Developing PISA-Like Mathematics Problems

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Abstract: This study aims to develop valid and practical PISA-like mathematics problems contextualized within Jambi batik patterns. A design research methodology in the form of development studies was chosen for this study, which consists of preliminary, prototyping, and assessment phases. The prototyping phase included self-evaluation, expert review, one-on-one evaluation, small group evaluation, and field testing. The participants were 30 eighth-grade junior high school students in Jambi City. Data were collected through walk-throughs, tests, and questionnaires. The study produced valid PISA-like mathematics problems within the context of Jambi batik patterns. They were valid in terms of content, aligning with the PISA framework: construct, as they conformed to the eighth-grade curriculum; language, by adhering to the PUEBI (General Guidelines for Indonesian Spelling); and avoiding ambiguity. The problems were also deemed practical, as they were usable, understandable, and engaging for students. The findings of this study were that the questions produced had a potential effect, in enhancing students' mathematical literacy skills.

Keywords: PISA-like mathematics problems; Jambi *batik* patterns; design research

INTRODUCTION

One of the essential skills that all students must have is mathematical literacy. It refers to an individual's ability to apply mathematical reasoning to formulate, employ, and interpret mathematical concepts to solve problems related to real-world contexts or everyday life (OECD, 2018b). Individuals with strong mathematical literacy skills can apply their mathematical knowledge to solve everyday problems (Gustiningsi et al., 2023; Kemendikbud, 2017; Stacey & Turner, 2015). In addition, mathematical literacy is an important focus of the Programme for International Student Assessment (PISA), which measures the students' capacity to apply mathematical concepts to solve problems. Based on the results of PISA in 2022, Indonesia is ranked 70th out of 81 countries. Indonesia's average mathematical literacy score is 366, compared to the average score achieved by OECD countries, which is 472 (OECD, 2023). This indicates a low level of mathematical literacy. Similarly, previous studies have shown that Indonesian students have not been able to formulate questions from the problems given (Gustiningsi, Indra

Putri, et al., 2024; Gustiningsi, Putri, et al., 2024a), have difficulty interpreting information in the form of images in the problems given (Gustiningsi & Somakim, 2021), and can only solve basic-level questions (Gustiningsi, 2015; Gustiningsi & Somakim, 2021; Pratiwi, 2019; Stacey, 2011; Widjaja, 2011). According to preliminary research conducted at a school in Jambi City, data was obtained that students were unable to solve PISA questions properly, had difficulty constructing geometric shapes, failed to write arguments in each answer, and struggled to interpret the meaning of the questions.

One contributing factor to students' low mathematical literacy skills is the lack of experience in solving problems relevant to real-life context (Lisnani et al., 2025; Putri & Zulkardi, 2020). Based on the interviews with teachers, the questions given to students during learning are routine. This is also related to the lack of availability of contextual questions in mathematics textbooks(Gustiningsi, Putri, Zulkardi, & Hapizah, 2022; Gustiningsi & Somakim, 2021; Wijaya et al., 2015a). Wahyuni et al. (2023) analyzed the content of mathematical literacy questions in the Merdeka Curriculum mathematics textbook and found that 69% of the questions were included in levels 1, 2, and 3. In addition, the content also does not include all content in mathematical literacy according to the PISA framework (Wijaya et al., 2015b).

One approach to addressing low mathematical literacy is the development of learning resources in the form of PISA-like mathematics problems in everyday life contexts or situations (Gustiningsi, Putri, Zulkardi, Sari, et al., 2022; Zulkardi & Kohar, 2018). Galen & Eerde (2019) stated that providing contextual problems can stimulate students' engagement and learning. Incorporating real-life situations into the development of PISA-like mathematics problems can increase the vocabulary of questions that can be used by teachers in learning and support students' mathematical literacy skills (Gustiningsi et al., 2023; Gustiningsi, Putri, Zulkardi, Sari, et al., 2022). A particularly relevant and accessible context for students is local culture (Deda & Maifa, 2021; Muslimahayati, 2020).

Internationally, it is also recognized that there is a need for integration of local culture in mathematics education (Suherman & Vidákovich, 2024). Several studies have demonstrated integration of local culture in mathematics education, such as the South African curriculum (Madusise, 2015), Malaysian culture elements in permutations and combinations (Ismail & Ismail, 2010), cultural contexts in the South Pacific and Northern Brazil (François & Fantinato, 2018), as well as Nias culture (Ramadhani et al., 2025) and Javanese batik motifs (Hamidah et al. 2024) in Indonesia. These studies highlight that culture can be a medium that connects with mathematics so that students can understand mathematics learning. Therefore, incorporating local culture into mathematics education is essential.

Several studies have developed PISA-like mathematics problems using diverse cultural contexts, such as Minang Kabau (Isnaniah & Imamuddin, 2022), North Sumatran snack (Pangaribuan et al., 2023), Bangka Belitung tourism (Dasaprawira & Aspriyani, 2020), Lampung (Putra et al., 2016), and Yogyakarta tourism (Rokhima et al., 2023). Jambi, a province that is rich in culture and has unique tourism, traditional clothing, batik, and traditional houses, can be used as a context for

PISA questions. Therefore, it is possible to develop PISA questions with the Jambi context to increase the vocabulary of PISA-like mathematics problems. The uniqueness that is used as the context in the PISA questions to be developed is the Jambi batik pattern.

Several studies in Indonesia have explored the use of *batik* patterns in mathematics education. Sofliatin et al., (2024) showed that Pekalongan *batik* motifs can serve as geometry teaching materials in elementary schools after being validated by experts and receiving positive student responses. Meanwhile, Susanti & Budiarto (2020) found that Jonegoroan *batik* motifs demonstrate mathematical literacy concepts such as symmetry and transformation. These works highlight the pedagogical value of indigenous cultural resources in mathematics instruction. However, most have not explicitly aligned with international frameworks such as PISA. In addition, few have focused on the unique characteristics of Jambi batik as a cultural context. This study addresses these gaps by designing and evaluating PISA-like mathematics problems based on the Jambi batik tradition.

Although previous studies have developed PISA-like items using real-world contexts, limited attention has been given to incorporating local cultural elements, such as traditional *batik* patterns, in contextualizing mathematical problems. Most existing studies have not specifically addressed how such cultural integration supports the development of mathematical literacy aligned with PISA. This study addresses this gap by integrating culturally responsive pedagogy with PISA-based problem design.

This study is based on the theory of mathematical literacy as defined by the OECD (2018b), which emphasizes the ability to formulate, employ, and interpret mathematics in real-world contexts. Additionally, the development of items is informed by the construct of culturally responsive pedagogy (Gay, 2002), which promotes the use of instructional materials to enhance student engagement and understanding.

Based on the study's objective, the following research questions are proposed:

1) How can PISA-like mathematics problems be developed using Jambi batik patterns?
2) Are the developed PISA-like mathematics problems valid and practical according to expert valuations and student feedback?

METHOD

Types and Stages of Research

This study employs a design-research approach in the form of development studies (Bakker, 2019). This study aims to produce valid and practical PISA-like mathematical problems. The research was conducted through preliminary, prototyping, and assessment phase (Van den Akker et al., 2007). The stages are outlined as follows:

1) *Preliminary Phase:* The researcher analyzed the curriculum, PISA framework, Jambi batik motifs, and existing PISA problems tested by the OECD. The researcher also gave a pre-test to students to determine their initial knowledge before using the questions developed. Then, the researcher compiled the problems to be developed based on the results of the analysis that had been carried out.

2) *Prototyping Phase:* Prototyping was carried out by following the formative evaluation flow consisting of (a) self-evaluation stage, (b) expert review, (c) one-to-one, (d) small-group, and (e) field test, as in Figure 1.

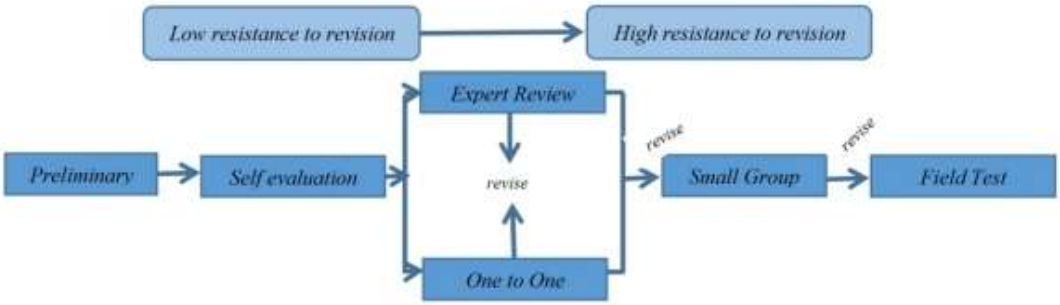


Figure 1. Formative evaluation flow (Tessmer, 1993; Zulkardi, 2002)

Based on Figure 1, the stages carried out consist of the following: (1) Self-evaluation stage, (2) Expert-review and one-to-one evaluation, (3) Small-group evaluation, and (4) Field-test stage. During the self-evaluation stage, the researcher drafted the PISA-like questions and conducted a self-assessment, resulting in prototype I which will be tested in the next stage. The Expert-review and one-to-one evaluation was carried out in parallel; the researcher gave prototype I to two experts for validation. The expert in this study has expertise in the field of mathematics education and is also a PISA researcher. They assessed the product from the aspects of content, structure (construct), and language validity. Simultaneously, the prototype I was tested at the one-to-one evaluation with two students. Comments and suggestions from the expert review and students during one-to-one evaluation were used as material to revise prototype I. The revised draft is called prototype II which was tested at the next stage. During Small-group evaluation, prototype II was tested on six students. Students worked on the PISA questions that were developed in groups. At this stage, the practicality of the developed product is seen. Students' comments and suggestions are used as material to revise prototype II. The revised result is called prototype III. Finally, during the Field-test stage, prototype III was tested on 30 students at a junior high school in Jambi City. The students who were the subjects of the one-to-one evaluation, small group evaluation, and field test stages were different students.

3) *Assessment Phase:* In the assessment phase, students' answer sheets at the field test stage were analyzed to evaluate the potential effects of the developed questions. The assessment

focused on the mathematical process that occurs in solving PISA questions which consists of the ability to formulate, employ, and interpret and evaluate.

Data Collection Technique

Data in this study were collected through walk-throughs, questionnaires, and tests. Walk-throughs were conducted to validate the developed prototype in terms of content, construct, and language at the expert-review stage by providing the developed prototype and assessment instruments to experts. Feedback obtained from experts were used as material to improve the developed prototype.

Open and closed questionnaires were given to students during the one-to-one, small-group, and field-test stages. Closed questionnaires were used to see the practicality assessment scores of the developed prototype but were supplemented with open questionnaires to obtain students' suggestions or comments on the practicality of the developed prototype.

Tests were used to assess the usability of the developed prototypes and to measure students' mathematical literacy skills.

Data Analysis Techniques

Walk-through and questionnaire data were analyzed qualitatively, while test data were analyzed using mathematical processes in the PISA framework, as outlined in Table 1(Gustiningsi, Putri, Zulkardi, & Hapizah, 2022).

Mathematical Process	Description
Formula	Express the problem in mathematical terms to find a solution.
Employ	Applying mathematical concepts, procedures, facts, and tools to obtain solutions to mathematical problems.
Interpret and evaluate	Evaluating a mathematical solution or outcome and interpreting it within the context of the problem or challenge.

Table 1. Mathematical Process

The developed problems are considered valid if experts confirm that the questions are valid in terms of content, construct, and language, and said to be practical if students can easily use the problems (Nieveen et al., 2006; Van den Akker et al., 2007). The valid and practical criteria are presented in Table 2.

No.	Criteria	Description
1.	Valid	
	Content	The problem align with the PISA framework consisting of mathematical processes (formulate, employ, and interpret), real world contexts (personal, occupational, societal, and science), content domains (quantity, change and relationship, space and shape, uncertainty and data) (OECD, 2018b), the Jambi cultural context, and relevant basic competencies in the school curriculum.
	Construct	The questions align to the indicators of mathematical literacy as seen from the mathematical process, presented systematically, and the level of difficulty is calibrated to the character of the students.
	Language	The questions use Indonesian language according to the rules (PUEBI), feature clear and concise language, avoid ambiguity, local cultural terms are explained through definitions or visuals and apply mathematical terms accurately and contextually.
2.	Practical	The questions are easy for students to understand, appropriate for the available class time, supported by accessible resources or tools for problem solving.

Table 2. The valid and practical criteria

RESULTS & DISCUSSION

This study developed PISA-like mathematics problems using the context of Jambi batik motifs. The research was conducted through preliminary and prototyping stages.

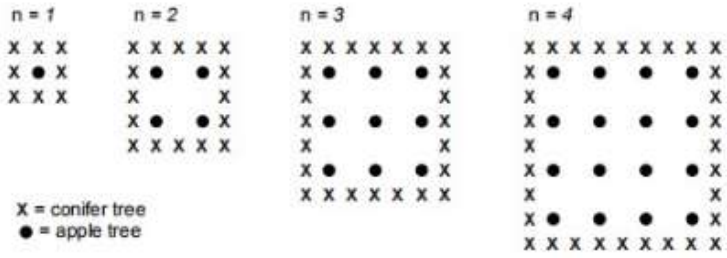
Preliminary Phase

In this phase, analysis of the PISA framework resulted in the selected content being “change and relationship” content domain, while the context used was the work context of making Jambi batik production. The researcher also referenced PISA questions that inspired the development of the questions, as shown in Figure 2.

M136: Apples

A farmer plants apple trees in a square pattern. In order to protect the apple trees against the wind he plants conifer trees all around the orchard.

Here you see a diagram of this situation where you can see the pattern of apple trees and conifer trees for any number (n) of rows of apple trees:



Question 1: APPLES

M136Q01- 01 02 11 12 21 99

Complete the table:

n	*Number of apple trees*	*Number of conifer trees*
1	1	8
2	4	
3		
4		
5		

(a)

Question 2: APPLES

M136Q02- 00 11 12 13 14 15 99

There are two formulae you can use to calculate the number of apple trees and the number of conifer trees for the pattern described above:

Number of apple trees = n^2

Number of conifer trees = $8n$

where n is the number of rows of apple trees.

There is a value of n for which the number of apple trees equals the number of conifer trees. Find the value of n and show your method of calculating this.

Question 3: APPLES

M136Q03- 01 02 11 21 99

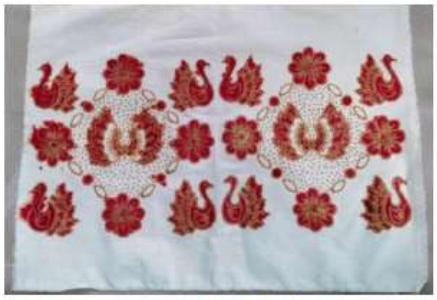
Suppose the farmer wants to make a much larger orchard with many rows of trees. As the farmer makes the orchard bigger, which will increase more quickly: the number of apple trees or the number of conifer trees? Explain how you found your answer.

(b)

Figure 2. PISA items (OECD, 2006)

Figure 2 presents a PISA question tested by the OECD in 2006. The researcher selected two patterns of Jambi *batik* as a suitable context for the question. Based on inspiration from PISA items, PISA-like mathematics problems were developed as in Figure 3 and Figure 4.

Jambi *Batik*



Jambi batik motif
(source: personal documentation)

The figure shows one of the Jambi batik motifs made on a cloth measuring 30 cm x 20 cm. A description of the motif is available in the table.

Figure	Description Motif
	Swan facing left
	Swan facing right
	Flower
	Broken durian

(a)

The following pattern is formed in the batik motif in the figure.

n = 1 n = 2

a) Complete the following table:

n	Number of broken durian images	Number of flower images
1	1	4
2	2	8
3	…	…
4	…	…
5	…	…

Explain your answer.

b) If the batik motif in figure is made on a cloth measuring 100 cm x 100 cm. How many swans are facing right? Explain your answer.

(b)

Figure 3. Developed PISA questions with the first Jambi *Batik* Pattern

Figure 3 asks students to complete a table provided by analyzing the first Jambi *batik* patterns, followed by a question on the number of swan motifs if the cloth is expanded. Within the same context, questions were also posed with other Jambi *batik* pattern, as shown in Figure 4.

Jambi's *angso duo* batik motif is one of the famous batik motifs in Jambi city. The tailor makes several pieces of cloth using the *angso duo* batik motif as follows:

n = 1 n = 2 n = 3

Information:

 : flower motif

 : swan motif

(Source: batik-tulis.com)

a. Based on the information provided, please complete the tables below.

n	Number of swan motifs	Number of flower motifs
1	1	4
2	2	….
3	….	….
5	….	….
10	….	….

b. Based on the previous question, on which piece of cloth there are 22 swan motifs and 44 flower motifs? Please explain your opinion.

Figure 4. The other PISA question which was developed with the second Jambi *Batik* pattern

Questions prepared during the preliminary phase are then continued into the next prototyping phase.

Prototyping Phase

The prototyping phase uses formative evaluation, consisting of self-evaluation, expert review, one-to-one evaluation, small group evaluation, and field testing.

a) *Self-evaluation*: In formative evaluation, the first stage of prototyping is self-evaluation. The researcher composes the questions and evaluates the content, construct, and language suitability. The questions prepared during the self-evaluation stage are referred to as prototype I, which is then advanced to the next prototyping stage.

b) *Expert-review:* At the expert review stage, prototype I was validated by experts in mathematics education and PISA researchers. The validators provided suggestions and comments on the questions, as presented in Table 3. These inputs were used by the researcher to revise the questions.

Topic	Validators	Comments and Suggestions
Question of the first Jambi *Batik* patterns (Figure 3)	Validator 1	• Better if the question is changed, "if the cloth is expanded to a size of 100 cm x 100 cm, is the number of swan motifs facing right and left the same?" • Improve the level of the question • Is it better to find the formula for the nth term? Add the sentence "What is your strategy, show the mathematical calculation"
	Validator 2	What is the purpose of the students looking for a batik motif with a flower image? Each question should be able to be added to their purpose in completing the question.
Question of the second Jambi *Batik* patterns (Figure 4)	Validator 1	• Question *b* should be adjusted again to the original PISA question. • The sentence "based on previous questions" does not match the PISA questions in general. • Add one more question that matches the apples unit in the original PISA question.
	Validator 2	• Questions that are not included in the high-level category should be changed to become questions that require high-level thinking skills. • In the question section, "complete the tables below" the word table should only be written once.

Table 3. Comment and Suggestion of Expert

c) *One-to-one Evaluation:* In the one-to-one evaluation, the questions were tested on three students. They were asked to complete the questions and respond to a questionnaire to assess the usability of the items. Table 4 shows the findings of comments or responses in the one-to-one evaluation.

Topic	The finding
Question of the first Jambi *Batik* patterns (Figure 3)	Students did not explain how to find the nth term in question *a*, indicating the need to revise the wording of the question.
Question of the second Jambi *Batik* patterns (Figure 4)	Students were unable to answer the second question (question *b*).

Table 4. Findings during one-to-one evaluation

From the expert review comments and the findings of the one-to-one evaluation, revisions were made available in Table 5.

Topic	Revision Decision
Question of the first Jambi *Batik* patterns (Figure 3)	• Change the question sentence to "If the fabric is expanded to a size of 100 cm x 100 cm. Is the number of swan motifs facing right and left the same? Show your strategy. • Adding the sentence "To be able to create batik with a larger cloth size, we must know the pattern and number of motifs formed, one of which is as in the picture, there are durian and flower motifs in different numbers." • Adding the sentence "What is your strategy? Show the mathematical calculations."
Question of the second Jambi *Batik* patterns (Figure 4)	• Adjusting question *b* according to the second question of the apples unit in the PISA questions that have been tested by the OECD. • Delete the sentence "based on previous questions." • Adding one more question (the third question) according to the apples unit in the PISA questions. • Changing the question so that the question falls into the high-level question category, namely by asking students to draw a batik motif according to the requested cut. • Correction of the words "the tables" to "the table"

Table 5. Revision Decision of Prototype I

Based on the revision decision, the questions were revised to be as shown in Figure 5 and Figure 6.

The following pattern is formed in the batik motif in the figure.

n = 1 n = 2

To be able to create batik with a larger cloth size, we must know the pattern and number of motifs formed, one of which is as in the picture, there are durian pecah and flower motifs with different numbers.

a) Complete the following table:

n	Number of broken durian images	Number of flower images
1	1	4
2	2	8
3	…	…
4	…	…
5	…	…

What is your strategy to fill the table above? Show your mathematical calculations.

b) If the cloth is expanded to a size of 100 cm x 100 cm, is the number of swan motifs facing right and left the same?

Addition of sentences according to expert suggestions.

Improvement of questions according to expert suggestions.

Figure 5. Prototype II with the first Jambi *Batik* patterns question

The question with the context of the second Jambi batik pattern, which is presented in Figure 6.

Jambi's *angso duo* batik motif is one of the famous batik motifs in Jambi city. The tailor makes several pieces of cloth using the *angso duo* batik motif as follows:

n = 1 n = 2 n = 3

Information:

 : flower motif

 : swan motif

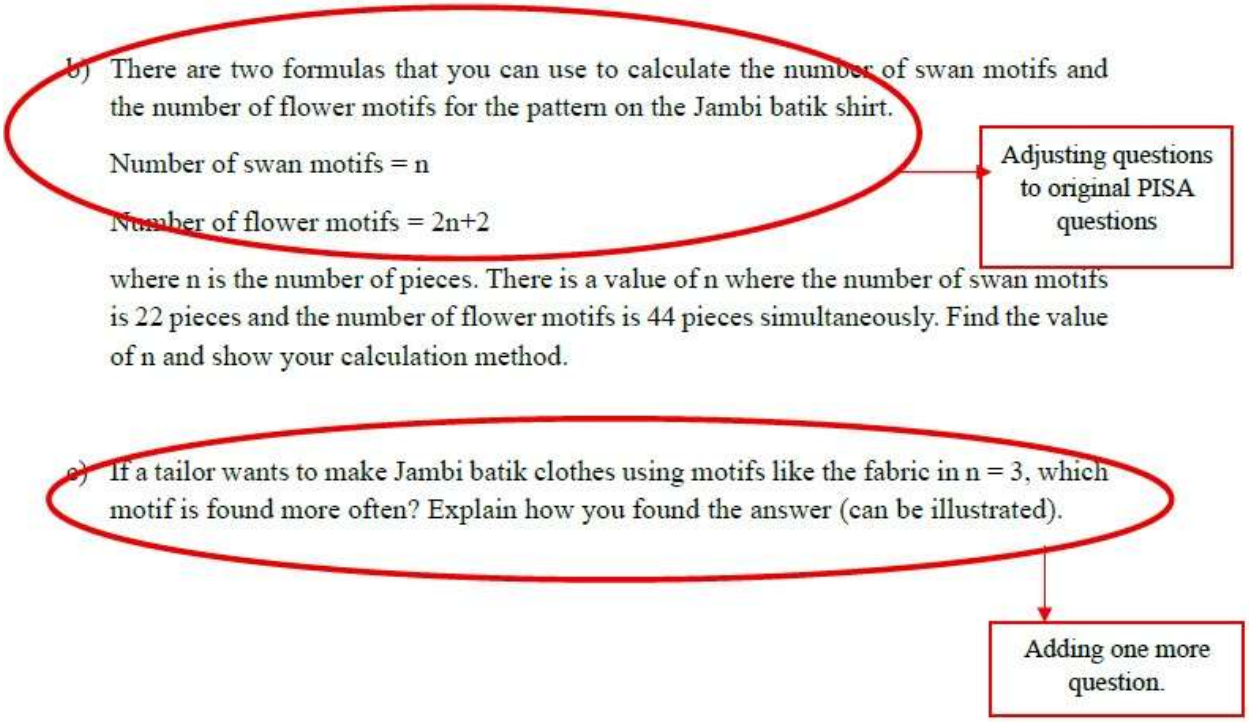
Source: https://batik-tulis.com/blog/batik-jambi/#google_vignette

a) Based on the information provided, draw a batik motif according to the cuts requested in the table below.

n	Batik pattern
4	
5	
6	
8	

Changing the question to ask students to draw a batik motif.

(a)



(b)

Figure 6. Prototype II with the second Jambi *Batik* patterns question

The revised result is called Prototype II. The revised questions (prototype II) were then tested at the small group stage.

d) *Small-group Evaluation:* At the small group stage, the questions were tested on six students. They were given time to complete the questions, followed by a questionnaire to identify difficulties related to pictures, tables, or sentences in the questions. Based on their answers, students were able to complete the questions successfully without difficulties; therefore, no revisions were made. The questions were then referred to as prototype III, as presented in Figures 7 and Figure 8.

Jambi *Batik*

Jambi batik motif
(source: personal documentation)

The figure shows one of the Jambi batik motifs made on a cloth measuring 30 cm x 20 cm. A description of the motif is available in the table.

Figure	Description Motif
	Swan facing left
	Swan facing right
	Flower
	Broken durian

The following pattern is formed in the batik motif in the figure.

n = 1

n = 2

To be able to create batik with a larger cloth size, we must know the pattern and number of motifs formed, one of which is as in the picture, there are durian pecah and flower motifs with different numbers.

a) Complete the following table:

n	Number of broken durian images	Number of flower images
1	1	4
2	2	8
3	...	...
4	...	...
5	...	...

What is your strategy to fill the table above? Show your mathematical calculations.

b) If the cloth is expanded to a size of 100 cm x 100 cm, is the number of swan motifs facing right and left the same?

Figure 7. Prototype III with the question of the first Jambi *batik* pattern

Jambi's *angso duo* batik motif is one of the famous batik motifs in Jambi city. The tailor makes several pieces of cloth using the *angso duo* batik motif as follows:

n = 1 n = 2 n = 3

Information:

 : flower motif

 : swan motif

Source: https://batik-tulis.com/blog/batik-jambi/#google_vignette

a) Based on the information provided, draw a batik motif according to the cuts requested in the table below.

n	Batik pattern
4	
5	
6	
8	

(a)

b) There are two formulas that you can use to calculate the number of swan motifs and the number of flower motifs for the pattern on the Jambi batik shirt.

Number of swan motifs = n

Number of flower motifs = 2n+2

where n is the number of pieces. There is a value of n where the number of swan motifs is 22 pieces and the number of flower motifs is 44 pieces simultaneously. Find the value of n and show your calculation method.

c) If a tailor wants to make Jambi batik clothes using motifs like the fabric in n = 3, which motif is found more often? Explain how you found the answer (can be illustrated).

(b)

Figure 8. Prototype III with the question of second Jambi *batik* pattern

The revised questions (prototype III) were then tested at the field test stage.

e) *Field Test:* In the field test stage, the questions were administered on 30 students. Their responses were analyzed to determine the potential effects of the developed PISA-like mathematics problems. The students' answers from this stage are presented in Figure 9.

Translation:

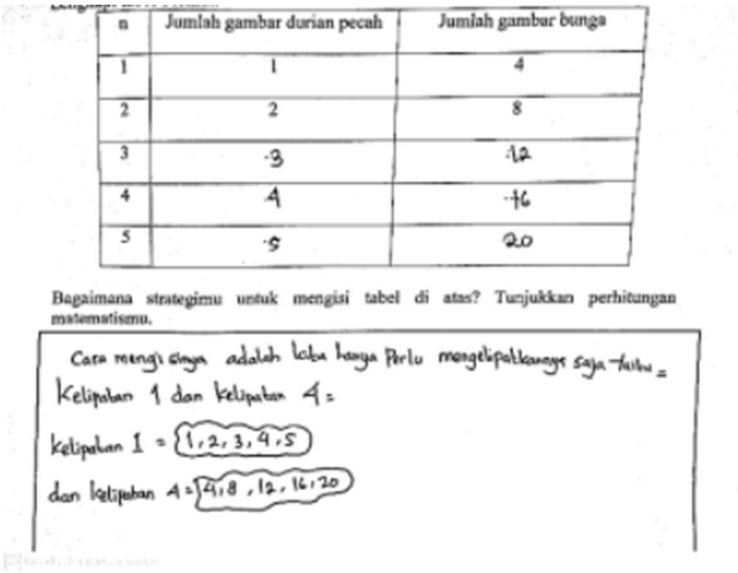
Creating batik on a larger cloth is analogous to adding to the initial number of motifs.

So,

No.	Broken durian	Flower
1	1	4
2	2	8
3	2+1	8+4 = 12
4	3+1	12+4 = 16
5	4+1	16+4 = 20

Figure 9. Student's answer to the question *a* of the first Jambi *batik* pattern question

In Figure 9, students identified a pattern for determining the number of broken durian motifs using the formula (n-1) + 1, and for determining the number of flowers, which increases by 4 with each successive n. Figure 9 shows that students can formulate problems mathematically, relate the number of broken durian motifs to flower motifs using certain patterns, apply appropriate mathematical concepts and calculations, and interpret these patterns to solve the problems to solve problems (Gustiningsi & Somakim, 2021; OECD, 2018b; Rawani et al., 2019; Utari & Gustiningsi, 2021). Additional student responses are shown in Figure 10.



n	Jumlah gambar durian pecah	Jumlah gambar bunga
1	1	4
2	2	8
3	3	12
4	4	16
5	5	20

Bagaimana strategimu untuk mengisi tabel di atas? Tunjukkan perhitungan matematismu.

Cara mengisinya adalah kita hanya perlu mengelipatkangan saja-kalau =
Kelipatan 1 dan kelipatan 4 =
kelipatan 1 = {1, 2, 3, 4, 5}
dan kelipatan 4 = {4, 8, 12, 16, 20}

Translation:

It can be completed by folding based on multiples of 1 and 4.

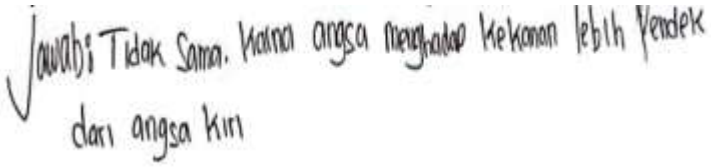
multiples of 1 = 1, 2, 3, 4, 5

multiples of 4 = 4, 8, 12, 16, 20

Figure 10. Another student's answer

Figure 10 shows that students identified the number of durian burst motifs as a multiple of 1 and the number of flower motifs as a multiple of 4. The responses in Figure 10 show that students can find a pattern between the two motif types. These responses demonstrate the potential of the developed questions to foster students' mathematical literacy skills, as reflected in the mathematical processes of formulating, employing, and interpreting (Gustiningsi et al., 2024; Putri & Zulkardi, 2020, 2019; Zulkardi & Putri, 2019).

In addition, the student's answer of the question *b* of the first Jambi *batik* pattern question is presented in Figure 11.

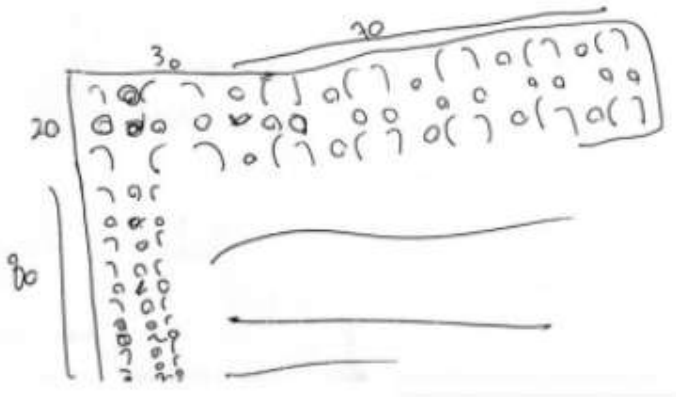


Jawab: Tidak Sama. Karna angsa menghadap kekanan lebih pendek dari angsa kiri

Translation:

Different, because the goose facing right is shorter than the goose facing left.

(a)



(b)

Figure 11. Student's answer to the question *b* of the first Jambi *batik* pattern question

In Figure 11, the student draws a batik pattern measuring 100 cm x 100 cm. It shows that the student can determine the repetition of the pattern when the cloth is expanded to that size. The student can analyze the batik patterns and interpret whether the number of goose images facing right and left is equal based on the pattern formed. This evidence supports the attainment of the targeted mathematical processes (Gustiningsi, Putri, Zulkardi, & Hapizah, 2022; Gustiningsi & Somakim, 2021; OECD, 2018b).

Then the students' answers to questions of the second Jambi *batik* pattern are presented in Figures 12, 13, and 14.

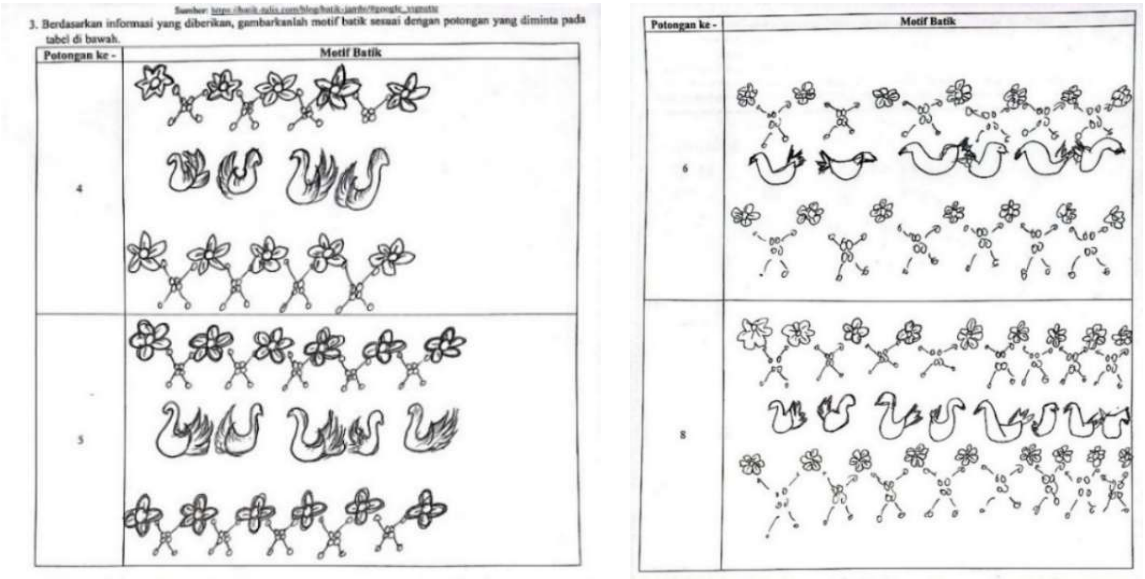
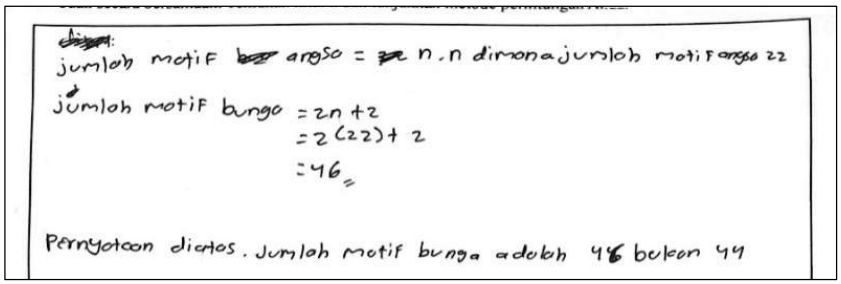


Figure 12. Student's answer to question *a* of the second Jambi *batik* pattern question

Based on Figure 12, students demonstrate mathematical literacy skills. In the formulating aspect, students can recognize that batik patterns consist of several repeating elements, and can identify the basic structure of the pattern, both in terms of shape and direction of the motif. In terms of employing, students demonstrate the skill of placing motifs in an organized arrangement, both horizontally and vertically, and maintaining a consistent repetition sequence, which reflects an understanding of the mathematical structure of the pattern. Meanwhile, in the interpreting and evaluating aspect, students can connect patterns between pieces (for example from the 4th to the 5th or from the 6th to the 8th), and continue the pattern with appropriate adjustments in size and direction, which shows that they can interpret mathematical structures in a visual context and evaluate the suitability of the results to the previous pattern. Then, the students' answers to question *b* on the second Jambi batik motif are shown in Figure 13.



Translation:
The number of swan motifs = n, where the total number of swan motifs is 22.
The number of flower motifs = 2n + 2
= 2(22) + 2
= 46
Based on the calculation above, the number of flower motifs is 46, not 44.

Figure 13. Student's answer to question *b* of the second Jambi *batik* pattern question

Based on Figure 13, students demonstrate mathematical literacy skills that include indicators of applying, interpreting, and evaluating. In the applying aspect, students are able to use the given mathematical model, namely substituting the value n=22 into the equation for the number of flower motifs and obtaining a result of 46. Furthermore, in the interpreting and evaluating aspect, students are able to check the results of their calculations and criticize the discrepancy between the results and the information in the question, which states that the number of flower motifs should be 44. Students can also correctly conclude that the results obtained (46) do not match the conditions of the question, and correctly explain that the number of flower motifs they calculated is 46, not 44. This shows that student has good evaluative skills regarding the suitability of the mathematical model and the context of the question. The students' answers to question b on the second Jambi batik motif are shown in Figure 14.

Translation:
The flower motif appears more often because, in the picture of the batik shirt above, there are 16 swans and 27 flowers.

(a)

Translation:
There are more flower motifs because for each additional pattern, the flowers increase by 2 while the swans only increase by 1."

(b)

Figure 14. Student's answer to the question *c* of the second Jambi *batik* pattern question

Based on Figure 14(a), the student demonstrates mathematical literacy skills that encompass the aspects of formulating, applying, interpreting, and evaluating. In the formulating aspect, the student is able to distinguish between the types of motifs used in the batik pattern, namely flower motifs and swan motifs, and identify the relevant elements from the given context. In the applying aspect, the student draws a batik shirt as part of the solution and adjusts the motifs in the illustration according to the given information, showing the ability to use visual representation as a mathematical strategy. For the interpreting and evaluating aspect, the student connects the question to the appropriate response, as seen in the reasoning provided at the beginning of the answer. The student states that the flower motif appears more frequently, which is supported by a logical explanation or visual evidence. This indicates that the student understands the context, applies the given information correctly, and evaluates the relationship between data in a meaningful way. Based on Figure 14(b), the student was able to identify relevant elements in the context of the problem, namely the swan motif and the flower motif, and recognize that both need to be counted and compared. In the applying aspect, students calculate the number of each motif based on the available images or information. Furthermore, in the interpreting and evaluating aspect, the student was able to compare the calculation results and draw the right conclusions about which motif is more, accompanied by logical arguments to support his answer. This shows that the student can use mathematical results meaningfully in the given context.

Students' answers indicate that the questions have the potential to enhance their ability to formulate, employ, and interpret mathematical problems. The potential is evident not only qualitatively through students' answers but also quantitatively from the pre-test and post-test scores presented in Table 6.

No.	Initial Name	Score	
		Pre-test	Post-test
1.	FD	20	20
2.	PPR	10	37,5
3.	AH	35	65
4.	ACC	20	60
5.	DSA	10	27,5
6.	CDS	15	60
7.	FPO	10	15
8.	MAG	10	70
9.	MPA	5	12,5
10.	MSK	10	30
11.	ZAA	45	72,5
12.	DOF	10	57,5
13.	KA	20	75
14.	FDA	5	35
15	NDA	0	5
16.	RK	5	60
17.	MAGA	10	70
18.	EKA	15	60
19.	MHR	25	70
20.	RFZ	5	65
21.	MRA	45	70
22.	DA	35	67,5
23.	CPV	30	55
24	BDP	45	87,5
25	ZR	5	10
26.	OK	25	55
27.	ZPKR	25	17,5
28.	NHN	5	77,5
29.	VDA	20	62,5
30.	AAS	0	60
	Percentage	28,88%	51%

Table 6. Pre-test and Post-test score

Based on Table 6, it can be seen that there was an increase in the average student score from the pre-test of 28.88% to the post-test of 51%. This shows an increase of 22.12 percentage points after students used the developed questions. This increase reflects that the questions contributed positively to strengthening students' mathematical literacy skills.

Based on students' answers, none expressed confusion about the meaning of the question. This shows that the questions are usable and practically meaningful, aligning with Nieveen et al. (2006),

who stated that practicality is achieved when a designed product can be effectively used. In addition, the questions developed align with the criteria of a work context, namely the creation of Jambi *batik* patterns (OECD, 2018a).

The description above indicates that the questions developed are valid, as validated during the expert review and one-to-one stages. Their validity is supported by content, construct, and language considerations (Van den Akker et al., 2007). The questions were also tested for practically during the one-to-one stage and small group stages, demonstrating their usability. Moreover, the questions showed a potential effect, as reflected in students' responses during the field-testing stage. The findings reveal that the developed PISA-like mathematics problems have the potential to foster students' mathematical literacy abilities.

In this study, a test item is considered "PISA-like" if it aligns with the PISA framework outlined by the OECD, which includes the use of real-world contexts and the incorporation of mathematical processes—formulating, employing, and interpreting—in various contexts (OECD, 2018b). The questions developed incorporate local cultural contexts, especially Jambi batik patterns, within the occupational context. They also involve the three mathematical processes and align with the content of change and relationship.

The methodology used in this study—developing PISA-like mathematics problems based on the Jambi *batik* pattern, specifically the *angso duo* motif—demonstrates characteristics that can be adapted to other regions in Indonesia, particularly those with similar educational infrastructure and socio-cultural dynamics. For instance, batik motifs such as *Parangklitik*, *Parangbarong*, and *Sidomukti* in Yogyakarta (Prahmana & D'Ambrosio, 2020), Javanese *batik* patterns (Selamet, 2018), and other regional *batik* designs across Indonesia (Trixie, 2020) offer culturally rich alternatives that serve as authentic mathematical contexts. Beyond national application, this methodology holds global potential by incorporating local cultural elements such as traditional textiles, architecture, or crafts. However, successful contextualization requires careful consideration of cultural practices, linguistic diversity, and policy frameworks. Culturally responsive learning models have been implemented in countries such as Malaysia and the Philippines, where they have been shown to enhance student engagement and learning relevance (Idrus, 2014; Mercado, 2020). This approach can also be applied to other subjects, such as science and social studies, by incorporating local wisdom. Integrating this model into teacher training programs can enhance educators' capacity to design culturally meaningful, competency-based assessments and provide valuable insights for curriculum developers in aligning global standards with local identities.

Limitations and Future Research

Despite the promising results, several limitations must be acknowledged. First, the expert review involved a relatively small number of participants, which may limit the generalizability of the

validity judgments. Although expert selection was purposive, it may introduce bias due to their shared academic background and familiarity with the local context. Additionally, the study was conducted in a single region (Jambi), which may restrict the broader applicability of the findings to other cultural or educational settings in Indonesia or beyond. Future research should involve a more diverse group of experts from various regions and academic disciplines to reduce potential bias and enhance the credibility of the validation process. Expanding the study to different regional contexts would also strengthen external validity and enable comparative insights across cultural settings.

CONCLUSION

Based on the question development process, PISA-like mathematics problems can be developed by integrating contextual elements from Jambi *batik* patterns, particularly by utilizing the motifs and structures to construct problems that require mathematical reasoning, representation, and problem-solving in real-life contexts. PISA-like mathematics problems using the context of Jambi *Batik* patterns were produced and found to be qualitatively valid and practical. The question was declared valid in terms of content, as they aligned with the PISA framework and the work context of creating Jambi Batik Patterns. The question was also valid in terms of construct, as they corresponded to the grade VIII curriculum, and in terms of language, as they adhered to PUEBI *(General Guidelines for Indonesian Spelling)* and avoided ambiguity. The questions were considered practical, as they could be used by students, were clearly understood, and effectively elicited students' mathematical literacy skills. This study suggests that similar PISA-like problems should be developed using other batik motifs or cultural elements beyond batik.

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