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Feasibility of Jambi Batik-Based Number Pattern Worksheets Integrating Problem Posing and Deep Learning Principles

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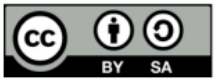
ABSTRACT

Number pattern learning in junior high schools still tends to be procedural, resulting in students being less active and not yet accustomed to posing problems independently. The worksheets commonly used in schools generally contain routine exercises and do not fully support meaningful learning experiences. This study aims to develop and evaluate the feasibility of number pattern student worksheets (LKPD) based on the problem posing model with a deep learning approach integrated with the local cultural context of Jambi batik. The evaluation in this study is limited to validity and practicality aspects. The research employed a development studies type of design research consisting of three stages: preliminary, prototype, and assessment. Data were collected through validation by subject matter and media experts using a Likert-scale instrument, as well as practicality assessment through a limited trial involving one mathematics teacher and six junior high school students. The final validation results showed that the LKPD obtained scores of 64 from the subject matter expert and 61 from the media expert, both categorized as very good. The practicality test results indicated that the LKPD obtained a percentage score of 77.5% from the teacher and 77.29% from students, categorized as very good and good, respectively. These findings indicate that the developed LKPD is valid and practical, making it suitable for use as teaching material in junior high school mathematics learning. In addition, the integration of problem posing, deep learning principles, and Jambi batik context has the potential to support more meaningful learning experiences. This study was limited to validity and practicality testing and did not examine the effectiveness of the worksheets on students' learning outcomes or analogical reasoning abilities.



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1. INTRODUCTION

Mathematics is a subject that plays a crucial role in developing students' logical, critical, and creative thinking skills [1]. At the junior high school (SMP) level, the topic of number patterns plays a significant role in developing critical thinking skills, as it requires students to identify patterns, make generalizations, and apply them to new situations [2]. However, in reality, many students still learn number patterns mechanically, focusing on memorizing formulas without understanding the conceptual meaning behind them. This situation makes it difficult for them to grasp the underlying patterns and hinders their ability to generalize. As a result, their conceptual understanding remains superficial, and the teaching of number patterns does not optimally contribute to the development of students' mathematical thinking skills [3]–[7]. Mathematics learning in junior high schools is still predominantly procedural and focuses on routine exercises. Students are often required to memorize formulas and solve repetitive problems without being encouraged to connect concepts, transfer knowledge to new situations, or construct their own understanding. In addition, learning materials are frequently presented in abstract forms that are detached from students' real-life experiences and local culture, making mathematics less meaningful and limiting opportunities for higher-order thinking.

Analogical thinking is an important cognitive ability in mathematics learning because it enables students to identify similarities, recognize relationships between concepts, and apply prior knowledge to new situations. In learning number patterns, analogical thinking helps students understand regularities, compare relationships among patterns, and generalize mathematical ideas. Therefore, learning activities should provide opportunities for students to develop analogical thinking through meaningful and contextual experiences. This indicates that students' problem-posing skills remain low, even though this skill is essential for fostering deep conceptual understanding and supporting meaningful learning.

One factor contributing to the low quality of number pattern instruction is the lack of variety in teaching materials. Collections of routine practice problems with uniform formats and solutions still dominate the worksheets commonly used in schools. This situation causes students to focus solely on the final result without being given the opportunity to pose new problems or connect the concepts they have learned to broader contexts. Consequently, worksheets, which are intended to serve as tools for active learning, have not been able to encourage students to use higher-order thinking strategies. The learning process tends to be monotonous, lacking in context, and fails to provide strong motivation for students.

The problem-posing model offers an alternative that can address the limitations of number pattern learning. Through this approach, students are encouraged to actively formulate, understand, and modify problems based on their existing knowledge [8], [9]. These activities not only foster active participation but also cultivate creativity in formulating new problems [10], [11], improve problem-solving skills, deepen understanding of the concepts being studied, enhance the ability to apply knowledge across different contexts, and strengthen conceptual understanding of mathematics [12]–[15].

Previous studies have shown that the use of problem posing can have a positive impact on mathematics learning, particularly in improving students' understanding of the material and their mathematical thinking skills [9], [16], [17]. Thus, problem-posing is considered relevant for use in developing more interactive and meaningful worksheets on number patterns.

In this study, problem posing is positioned as the learning model that actively engages students in generating and reformulating mathematical problems. Deep learning is adopted as an educational approach that emphasizes meaningful understanding and reflective learning experiences. Meanwhile, Jambi batik is incorporated as an ethnomathematical context that connects mathematical concepts with local culture and students' everyday experiences. Analogical thinking is positioned as the cognitive ability expected to be facilitated through the integration of these components in the developed worksheets.

The integration of problem posing with a deep learning approach is a crucial foundation for designing meaningful worksheets on number patterns. Deep learning in an educational context emphasizes conceptual connections, reflective skills, self-regulation, and the cultivation of intrinsic motivation to encourage students to engage in deeper learning. Within this framework, problem posing serves not only as a means of presenting problems but also as a tool to help students understand the reasoning behind a pattern (why) rather than merely how to calculate it (how). Deep learning in education refers to an approach that emphasizes students' ability to construct meaningful understanding, connect prior knowledge with new concepts, transfer learning to different situations, and reflect on their own thinking processes. Unlike surface learning, which focuses on memorization and procedural knowledge, deep learning promotes conceptual understanding, higher-order thinking, and active engagement in learning. In the Indonesian educational context, deep learning is characterized by meaningful, mindful, and reflective learning experiences.

The application of deep learning transforms worksheets from mere collections of questions into learning tools that encourage students to establish connections between concepts, develop a deep understanding, and foster a mindset of lifelong learning. Through this design, students can experience learning that is engaging because they are actively involved, meaningful because the knowledge gained is relevant and deep, and joyful because the learning process is enjoyable. Thus, deep learning is not merely an addition but the core of the problem-posing-based worksheet design, which is expected to strengthen the quality of number pattern learning.

Previous studies have demonstrated the benefits of ethnomathematics, problem posing, and deep learning in mathematics education. Several studies have developed ethnomathematics-based teaching materials or implemented problem-posing activities separately. However, limited studies have integrated Jambi batik as an ethnomathematical context, problem posing as a learning model, and deep learning principles into number pattern worksheets designed to facilitate students' analogical thinking. Therefore, this study addresses this gap by developing and evaluating the validity and practicality of such worksheets. Furthermore, to make the worksheets more relatable to students, they are designed to include contextual examples such as patterns found in Jambi Batik. In addition

to helping students identify patterns in real life, the integration of Jambi Batik into the worksheets also serves as a cultural introduction for students so that they understand the various types of batik motifs found in Jambi. To ensure optimal use, the developed worksheets must meet validity criteria across various aspects, ranging from content appropriateness, application of instructional models, graphic design, clarity of language, and ease of use. This validity test is a crucial stage because, without a guarantee of validity, the worksheets cannot proceed to the next stage, namely the practicality and effectiveness tests. Thus, this research is important to produce valid number pattern worksheets based on problem posing and deep learning, thereby making a tangible contribution to improving the quality of mathematics learning at the junior high school level.

Accordingly, this study addresses the following research questions: (1) What are the characteristics of number pattern worksheets based on problem posing and deep learning integrated with Jambi batik that meet validity criteria? (2) To what extent are the developed worksheets practical for use in junior high school mathematics learning? This study focuses on the validity and practicality of the developed worksheets and does not examine their effectiveness in improving students' learning outcomes or analogical thinking abilities.

2. METHOD

This study was conducted with the aim of creating a mathematics learning experience that not only emphasizes cognitive achievement but also stimulates deeper and more meaningful thinking among students. To that end, a design research approach of the development studies type [18] was chosen because it allows researchers to design, develop, and reflect on learning designs in a continuous and contextual manner. Development studies emphasize the importance of researchers' direct involvement in the process of developing learning materials in order to gain a deep understanding of the process and its impact.

The study was conducted at SMP Negeri 17 Kota Jambi, Indonesia. The participants consisted of Grade VII D4 students who had studied number pattern material according to the Merdeka Curriculum. The class consisted of 32 students with heterogeneous mathematical abilities, including high, medium, and low-achieving students. Classroom implementation was conducted face-to-face over three meetings. The first and second meetings focused on learning activities using the developed worksheets, while the third meeting was used for evaluation activities.

In addition to the field test, a small-group evaluation involving six students was conducted. The six students were purposively selected to represent different levels of mathematical ability and to obtain in-depth feedback regarding the clarity, usability, and practicality of the developed worksheets. This selection is consistent with the design research approach, which emphasizes iterative improvement through intensive feedback from a limited number of participants.

In general, this research process consists of three main stages: the preliminary and design stage, the prototype phase, and the assessment phase. These three stages were

conducted within the context of developing Jambi batik-based worksheets that integrate the problem-posing model and the deep learning approach. Each stage in this approach is dynamically interconnected. Jambi batik was chosen not only as a visual element but also as a means of integrating local cultural values into learning, so that students can learn within a context closely related to their lives. It is hoped that by leveraging the region's cultural richness, students will become more emotionally and intellectually engaged in the learning process.

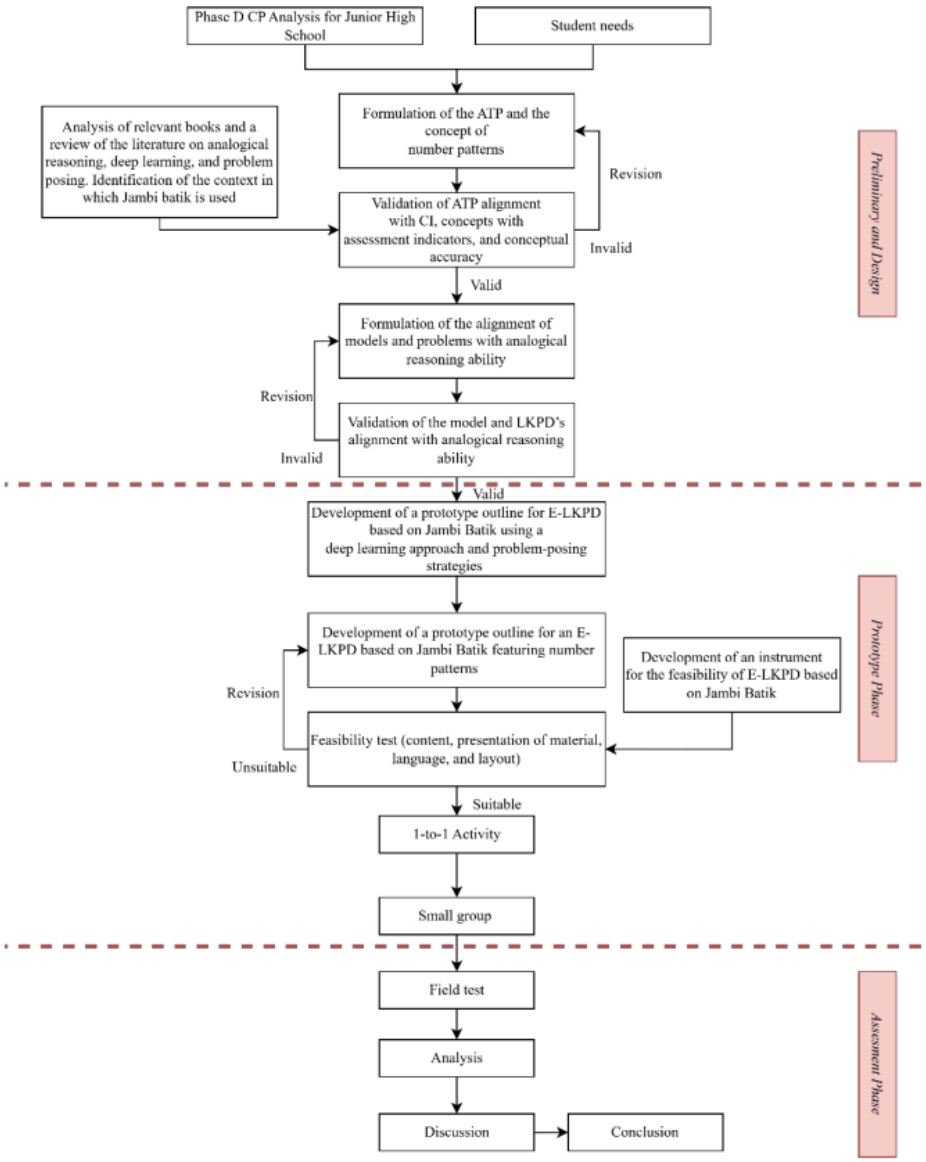


Figure 1. Development Procedures

This study is a design research project aimed at developing student worksheets (LKPD) based on problem posing and deep learning that integrate Jambi batik motifs into number pattern lessons, as well as evaluating the feasibility of the developed product. The study was conducted in three main phases: the preliminary phase, the prototype phase, and the assessment phase.

The preliminary phase aims to establish a foundation for product development through an analysis of the Learning Outcomes (LO) and Learning Objective Sequence (LOS) for the junior high school Phase D number patterns curriculum, an analysis of learning needs, and a review of relevant theories and prior research. The results of this phase serve as the basis for designing the structure, content, and initial layout of the worksheets.

The prototype phase focused on the design and development of the worksheets, as well as testing the product's validity. During this phase, the researchers developed an initial draft of the worksheets based on problem-posing and deep learning, integrated with Jambi batik motifs; designed activities in accordance with learning syntax; and formatted the worksheets to suit the students' characteristics. Subsequently, the resulting prototype is validated by subject matter experts and media experts to assess the appropriateness of the content, structure, language, and layout. The validation results were used as the basis for revising the product until a theoretically valid LKPD was obtained. At this stage, the LKPD that had been declared valid was pilot-tested on a limited scale to assess ease of use, the feasibility of activities, and the responses of students and teachers. To determine the level of validity of the LKPD, the following validity criteria were applied:

Table 1. Validation Level Categories for Subject Matter Experts and Media Experts

Score Scale	Score Range	Level of Validity
5	67,20 – 80,00	Very Good
4	54,40 – 67,19	Good
3	41,60 – 54,39	Fair
2	28,80 – 41,59	Poor
1	16,00 – 28,79	Very Poor

The validation process involved two experts. The subject matter expert was a lecturer in mathematics education with expertise in mathematics learning and curriculum development, while the media expert was a lecturer with expertise in educational media and instructional technology. Both validators had experience in developing and evaluating learning materials for junior high school mathematics.

The validation instrument employed a four-point Likert scale ranging from 1 (very poor) to 5 (very good). The subject matter validation assessed aspects of content suitability, alignment with the problem-posing model, integration of deep learning principles, language, and presentation. The media validation assessed layout, typography, illustrations, color composition, and usability. The total score obtained from each validator was converted into qualitative categories to determine the validity level of the worksheets.

The practicality instrument consisted of a teacher questionnaire and a student response questionnaire. The teacher questionnaire contained 16 items assessing ease of use, clarity of instructions, content suitability, and support for the learning process. The student questionnaire consisted of 16 items related to content clarity, presentation, ease of use, visual appearance, and the meaningfulness of problem-posing activities. The responses were analyzed using percentage scores and categorized into qualitative levels ranging from poor to very good.

Table 2. Student and Teacher Practicality Category Criteria

Score Scale	Score Range	Level of Validity
5	85% – 100%	Very Good
4	69% – 84%	Good
3	53% – 68%	Fair
2	37% – 52%	Poor
1	0% – 36%	Very Poor

The assessment phase is conducted after the worksheets have undergone validation by experts and product revisions during the prototype stage. At this stage, the worksheets that have been deemed valid are pilot-tested in a limited number of classrooms to evaluate their practicality based on feedback from teachers and students. The purpose of the assessment is to review the implementation of the LKPD in real learning conditions, as well as to ensure that the revised product is in its final form and is suitable and practical for use as teaching material.

A practicality test of the worksheets was conducted to determine their ease of use, clarity of instructions, and feasibility in the classroom. The practicality assessment involved 1 mathematics teacher as a learning practitioner and 6 students in a small-group pilot test. The teacher was asked to complete a practicality questionnaire based on the aspects of ease of use, appropriateness of content, clarity of instructions, and the worksheets' support for the learning process. Meanwhile, students completed a response questionnaire to assess the clarity of content, presentation, ease of use, and meaningfulness of the problem-posing activities. The practicality data were analyzed using percentage scores and categorized into the criteria of excellent, good, fair, or poor to determine the level of practicality of the worksheets.

Ethical considerations were observed throughout the study. Permission to conduct the research was obtained from SMP Negeri 17 Kota Jambi and the mathematics teacher involved in the study. All participants were informed about the objectives of the research, and their participation was voluntary. The identities of teachers and students were kept anonymous, and all collected data were used solely for research purposes.

3. RESULTS AND DISCUSSION

This study employs a design research approach based on development studies, consisting of three phases: a preliminary study, prototype design, and assessment phase.

3.1. Results

Preliminary & Design

In the initial phase, a preliminary study was conducted to identify the need for instructional materials tailored to the characteristics of junior high school students in the area of number patterns. Based on the results of observations and interviews with teachers, it was found that instruction remains teacher-centered and learning activities primarily emphasize routine problem-solving exercises. Students were not yet accustomed to formulating their own problems or reasoning about number patterns in depth. Furthermore, the instructional materials used were still of a general nature and did not incorporate local cultural elements.

An analysis of Learning Outcomes (LO) and Learning Objective Sequences (LOS) indicates the need for worksheets that not only include practice questions but also guide students toward higher-order thinking through problem-posing activities. Based on this, worksheets on number patterns were developed using problem-posing and deep learning approaches, integrating Jambi batik motifs as a cultural context closely related to students' lives.

Table 3. Results of the CP and TP analysis on the Number Patterns material

Learning Outcomes	Learning Objectives
By the end of Phase D, students will be able to identify, predict, and generalize patterns in sequences of objects and numbers.	1. Students can identify patterns in arrangements of objects, images, or motifs and determine the regularity that emerges. 2. Students can explain the rules of a number pattern or image pattern using mathematical sentences or representational models. 3. Students can predict the nth term of a sequence based on the observed regularity. 4. Students can create number sequence problems based on given images or patterns. 5. Students can solve number sequence problems that they have created themselves or that have been created by the teacher.

Based on Table 2, it is evident that the TP is designed to comprehensively support the achievement of the CP while aligning with the characteristics of the problem-posing model and the deep learning approach. Each TP is designed so that students are not only able to recognize and predict patterns, but also to generalize, relate patterns to context, and pose and solve problems independently. Thus, TP serves as the primary foundation for developing interactive, challenging, and meaningful worksheets for students.

Prototype Design

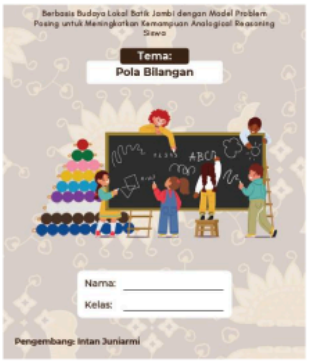
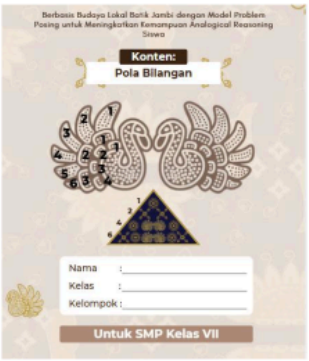
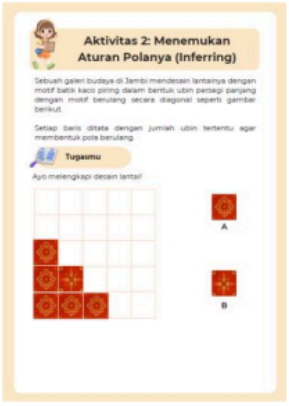
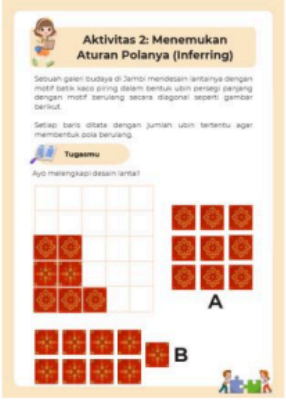
The prototype phase is the core of the LKPD development process. In this phase, researchers design the LKPD concept by establishing learning objectives that align with the Learning Outcomes (LO) and Learning Objective Sequence (LOS) for Phase D, and by determining a problem-posing learning model using a deep learning approach to support students' analogical thinking skills. The structure of the LKPD is systematically organized to include an introduction, learning activities, and a conclusion, with each section aligned with the stages of problem posing.

The content of the worksheets is structured according to the problem-posing syntax, namely situation analysis, variation, generation, problem solving, and evaluation. Each activity includes a reflection column and space for students to write their conclusions as a way to reinforce their understanding of the concepts. In terms of design, the worksheets are designed to be communicative and user-friendly, with careful attention to color selection, fonts, layout, and the use of Jambi batik patterns as visual cues for identifying patterns.

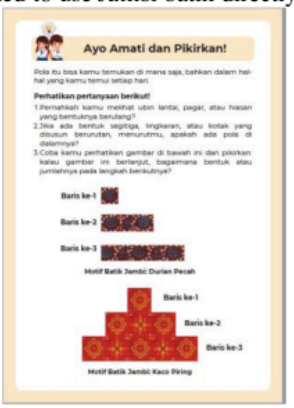
The worksheets are available in both print and digital formats to support flexible use in the classroom.

After the first prototype was completed, the researchers developed a validation instrument that covered content validity, alignment with the problem-posing and deep learning models, media presentation, and language. The validation was conducted by two experts: a subject matter expert and a media expert. The validation results were accompanied by recommendations for improvement, including increasing the variety and contextual relevance of the questions, refining the wording of the instructions, and adjusting the layout and visual presentation to make them more balanced and easier to read.

Table 4. Product Revisions and Improvements Based on Feedback from Validators

Validator	Before the Revision	After the Revision
I	The cover image now features Jambi batik, which is the focus of the worksheet. Additionally, the word "developer" has been removed and replaced with the grade level and class for which the worksheet is intended, and a "group" column has been added to the cover.	The researcher revised the cover design based on the validators' suggestions and comments, placing greater emphasis on Jambi batik on the cover.
		
	If you ask students to fill in the blanks, you should provide them with pictures of batik patterns to use	The researcher added images of batik fabric pieces that the students used to fill in the columns of the batik design they were creating.
		
	The sentences in the reflection are adapted from the reflection on deep learning.	The researcher's reflective statements should align with reflections on deep learning.

II	It is best to use examples directly from Jambi batik.	The researcher revised the study as suggested to use Jambi batik directly.

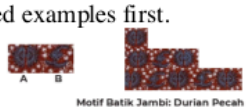


	The position of the batik pattern should be changed because the current arrangement is not in rows. The instructions in column 3 should also be changed to reflect the pattern found and ask students to continue directly from row 7.	The researcher rearranged the batik patterns into rows and labeled each pattern A or B. In addition, the researcher revised the instructions in the columns and provided examples first.

Tugasmu

Isilah tabel berikut berdasarkan gambar motif batik yang kamu lihat!

Baris ke	Jumlah Motif	Apa yang Berubah? (Perbedaan dengan baris sebelumnya)
1		
2		
3		
4		
5		

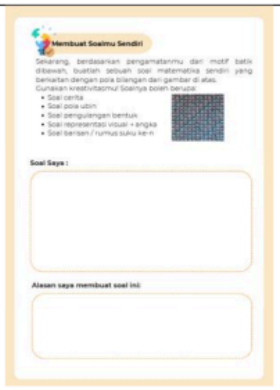


Tugasmu

Isilah tabel berikut berdasarkan gambar motif batik yang kamu lihat!

Baris ke	Jumlah Motif	Pola Gambar yang muncul
1	1	A
2	3	ABA
3	5	ABABA
7	.....	.....
8	.....	.....

	The questions the students create should still be related to Jambi batik, so provide them with a picture of the batik, and let the students use their creativity to come up with questions based on it.	The researcher included batik images in the activity of creating their own questions.

	
Add an emoji at the end of the reflection so we know how the students felt during the lesson.	The researcher added 3 emojis as suggested by the validator.
	

Based on the validation results, the researchers received various comments and suggestions from both validators as a basis for refining the LKPD. The media expert validator provided feedback focused on visual and graphic aspects, particularly regarding the cover design to better highlight the Jambi batik motif as the LKPD's local identity. Additionally, the validators suggested rearranging the images and text to achieve better proportions, improving the quality of the illustrations to align with the number pattern content, and adjusting the colors, spacing between elements, and typographic consistency to enhance readability and visual appeal.

Meanwhile, subject-matter experts provided feedback on the clarity of the language, the effectiveness of sentence structure, and the alignment of the questions with the learning objectives. Some narratives and questions were deemed in need of rewriting to make them easier for students to understand and to better encourage the process of analogical thinking. The validators also emphasized the importance of integrating indicators of analogical reasoning skills with the activities in each section of the worksheet, so that the questions presented are not merely procedural but guide students to identify patterns, compare relationships, and apply concepts to new contexts based on Jambi batik motifs.

In response to this feedback, the researchers made revisions by refining the cover design, improving the layout and visuals, and clarifying the wording of the narratives and questions. The questions in the worksheets were also adjusted to better align with the indicators of encoding, inferring, mapping, and applying. After the revisions were made,

the worksheets were reviewed again and found to meet the validity criteria in terms of content, presentation, and language, making them suitable for use in the subsequent practical testing phase.

Table 5. Summary of Worksheet Validation Results by Validators

Type of Validator	Validation I	Validation II	Validity Categories
Material Expert	64	64	Good
Media Expert	65	61	Good
Average	64,5	62,5	Good (Valid)

Based on the assessment results in the validation table, the developed worksheets received a "good" rating from both the content expert and the media expert. In the first validation, the scores obtained from the content expert and the media expert were 64 and 65, respectively, indicating that the worksheets met the eligibility criteria in terms of content, presentation, language, and media design. After revisions were made according to the validators' suggestions, the results of the second validation showed a score of 64 from the content expert and 61 from the media expert. Although there was a decrease in the score from the media expert, the score remained in the "good" category, indicating that the improvements made maintained the overall quality of the LKPD. The average validation scores for the two stages were 64.5 and 62.5, respectively; thus, the problem-posing and deep learning-based number pattern LKPD was declared valid and suitable for use in the practicality testing phase.

Interestingly, the media expert score decreased slightly from 65 in the first validation to 61 in the second validation. This decrease does not indicate a decline in product quality; rather, it reflects a more comprehensive evaluation after revisions were implemented. During the second validation, the expert assessed additional aspects related to visual consistency, typography, and the balance between illustrations and learning content. Despite the decrease in score, the developed worksheets remained within the "Good" category and were considered suitable for classroom use after revision.

Based on feedback from the validators, the researchers revised the worksheets, including improvements to the language and layout, the addition of supporting examples, and adjustments to the context of the number patterns based on Jambi batik motifs. The results of the revisions showed improved clarity of instructions, alignment of content with learning objectives, and the visual quality of the worksheets. Consequently, the number pattern worksheets based on problem posing and deep learning were deemed valid and suitable for use in the next pilot phase.

The practicality of the Jambi batik-based number pattern worksheets was assessed using two sources: an evaluation by one teacher and a survey of six students during a small-group pilot test. The practicality findings should be interpreted cautiously because the small-group evaluation involved only six students. Although the participants represented different levels of mathematical ability, the results cannot be generalized to a broader population. Future studies are recommended to involve larger samples and examine the effectiveness of the worksheets in improving students' learning outcomes and analogical thinking abilities.

Table 6. Teacher Evaluation Survey Results

Question Score																Total Score
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
4	4	4	3	4	4	4	3	4	4	4	4	4	4	4	4	62
Percentage (%)																77,5%
Category																Good

Based on teachers' evaluations of ease of use, clarity of instructions, appropriateness of content, and availability of supporting materials in the learning process, the worksheets received a total score of 62, representing 77.5%, and were categorized as "Good." These results indicate that teachers found the worksheets easy to use as teaching materials, aligned with learning objectives, and supportive of classroom instruction. In addition to teacher evaluations, the practicality of the worksheets was also analyzed through student feedback questionnaires during the pilot phase.

Table 7. Summary of Small Group Pilot Test Results

No	Statement Indicators	Score
1	Fill out the worksheet based on the math lessons I learned in school	23
2	The activities in the LKPD help me learn how to create and understand number pattern problems	23
3	The learning objectives in the worksheet are clear and easy for me to understand	24
4	The questions in the worksheet relate to daily life and local culture (such as Jambi batik)	24
5	LKPD allows me to learn by creating my own questions (problem posing)	22
6	The language in the worksheets is easy to understand	23
7	The spelling of words and sentences in the worksheet is correct	23
8	The instructions in the worksheet are clear and easy to follow	24
9	The text, images, and Jambi batik patterns are engaging and help me learn	24
10	The LKPD was easy for me to use from start to finish	21
11	The LKPD helps me learn independently and be more active	23
12	The pictures and illustrations in the worksheets help me understand number patterns	24
13	Learning starts with examples from my own life	22
14	The worksheet includes patterns and images that help me see the relationships between numbers	23
15	I can gain a new understanding from the questions and activities in the worksheet	25
16	The LKPD helps me see the connections between one question and another	23
Total		371
Percentage		77,29%
Category		Good

The survey results showed a total score of 371, representing 77.29%, and fell into the "Good" category. Students gave positive feedback, particularly regarding the clarity of learning objectives, visual presentation, and the integration of local culture through Jambi batik motifs. Additionally, the learning activities presented in the worksheets were found to help students develop a new understanding of number patterns.

Although the developed worksheets were categorized as valid and practical, the practicality scores obtained from teachers and students were around 77%, indicating that there is still room for improvement. One possible explanation is that the worksheets adopt the problem-posing model, which requires students to generate and formulate their own

mathematical problems. This learning activity differs from conventional worksheets that mainly provide routine exercises and predetermined questions. Consequently, some students needed more time to understand the instructions and adapt to the learning activities. The novelty of integrating problem posing, deep learning principles, and Jambi batik context may also have influenced students' initial responses to the worksheets.

Qualitative feedback also supported the questionnaire results. The mathematics teacher stated that the worksheets were easy to implement and encouraged students to participate actively in learning activities. Students reported that the integration of Jambi batik made the lessons more interesting and helped them understand number pattern concepts through familiar cultural contexts. They also expressed enthusiasm in creating and solving problems during the problem-posing activities.

However, the students' feedback also revealed several points for consideration, particularly regarding the instructions for use and the sequence of activities in the problem-posing process. Some students noted that the instructions in certain sections still need to be simplified to make them easier to understand, and that the sequence of activities should be made more systematic from start to finish. These findings will be taken into account when refining the next version, so that the worksheet can be used more independently by all students.

Assessment Phase

The assessment phase aims to evaluate the suitability of the worksheets developed through direct application in classroom instruction on number patterns. In this phase, students use the worksheets in accordance with the designed problem-posing activity sequence, with the teacher serving as a learning facilitator. This application is intended to provide a realistic picture of the implementation of the worksheets, students' initial responses, and the ease with which teachers can implement the learning materials in the classroom. Documentation of learning activities is presented as contextual evidence that the worksheets have been used in actual learning situations prior to the practicality assessment by students and teachers.

Figure 2. Implementation of LKPD in the Classroom

Based on documentation of the implementation of the worksheets during the assessment phase, it is evident that students were actively engaged in the activities contained in the worksheets, both individually and in groups. Students followed the problem-posing stages, beginning with observing the given situation, identifying patterns, and then formulating simple problems based on those patterns. Throughout the activity, the teacher acted as a facilitator, providing guidance when needed, particularly during the question formulation stage. The developed worksheets are considered valid and practical for use in mathematics learning. Furthermore, the integration of problem posing, deep learning principles, and Jambi batik context has the potential to facilitate meaningful learning experiences and support students' analogical thinking.

Based on the findings from classroom implementation during the assessment phase, the worksheets developed were deemed suitable for use in teaching number patterns in junior high school. This suitability is supported by their ease of use, clear instructions, and the alignment of the content with learning objectives. Furthermore, the design of activities within the worksheets reflects the principles of deep learning, particularly through activities that encourage students to focus and be mindful of the information being learned (mindful learning), meaningfully connect number pattern concepts with the local cultural context of Jambi batik (meaningful learning), and reflect on the process and outcomes of their understanding (reflective learning). With these characteristics, the worksheets are not only technically and pedagogically sound but also have the potential to support deeper learning in line with the characteristics of mathematics learning in junior high school.

3.2. Discussion

The strengths of this study are evident in several aspects. First, the product was developed by integrating local cultural context (Jambi batik motifs), thereby providing contextual and relevant ethnomathematical value for local students; this enriches the meaning of learning tasks and encourages engagement. Second, the worksheets developed are not merely a collection of questions, but rather a tool designed to develop higher-order thinking skills. Third, the validation process by two competent validators (a subject matter expert and a media expert) and measured revisions demonstrates good methodological quality in the early development phase. Empirical support for the importance of combined content-media validation is also found in recent studies on the development of worksheets and learning tools that emphasize the synergy between content and media design [19], [20].

The integration of Jambi batik motifs also contributed to making number pattern concepts more meaningful for students. The repetitive and structured elements found in batik motifs provide visual representations of mathematical regularities, allowing students to identify sequences, observe repetitions, formulate generalizations, and determine nth-term rules. In this way, the ethnomathematical context helps students connect abstract mathematical ideas with familiar cultural objects. Moreover, the developed worksheets facilitate deep learning practices through meaningful learning, where students relate number patterns to Jambi batik motifs; mindful learning, where students observe and analyze pattern regularities; reflective learning, where students summarize their findings

and draw conclusions; and problem-posing activities, where students create and solve their own mathematical problems.

The developed worksheets were designed to operationalize deep learning principles through several learning activities. Meaningful learning was facilitated by connecting number pattern concepts with Jambi batik motifs, enabling students to relate abstract mathematical ideas to familiar cultural contexts. Mindful learning was implemented by encouraging students to observe batik patterns, identify regularities, analyze relationships among terms, and formulate generalizations. Reflective learning was supported through activities that required students to summarize their findings, write conclusions, and reflect on the strategies they used during problem solving. In addition, the problem-posing activities encouraged students to create and solve their own mathematical problems based on the presented contexts. These activities were designed to provide meaningful and active learning experiences; however, the present study did not empirically measure the effectiveness of the worksheets in improving students' deep learning outcomes or higher-order thinking skills.

Another factor that may have influenced the practicality results is students' limited experience with problem-posing activities. In conventional mathematics learning, students are generally accustomed to solving teacher-provided problems rather than creating their own questions. Therefore, some students initially experienced difficulties in formulating meaningful mathematical problems and connecting them with the presented contexts. Nevertheless, as the learning activities progressed, students became more actively involved in exploring patterns, discussing ideas, and generating questions related to the given situations.

On the other hand, the study's limitations must also be acknowledged: Although this study has reached the feasibility assessment stage through expert validation and practicality testing, experimental testing of learning effectiveness has not yet been conducted. Therefore, the findings of this study are still limited to the quality of the product as a valid and practical teaching material and cannot yet be used to draw causal conclusions regarding improvements in student abilities; the sample of validators is relatively small (only two experts), making the results susceptible to individual assessment bias; and contextual revisions may require adaptation if applied in other regional contexts. Consequently, the findings of high validity must be supplemented with an effectiveness test (control class) to assess student responses and the actual impact of learning [21], [22]. It should be noted that the present study did not directly measure students' higher-order thinking or analogical thinking abilities. Therefore, the developed worksheets cannot be claimed to improve these abilities empirically. Nevertheless, the worksheets were designed to facilitate learning activities that are theoretically associated with analogical thinking processes, such as identifying relationships, analyzing patterns, and constructing mathematical problems.

Compared to previous research, the findings of this study generally align with recent findings. For example, a study on the integration of Jambi batik ethnomathematics reported that Jambi batik-based learning materials can be validated and are practically valuable if their design and content are adapted to the context [23]. Thus, the alignment

between these findings and the results of this study underscores the benefits of integrating local culture into instructional materials. Furthermore, recent meta-analyses and empirical reviews on problem-posing indicate that problem-posing interventions designed with scaffolding and exploratory activities have the potential to support the development of higher-order thinking skills [24]. This is consistent with the finding that questions tailored to higher-level abilities received very high ratings from content validators.

In the field of instructional design, research on design-based learning and deep learning approaches emphasizes that activities that facilitate conceptual connections and deep reflection have the potential to foster meaningful learning through these connections and reflective activities; findings of high validity regarding the construct aspects of the worksheets support this thesis [25]. In other words, there appears to be no substantive contradiction with previous research; on the contrary, this study reinforces the evidence that the combination of problem posing, Jambi Batik, and well-designed media is a promising approach. The results of the practicality test, which demonstrated ease of use and positive student responses to reflective activities and the local cultural context, indicate that the principles of deep learning are not merely present conceptually but can also be operationally implemented in instructional materials.

In terms of contributions, the findings of this study have clear theoretical and practical implications. Theoretically, the study confirms that the design of problem-posing activities can be standardized as an operational strategy for implementing deep learning on the topic of number patterns; this enriches the literature on how indicators of analogical thinking can serve as a framework for designing items and tasks. Practically, the validated worksheets provide ready-to-use instructional materials for junior high school teachers who wish to integrate local contexts (Jambi batik) into mathematics instruction, while also offering activity guidelines that guide students in problem posing and reflection activities that have the potential to support student engagement and aid in the conceptual understanding of number patterns. Furthermore, these findings encourage the design of controlled practical tests, such as one-on-one and small-group settings, as well as field experiments to measure the impact on analogical thinking skills and mathematics achievement; the results of these further tests will determine whether this theoretical validity can be translated into real-world learning effectiveness.

This study has several limitations that should be considered when interpreting the findings. First, the practicality evaluation involved only one mathematics teacher and six students in the small-group stage, which limits the generalizability of the results. Second, the study focused only on validity and practicality aspects and did not examine the effectiveness of the worksheets in improving students' learning outcomes or analogical thinking abilities. Therefore, future studies are recommended to involve larger samples and employ experimental designs to investigate the impact of the developed worksheets on students' mathematical performance and cognitive skills.

The findings of this study have practical implications for mathematics teachers. The developed worksheets can serve as an alternative teaching material that integrates local culture into mathematics learning while encouraging students to participate actively through problem-posing activities. Teachers may adapt similar ethnomathematics-based

worksheets to other mathematical topics and local cultural contexts to create more meaningful and engaging learning experiences.

4. CONCLUSION

This study concludes that the developed number pattern worksheets based on problem posing and deep learning, integrated with Jambi batik motifs, meet the validity and practicality criteria based on expert validation and limited practicality testing. The validation results from the subject matter expert and media expert indicate that the worksheets are theoretically valid in terms of content, language, and media presentation. In addition, the practicality results obtained from one mathematics teacher and six students show that the worksheets are practical to use, provide clear instructions, and can facilitate number pattern learning activities in junior high school mathematics classrooms.

However, these findings should be interpreted cautiously because the study involved a limited number of validators and participants, and the practicality evaluation was conducted only on a small group of students. Therefore, the developed worksheets are considered suitable for use in junior high school mathematics learning based on expert validation and limited practicality testing. This study did not examine the effectiveness of the worksheets in improving students' learning outcomes, deep learning, or mathematical thinking skills. Future studies are recommended to involve larger samples and investigate the effectiveness of the developed worksheets in broader classroom settings. Further development may also explore the integration of other local cultural contexts, the application of the worksheets to different mathematics topics, and the development of digital worksheet formats to better accommodate students' learning needs in the digital era.

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