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Development of TIMSS-Model Mathematics Problems with Banjar Cultural Ethnomathematics Context for Junior High School Students

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Abstrak
Hasil TIMSS menunjukkan bahwa kemampuan matematika siswa Indonesia masih rendah dibandingkan negara lain. Karena hanya sebagian kecil siswa yang mengikuti TIMSS akibat teknik sampling, banyak siswa yang kurang familiar dengan model soalnya. Oleh karena itu, diperlukan pengembangan soal matematika bermodel TIMSS agar lebih banyak siswa dapat berlatih dan terbiasa dengan pola soal tersebut. Adapun tujuan dari penelitian ini yaitu, untuk menghasilkan soal matematika model TIMSS dengan konteks etnomatematika budaya Banjar yang valid, reliabel, dan praktis. Dalam penelitian ini metode yang digunakan ialah Research and Development dengan model pengembangan ADDIE yang terdiri dari lima tahapan yaitu: Analisis, Rancangan, Pengembangan, Implementasi, dan Evaluasi. Subjek uji coba penelitian ini adalah siswa SMP Negeri 15 Banjarmasin kelas VIII D yang berjumlah 30 orang. Instrumen yang digunakan adalah lembar validasi, angket respons siswa, dan skor hasil pengerjaan soal. Produk yang dikembangkan divalidasi oleh 2 validator dan memperoleh skor validitas logis sebesar 3,78 yang masuk pada kategori valid. Berdasarkan skor pengerjaan soal didapatkan hasil bahwa soal yang diujikan valid secara empiris dan reliabel. Selain itu, menurut angket respons siswa didapatkan nilai kepraktisan sebesar 4,475 yang berkategori praktis. Hasil akhir penelitian pengembangan ini diperoleh 5 soal uraian yang dikategorikan valid, reliabel, dan praktis.

Abstract
TIMSS results show that Indonesian students' math skills remain low compared to other countries. Due to the limited number of participants selected through sampling, many students are unfamiliar with TIMSS-style questions. Therefore, it is necessary to develop TIMSS-modeled math problems to help more students practice and become familiar with the question format. This research aims to develop TIMSS-model math problems using Banjar cultural ethnomathematics that are valid, reliable, and practical. The study used a Research and Development (R&D) method with the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The test subjects were 30 eighth-grade students from SMP Negeri 15 Banjarmasin. Instruments included validation sheets, student response questionnaires, and test scores. Two experts validated the product, resulting in a logical validity score of 3.78, categorized as valid. Based on student performance, the questions were empirically valid and reliable. The practicality score from the student questionnaire was 4.475, categorized as practical. This research successfully produced five descriptive math problems that meet the validity, reliability, and practicality criteria.

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Introduction

Science and technology rapidly advance, shaping the era of Society 5.0, where humans and advanced technology are harmoniously integrated into daily life (Tahar et al., 2022). This development expands international job opportunities, and demands improved human resource capabilities to compete globally. Education is crucial in shaping high-quality human resources (Mantiri, 2019). Mathematics is one of the key components of education. Sembiring, as cited in Trimahesri (2019), states that mathematics is studied due to its benefits in everyday life and its role as a tool and language that supports scientific and technological progress.

The curriculum plays a significant role in educational progress. Indonesia implements the *Merdeka Curriculum* with the Minimum Competency Assessment (AKM) as the primary evaluation tool to improve students' math skills to an international level, such as the Trends in International Mathematics and Science Study (TIMSS). TIMSS is a long-term international assessment in mathematics and science for fourth- and eighth-grade students, collecting data every four years since 1995. According to the TIMSS 2023 Assessment Framework (2021), around 70 countries use TIMSS trend data to evaluate their education systems in a global context, with more countries joining each assessment cycle. TIMSS assesses students' knowledge in content domains (e.g., number, algebra, geometry) and cognitive domains (knowledge, application, and reasoning) (Sari, 2015), which aligns with the structure of AKM.

Indonesia has participated in TIMSS since 1999, consistently scoring below the international average and falling into the *low international benchmark* category. This indicates that Indonesian students' mathematical abilities remain below expected standards compared to other countries. It is important to note that TIMSS is conducted using sampling techniques, meaning only a small proportion of students in each country take the test. As a result, most Indonesian students lack experience with TIMSS-style questions, which require higher-order reasoning and real-life application. Students are usually exposed to routine questions with little connection to real-world contexts, limiting their ability to express their thinking processes and argumentation—skills emphasized in TIMSS, which features contextual problems requiring reasoning, argumentation, and creativity (Rudhito & Prasetyo, 2016). Therefore, developing TIMSS-modeled math problems is necessary to help students become more familiar with these question formats and build a more profound understanding.

One strategy to enhance students' mathematical competence is an ethnomathematical approach, which connects mathematics with local culture. According to Puspendik in Andy (2016), one effort to improve students' mathematical abilities is by encouraging schools to study and integrate cultural contexts into learning through ethnomathematics. Combining TIMSS-style question characteristics with an ethnomathematical approach can effectively enhance students' math skills. It fosters higher-order thinking and helps students understand mathematical concepts through familiar cultural contexts. Previous studies have shown that TIMSS-based questions using various contexts, including

ethnomathematics, can improve students' motivation and understanding (Vebrian & Hartono, 2019; Vebrian et al., 2022; Susanti, 2016).

South Kalimantan is rich in cultural heritage, such as traditional mosques, houses, floating markets, *sasirangan* fabric, *purun* weaving, and more. These cultural elements are integral to Banjar community life and can be used in educational contexts, especially in mathematics learning. Incorporating local culture into math education can make learning more relevant to real life and engaging and encourage students to be more involved and think creatively (Fauzi & Setiawan, 2020; Mailana et al., 2024). This study was conducted in Class VIII D at SMP Negeri 15 Banjarmasin, where routine questions still dominate math learning and lack connection to TIMSS models and local culture. The local culture referred to in this context is the Banjar culture, which encompasses traditional architecture, decorative motifs on fabric, river-based transportation systems, and daily practices of the Banjar community. Based on this background, this research aims to develop TIMSS-model math problems for junior high school students using Banjar cultural ethnomathematics. This development is expected to help students become more familiar with TIMSS-style problems, enhance their numeracy skills, and better prepare them for global educational challenges.

Methods

The research method used in this study is Research and Development (R&D), employing the ADDIE development model, which consists of five stages: Analyze, Design, Develop, Implement, and Evaluate (Branch, 2010). The first stage carried out is the analysis phase. This study includes class-level analysis, curriculum analysis, TIMSS model question analysis, and the analysis of the ethnomathematics context of Banjar culture. The next stage is designing or creating a product draft based on the identified needs. The steps in this stage include determining the question format, creating a blueprint, designing the instructions, designing five items to be developed, and creating other instruments such as validation sheets and student response questionnaires.

The development stage is the process of turning the design into reality. Activities in this stage include preparing the instructions, developing open-ended questions based on the blueprint, and creating other instruments like validation sheets and student response questionnaires. Once the questions and validation sheets are completed, the math questions are submitted to two validators and validated to obtain logical validity.

The implementation stage involves applying the developed product in a real-life setting. Based on validator feedback, the validated and revised questions are tested on students. Student scores during the trial phase are used to measure empirical validity and reliability. At this stage, students also complete the response questionnaire to assess the practicality of the questions.

The evaluation stage occurs throughout all research phases, from analysis to implementation. Evaluation is used to identify the strengths and weaknesses of the research process and provide suggestions for future improvements. The study was conducted at SMP Negeri 15 Banjarmasin.

The types of data used in this development research are quantitative and qualitative data. The subjects of this development research were Grade VIII D students at SMP Negeri 15 Banjarmasin who responded to the developed questions. The object of this research is TIMSS model math questions with the ethnomathematics context of Banjar culture for junior high school (SMP/MTs) students.

The instruments used in this study include validation sheets, test questions, and student response questionnaires. The data analysis techniques used in this research are development research data analysis techniques to provide an overview of the quality of the TIMSS model math questions with the ethnomathematics context of Banjar culture that have been developed. The analyses conducted include logical validity analysis, empirical validity analysis, reliability test analysis, and question practicality analysis.

Result and Discussion

The result of developing the TIMSS-model mathematics questions with the ethnomathematics context of Banjar culture for junior high school (SMP/MTs) students consists of 5 questions categorized as valid, reliable, and practical. The development process is explained through the five stages of the ADDIE development model.

Result

Analyze

The first stage of this research is the analysis stage. The analysis includes class-level analysis for the selected research sample, the curriculum used at SMP Negeri 15 Banjarmasin, the TIMSS question model, and the context of ethnomathematics. In the class-level analysis, class VIII D class VIII D was selected as the research sample based on discussions with the mathematics teacher, who considered factors such as learning needs and the suitability of the class for implementation of the research. The TIMSS-model mathematics questions to be developed refer to the Learning Outcomes (*Capaian Pembelajaran*/CP) in Phase D of the Merdeka Curriculum. During the analysis of TIMSS question models, a review was conducted on TIMSS questions available on the official TIMSS & PIRLS website and other reference sources. This step aims to ensure that the developed questions align with the characteristics of TIMSS questions. Lastly, the context of Banjar's cultural ethnomathematics was analyzed to ensure that the developed questions were relevant to the students' local culture. The ethnomathematical contexts used include the floating market, *sasirangan* fabric, *Sultan Suriansyah* Mosque, *Bubungan Tinggi* traditional house, and *purun* weaving.

Design

After completing the analysis stage, the next step is to design mathematics questions intended for Grade VIII students at SMP Negeri 15 Banjarmasin. At this stage, the following activities were carried out: (1) the process began by determining the type of mathematics questions to be developed—TIMSS questions are typically in the form of multiple choice with 4 to 5 options, short answers, and open-ended questions; in this study, all questions were designed as open-ended; (2) the construction of a question blueprint was based on the Learning Outcomes (CP) for Phase D; (3) the design of mathematics questions included drafting the instructions and developing five items based on the blueprint; and (4) the development of other research instruments such as expert validation sheets to assess logical validity and student response questionnaires to assess the practicality of the questions.

Develop

After the design stage, the developed blueprint served as a guide for constructing the TIMSS-model mathematics questions during the development stage. This stage includes the following activities: (1) creating instructions on the question sheet; (2) gradually constructing the test items along with written answer keys and repeatedly revising them until they are ready to be printed and duplicated, and (3) preparing expert validation sheets and student response questionnaires. These validation sheets were then printed and given to two validators to collect data regarding the quality of the developed test instrument.

The results of the logical validity analysis are presented in Table 1.

Table 1. Results of the logical validity

Question Number	Aspect	$\overline{V_1}$	$\overline{V_2}$	V_r	Category
1	Content	3,3	3,8	3,52	Very valid
	Construction	3,6	3,6		
	Language	2	3,6		
	Ethnomathematics	4	4		
2	Content	4	3,8	3,97	Very valid
	Construction	4	4		
	Language	4	4		
	Ethnomathematics	4	4		
3	Content	3,6	3,6	3,91	Very valid
	Construction	4	4		
	Language	4	4		
	Ethnomathematics	4	4		
4	Content	3,6	4	3,70	Very valid
	Construction	4	4		
	Bahasa	2	4		
	Ethnomathematics	4	4		
5	Content	3,8	3,8	3,79	Very valid
	Construction	4	3,6		
	Language	4	4		
	Ethnomathematics	3	4		
	Total	3,68	3,88	3,78	Very valid

The validity score of all the questions was 3.78, placing them in the "very valid" category based on the criteria by Riyani et al. (2017). However, revisions were still necessary based on the suggestions and feedback provided by the two validators. The revisions during this stage resulted in a logically valid product categorized as "very valid." In this development process, the questions were deemed logically very valid overall, although some aspects scored lower than others. For example, in question number 1, the language aspect received a score of 2 from Validator 1. According to the validator's notes, this was because the researcher had used a term from the Banjar language—acil. The validator suggested replacing the term acil with the standard Indonesian term ibu. Therefore, the term was revised accordingly. Additionally, several sentences in the question items were revised to improve effectiveness and clarity.

Implement

In the implementation stage, the questions revised according to the validators' feedback were used in the field test. The field test was conducted with 30 eighth-grade students from class VIII D at SMP Negeri 15 Banjarmasin. In this test, students were asked to complete the prepared questions. Their answers were then analyzed to evaluate the empirical validity and reliability of the questions. Afterward, students were also asked to fill out a response questionnaire, which was used to assess the practicality of the developed questions.

The average scores obtained from the students' answers are presented in Table 2.

Table 2. Averages score

Question Number	Average Scores
1	13,9
2	8,5
3	15,4
4	7,4
5	2,8

The results of the empirical validity analysis, reliability analysis, and practicality analysis are presented in the following explanation.

Table 3. The results of the empirical validity analysis

Question Number	r_{xy}	Category
1	0,637	Valid
2	0,557	Valid
3	0,714	Valid
4	0,715	Valid
5	0,536	Valid

Based on Table 3, the results of the empirical validity analysis for the five questions showed that all of the questions were categorized as valid because the calculated r values (r_{hitung}) for all five were greater than the table r values (r_{tabel}). The reliability of the developed TIMSS mathematics test items was analyzed using SPSS Statistics 25 software by calculating Cronbach's Alpha. The items are

considered reliable if the Cronbach's Alpha correlation coefficient is greater than 0.60. The test results using SPSS Statistics 25 can be seen in Figure 1.

Reliability Statistics

Cronbach's Alpha	N of Items
,612	5

Figure 1. The result of reliability analysis

The analysis results showed that the reliability coefficient obtained was 0.612. This indicates that the TIMSS-style mathematics test items developed are considered reliable. Therefore, the items demonstrate good consistency and can be used repeatedly in similar assessments.

The items' practicality test was conducted during the field trial stage by distributing questionnaires to the students who were the research subjects. The students were asked to provide their responses using a 1–5 scale, reflecting answers from "Strongly Disagree" to "Strongly Agree" to the given statements. The results of the student response questionnaire can be seen in Table 4.

Table 4. Student response questionnaire results

No.	Statements	STS	TS	KS	S	SS
1	The questions are aligned with the material that has been taught	0	0	0	16	14
2	The questions are easy to understand	0	0	4	16	10
3	The language used follows proper Indonesian grammar	0	0	0	4	26
4	The questions and illustrations presented are clear and engaging	0	1	0	6	23
5	The instructions for solving the questions are clear and easy to follow	0	1	3	17	9
6	Each question relates to Banjar culture and adds to students' knowledge	1	1	0	9	19
7	The time allocated is appropriate for the number of questions	0	1	0	19	10
8	Each question provides a challenge when being answered	1	0	0	5	24
	Averages			4,475		

The student response questionnaire results showed that most students gave positive responses to the assessed aspects, with a final score of 4.475. According to Maulana's (2017) interpretation of student response questionnaires, this score falls into the "practical" category.

Evaluate

Each of the four previous stages underwent an evaluation process, ranging from analysis to implementation. During the analysis stage, a self-evaluation was conducted to ensure the clarity of the research direction. The product design and related components were prepared clearly and structured to align with the established objectives. The development stage involved revising the test items based on input from validators. In the implementation stage, a field trial was conducted along with the distribution of student response questionnaires, which provided student feedback and suggestions as a

basis for evaluation. This explanation shows that a comprehensive evaluation was carried out throughout the research process.

Discussion

This study followed the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The mathematics questions developed were in the form of five essay-type questions. These items were designed based on TIMSS questions, which consist of two domains as outlined in the TIMSS 2015 Assessment Frameworks (2013): (1) the content domain, which includes four areas—number, algebra, geometry, and data and probability; and (2) the cognitive domain, which includes three categories—knowing, applying, and reasoning.

The developed mathematics questions utilized the ethnomathematics context of Banjar culture. Designing questions within a context familiar to students can help them apply the mathematical concepts they understand to real-world problems in their environment. Additionally, incorporating Banjar cultural ethnomathematics in question development contributes to research focused on integrating Banjar culture into mathematics education. The five questions developed can serve as learning tools, practice questions, and a reference for teachers in creating similar items since the questions have been categorized as valid, reliable, and practical. Nonetheless, some aspects were revised according to validator suggestions and student feedback.

In the development stage, the first question's language aspect received a score of 2 from Validator 1. According to the validator's comments, the researcher still used the Banjar term *acil* (aunt). The validator suggested that the term *acil* should be replaced with the standard Indonesian word *ibu*. Accordingly, the term was changed. Several sentences in the questions were also revised to make them more effective and easier to understand.

In the practicality test, the student response questionnaire indicated that most students responded positively to the evaluated aspects, with a final score of 4.475. Based on the interpretation of student responses, the questions were categorized as practical. Although considered practical overall, several students gave responses of "disagree," "somewhat disagree," or "strongly disagree." For example, in Statement 6, which can be seen in Table 3, the statement reads: "Each question relates to Banjar culture and increases knowledge." Some students who answered "strongly disagree" or "disagree" may have already been familiar with the Banjar cultural context presented and felt that it did not enhance their knowledge.

In Statement 2, which reads: "The questions are easy to understand," four students responded with "somewhat disagree," possibly because they found the questions difficult to comprehend. Similarly, in Statement 5, "The instructions for solving the questions are clear and easy to follow," three students responded with "somewhat disagree" and one with "disagree."

Based on all the points presented above, the final result of this development research is a set of five essay questions categorized as valid, reliable, and practical.

Table 2 shows that Questions 4 and 5 received the lowest average scores compared to the other three questions. Based on direct observations during the field test, most students faced time constraints in completing all five questions as they worked through them sequentially without considering difficulty levels. For instance, Question 2, which was more difficult than the others, caused many students to spend more time trying to understand and solve it. As a result, they had minimal time left for the remaining questions, and many did not have a chance to answer Questions 4 and 5 before time ran out.

Based on the discussion, it can be concluded that the TIMSS-style mathematics questions with Banjar ethnomathematics context developed for junior high school (SMP/MTs equivalent) students have several advantages, as follows:

1. The TIMSS-style mathematics questions incorporating Banjar ethnomathematics context contribute to the development of valid, reliable, and practical ethnomathematics-based assessment tools, as also done by Jafirah et al. (2024).
2. The questions contain culturally relevant and engaging Banjar ethnomathematics contexts for students, as reflected in the student questionnaire responses and their diligence during the field test. This is supported by Ardiyanti et al. (2024), Khaerani et al. (2024), and Hartati & Ramlah in Solihin & Habibie (2024), who stated that ethnomathematics is not only relevant in academic contexts but also enhances students' understanding and application of mathematics in everyday life, ultimately improving learning outcomes. Moreover, students feel more connected to the material, thus supporting better achievement.
3. The positive student responses indicate that the TIMSS-style mathematics questions incorporating Banjar ethnomathematics context also expand students' knowledge of Banjar culture.

However, developing these questions also has some limitations, as highlighted in the student response questionnaire. Some students still found the questions difficult to understand, the instructions unclear and hard to follow, and the tasks not challenging enough. Some suggested solutions include developing TIMSS-style questions with varying difficulty levels and using more straightforward and more easily understandable language.

Conclusion

Based on the development research results, designing TIMSS-style mathematics questions with a Banjar ethnomathematics context for junior high school (SMP/MTs equivalent) students was conducted through five stages. In the first stage, an analysis of the grade level and the curriculum implemented at SMP Negeri 15 Banjarmasin was conducted, along with an analysis of TIMSS-style questions. Additionally, the Banjar cultural ethnomathematics context was analyzed to apply to the question items. Next, in the design stage, a question blueprint was developed to serve as a reference for question construction. In the development stage, five logically valid essay-type questions were produced. The implementation stage involved a trial in class VIII D, and the results were used to analyze the empirical

validity and reliability of the questions. During this stage, students also completed a response questionnaire, and the results were used to assess the practicality of the questions. Finally, in the evaluation stage, continuous assessments were conducted throughout the research process. The development of TIMSS-style mathematics questions with a Banjar ethnomathematics context resulted in five logically and empirically valid essay questions that are reliable and practical.

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