



The Development of HOTS Questions Based on Ethnomathematics to Measure Students' Mathematical Problem-Solving Abilities

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Abstract: The research aims to develop ethnomathematics-based Higher Order Thinking Skills (HOTS) questions to measure students' problem-solving abilities. This research uses a research and development (R&D) method with an ADDIE model, which consists of five stages, i.e., analysis, design, development, implementation, and evaluation. The subjects in this research were 30 class VIII students at SMP Negeri 1 West Sorkam. Research instruments include expert validation questionnaires, student response questionnaires and tests of students' mathematical problem-solving abilities. The research data were analyzed using quantitative descriptive methods by determining the average achievement value of the products developed. The experts' assessment shows that the product developed has a score of 84.6 with the criteria "Very Valid". Based on the results of the questionnaire, students' responses to HOTS questions based on ethnomathematics were seen from the practical aspect with a score of 77.63 in the "Practical" criteria and the results of tests on students' mathematical problem-solving abilities obtained an average score of 75.22 so that the product developed met the "effective" criteria. So it can be concluded that the development of ethnomathematics-based HOTS questions on geometric material produces a good product and is suitable for measuring students' mathematical problem-solving abilities.

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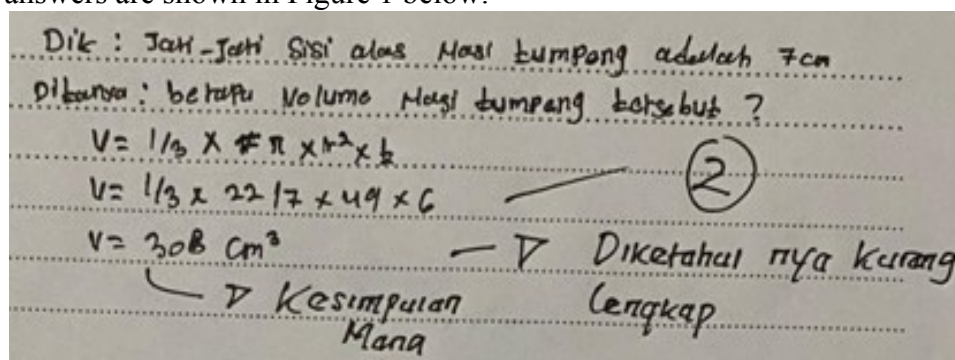
Introduction

Education plays a role in forming the human resources needed in the current era of globalization both in the lives of national and state communities. One of the subjects taught in school education is mathematics. Mathematics is a science studied at every level of education from elementary school to other tertiary institutions (Rohani et al., 2022). Where in various fields of life we cannot be separated from mathematics. Mathematics is sometimes considered difficult because students are less comfortable with the learning implemented by teachers in the classroom. Improving the quality of education is an effort that must be pursued continuously so that hopes for quality and relevant education can be achieved (Siahaan et al., 2023).

Higher Order Thinking Skills (HOTS) is a thinking process for someone who is not only able to memorize but is able to interpret a problem that requires analyzing ideas, creating ideas, making associations and drawing conclusions from various new information obtained (Widhiyani, et al., 2019). The aim of HOTS is to help students improve their ability to analyze or understand a problem in the form of information more critically and creatively in obtaining final results (Dinni, 2018). HOTS is a competency that is really needed in the modern era that must be achieved and possessed which involves students' high-level thinking

abilities in the learning process. Regarding the aspect of problem-solving abilities in mathematics, a student is required to have higher thinking abilities. For decades, problem-solving has been a focus of elementary mathematics education reform (Hourigan & Leavy, 2022). This makes problem-solving an integral part of all mathematics learning (Son et al., 2020). Problem-solving is widely considered a cornerstone of educational curricula and a theoretical basis for assessing international student achievement (Vicente et al., 2022; Harahap et al., 2023). This is the reason that thinking is a mental activity that a person carries out to help formulate or solve problems and make the right decisions according to what he wants. One of the important components that students must have is the ability to solve problems (Mendikbud, 2014).

Based on the facts that researchers found at West Sorkam 1 Middle School, efforts to improve problem-solving abilities in students in class VIII are still low, the difficulties faced by students when studying are students' mathematical problem-solving abilities in mathematics, where many students do not complete the concept of the problem and are less able to interpret or give answers based on mathematical models. This can be seen from the results of the students' answer sheets by giving the question "The tumpeng rice at the Uak Togop Christmas event is cone-shaped with the radius of the base of the tumpeng rice being 7 cm. If the height of Tumpeng rice is 6 cm. Determine the volume of the tumpeng rice?" The students' answers are shown in Figure 1 below.



Dik : Jari-jari Sisi alas Nasi tumpeng adalah 7cm
Ditanya : berapa Volume Nasi tumpeng tersebut ?
 $V = \frac{1}{3} \times \pi \times r^2 \times t$
 $V = \frac{1}{3} \times 22 \frac{1}{7} \times 49 \times 6$
 $V = 308 \text{ cm}^3$
Kesimpulan Mana
Diketahui nya kurang lengkap

Figure 1. Results of one student's test answers

The picture above shows the low problem-solving abilities of students in completing spatial construction material. This can be seen from the students' answer sheets, we see that the answers given are the result of memorizing examples of previous questions or memorizing formulas, so if the picture or the position of the letters is changed then students can no longer give answers that are in accordance with the concept of geometric figures. Furthermore, the researcher also conducted an interview with a mathematics teacher in Central Tapanuli Regency to obtain several facts, namely the lack of problem-solving abilities in students in learning mathematics, students already considering mathematics as fun learning, students' courage in asking and solving questions in class, lack of activity. students in learning, do not use learning models, and only use conventional methods and discussions.

Students' difficulties in connecting mathematics with various real-life problems makes the main factor in the importance of culture-based learning (Ahmad et al., 2018), namely using an ethnomathematics approach. Ethnomathematics is a type of science that is influenced or seen by culture. Culture and mathematics are two inseparable components, the development of both is synergistic and mutually reinforcing (Umbara et al., 2021). Mathematics is a cultural science that grows and develops according to human needs. In this way, students will be more interested in learning if they use problems related to students'



lives and culture (Arthur et al., 2018; Wahyu et al., 2021). Ethnomathematics-based mathematics learning has proven effective in improving students' mathematical abilities.

The presence of ethnomathematics in mathematics learning gives a new nuance that learning mathematics is not only confined to the classroom but to the outside world by visiting or interacting with local culture can be used as a medium for learning mathematics. Meanwhile, seen from the perspective of the learning approach, ethnomathematics is in line with the mathematics learning approach that is suitable if applied in the 2013 curriculum (Richardo, 2017). Culture-based learning is learning that allows teachers and students to participate actively based on the culture they are familiar with, so that optimal learning results can be obtained (Rewatus et al., 2020). Ethnomathematics functions to express the relationship between culture and mathematics, ethnomathematics is a science that is used to understand how mathematics is adapted from a culture (Marsigit, 2013). Mathematics as a basic science needs to study and examine the basics of arithmetic or computing as applied in society. The practice of ethnomathematics is a cultural group that demonstrates mathematics. Ethnomathematics can be interpreted as the application of mathematics to cultures related to mathematical activities such as counting, measuring, designing buildings or tools, playing, determining locations, and so on (Yudantia et al., 2022).

Education and culture play an important role in developing and cultivating the honorable values of our country, which influences the development of character in relation to honorable social qualities (Hariadi, 2014). In fact, students only assume that learning about culture must be explored by paying attention to expressions and culture. One thing that can overcome any barriers between culture and training is ethnomathematics. The mathematics lessons that students learn at school are sometimes different from the mathematics problems they encounter in everyday life, making it difficult for students to make connections between mathematical concepts and cultural problems. Based on the description above, there are problems in mathematics learning and the importance of using ethnomathematics in learning so the author is encouraged to develop ethnomathematics-based HOTS questions which can be used to measure mathematical problem-solving abilities in junior high school students.

Research Method

This study used a Research and Development method, namely research that aims to produce certain products and measure the quality of these products (Sugiyono, 2016). The product produced in this research is ethnomathematics-based HOTS questions to measure students' mathematical problem-solving abilities. The research location is West Sorkam 1 Middle School located at Jln. Sibolga-Barus Km.36 Sorkam Kanan, West Sorkam District, Central Tapanuli Regency, Postal code: 22563 North Sumatra Province. There are several considerations and reasons why the researcher chose this research location, which was based on the consideration that the school had problems with mathematics learning and the use of interactive learning.

The development procedure uses the ADDIE model (Sugihartini & Yudiana, 2018). The ADDIE development steps were chosen because the steps are in accordance with the research design to produce ethnomathematics-based HOTS questions which are useful in improving mathematical problem-solving abilities. The ADDIE development model has 5 development stages, namely: Analysis stage, initial product design stage, product development stage, product implementation stage, and product evaluation stage. At this analysis stage, an examination of the need for HOTS-based questions will be carried out. At this stage, information about the requirements for displaying the material is collected using the procedures of distributing surveys, meetings and perceptions. Based on the results of the



previous analysis stages, researchers will design appropriate ethnomathematics-based HOTS questions at the design stage. From the results. At this investigation stage, the ethnomathematics-based HOTS question configuration is ready. This underlying plan will be the draft on which the items created are based. Plan the HOTS questions that will be used using ethnomathematics. The results of the analysis stage are evaluated to proceed to the planning stage.

The initial product design that has been created is evaluated at the product development stage. In the refinement stage, the plan is still in the theoretical stage of being communicated as an item that is feasible to be implemented. The stage of care in this exploration is the stage of approval of the item by material experts, media experts and language experts. The fourth stage is the execution stage. At this stage, the analyst will carry out HOTS questions which display spatial building material that has been created and declared valid by experts. This execution was directed at class VIII -1 of SMP N 1 West Sorkam. Ethnomathematics-based HOTS questions that have been declared substantial will be applied to students in learning exercises to see the fairness of the broadcast material created by giving polls to educators and students. At this stage, the data is obtained and then analyzed. Analysis includes analysis of data from validation results by expert validators, student response questionnaires, and observations of learning implementation on teaching materials developed to determine the level of validity, effectiveness and practicality. The purpose of product testing is to determine the suitability of the product that has been made.

Results and Discussion

This research was conducted on mathematics subjects, especially material on building flat-sided spaces which will be taught to students in grades VIII - 1 at junior high school level. The product produced in this development research is a HOTS instrument based on Ethnomathematics material on flat-sided spatial construction at SMP N 1 Sorkam Barat which has been tested for content validity. At the end of the product of this development research is a HOTS-type question in the form of multiple choice with a total of 30 questions which are distributed directly to students.

Analysis Stage

At the analysis stage, it was discovered that in online mathematics learning activities there were still many students who did not play an active role in participating in learning due to the teacher's lack of familiarity with learning media that could be used to build student enthusiasm during distance learning activities. One of the mathematics subject teachers at the research school stated that mathematics learning activities were held twice a week. Furthermore, mathematics assignments are given which are used as homework, thus causing a decrease in motivation and making students bored in learning mathematics. So the researcher wants to develop a product in the form of an ethnomathematics-based HOTS question instrument, determining the title and indicators based on the results of learning analysis. Next, student analysis is carried out. This analysis is used to identify student characteristics regarding mathematics learning, the learning used by students and the learning models applied to students, especially in spatial material. Then a curriculum analysis was carried out based on competency standards and basic competencies which are in accordance with the 2013 curriculum which is currently implemented in education.

After the analysis stage is complete, the next step is the design stage, where this stage aims to design a product that is as attractive as possible. This design stage aims to design a product in the form of a HOTS question instrument used in mathematics learning, especially flat-sided geometric material. In this step, the researcher designs questions according to KI



and KD. The questions designed are in the form of HOTS (Higher Order Thinking Skill) with the following tasks: C4 (analyzing), C5 (evaluating), and C6 (creating).

Development Stage

The next stage is the development stage, namely the stage where the researcher creates an ethnomathematics-based HOTS question instrument using flat-sided geometric material based on the design results, in this HOTS question is in book form. Supporting elements in this HOTS question. The ethnomathematics-based HOTS questions have been produced at the design stage. The next stage is that the teaching materials are validated by 3 experts, namely material experts, media experts and language experts. validation carried out by the validator is the assessment of teaching materials on each aspect of the statements on the validation sheet. Validation by Material Experts In the validation assessment by material experts there are 3 aspects assessed, namely material coverage, contextual approach-based teaching materials to improve students' mathematical communication skills and presentation techniques.

Table 1. Validation results by material experts

No.	Rated aspect	Score obtained	Maximum score	Percentage
1.	Eligibility aspects of HOTS questions	45	50	90%
2.	Question Display Aspects	36	40	90%
Average value				90%

Based on the table above, it is concluded that the results of the expert validation of the HOTS question material include an illustration that is suitable for testing with an overall score percentage of 90% with the criteria "Very Valid".

Table 2. Validation results by media experts

No.	Rated aspect	Score obtained	Maximum score	Percentage
1.	Feasibility Aspects of Question Content	28	35	80%
2.	Color design on teaching materials	9	10	90%
3.	Letter design on HOTS questions	26	30	86%
Average value				84%

Based on the table above, it is concluded that the media expert's validation results regarding HOTS include a picture that is worth testing with an overall score percentage of 84% with the criteria "Very Valid".

Table 3. Validation results by language experts

No.	Rated aspect	Score obtained	Maximum score	Percentage
1.	Use of grammar in HOTS questions	40	50	80%
2.	Use of letters in HOTS questions	20	25	80%
Average value				80%

Based on the table above, we can conclude that the results of the language expert's validation of the teaching materials include descriptions that are suitable for testing with an overall score percentage of 80% with the criteria "Valid". Furthermore, by paying attention to the validation results from the 3 aspects that were the focus of development, namely 90% Material, 84% Media, 80% Language, an average score of 84.6 was obtained with the "Valid" criteria. The graph of achievement of these three aspects can be seen in Figure 2 below.

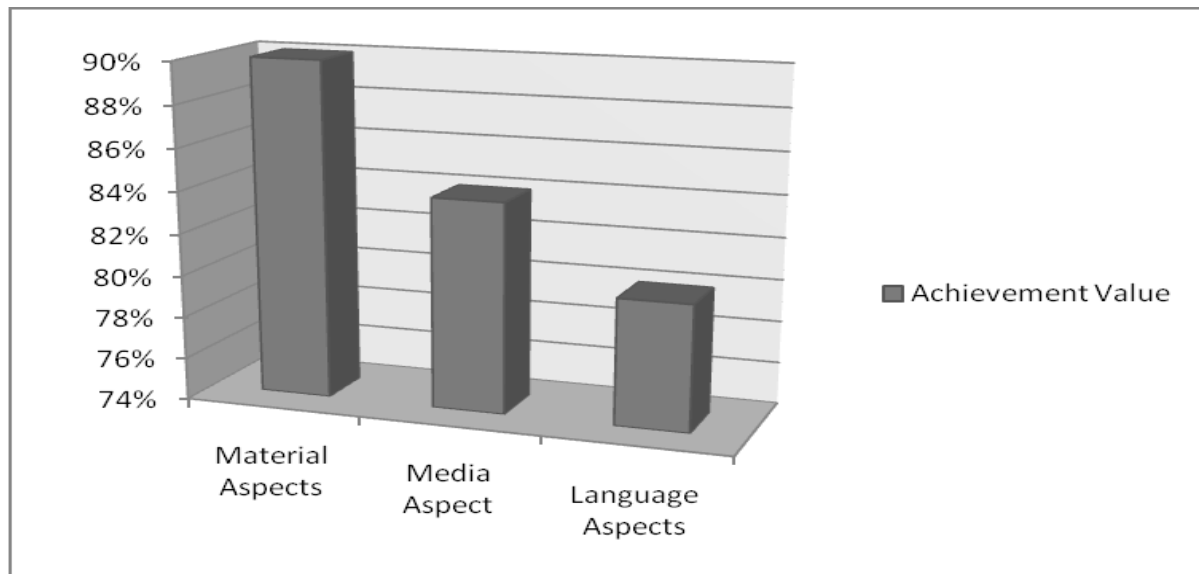


Figure 2. Validator Assessment Achievements

After the HOTS questions have been validated, if there are several criticisms and suggestions for improvements to the HOTS questions. So the HOTS questions were revised according to criticism and suggestions from experts. Suggestions and comments regarding HOTS ethnomathematics questions with a realistic mathematics education approach based on ethnomathematics that were developed were obtained from input provided by experts, below are details of revisions to improve the product being developed.

Table 4. Expert suggestions and comments

No	Validator	Suggestions and Comments
1	Materials Expert	The pictures in the questions are made even more interesting.
2	Media Expert	The book must have a table of contents, and a foreword. Adjust to real conditions.
3	Linguist	The writing needs to be tidied up and the use of EYD needs to be paid attention to, especially capital letters and prepositions.

After revision, it is then assessed again by experts so that it is suitable for testing at the next stage. The following is a display of teaching materials that have been revised according to suggestions and criticism from validators as follows:

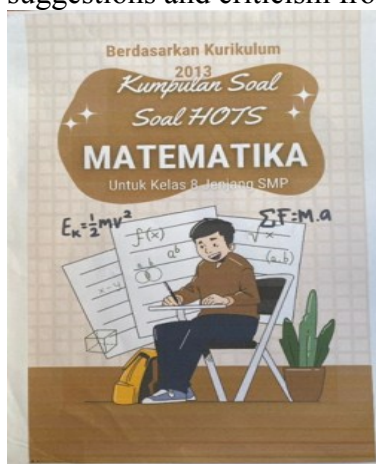


Figure 3. HOTS cover

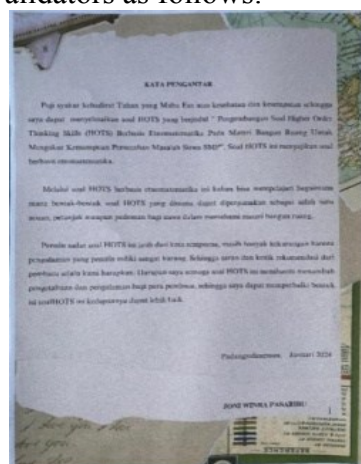


Figure 4. Foreword

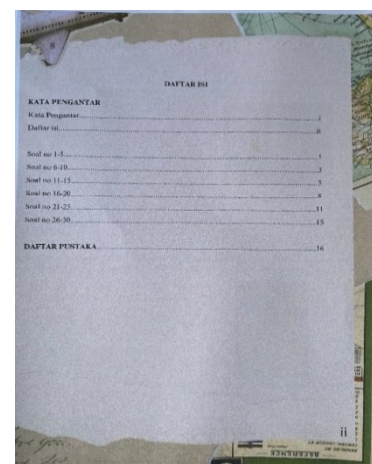


Figure 5. Table of Contents



Figure 6. HOTS question

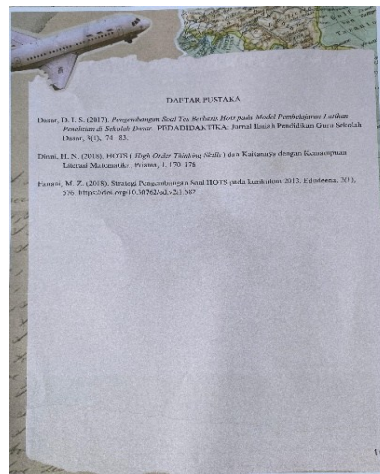


Figure 7. Bibliography



Figure 8. Back Cover

Validation questionnaire for material experts, media experts and language experts. In material expert validation with 3 aspects including the feasibility coverage of HOTS questions, HOTS questions based on ethnomathematics to measure problem-solving abilities, and the appearance aspect of HOTS questions obtained an average percentage of 90% with the "Very Valid" category. Then, in media expert validation with 3 assessment aspects which include the appropriateness aspect of the HOTS question content, the problem-solving ability aspect, and the language appropriateness aspect, an average percentage of 84% was obtained in the "Very Valid" category. Furthermore, in validation by language experts with 3 aspects of assessment which include the use of grammar in HOTS questions, the use of letters in HOTS questions obtained an average score with a percentage of 80% in the "Valid" category. So it can be concluded that the overall average rating of the ethnomathematics-based HOTS questions from the 3 validators is 84.67% in the "Very Valid" category.

Ethnomathematics-based HOTS questions are designed to involve students in constructing or connecting knowledge with students' everyday experiences. So, students are interested in learning using ethnomathematics teaching materials with this ethnomathematics-based mathematics education approach. This product development was developed according to the characteristics of class VIII junior high school students, so the product developed is only intended for junior high school students. The feasibility of ethnomathematics teaching materials is reviewed from the validation results of material experts, media experts and language experts as well as product trials using student response questionnaires and tests. From all the development stages described previously, the assessment results were obtained as "suitable" for use in teaching mathematics subjects such as algebra at West Sorkam 1 State Junior High School.

Based on the validity obtained above, the ethnomathematics-based HOTS questions that were developed are suitable for further testing. This is in line with previous research, which was carried out by Saodah et al. (2016) in research on the development of realistic mathematics-based teaching materials on social arithmetic material for junior high school students, revealing that the product feasibility test results were 86% in the "very good" category. Furthermore, research findings Jazirah & Ibrahim (2023), namely through research into the development of student worksheets using a contextual approach in facilitating critical thinking skills, produce valid products. Likewise the research results of Siregar, et al. (2020) revealed that developing an instrument for the ability to understand concepts in terms of format, language and content aspects, shows that the product developed is valid and suitable to be used as an instrument to measure students' mathematical abilities. Then, research



conducted by Aisyi et al. (2020) revealed that the development of discovery learning-based teaching material products accompanied by Islamic values, material for a 3-variable linear equation system, met the valid criteria.

Implementation Stage

Based on the acquisition of the Ethnomathematics-Based HOTS question product which meets the validity aspect, the product is then implemented on students to determine student responses to the product being developed. This stage provides a level of practicality for the product being developed. HOTS questions that have been validated by experts are then tested in the field. The trial test was carried out at SMP Negeri 1 West Sorkam in class VIII with 30 students and the large group trial was carried out by VIII-1 Negeri 1 West Sorkam students, totaling 30 students. The trial was carried out to determine students' assessment of the use of the HOTS questions that had been developed. Each student studied the HOTS questions in class, accompanied by researchers. The data obtained from this trial regarding student assessments was used to determine the data from the HOTS question trial results, then analyzed to find out whether the learning tools that the researchers developed included effective criteria. The data obtained from this trial regarding student assessments was used to find out the data from the trial results of teaching materials, then analyzed to find out whether the learning tools that the researchers used included practical criteria. The following are the results of the analysis of student response questionnaire data which are presented in the following table 5:

Table 5. Results of student response questionnaires to HOTS questions

Questionnaire	Average Score	Average Value	Criteria
Student Response	69,87	77,63	Practical

Based on table 5. Above, the results of the overall assessment of student responses to HOTS question products in large groups carried out by 30 class VIII1 students at SMP Negeri 1 West Sorkam show that student responses with a score percentage were 77.63% in the "Practical" criteria. The practicality test was carried out by giving response questionnaires to students. On the questionnaire sheet, student responses consist of 5 aspects of assessment, namely assessment of HOTS questions, use of letters and grammar, material coverage, and design of HOTS questions. The response questionnaire given to 30 students overall obtained an average percentage of 77.63% and in the "Practical" category.

The ethnomathematics-based HOTS questions developed in this research overall received a positive response from students when they were tested. HOTS questions based on ethnomathematics by measuring students' problem-solving abilities based on ethnomathematics are designed to teach students' mathematical problem-solving abilities on geometric material to overcome students' low mathematical problem-solving abilities. Based on the practicality gains above, HOTS questions based on student ethnomathematics in learning activities are practical HOTS questions. Still in line with research conducted by Saodah et al. (2016) where the product he developed was also in the "Very Practical" category with a percentage of 93.75%. Then, research conducted by Ahmad & Asmaidah (2017) on developing realistic mathematics learning tools to teach junior high school students' mathematical problem-solving abilities, the product developed was in the "Very Good" category with a percentage of 91.67%.

Evaluation Stage

Based on the findings that the product developed had fulfilled the practical aspect, a test of students' problem-solving abilities was carried out in the form of all the HOTS questions developed. Next, the data obtained is analyzed to obtain the level of effectiveness of the product being developed. The results of the tests that had been carried out by the



students were then analyzed by following the guidelines for scoring students' mathematical problem-solving abilities, with an average percentage of 75.22% in the "Effective" category. Where indicators of problem-solving abilities include understanding problems, implementing problems, and drawing conclusions. Based on the explanation above, it can be concluded that HOTS questions are based on ethnomathematics to measure students' problem-solving abilities.

Table 6. Mathematical Problem-Solving Ability Test Results

Test	Average Score	Average Value	Criteria
Mathematical Problem-Solving Ability	36,11	75,22	Effective

Based on table 6, the results of the overall post-test assessment (after using HOTS questions) show that the results of students' problem-solving abilities are based on ethnomathematics with an average score of 75.22% in the "Effective" criteria. Research that is relevant to the results of the effectiveness of teaching materials to increase students' mathematical problem-solving abilities is research that has been conducted Afifah et al. (2021) with the title "Development of Teaching Materials Based on an Investigational Approach to Improve the Mathematical Solving Abilities of Mathematics Education Study Program Students" where the product was developed is also in the "Very Effective" category with a percentage of 92.5%. Then, research was conducted by Saodah et al. (2016) where the product effectiveness test results were obtained at 84.38% in the "Very Effective" category.

The final product result of this development research is HOTS (Higher Order Thinking Skills) questions based on ethnomathematics on spatial material to measure students' problem-solving abilities. The development of HOTS question products based on ethnomathematics, in this research has gone through the validation stage by material, media and experts. language as well as trials to determine student responses and evaluate students' mathematical problem-solving abilities. This stage is carried out after receiving suggestions, criticism and an assessment of the feasibility of the product that has been developed so that it meets the criteria for validity, practicality and effectiveness. Thus, the ethnomathematics-based HOTS question product developed is suitable for teaching students' mathematical problem-solving abilities. This is in line with the findings of the development of a Higher Order Thinking Skills (HOTS) assessment instrument based on mathematical literacy which is categorized as very suitable for mathematics learning (Setyaningsih, 2022).

The HOTS question test instrument requires students to think at a high level which includes analysis, synthesis, evaluation and creativity in various aspects of problem-solving. The use of ethnomathematics-based HOTS questions can increase the quality of students' understanding, and can also train scientific thinking patterns and ways of working in building an integrated understanding of local culture concepts (Annizar, et al., 2021). Furthermore, students in learning feel interested and enthusiastic in learning because the problems presented are problems that are close to students' real-world lives. In other words, ethnomathematics can provide a learning environment that provides fun, positive motivation, so that it can eliminate the concept that mathematics is a scourge and scary (Ricardo, 2016).

The resulting development product can be used as an instrument for conducting assessments based on students' high-level thinking abilities in problem-solving, especially in spatial construction material for junior high school students. In other words, the ethnomathematics-based HOTS test instrument that has been developed can be used to measure students' level of high-level thinking abilities during learning (Jasaputri, et al., 2023). The use of ethnomathematics-based HOTS questions also brings students to know



more about and appreciate their own cultural heritage and other cultures. The development products found provide the latest information about the use of HOTS questions in mathematics learning. This can support the development of students' high-level thinking skills in mathematics through the problem-solving process (Jakiyah, et al., 2022). Apart from that, this product is also a reference for teachers, especially mathematics teachers, in developing assessment instruments in mathematics learning to achieve the expected learning goals in mathematics learning activities.

Conclusion

Based on the results and discussion of the research that has been described, it can be concluded that the development of ethnomathematics-based HOTS questions on spatial construction material produces a product that is suitable for measuring students' problem-solving abilities. The research results can be seen from: a) The validity of the HOTS questions which were developed based on the assessment of material experts, media experts and language experts with a score of 84.6% showing the criteria "Very valid"; 2) The practicality of the HOTS questions was developed based on the assessment of the responses of class VIII-1 students at SMP N 1 West Sorkam with an average score of 77.63% indicating the "Practical" criteria; 3) The effectiveness of HOTS questions is determined based on the results of the post-test of students' ethnomathematics-based mathematical problem-solving abilities with an average score of 75.22% in the "Effective" criteria.

Recommendation

Based on the conclusions that have been presented, the researcher makes the following recommendations: 1) Students need to use HOTS (Higher Order Thinking Skills) questions as mathematics learning material, especially in building materials, both at school and at home; 2) Mathematics teachers need to apply ethnomathematics-based hot questions to measure students' mathematical problem-solving abilities, especially in geometric material; 3) Utilizing the developed ethnomathematics-based HOTS questions can be used as a reference for future researchers using quantitative and qualitative research methodologies.

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