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Interactive Teaching Materials Based on Balinese Ethnomathematics to Improve the HOTS Abilities of Third-Grade Elementary School Students

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Abstrak

Penelitian ini dilatarbelakangi oleh kurangnya sumber belajar dan rendahnya kemampuan HOTS siswa di sekolah dasar. Oleh karena itu penelitian ini bertujuan untuk mengembangkan bahan ajar interaktif berbasis etnomatematika bali untuk meningkatkan kemampuan HOTS siswa. Penelitian ini merupakan jenis metode penelitian dan pengembangan dengan jenis data kualitatif dan kuantitatif. Model penelitian yang digunakan adalah model ADDIE yang terdiri atas lima tahapan, yaitu analyze, design, development, implementation, dan evaluation. Metode pengumpulan data yang digunakan adalah metode tes dan non tes dengan instrumen pengumpulan data berupa tes pilihan ganda dan kuesioner. Subjek dalam penelitian ini, yakni ahli validasi dan siswa kelas III di SD Negeri 3 Penarukan. Hasil penelitian menunjukkan bahwa bahan ajar interaktif memperoleh indeks validitas sebesar 0,957 dengan kualifikasi validitas isi sangat tinggi. Kedua, nilai kepraktisan produk memperoleh hasil penilaian sebesar 97% dengan kualifikasi sangat baik. Ketiga, nilai signifikansi (2-tailed) pada uji-t berkorelasi menunjukkan bahan ajar interaktif pada materi bangun datar berbasis etnomatematika Bali efektif guna meningkatkan kemampuan HOTS siswa kelas III SD. Dengan demikian, penelitian pengembangan ini dapat memberikan kontribusi positif terhadap pembelajaran yang lebih kontekstual dan relevan dengan budaya lokal, khususnya di Bali. Bahan ajar interaktif ini dapat dijadikan referensi bagi guru dalam meningkatkan kualitas pembelajaran di sekolah dan tetap mempertahankan warisan budaya dan kearifan lokal.

Kata Kunci: *Bahan Ajar Interaktif, Etnomatematika, HOTS*

Abstract

This research was motivated by the need for more learning resources and the low HOTS abilities of students in elementary schools. Therefore, this research aims to develop interactive teaching materials based on Balinese ethnomathematics to improve students' HOTS abilities. This research is a type of research and development method that uses qualitative and quantitative data. The research model used is the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The data collection methods used are test and non-test methods, with data collection instruments in the form of multiple-choice tests and questionnaires. The subjects in this research were validation experts and third-grade students at SD Negeri 3 Penarukan. The research results showed that interactive teaching materials obtained a validity index 0.957 with very high content validity qualifications. Second, the practical value of the product obtained an assessment result of 97% with very good qualifications. Third, the significance value (2-tailed) in the correlated t-test shows that interactive teaching materials based on flat figures based on Balinese ethnomathematics effectively improve the HOTS abilities of third-grade elementary school students. Thus, this development research can positively contribute to learning that is more contextual and relevant to local culture, especially in Bali. This interactive teaching material can be a reference for teachers to improve the quality of learning in schools and maintain cultural heritage and local wisdom.

Keywords: Interactive Teaching Materials, Ethnomathematics, HOTS

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1. INTRODUCTION

The development of science and technology impacts several aspects of human life. Every individual, especially elementary school students, certainly needs certain abilities to welcome the increasingly rapid development of science and technology. The abilities that must be provided to students include critical thinking, creativity, and problem-solving (Hastuti, Pujiastuti, Tiarani, Nugroho, & Herwin, 2021). This ability is known as high-level thinking skills (HOTS). HOTS is a thinking skill that uses the ability to analyze, assess, and

create to solve problems. HOTS requires critical and creative thinking to solve problems. HOTS allows individuals to deal with the complexity of information and rapidly developing problems because HOTS involves the ability to think critically, find patterns, and make the right decisions based on existing information (Dinayah, Pamungkas, & Taufik, 2023). HOTS is very important for students when learning mathematics. Using HOTS skills, students can gain a deeper understanding of mathematical concepts and be able to apply them in real life. Developing students' HOTS skills is closely related to the thinking process when solving mathematical problems (Anita, Arwin, Ahmad, Helsa, & Kenedi, 2022; Musrikah, 2018).

However, based on the evaluation results conducted by Trends in International Mathematics and Science Study (TIMSS) in 2015, Indonesia was ranked 46th out of 51 participating countries. In line with the PISA (Program for International Student Assessment) survey test and evaluation results, Indonesia still needs to improve its science, reading, and mathematics performance. Research conducted by PISA in 2018 showed that the average international PISA mathematics score was 494. According to the 2018 PISA assessment results, Indonesian students were ranked 72nd out of 78 countries in mathematics with a score of 379. Many students still need help applying these abilities, especially in solving HOTS-type problems and questions (Megawati, Wardani, & Hartatiana, 2019; N. M. Sari, Pamungkas, & Alamsyah, 2020). Students always feel that HOTS questions are difficult to solve, thus weakening students' literacy culture. This causes high-level thinking skills in Indonesia to remain relatively low (Deviana & Sulistyani, 2021; H. R. Handayani & Muhammadi, 2020). In addition, delivering material in mathematics learning requires real or concrete objects close to students' lives (N. P. W. P. Dewi & Agustika, 2020; Wiryanto, 2020). However, what is learned in mathematics is generally abstract and requires deductive reasoning. Therefore, mathematics is considered frightening and difficult for students, especially elementary school students, at the concrete operational cognitive development stage.

One of the elementary school mathematics materials with an abstract concept is a plane shape (Anggraini, 2021; Fajari, 2020). A plane shape consists of several straight or curved line segments without any thickness elements and can, therefore, be called a two-sided shape (P. Handayani, 2021; Lumbantoruan, 2021). From Jean Piaget's cognitive development theory, elementary school children are at the concrete operational stage. At this stage, students begin to see the world objectively, move reflectively from one point of view to another, examine elements simultaneously, think functionally, and know how to use operational thinking to classify objects (Bujuri, 2018; Marinda, 2020). For elementary school students to understand the concept of flat shapes, implementing learning requires concrete and contextual learning by using the students' surroundings. The Realistic Mathematics Education (RME) model is the right model for learning the concept of flat shapes in elementary schools because the RME model is a learning model that utilizes the surrounding environment or students' daily environment (Ananda, 2018; Sholeh, 2021). Culture-based learning resources can be used in the learning process with the RME model (Papadakis, Kalogiannakis, & Zaranis, 2021; Sutarto, 2018). Learning that combines mathematics and culture is called ethnomathematics. Ethnomathematics, as one way of learning about a culture that encompasses mathematics, can be a learning tool that allows students to build their knowledge related to mathematical concepts based on the knowledge that students already have about their environment (Muhammad & Novitasari, 2020; Sarwoedi, Marinka, Febriani, & Wirne, 2018).

This aligns with the theory of Culturally Relevant Pedagogy (CRP), a pedagogical theory built on the thoughts, experiences, and traditions of students in society to empower students intellectually, socially, and emotionally through cultural references. Culturally relevant pedagogy is rooted in pedagogy that connects home and school culture, social

interaction and learning, and the belief that knowledge is constructed and transformed socially. The theory of culturally relevant pedagogy recommends that educational institutions pay attention to cultural conditions around students to have the knowledge, understanding, and ability to adapt to and build a better community environment (Habibi, 2019). Applying the theory of culturally relevant pedagogy offers significant benefits, especially for student learning outcomes and learning experiences to recognize their culture in the curriculum and classroom teaching. It can motivate students to preserve the culture.

In addition, selecting learning resources as a learning support for independent learning greatly influences students' learning styles, which can trigger student motivation. Educators can use interactive teaching materials to support student learning (Amalia, Artharina, & Kiwwoyo, 2022; Wirawan, Wulandari, & Agustika, 2022). With interactive teaching materials, students can be actively involved in learning. Students can participate in activities that build better understanding. Interactive teaching materials can increase student involvement directly to explore the concepts and ideas they have. This can help students understand the material better, improving learning with direct experience.

Several previous studies have stated that developing ethnomathematics-based teaching materials has proven good for learning (P. D. P. Dewi, Agustika, & Suniasih, 2022; Oktarina, Luthfiana, & Refianti, 2019). The ethnomathematics-based mathematics teaching materials developed are valid, practical, and effective in improving students' mathematical understanding (Muhammad & Novitasari, 2020; Nurmaya, 2021). Other research states that ethnomathematics-based teaching materials can improve students' critical thinking skills and learning motivation (Ndiung & Jediut, 2021; Widiantari, Suparta, & Sariyasa, 2022). However, in previous studies, no specific study has discussed the development of interactive teaching materials based on Balinese ethnomathematics. The product developed has an element of novelty by combining Balinese ethnomathematics and interactive teaching materials in e-books to improve the HOTS skills of third-grade elementary school students and support mathematics learning in elementary schools. The reason e-books were chosen as interactive teaching materials is that e-books have diverse and interesting features, including animation, games, videos, and other interesting features. E-books present basic materials relevant to everyday life, learning activities, and interactive quizzes that can improve students' HOTS skills.

This development research is focused on the study to produce interactive teaching materials on flat geometry material based on Balinese ethnomathematics that are valid, practical, and effective to use in the learning process and can also be used to improve HOTS skills of third-grade elementary school students. The products developed can function as learning resources to help improve student learning, provide relevant cultural contexts, facilitate collaborative learning, and improve students' HOTS skills. This research can positively contribute to learning that is more contextual and relevant to local culture, especially in Bali. These interactive teaching materials can be used as a reference for teachers to improve the quality of learning in schools while still maintaining cultural heritage and local wisdom.

2. METHODS

This type of research is development research using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model development method, which aims to develop interactive teaching materials on flat building materials based on Balinese ethnomathematics to improve the HOTS abilities of qualified third-grade students by paying attention to aspects of validity, practicality, and effectiveness. The ADDIE model is a research model that is still very relevant because it is structured and able to adapt very well to

various conditions, and there are revisions and evaluations at each stage (Arina, Mujiwati, & Kurnia, 2020; Sudewa, Sugihartini, & Divayana, 2021). Data was collected using questionnaires and test methods (Zulvira & Desyandri, 2022). There are two types of data analysis techniques, namely quantitative descriptive data analysis and qualitative descriptive data analysis. Quantitative descriptive analysis is used to process data from questionnaires and test sheets.

In contrast, qualitative descriptive analysis processes data through responses (suggestions/responses/criticisms). The results of the analysis can be used as a reference for revising the developed teaching materials. The quantitative and qualitative descriptive data are obtained from three data types: validity, practicality, and effectiveness. The grid of the research instrument can be seen in Table 1, Table 2, and Table 3.

Table 1. Expert Validation Instrument Grid

No.	Aspect	Indicator
1	Content Language Presentation	Compliance with Basic Competencies and Learning Indicators Compliance with learning objectives Interesting material Relationship of material with real-life Learning materials can train HOTS skills. Contains HOTS-based exercises
2	Content Language	Compliance of evaluation with learning materials Clarity of information delivery Language used is easy to understand Use of good and correct language
3	Presentation	Clarity of instructions for using teaching materials Suitability of images with learning materials Suitability of background color combinations with writing/images/graphs/tables
4	Overall Appearance	Attractiveness of teaching material covers Ease of reading text or writing The overall presentation of text, symbols, and images

Table 2. Practicality Instrument Grid

No.	Aspect	Indicator
1	Material/Content Use of Language	The material is presented and accompanied by images The material is connected by Balinese ethnomathematics. The material provides benefits for real life.
2	Presentation	Using easy-to-understand language
3	Clarity of Text and Images	The presentation of the material is interesting. The presentation of the material is oriented towards Balinese ethnomathematics.
4	Presentation	The text presented is clear. The images presented are clear.
5	Material/Content	The cover/front page/cover is by the material. The composition of the background color is by the writing/images/graphs/tables.

Table 3. HOTS Ability Assessment Instrument Grid

No.	HOTS Indicator	Question Indicator	Question Form
1	Analyze (C4)	Students can find the shape of a plane figure that makes up a picture correctly Students can analyze the truth of the shape of a plane figure correctly	Objective
2	Evaluate (C5)	Students can compare various shapes of plane figures correctly Students can prove the properties of plane figures correctly	Objective
3	Create (C6)	Students can categorize various shapes of plane figures correctly	Objective

3. RESULTS AND DISCUSSION

Result

Research developing interactive teaching materials on Balinese ethnomathematics-based flat geometry materials using the ADDIE model. The ADDIE model is often used for instructional development and various forms of product development, such as models, learning strategies, learning methods, media, and teaching materials. The ADDIE model consists of five stages: analysis, design, development, implementation, and evaluation. In the first stage, namely the analysis stage, needs analysis activities, such as analyzing students' competencies and characteristics. The needs analysis aims to identify the needs of students and teachers in carrying out learning activities, such as the availability of learning materials or resources. Students' competencies are analyzed by examining basic competencies (KD), competency achievement indicators, and learning materials. This aims to ensure that the teaching materials developed meet the demands of the applicable curriculum.

Furthermore, student characteristics are analyzed to determine third-grade students' demographic data, character, and learning styles. The second stage, namely the design stage, compiles a design or sketch of the interactive teaching materials developed. The format of the teaching materials consists of a front cover, preface, table of contents, a guide to using teaching materials, learning stages, learning competencies consisting of core competencies and basic competencies, indicators and learning objectives, discussion of Balinese ethnomathematics-based flat building material, a summary of the material, a comprehension test, a list of references, and a back cover. The designs or sketches that have been prepared are then discussed with the supervising lecturer to provide input and suggestions. In addition, at this stage, product validity instruments, product practicality instruments, and product effectiveness instruments for students' HOTS abilities are also prepared. The third stage is development: making the product design a prototype. All components, such as background design, images, characters, material materials, and questions, are prepared using Canva and Ispring Suite software. After all the components are made, the ready teaching materials are saved in the Flip PDF Professional software with .exe and HTML file formats to access the developed interactive teaching material products offline and online. At the development stage, judges' tests are also carried out to determine the validity of the research instruments and the implementation of product validity tests by experts. The assessment results by the experts were then analyzed to determine the validity of the product being developed and to make improvements if there was input and suggestions for product improvement before being tested. Four validators carried out the validity test of interactive teaching materials based on Balinese ethnomathematics. The results of the content validity can be seen in Table 4.

Table 4. Results of the Validity Analysis of Teaching Materials

Item	Expert				S_1	S_2	S_3	S_4	Σs	n(c-1)	V	Description
	I	II	III	IV								
1-16	72	77	80	80	56	61	64	64	245	256	0.957	**Very High**

Based on the Table 4, it can be seen that the interactive teaching material product based on Balinese ethnomathematics obtained a validity index of 0.957 and is included in the range ≥ 0.8. According to Aiken's validity criteria, if the validity index shows a number ≥ 0.8, the product developed is included in very high validity. Furthermore, the product, validated from an expert's point of view, was tried on 33 third-grade students to determine the practicality of the product developed. Based on the data obtained, it can be seen that the interactive teaching material product based on Balinese ethnomathematics obtained a practicality percentage of 93.09% and is included in the range of 90% to 100%. According to the five-scale conversion guidelines, the product developed is very good quality if the percentage range shows a number from 90% to 100%. The fourth stage is the implementation stage, which is carried out, namely implementing or applying the product in the field to find out the results of the development that has been carried out. The implementation stage took a sample of one class in the third grade at SD Negeri 3 Penarukan using a pre-experimental one-shot case study type design. The implementation stage aimed to determine the product's effectiveness on students' HOTS abilities. The effectiveness of interactive teaching materials based on Balinese ethnomathematics was obtained from the students' pre-test and post-test results using multiple-choice tests to determine students' HOTS abilities before and after using the teaching materials. The tests given were based on HOTS questions related to shape material. Data on students' HOTS abilities are presented in Figure 1.

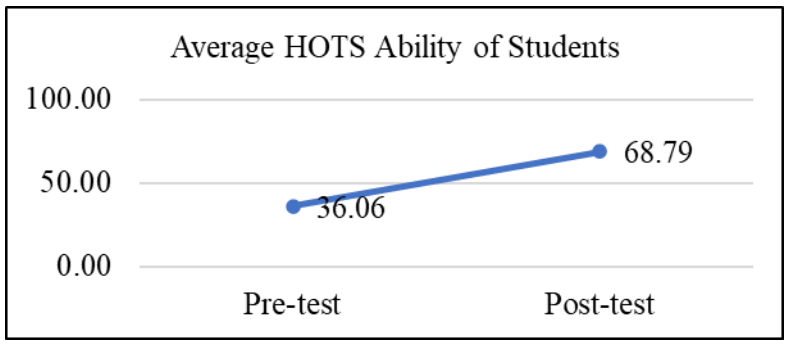

Figure 1. Average HOTS Ability of Students

Figure 1 shows increased students' HOTS abilities before and after using interactive teaching materials based on Balinese ethnomathematics. Based on the analysis of students' HOTS ability data, the effectiveness of interactive teaching materials based on Balinese ethnomathematics is effectively used in the learning process for third-grade elementary school students. Furthermore, a prerequisite test was conducted to conduct a correlated t-test analysis. The prerequisite tests carried out in this study include the normality test of data distribution and the homogeneity test of variance. The normality test aims to determine whether the distribution of research data is arranged normally or not. Based on the normality test analysis results using the IBM SPSS Statistics 22 for Windows program in Table 4, the significance value (Shapiro-Wilk) of the pre-test data is 0.149, and the post-test data is 0.079. Based on these results, it can be seen that the Sig. Value> 0.05 for all data groups, so it can be concluded that both data groups are normally distributed. Furthermore, the results of the homogeneity test of the variance of the effectiveness test data in this study, using the

assistance of the IBM SPSS Statistics 22 for Windows program, showed that the significance value (Based on Mean) was 0.334. Based on these results, it can be seen that the Sig. Value> 0.05, so it can be concluded that the data variance is homogeneous.

The results of hypothesis testing in this study used a Paired Sample T-Test/ Correlated Sample t-test. The t-test aims to determine the differences in students' HOTS abilities before and after implementing interactive teaching material products based on Balinese ethnomathematics. Based on the Paired Sample T-Test/ Correlated Sample t-test analysis using the IBM SPSS Statistics 22 for Windows program, a significance value (Sig. 2-tailed) of 0.000 was obtained. Based on these results, it can be seen that the Sig. Value <0.05, so it can be concluded that H0 is rejected and Ha is accepted. In other words, there is a significant difference in the HOTS abilities of third-grade elementary school students before and after participating in learning using interactive teaching materials based on Balinese ethnomathematics. Thus, using interactive teaching materials based on Balinese ethnomathematics effectively improves the HOTS abilities of third-grade elementary school students. The fifth stage is the evaluation stage. The researcher makes a final revision to the developed product based on suggestions and comments from experts and students using teaching materials on the questionnaire or response questionnaire. This stage aims to ensure that the interactive teaching material product on the Balinese ethnomathematics-based plane geometry material is appropriate or suitable for the learning process.

Discussions

This development research produces interactive teaching materials on flat building materials based on Balinese ethnomathematics to improve the HOTS skills of third-grade elementary school students. The teaching materials developed are interactive teaching materials packaged as e-books. The interactive teaching materials developed differ from similar products developed previously; this teaching material uses PMRI learning syntax based on HOTS. In addition, this teaching material can be used online or offline, depending on the facilities available at the school. This teaching material is also interactive because students can interact directly with the teaching material, which can provide a new atmosphere for students and increase their interest and motivation in following the learning process in class. Previous research stated that interactive teaching materials could help increase student interest (Ningsih & Mahyuddin, 2021; I. S. Sari, Lestari, & Sari, 2020). Interesting and innovative teaching materials that are equipped with materials, images, and problems related to students' lives that are presented in the materials can help students to be more enthusiastic and motivated in the learning process that is carried out (Istuningsih, Baedhowi, & Sangka, 2018; Nurmaya, 2021). Another role of teaching materials is that they can change the role of educators from teachers to facilitators, and students can explore by collaborating to complete tasks in their learning process (Matsun, Andrini, Maduretno, & Yusro, 2019; Muhammad & Novitasari, 2020).

Based on the results of the validity, practicality, and effectiveness of the developed product, it is known that interactive teaching materials on flat geometry material based on Balinese ethnomathematics can be declared valid, practical, and effective for use in the learning process as well as to improve students' HOTS abilities. The interactive teaching materials developed in it contain flat geometry material using the PMRI approach, which elaborates on Balinese local wisdom values, especially Balinese sewing. The involvement of Balinese sewing in learning is one example of applying the theory of culturally relevant pedagogy. Learning that uses cultural references will provide students with the opportunity to learn optimally and ultimately can improve students' abilities (cognitive, affective, psychomotor) and improve cultural competence. The involvement of culture in learning activities can provide benefits because culture is a bridge between academic knowledge and

students' environment so that students can easily understand learning materials, achieve competence in the affective, psychomotor, and cognitive domains, and achieve the learning objectives that have been set. This is in line with the results of previous research, which stated that the development of e-LKPD with Jambi cultural characteristics is valid from an expert perspective and is effective in improving students' mathematical creative thinking skills (Fairuz, Fajriah & Danaryanti, 2020; Subakti, Marzal, & Effendi, 2021).

There are several reasons why this interactive teaching material has received very good ratings from experts and users of teaching materials. The first is that the interactive teaching material developed contains flat geometry using the PMRI approach elaborated with Balinese local wisdom values, especially Balinese sewing. Flat geometry material integrated with Balinese ethnomathematics can allow students to learn actively about Balinese culture, especially Balinese sewing. The material created in this teaching material is only special material for Mathematics lessons contained in theme 8 (Praja Muda Karana) and subtheme 2 (I am an Independent Child). The results of the practicality of using interactive teaching materials on flat geometry material based on Balinese ethnomathematics are very good and worthy of being implemented in the learning process. The teacher said using this teaching material can increase student activity and learning. Learning followed by students is more meaningful because the teaching material is based on Balinese culture, closely related to students' lives. Supported by the facilities available at school, this teaching material is suitable for use to make it easier for teachers to learn. In addition, using teaching materials will reduce the burden on teachers when presenting material face to face.

With the availability of adequate teaching materials, it is hoped that learning can run efficiently and effectively and ultimately improve student learning outcomes (Magdalena, Rahmanda, Armianti, & Nabilah, 2020; Yulis, Dafit, Fitriani, & Amnestya, 2024). Using interactive teaching materials on Balinese ethnomathematics-based flat building materials can effectively improve the HOTS abilities of third-grade elementary school students. The teaching materials are equipped with several pictures and learning videos so that students are more interested in reading the teaching materials, and the learning process will be more effective. The selection of attractive colors and the addition of animations and images to these teaching materials will make students interested in using the teaching materials in their learning process and, of course, can increase students' enthusiasm for participating in the learning (Ndiung & Jediut, 2021; Riwu, Laksana, & Dhiu, 2018). Based on the Paired Sample T-Test analysis results, it can be concluded that there is a significant difference in students' HOTS abilities before and after participating in learning using interactive teaching materials on Balinese ethnomathematics-based flat building materials. This states that using interactive teaching materials on Balinese ethnomathematics-based flat building materials effectively improves students' HOTS abilities.

Several previous studies have stated that developing ethnomathematics-based teaching materials has proven good for learning (P. D. P. Dewi et al., 2022; Oktarina et al., 2019). The ethnomathematics-based mathematics teaching materials developed are valid, practical, and effective in improving students' mathematical understanding (Muhammad & Novitasari, 2020; Nurmaya, 2021). Other research states that ethnomathematics-based teaching materials can improve students' critical thinking skills and learning motivation (Ndiung & Jediut, 2021; Widiantari et al., 2022). Based on these findings, developing ethnomathematics-based teaching materials is feasible and positively impacts learning. The limitations of this study lie in the scope of the material, level, and learning content developed in the teaching materials. This teaching material is only limited to the mathematics lesson content in theme 8 sub-theme 2 in the third grade of elementary school, and the number of subjects involved in the effectiveness test is only 1 class, totaling 33 students using the One Group Pre-Test-Post-Test research design.

4. CONCLUSION

Interactive teaching materials based on Balinese ethnomathematics have the final result as an e-book. They are based on the ADDIE development model, which is feasible, practical, and effective in learning, especially in the mathematical content of shape material. The integration of local cultural context in the interactive teaching materials developed can help students stimulate creativity and critical thinking skills and solve problems in depth to improve higher-order thinking skills (HOTS) in students. So that in the future, cooperation from all parties is expected to create learning that can help students improve their abilities. Teachers are expected to apply more student-centered learning methods, creating active, innovative, and enjoyable learning activities so that students' potential can develop optimally.

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