EDUMATIKA: *Jurnal Riset Pendidikan Matematika* *e-ISSN 2620-8911*
Volume 8, Issue 1, May 2024 *p-ISSN 2620-8903*

Developing Ethnomathematics-based E-Modules to Support Students' Problem Solving Skills

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Abstract. The lack of learning resources and learning media have an impact on reducing the quality of learning. Learning media innovation is needed to provide interactive and joyful learning and integrate cultural context. This research aims to create an ethnomathematics-based electronic module on the topic of number patterns based on ethnomathematics to support students' problem solving skills. This research uses 4D model (define, design, develop, and disseminate). This research involved 29 eighth-grade students from one of the junior high schools in Metro, Indonesia. The research results show that the ethnomathematics-based electronic module on number patterns topic meets the criteria for being suitable for use in learning based on experts review and is able to attract student interest. This fact indicates that ethnomathematics-based modules can be an innovative solution in improving the quality of mathematics learning in the digital era.

Keywords: Electronic Module; Ethnomathematics; Mathematics Learning; Number Patterns; Problem Solving Skills

Abstrak. Keterbatasan sumber belajar dan media pembelajaran berdampak pada menurunnya kualitas pembelajaran. Inovasi media pembelajaran dibutuhkan untuk menghadirkan pembelajaran yang interaktif dan menyenangkan serta mengintegrasikan konteks budaya. Penelitian ini bertujuan untuk menciptakan modul elektronik berbasis etnomatematika pada topik pola bilangan yang didasarkan pada etnomatematika untuk mendukung kemampuan pemecahan masalah siswa. Penelitian ini menggunakan model pengembangan 4D (*define, design, develop*, dan *disseminate*). Penelitian ini melibatkan 29 siswa kelas VIII salah satu SMP di Metro, Indonesia. Hasil penelitian menunjukkan bahwa modul elektronik berbasis etnomatematika pada materi pola bilangan memenuhi kriteria layak untuk digunakan dalam pembelajaran berdasarkan penilaian ahli dan mampu menarik minat siswa. Ini mengindikasikan bahwa modul berbasis etnomatematika dapat menjadi solusi inovatif dalam meningkatkan kualitas pembelajaran matematika di era digital.

Kata Kunci: Etnomatematika; Kemampuan Pemecahan Masalah; Modul Elektronik; Pembelajaran Matematika; Pola Bilangan

Available online at journal homepage:
http://ejournal.iainkerinci.ac.id/index.php/edumatika
Email: edumatika@iainkerinci.ac.id
DOI: https://doi.org/10.32939/ejrpm.v8i1.3427

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Volume 8, Issue 1, May 2024 *p-ISSN 2620-8903*

INTRODUCTION

Mathematics is one of the important knowledge that influences civilization. Mathematics is a universal language that is useful for human life, supports the advancement of modern technology, and plays an important role in various academic fields and the advancement of human thinking (Suryani et al., 2020). As a science that is important for civilization, it is passed down from generation to generation through education. So that mathematics is an important subject taught at all levels of education (Davita & Pujiastuti, 2020).

Mathematics not only teaches abstract concepts, but also trains high-level thinking skills including problem-solving skills. As stated by Lisnani et al. (2020) which states that problem-solving skills are one of the mathematical skills that students must have. Problem solving is a process or effort for someone to respond to or overcome obstacles when the solution or strategy is not clear (Cahyadi et al., 2020). Meanwhile, problem-solving skills in the context of mathematics are students' abilities in solving mathematical problems (Sulistyaningsih et al., 2023) or real-world problems that are solved mathematically. Therefore, mathematics learning must train mathematical problem-solving skills along with increasing student involvement in learning.

However, empirical data based on PISA statistics in 2022 shows that Indonesia is only ranked 68th out of 76 countries (Lewalter et al., 2023). This indicates students' low ability to solve problems mathematically. Several studies have revealed that during the mathematics learning process in schools, students are still unable to solve mathematical problems even though they are relatively simple. Students are more focused on the examples of questions given by teachers that are less varied and contextual according to real-world problems.

Mathematics learning that takes place only conveys abstract mathematical ideas and formulas without linking them to real-world problems, causing mathematics learning to be less meaningful. Learning that is less meaningful causes students to be unable to apply mathematics in various contexts (Acharya, 2017). In addition, less meaningful learning can also reduce students' interest in mathematics (Kahu et al., 2017).

To increase students' interest in learning mathematics, developing teaching materials that suit students' needs can be one of the innovative solutions such as modules, worksheets, or books. Even with the development of technology, teaching materials can be varied using digital media to produce e-module, e-worksheet, or e-book products. These teaching materials have the advantage of being easily accessible at any time and through various devices such as mobile phones, laptops, and computers. In addition, this product not only displays images, but also displays videos and animations. Another benefit of using this digital product is to reduce the need for paper in the learning process.

In this study, researchers offer the development of e-modules. E-modules were chosen because they can be used to measure and manage students' learning abilities even independently by

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Volume 8, Issue 1, May 2024 *p-ISSN 2620-8903*

students (Laili et al., 2019). E-modules are designed with language that can be adjusted to the level of students' abilities so that they are easier to understand. The e-modules to be developed emphasize mastery of problem-solving steps accompanied by video explanations of the content. The context of the problems used is relevant to students' daily lives, so that students do not feel that mathematics is separate from their lives when studying mathematics.

The use of relevant problem contexts not only improves students' understanding of mathematical concepts but also provides an interesting and meaningful learning experience for students in everyday life. Therefore, mathematical concepts that live in cultural life can be used as a means of learning mathematics. The study of the relationship between mathematics and culture or vice versa has become a study that is widely researched and applied in mathematics learning. This study is known as ethnomathematics.

Ethnomathematics involves the study of how traditional societies or certain ethnic groups develop mathematical understanding and knowledge in everyday life. Ethnomathematics is an academic field that studies the relationship between mathematics and culture (Pathuddin et al., 2021). Studying ethnomathematics is not just studying mathematical phenomena and turning them into formal mathematical concepts (Maryati & Prahmana, 2018). Through the application of ethnomathematics, students are expected to be able to appreciate cultural diversity while getting to know mathematics.

The application of ethnomathematics in mathematics learning can actively contribute to the introduction of mathematical concepts and connect them with students' cultural and social backgrounds. This innovation can be achieved by introducing ethnomathematics to students, from which students can understand the cultural concepts around them (Lubis et al., 2023). The ethnomathematics approach opens the door to explaining mathematical material more contextually, one of which is the material on number patterns. With this approach, students are invited to understand and apply mathematical concepts not only in the classroom and school environment, but also in everyday life situations (Yudianto et al., 2021).

Integrating cultural elements as a relevant context in mathematics learning is interesting (Fouze & Amit, 2017). Learning media that use ethnomathematics context can be an important breakthrough to increase student interest and involvement in the teaching and learning process (Choirudin et al., 2020) while facilitating students in improving their problem-solving abilities. Innovation in mathematics learning media is expected to create a more enjoyable and interactive learning experience for students (D'Apice, 2005).

Previous research shows that the use of ethnomathematics context in learning has a positive impact on various student abilities such as mathematical literacy (Yuliana et al., 2023), metacognition (Sutarto et al., 2022), problem-solving skills (Putri & Junaedi, 2022), and mathematical logical thinking skills (Patri & Heswari, 2021), and other mathematical thinking

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skills (Bintoro et al., 2021). The study on the integration of cultural context in mathematics learning on various topics including the topic of number patterns (Susanti et al., 2020). However, these studies used different cultural objects such as weaving and batik craft (Prahmana & D'Ambrosio, 2020).

The integration of ethnomathematics in mathematics learning, especially traditional musical instruments and traditional food presented in the mathematics module, is an innovation that has not been widely implemented. Therefore, this study focuses on the development of an electronic module based on ethnomathematics using a problem-solving approach to support students' problem-solving abilities. In this case, the researcher uses a problem-solving approach to teach and facilitate students in solving problems related to number patterns.

METHOD

This study has applied the research and development method or R&D which refers to the 4D model (define, design, develop, and disseminate) (Thiagarajan et al, 1974). At the define stage, researchers collect data related to curriculum documents, textbooks used, problems faced by teachers and students, and the needs of teachers and students to achieve learning objectives optimally. Data is collected through analysis of curriculum documents and textbooks, observation of learning implementation, and interviews with teachers. This stage includes front-end analysis, concept analysis, task analysis, and formulation of learning objectives.

The initial design of the e-module integrates various Indonesian cultural objects that are relevant to the topic of number patterns such as traditional musical instruments and traditional foods. The material study section is equipped with a video explaining the material as a variation to help students understand the material. In addition, the learning activities in the e-module are designed in such a way as to train students' problem-solving skills.

Meanwhile, the development stage of ethnomathematics-based e-modules includes a validation process by experts to test the feasibility of the developed product design and a product prototype trial to determine student responses. Experts involved in the validation of the product design are mathematics content experts who are also experienced in assessing students' problem-solving abilities (Lian, 2023). In addition to assessing the product design quantitatively, experts are also asked to provide input to improve the quality of the developed e-module design.

Prototypes that are declared feasible to use based on expert assessments are tested to measure the level of practicality of the product (Nuryati, 2022). This prototype trial involved 29 seventh grade students at a junior high school in Metro, Lampung, Indonesia, as research subjects. However, due to research limitations, the disseminate stage was not carried out so that the

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effectiveness of the resulting product is only limited to potential effects based on experts judgement.

Researchers used two main techniques in data collection in this study, namely interviews and questionnaire distribution. Interviews were conducted in the early stages of the study to obtain information about problems faced in learning, the use of teaching materials, and the limitations and needs of teachers and students (Suryaningsih & Putriyani, 2022). To support the interview results, researchers also observed the learning implementation process. Meanwhile, questionnaire distribution was used to reveal quantitative and qualitative assessments of product design and another questionnaire was used to assess the readability and practicality of the prototype's use by students (Utami et al., 2018). Feedback from validators or experts, student and teacher responses were used as the basis for revising the prototype that was developed.

All data were analyzed descriptively. Quantitative data of expert assessment of product design was determined based on the percentage of conformity of the assessment score to the ideal score. The e-module design is said to be valid if the validity value is above 60% (Azwar, 2013). Meanwhile, qualitative comments from the validator were used to conclude the strengths and weaknesses of the assessed product design. The student response questionnaire used a Likert scale (1-5). The product is said to be practical if the percentage of the questionnaire score to the ideal score is above 60%.

RESULTS AND DISCUSSION

Define Stage

Front-End Analysis

Based on the observation results obtained by the researcher, it appears that students have difficulty in understanding the material presented in the package book. The use of learning media in the form of textbooks tends to make students feel bored and passive in the learning process. The results of interviews with teachers also revealed that students face difficulties in understanding mathematical concepts and solving math problems by following the correct steps. In addition, math teachers have never compiled modules to support learning in the classroom. This was due to the lack of teacher interest in making modules, as well as because the process of making modules takes quite a long time.

Concept Analysis

In this step, the process of reviewing and analyzing the main concepts presented to students is carried out based on the curriculum documents and textbooks used. The main concepts used in the textbook are in accordance with the Basic Competencies or KD and Core Competencies (KI) or

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commonly referred to as KI Curriculum-2013 which are sourced from the regulation of the Ministry of Education and Culture Number 37/2018. The researcher did not make changes to the competencies mandated by the curriculum.

Task Analysis

At this stage, the researcher carried out activities to identify student assignments in the textbook. Based on the results of the analysis of the number pattern material, which consists of three sub-materials, namely odd and even number patterns, number lines, and arithmetic number patterns. These materials are interspersed with exercises. At the end of the chapter, a formative test is available containing questions that require problem-solving steps in their completion. The researcher did not make many changes to the tasks that must be done by students.

Learning Objective Analysis

Learning targets are arranged based on core competencies, basic competencies, and competency achievement indicators according to the curriculum. Not many changes were made to the learning targets. The researcher only emphasized the learning objectives so that students were able to solve problems using the correct procedures.

Design Stage

The design of the e-module on the topic of number patterns that was developed contains the context of Indonesian culture such as traditional musical instruments such as *gendang* from Kalimantan (Figure 2), *kolintang* from North Sulawesi, *saron* from Central Java and *angklung reog* from East Java as well as traditional foods from the Betawi namely *kue talam* (Figure 1), *bolu kojo* from Palembang, and *onde-onde* from Javanese tribes.

Figure 1. Traditional Food

In addition to musical instruments and traditional foods, there is also a cultural context of the work of the Indonesian people which is a combination of art and technology, namely *batik* craft. This *batik* craft has a *batik* wall art motif. The diversity of cultural elements used is in accordance

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with the diversity of tribes inhabiting the province of Lampung which originate from Java, Bali, Sulawesi, and other areas in Sumatra.

Figure 2. Traditional Music Instrumental

The electronic module was developed using the Canva application. The systematics of the front of the e-module that was developed consists of a front cover, table of contents, list of tables, and list of images to make it easier for readers to find pages.

Figure 4. Additional Explanation Video

In addition, it is also equipped with a concept map, foreword, introduction, and instructions for using the e-module. Meanwhile, the main part of the e-module consists of a description of the material (Fugure 3) including topic explanation video (Figure 4), example problems (Figure 5), summary, and formative test. In the next section there is a glossary, bibliography, and author identity.

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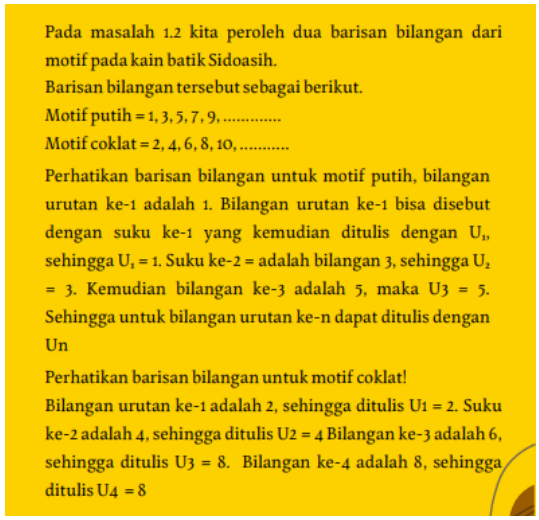
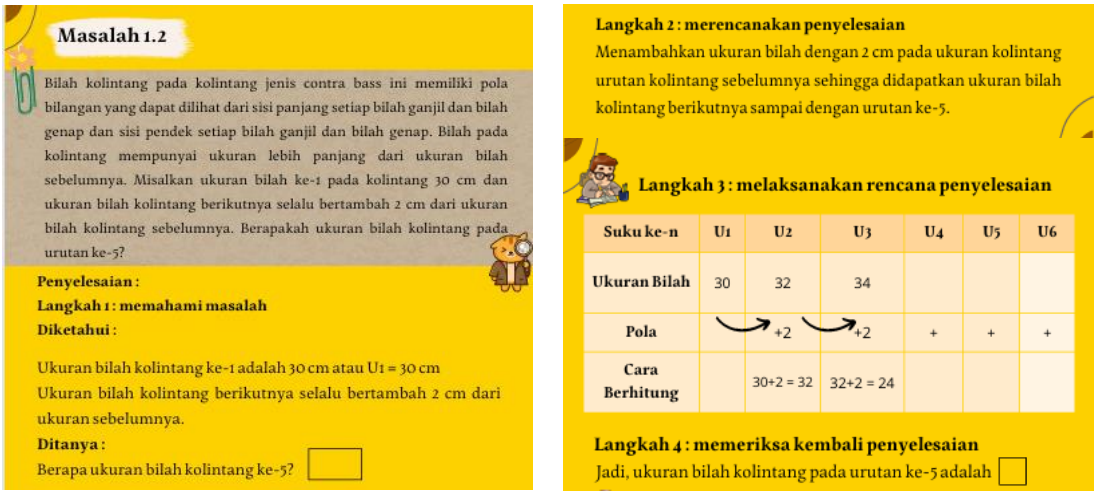

Pada masalah 1.2 kita peroleh dua barisan bilangan dari motif pada kain batik Sidoasih.
Barisan bilangan tersebut sebagai berikut.
Motif putih = 1, 3, 5, 7, 9, ...
Motif coklat = 2, 4, 6, 8, 10, ...

Perhatikan barisan bilangan untuk motif putih, bilangan urutan ke-1 adalah 1. Bilangan urutan ke-1 bisa disebut dengan suku ke-1 yang kemudian ditulis dengan U_1, sehingga $U_1 = 1$. Suku ke-2 = adalah bilangan 3, sehingga $U_2 = 3$. Kemudian bilangan ke-3 adalah 5, maka U3 = 5. Sehingga untuk bilangan urutan ke-n dapat ditulis dengan Un

Perhatikan barisan bilangan untuk motif coklat!
Bilangan urutan ke-1 adalah 2, sehingga ditulis U1 = 2. Suku ke-2 adalah 4, sehingga ditulis U2 = 4 Bilangan ke-3 adalah 6, sehingga ditulis U3 = 8. Bilangan ke-4 adalah 8, sehingga ditulis U4 = 8

Figure 3. Additional Explanation Video


Masalah 1.2

Bilah kolintang pada kolintang jenis contra bass ini memiliki pola bilangan yang dapat dilihat dari sisi panjang setiap bilah ganjil dan bilah genap dan sisi pendek setiap bilah ganjil dan bilah genap. Bilah pada kolintang mempunyai ukuran lebih panjang dari ukuran bilah sebelumnya. Misalkan ukuran bilah ke-1 pada kolintang 30 cm dan ukuran bilah kolintang berikutnya selalu bertambah 2 cm dari ukuran bilah kolintang sebelumnya. Berapakah ukuran bilah kolintang pada urutan ke-5?

Penyelesaian :
Langkah 1 : memahami masalah
Diketahui :

Ukuran bilah kolintang ke-1 adalah 30 cm atau U1 = 30 cm
Ukuran bilah kolintang berikutnya selalu bertambah 2 cm dari ukuran sebelumnya.
Ditanya :
Berapa ukuran bilah kolintang ke-5?

Langkah 2 : merencanakan penyelesaian
Menambahkan ukuran bilah dengan 2 cm pada ukuran kolintang urutan kolintang sebelumnya sehingga didapatkan ukuran bilah kolintang berikutnya sampai dengan urutan ke-5.

Langkah 3 : melaksanakan rencana penyelesaian

Suku ke-n	U1	U2	U3	U4	U5	U6
Ukuran Bilah	30	32	34			
Pola		+2	+2	+	+	+
Cara Berhitung		30+2 = 32	32+2 = 24			

Langkah 4 : memeriksa kembali penyelesaian
Jadi, ukuran bilah kolintang pada urutan ke-5 adalah

Figure 5. Problem-solviung Steps

Develop Stage

Experts Judgement

At this stage, the e-module was assessed by two content experts, namely a mathematics lecturer and a mathematics teacher. The assessment of the content aspect used a questionnaire consisting of 17 items (see Table 1), with a rating scale of 1 to 5. The scale indicates the level of agreement from strongly disagree, disagree, less agree, agree, to strongly agree.

Tabel 1. The Aspects of Content Validation

Indicators	Items
Appropriateness of Content	Suitability of the material in the e-module with main and basic competences.
	Appropriateness to learner development.
	Correctness of concepts in the e-module.
	Make it easier for learners to understand number patterns.
	Relevance of the material to daily life.

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Indicators	Items
Appropriateness of Presentation	Clarity of learning objectives.
	Appropriateness of the order in which the material is presented.
	Completeness of information.
	Appropriateness of font usage.
	Appropriateness of font size.
	Appropriateness of layout.
	Appropriateness of illustrations/pictures/photos.
Language Appropriateness	Conformity with good and correct Indonesian language rules.
	The language used is communicative.
	Sentences used are easy to understand.
	The sentences used are effective.
	Consistent use of words, terms, and sentences.

The e-module was also assessed by two media experts who were mathematics lecturers. The assessment of the media aspect was carried out using a questionnaire consisting of 23 items (see Table 2) with a scale of 1-5.

Tabel 2. The Aspects of Media Validation

Indicators	Items
E-Module Cover Design	The appearance of layout elements on the front, back, and spine harmoniously has rhythm and unity and is consistent
	Features a good centre point
	Cover illustrates the material in the e-module
	The font size of the e-module title is more dominant and proportional than the size of the e-module and author's name
	The colour of the e-module title contrasts with the background colour
	Use of font combinations
E-Module Page Design	Consistency of placement of layout elements
	Harmony of layout elements
	Use of font variations (bold, italic, all caption, small caption)
	Suitability of the material to the learning objectives
	Normal text arrangement width
	Spacing between lines of normal text organisation
	Spacing between letters (kerning) is normal
	The typography (font) of the module content facilitates understanding
	Explanation and functionality of images with concepts
	Image and text size comparison
	Attractiveness of the e-module display
Professional PDF Flipbook Media	E-modules with professional flipbook pdf are easy to use in the learning process
	Ease of navigation
	Navigation consistency

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Indicators	Items
	Ease of accessing the next piece of information
	Smooth operation of the system
	The overall appearance of the media is attractive

The results of the assessment by content experts and media experts are presented in Table 3.

Tabel 3. Validation Results by Each Experts

Validator	Percentage	Criteria
Content Expert I	94%	Valid
Content Expert II	81%	Valid
Media Expert I	93%	Valid
Media Expert II	75%	Valid

Student Response

Field testing was conducted during classroom learning on the topic of number patterns using the prepared e-learning module. The researcher emphasized that the problem-solving process in learning occurred according to plan. In addition to providing classroom learning, the researcher also conducted a survey to evaluate the appeal of the e-module. The e-module consists of 10 statements that are assessed using a scale of 1 to 5, with assessment guidelines that include the categories strongly disagree, disagree, less agree, agree, and strongly agree.

Tabel 1. The Aspect of Practicality

Indicators	Items
Content	The questions in the e-module are suitable for my ability.
	The writing and images on the e-module are clear and interesting.
	The language used in the e-module is easy for me to understand.
Usefulness of E-Modules	The images of traditional music of North Sulawesi increased my knowledge of Sulawesi culture.
	The e-module helps me understand the number pattern material.
	I was able to draw conclusions about number patterns after learning using the e-module.
	I am able to work on the problems in the e-module without the help of friends.
Attractiveness	The appearance of the e-module is very attractive.
	I am excited to learn using the e-module.
	I am more active when learning using e-module.

This survey was conducted on 29 students who participated in the learning. Based on the results of the product trial obtained by the researcher, it showed a percentage of 74% with an interesting classification. This shows that the learning e-module has been well received by students, and they consider this e-module interesting. This evaluation provides a positive picture regarding the effectiveness of the e-module in the context of actual learning.

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Teacher Response

Teacher responses to the e-module prototype were collected using the same questionnaire as the student response questionnaire. The collection of teacher responses was used as a comparison of student responses regarding the feasibility of ethnomathematics-based e-modules. The assessments contained in this questionnaire include aspects of material presentation, appearance, and module benefits. Based on the results of the product trial, student responses, and teacher responses, the researcher concluded that this product is very feasible and has very good quality.

Up to this point, this study has proven that ethnomathematics-based e-modules on the topic of number patterns have received good responses from students, or in other words, e-modules can increase students' positive responses to mathematics. The use of ethnomathematics-based e-modules not only has an impact on knowledge of learning materials, but also on knowledge of the surrounding culture (Utami et al., 2018).

The researcher realizes that the e-module that was developed still has shortcomings. The development of the e-module has not been able to reach the effectiveness test stage due to the limitations of the researcher. It is hoped that in further research, the effectiveness of the e-module can be tested to improve student learning outcomes in general.

CONCLUSION

The resulting ethnomathematics-based electronic module on the topic of number patterns has a high validation score and has received positive responses from students. This e-module is a digital product so it can be accessed through various devices. This e-module is also designed with a language that can be adjusted to the level of student ability so that it is easy to use and understand by students. The emphasis on problem-solving steps presented with relevant contexts can provide an interesting and meaningful learning experience. This e-module is expected to be one of the innovative solutions for teachers to increase student involvement in learning and optimize learning outcomes.

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