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Development of Three-Dimensional Space E-Module with Traditional Javanese Sundanese Culinary Ethnomathematics to Facilitate Students' Mathematical Spatial Ability

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Abstract

Mathematical spatial Ability is the ability of a person to imagine and represent a space. The lack of students' spatial mathematical abilities and the lack of variability of existing teaching materials to support mathematical learning became the background of this study. This study aims to produce e-modules using traditional Javanese Sundanese culinary ethnomathematics to facilitate students' valid, practical, and effective spatial mathematical abilities. The Research and Development method is used with the ADDIE development model (analyze, design, develop, implement, evaluate). The research was conducted on a limited basis by involving XII class students at one of the high schools in the Tajurhalang, Cibinong areas. The research instruments include expert validation sheets, student response metrics, and mathematical spatial ability tests. The results of this study show that the developed e-modules obtained very valid criteria based on expert validator assessments, were very practical based on student responses, and the results were valid. It is effective because students' spatial mathematical ability test results are higher than the school-designated Minimum Completeness Criteria (KKM), so e-modules are suitable for use in mathematical learning to facilitate students' spatial mathematical ability.

Keywords: ADDIE; E-Module; Ethnomathematics; Mathematical Spatial Ability; Traditional Culinary.

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1. Introduction

Spatial ability involves various abstract concepts related to understanding space. These include recognizing spatial relationships (how objects are positioned), using reference frames (benchmark signs for positioning), understanding projection relationships (viewing objects from different angles), estimating distance (measuring space between points), representing space cognitively (manipulating spatial relationships mentally), and mental rotation (imagining the rotation of objects in space) (Piaget & BarbelInhelder, 1969). Mathematical spatial ability is one of the aspects affecting students' mathematical abilities in geometry (Putri & Imanah, 2018). Furthermore, (Soraya et al., 2021b) stated that mathematical spatial ability is mental ability, which is concerned with understanding, manipulating, rotating, and interpret visual relationship.

Gardner stated that spatial intelligence is essential; spatial intelligence provides much-needed intellectual impetus in other areas (Gardner, 2011). Spatial ability is an important skill for recognizing space (Yurt & Tünkler, 2016). In the standard geometry issued by the National Council of Teachers of Mathematics (NCTM), students need to control four parts, which are closely related to spatial ability (National Council of Teachers of Mathematics (NCTM), 2000). According to (Naufal & Juandi, 2024) because many questions in the spatial material cannot be shown in their actual form and can only be drawn or visualized in two dimensions, spatial competence is crucial for solving problems in three dimensions. Therefore, mathematical spatial ability becomes an important ability for students to possess.

However, based on previous studies, students' mathematical spatial abilities are still low, and there are two forms of error-solving problems: concept error and operation error (Rosita & Novtiar, 2021; C. Utami, 2020). In addition, students with low spatial abilities find it difficult to master the indicators of the learned mathematical spatial abilities (Cahyani et al., 2020; Madya et al., 2023; Soraya et al., 2021a; Wulansari & Adirakasiwi, 2019). Based on the results of interviews with some students, it was found that the teacher explained the concept more often first, then continued with the students working on the practice in the package book. The exercise in the package book has also not been able to facilitate or contain all indicators of students' spatial mathematical abilities. Based on the existing problems, students' mathematical spatial abilities still need to be improved.

Moreover, the teaching materials used in mathematics learning generally still use textbooks, power point slides, and video Youtube (Zalsabella et al., 2023). The textbook has weaknesses; specifically, the teaching material is limited to text and still images. This limitation may hinder students' understanding of mathematical concepts, particularly abstract ones (Tralisno & Alfi, 2024) related to geometry materials on three-dimension space. Furthermore, with shortcomings and variations in teaching materials, students will be fixated on the availability of books, and some will eventually not be able to access material for mathematics learning (Nissa et al., 2024).

One of the efforts that can be made to solve the problem of mathematical spatial capabilities is to develop teaching materials that can be used in learning. Teaching materials are one of the components that contain learning materials to achieve learning goals (Abdulah, 2023). With mathematics teaching materials, students understand the material they are taught. Teachers have an important role because they must develop the teaching materials required by students so that they can become interested in learning math. Based on the results of an interview with one of the math teachers at school, it was found that students only learned to use teaching materials in the form of a package book issued by the Kemendikbud and PowerPoint that contained the previous sentences already in the package book. Therefore, teachers need to develop teaching materials to facilitate students' spatial mathematical abilities.

Today, technology has been so developed that it can help teachers in providing learning in class. In this digital age, teachers should act as facilitators and provide better opportunities for

students to create and gain knowledge. Therefore, teachers should utilize technology by developing digital teaching materials that students can learn from anywhere and anytime. One of the digital teaching materials that can be developed is an electronic module (e-module) in the form of a flipbook. Flipbook is the software used to convert PDF files, images, text, and video files into one such as print books (Amanullah, 2020). In developing teaching materials, teachers also need to consider the approach used in learning so that learning will become more meaningful. One approach that can be used is the ethnomathematics approach.

Ethnomathematics is a cultural approach to mathematical thought formed by the public about objects present in mathematics (Saparuddin Nur et al., 2020; Wahyuni et al., 2023). Many students think that ethnomathematics is only used in school studies, but it is also closely related to everyday life or tied to the cultural environment as it develops with local culture. Cultural games, weaving, cultural dances, symbolic calculations, architecture, food, and number systems are just a few of the ethnomathematics activities that can be included in math classes in schools (Batiibwe, 2024). Several scholars have investigated the food ethnomathematics activities however, no one has yet exploited the concept of the three-dimensional space. Borongko and Tumpi-tumpi are traditional foods from Buginese Culture that has the geometric idea of triangular prism and equilateral triangle (Mania & Alam, 2021). Another study revealed that the traditional snack form of terang bulan cake contains mathematical ideas such as fraction, angle, time, circle, cylinder, and proportion (Samosir & Ginting, 2023). Moreover, (Munir & Sholehah, 2023) stated that The mathematical concepts of space (cylinder and trapezium) and flat (circle and rectangle) are present in rombong gula gending.

Furthermore, some research results said that teaching materials with ethnomathematics approaches are well worth using in learning because the overall teaching materials are already said to be valid, practical, and effective for improving students' mathematical abilities (Liesandra & Nurafni, 2022; Nesri & Kristanto, 2020; R. E. Utami et al., 2018; Wiska, Tanjung, et al., 2020). It is also supported by other studies that the study of geometry using the ethnomathematical approach has a positive impact as there is an increase in students' mathematical abilities (Setiyadi, 2021; Sukestiyarno et al., 2023). In addition, other researchers say that e-modules with ethnomathematics approaches deserve to be used in learning and can improve students' mathematical abilities (Sutarto et al., 2022). Several previous studies have shown that no one has yet developed teaching materials, especially e-module ethnomathematics with traditional culinary contexts.

The Javanese and Sundanese people have a wide variety of unique customs, cultures, cuisines, and certain customs that can be developed to aid in mathematical study, especially in their cuisines. Each traditional culinary has its meaning in terms of process, serving, shape, or packaging. Previously, it was said that culinary forms could be used in mathematical studies (Febriyanty & Nasution, 2022). Therefore, this research needs to be conducted to develop teaching materials with a viable traditional culinary ethnomathematics approach, both valid, practical, and effective.

2. Methods

Research & Development (R&D) is a type of research that produces teaching materials in electronic modules with the traditional Javanese Sundanese culinary ethnomathematics approach to facilitate students' spatial mathematical ability. This research procedure uses an ADDIE development model consisting of five stages: analyis, design, development, implementation, and evaluation (Branch, 2010). The teaching materials developed must go through the product's validity, practicality, and effectiveness through expert assessment, student response, and student test results.

The first step in the ADDIE development model is to analyze. The analysis phase is conducted through interviews with teachers and students by meeting two aspects of analysis: needs analysis and curriculum analysis. The next step is design, which is (1) considering the software used, (2) designing a draft module of the ethnomathematics approach, and (3) composing a test instrument of mathematical spatial ability. During the development stage, we will develop a draft module into an electronic module in the form of a flipbook.

At the development stage, this product will be judged by experts to assess its validity and product. Apart from experts, the product will also be judged by students on a limited trial of 15 XII class students at one of the high schools in Tajurhalang to assess the practicality of the developed product. It continues with the implementation stage to see the effectiveness of teaching materials on students' spatial mathematical abilities. The implementation was carried out at one of the high schools in Cibinong, where 31 students were in class XII. At this stage, the final step of the evaluation will be revised based on expert comments, suggestions, and students' opinions. The data collection techniques in this study include interviews, sketches, and tests of mathematical spatial ability.

Interviews were conducted to obtain preliminary data before developing teaching materials. The scales were conducted using the Likert scale to get assessments from experts and students on limited trials. Experts consider seven aspects: content feasibility, presentation, appearance, language, flipbook teaching materials, traditional Javanese-Sundanese culinary ethnomathematics, and mathematical spatial capabilities. The student response framework has six aspects: content feasibility, presentation, appearance, language, conventional Javanese-Sundanese culinary ethnomathematics, and benefits. After using the developed teaching materials, tests were conducted to see students' spatial mathematical ability.

The data analysis techniques in this study used qualitative and quantitative descriptive analysis techniques. Qualitative descriptive analysis techniques describe development and revision and the effectiveness of teaching materials developed in the field. Furthermore, quantitative descriptive analysis techniques perform expert and student assessment calculations to determine the validity and practicality of the developed product. The score obtained was calculated using V Aiken with the following formula (Aiken, 1985).

$$V = \frac{\Sigma s}{n(c-1)} \quad (1)$$

Information:

V: Item validity index

Σs: The number of category scores given by the expert or student minus the lowest score in the category

n: Number of experts or students

c: Number of scoring categories to choose from

The basis for feasibility decision-making, both the level of validity and practicality, is based on the interpretation of the V Aiken index, as shown in Table 1.

Table 1 - Product feasibility level

Index V *Aiken*	Criteria
$V \leq 0{,}4$	Less Valid/Less Practical
$0{,}4 < V \leq 0{,}8$	Valid/Practice
$V > 0{,}8$	Very Valid/Very Practical

(Retnawati, 2016)

The result of evaluating validity and practicality to be achieved is that at least the value of the V Aiken index is > 0.4, with valid or practical criteria. The effectiveness of teaching materials is seen from classical learning satisfaction, which is at least 70% of students achieve the Minimum Satisfaction Criteria (KKM) determined by the school, which is 73 (Wiska, Saputra Tanjung, et al., 2020).

3. Results and Discussion

3.1. Analysis

Students have difficulty solving problems and need teaching materials to help them in learning process. Still, the teaching materials available and used in mathematics are only Kemendikbud and PowerPoint package books containing summaries of the package books. Table 2 presents some transcripts of the researcher's interview with the teacher.

Table 2 - Interview Transcript

Question	
Do you use teaching materials when learning math in class? If so, what are they?	
Answers	
Teacher 1	Yes, I use the textbooks issued by the Ministry of Education and Culture. In addition to printed books, I also summarize the textbooks in PowerPoint to make them more concise when explaining them in class.
Teacher 2	Yes, I use the package book issued by the Ministry of Education and Culture. I also make a PDF summary so that students can easily open it.
Teacher 3	Yes, I use the textbooks issued by the Ministry of Education and Culture.

Teaching materials are needed to help students, making it easier for them to learn. One teaching material that can be used is an electronic module that can be carried and opened anytime and anywhere. In addition, there needs to be an ethnomathematics approach in e-modules for learning to be meaningful. The curriculum used by schools for class XII still uses the 2013 Curriculum. Therefore, an e-module product with a traditional culinary ethnomathematics approach should be developed according to the curriculum used by the school.

3.2. Design

At this stage, teaching materials were designed using Canva, Microsoft Word, and Flip PDF Corporate software tools. Canva and Microsoft Word are used to design and write the module contents. Thereafter, the modules were stored in PDF format and converted into flipbook electronic modules using Flip PDF Corporate software. Modules are structured according to the applicable curriculum's Basic Competency (KD) and Competency Achievement Indicator (IPK) to achieve the learning objectives. The outline of the module developed consist of front cover, preface, table content, introduction, unit 1(position of point, line, and plane), unit 2(distance between two points), unit 3(distance between a point and a line), unit 4(distance between a point and a plane), unit 5(distance between two lines), unit 6(distance between a point and a plane), unit 7 (distance between two planes), evaluation, glossary, references, and answer key.

Figure 1 shows front cover design in e-modules developed using the traditional Javanese-Sundanese culinary ethnomathematics approach to facilitate students' spatial mathematical abilities.

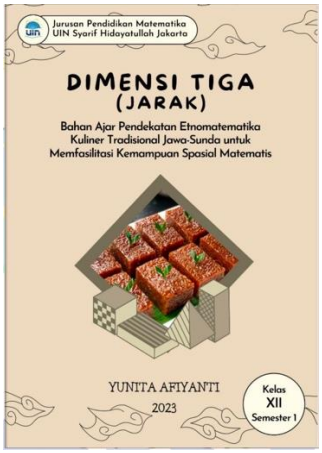

Figure 1 Cover design in e-modules developed

Figure 2 shows introduction design in e-modules developed using the traditional Javanese-Sundanese culinary ethnomathematics approach to facilitate students' spatial mathematical abilities.

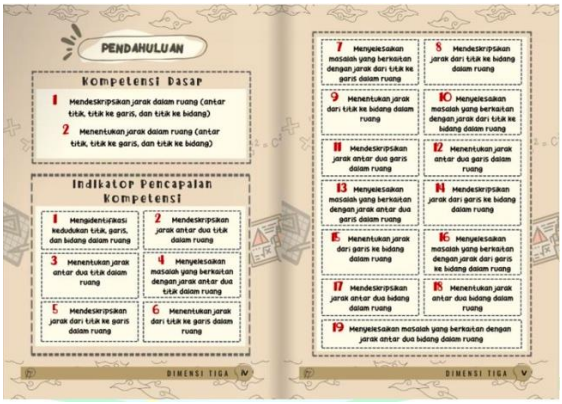

Figure 2 Design in e-modules developed

Figure 3 shows unit 6 (distance between a point and a plane) design in e-modules developed using the traditional Javanese-Sundanese culinary ethnomathematics approach to facilitate students' spatial mathematical abilities.

Figure 3 Unit design in e-modules developed

Figure 4 shows evaluation design in e-modules developed using the traditional Javanese-Sundanese culinary ethnomathematics approach to facilitate students' spatial mathematical abilities.

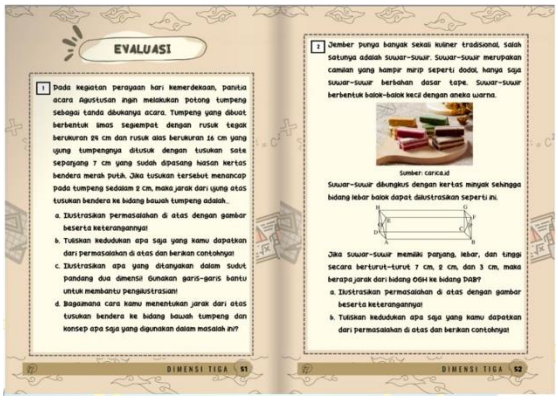

Figure 4 Evaluation design in e-modules developed

3.3. Development

At this stage, teaching materials will be converted into electronic modules. Experts and students will also examine the degree of validity and practicality based on the quantities judged against the developed e-module. The results of the expert validator assessment are shown in Table 3.

Table 3 - Results of validation by experts

Aspects	V *Aiken*
Content Eligibility	0,91
Presentation	0,95
Display	0,94
Language	0,96
Flipbook Teaching Materials	0,91
Traditional Javanese-Sundanese Culinary Ethnomathematics	0,96
Mathematical Spatial Abilities	0,96
V Aiken Overall	0,94
Criteria	Very Valid

According to Table 2, the assessment of expert validators with seven assessment aspects obtained a V Aiken index value of 0.94. Referring to Table 1, the developed electronic module is stated to be very valid because it is in the V index range of ± 0.8. In addition, the results of the student response dataset are shown in Table 4.

Table 4 -The results of the student response sequence

Aspects	V *Aiken*
Content Eligibility	0,89
Presentation	0,88
Display	0,89
Language	0,87
Traditional Javanese-Sundanese Culinary	0,88
Benefits	0,84
V Aiken Overall	0,88
Criteria	Very Practical

Based on Table 3, the assessment of students with six aspects of assessment obtained a V *Aiken* index value of 0.88. Referring to Table 1, the developed electronic module is stated to be very practical because it is in the V > 0.8 index range. This is in line with previous studies that teaching materials with ethnomathematical approaches have valid and practical criteria so that they are suitable for use in class learning (Sutarto et al., 2022; R. E. Utami et al., 2018).

3.4. Implementation

This stage was carried out by conducting a product test in the field for 31 students at one of the high schools in Cibinong. After students learn to use the developed electronic module, a mathematical spatial ability test is performed to determine the product's effectiveness. The tests are organized based on a predetermined lattice of mathematical spatial ability tests and contain traditional culinary ethnomathematical elements. The results of the mathematical spatial ability test are shown in Table 5.

Table 5 - The degree of completeness of classical students' mathematical spatial abilities

Category	**Mathematical Spatial Abilities**	
	The Number of Students	**Percentage**
Done	25	80,65%
Not Complete	6	19,35%
Sum	31	100%

According to Table 4, it is seen that the students' learning performance is classical from the results of spatial mathematics, namely the number of students who completed 25 out of 31 students, with 80.65%, and the number of students who did not complete six students, with a percentage of 19.35%. Per the classic student satisfaction criteria, at least 70% of students who participated in the study could score ≥73 (Wiska, Tanjung, et al., 2020). Thus, the results of the student's spatial mathematical ability test meet the criteria for classically achieving success. In addition to looking at the overall precision, it is also necessary to see the student test results from each indicator of mathematical spatial ability. The results are shown in Figure 5.

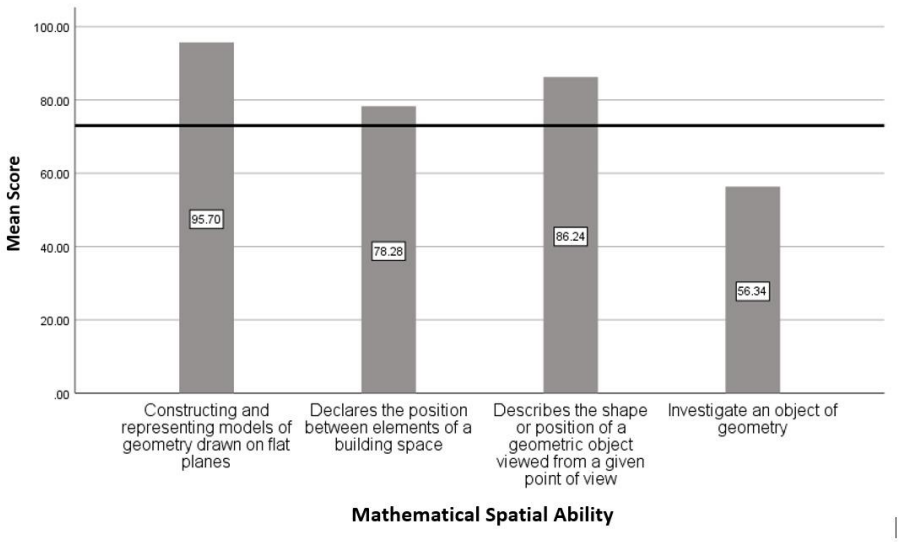

Figure 5 The results of each indicator's mathematical spatial ability test

According to Figure 5, the average value of students' spatial mathematical ability of each indicator is higher than the Minimum Satisfaction Criteria (KKM) set by the school, except for the indicator investigating a geometric object. It is also seen that the first indicator gets a higher average score than the other three indicators so that students can excel in representing space building. In addition, the fourth indicator's average score becomes the smallest and does not reach the KKM, so students need to retrain their calculation skills to solve problems in three-dimensional materials. This is in line with previous studies that the learning provided by the ethnomatistical approach had a positive impact on students' spatial mathematical abilities (Setiyadi, 2021; Sukestiyarno et al., 2023).

An example of student work in e-modules is shown in Figure 6.

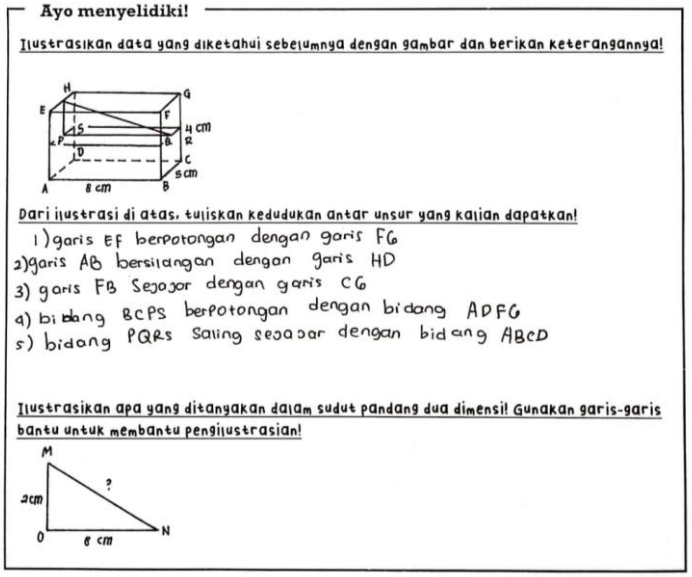

Figure 6 Examples of student work in e-module

Figure 6 shows that students can represent a space building using the traditional culinary form used in cases worked by each group. Traditional culinary forms and explanations related to the culinary can assist students in representing a building space. In addition, students can also write positions between points, lines, and planes and describe the flatness of the constructed space.

3.5. Evaluation

An evaluation of an electronic module (e-module) was conducted to analyze a module that had been developed in the previous development stage. The aim was to revise the module based on the comments and suggestions of expert and student validators on limited trials. The developed e-modules are considered highly valid by expert validators and highly practical by students on limited trials.

4. Conclusions

The development of e-modules with the traditional Javanese-Sundanese culinary ethnomathematics approach to facilitate students' spatial mathematical abilities is carried out through five development stages: analyze, design, develop, implement, and evaluate. The results of the analysis show that students need teaching materials that can be used anywhere and anytime to provide learning motivation and help develop students' spatial abilities.

Development results with e-module validation results of traditional Javanese-Sundanese culinary ethnomathematics approach obtained a V Aiken index value of 0.94 with very valid criteria and a practical V Aiken index value of 0.88 with efficient criteria. In addition, the results of the mathematical spatial ability test are considered effective because 80.65% of students who participated in learning using developed teaching materials received higher scores than the Minimum Satisfaction Criteria (KKM), which was 73 percent higher than 70%.

The implication of this research is to produce an innovation of digital teaching materials in the form of electronic modules (e-modules) with a traditional Javanese-Sundanese culinary ethnomathematics approach to facilitate students' mathematical spatial abilities worthy of use in class learning. Later, these electronic modules could be carried out as follow-up studies under ethnomatological approaches or mathematical spatial capabilities.

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Conflict of Interest

The authors state that there is no conflict of interest regarding the publication of this research paper. The authors have fully borne the ethical issues, including those related to plagiarism, infringement, data falsification, double submission, and redundancies.

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