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Pedagogical Content Validation of an Ethnomathematics-Based Role-Playing Game for Teaching Geometric Transformations

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Abstract

Students frequently experience difficulties in learning geometric transformations because the concepts are highly abstract and require well-developed spatial reasoning. Integrating ethnomathematics into interactive learning media offers a promising pedagogical approach to contextualize mathematical concepts while promoting students' spatial ability. This study aimed to develop and examine the content validity of an ethnomathematics-based educational role-playing game (RPG), namely Tapak Citra, which incorporates the cultural heritage of Gedog Tuban batik to support junior high school students' learning of geometric transformations. The study employed a development research approach focusing on expert validation. Two mathematics education experts and two educational media experts evaluated the game using validation instruments, and the level of agreement was analysed using Gregory's content validity formula. The findings revealed a material validity index of 1.00 and a media validity index of 0.72, indicating that the developed game possesses high content validity and is appropriate for classroom implementation. These findings suggest that ethnomathematics-based role-playing games have the potential to become meaningful pedagogical tools for supporting students' spatial ability through culturally contextualized mathematics learning. Nevertheless, the study was limited to expert validation without classroom implementation. Future studies should investigate the practicality and effectiveness of the game in improving students' spatial ability and learning outcomes in geometric transformations

Keywords: Commognitive Content Validity, Ethnomathematics, Educational Role-Playing Game, Geometric Transformations, Spatial Ability

Abstrak

Siswa sering mengalami kesulitan dalam mempelajari transformasi geometri karena konsep-konsepnya bersifat abstrak dan memerlukan kemampuan spasial yang baik. Integrasi etnomatematika ke dalam media pembelajaran interaktif menawarkan pendekatan pedagogis yang menjanjikan untuk mengontekstualisasikan konsep-konsep matematika sekaligus mengembangkan kemampuan spasial siswa. Penelitian ini bertujuan untuk mengembangkan dan menguji validitas isi permainan edukasi berbasis role-playing game (RPG) yang berlandaskan etnomatematika, yaitu *Tapak Citra*, yang mengintegrasikan warisan budaya Batik Gedog Tuban untuk mendukung pembelajaran transformasi geometri pada siswa sekolah menengah pertama. Penelitian ini menggunakan pendekatan penelitian pengembangan yang berfokus pada validasi ahli. Dua ahli pendidikan matematika dan dua ahli media pembelajaran mengevaluasi permainan menggunakan instrumen validasi, sedangkan tingkat kesepakatan antarvalidator dianalisis menggunakan rumus validitas Gregory. Hasil penelitian menunjukkan bahwa indeks validitas materi sebesar 1,00 dan indeks validitas media sebesar 0,72, yang menunjukkan bahwa permainan yang dikembangkan memiliki validitas isi yang tinggi dan layak digunakan dalam pembelajaran. Temuan ini mengindikasikan bahwa permainan role-playing berbasis etnomatematika berpotensi menjadi media pedagogis yang bermakna untuk mendukung pengembangan kemampuan spasial siswa melalui pembelajaran matematika yang kontekstual dan berakar pada budaya lokal. Meskipun demikian, penelitian ini masih terbatas pada tahap validasi ahli tanpa implementasi di kelas. Oleh karena itu, penelitian selanjutnya perlu menguji kepraktisan dan efektivitas permainan ini dalam meningkatkan kemampuan spasial serta hasil belajar siswa pada materi transformasi geometri.

Kata kunci: Validitas Isi, Etnomatematika, Permainan Edukasi Role-Playing, Transformasi Geometri, Kemampuan Spasial.

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Introduction

Spatial ability is the ability to represent and use objects and their relationships in two or three dimensions (Del Cerro Velázquez & Méndez, 2021; Ramful et al., 2016; Xie et al., 2019). Spatial ability consists of several indicators, including spatial visualization, mental rotation, and spatial orientation (Ramful et al., 2016). Spatial visualization refers to the ability to imagine the shape and position of objects on a flat plane, mental rotation relates to the ability to manipulate shapes or mental transformations, and spatial orientation refers to the ability to understand the location of an object and the direction of its movement in space (Pradana & Sholikhah, 2023; Ramful et al., 2016). This ability supports the problem-solving process involving visual relations, shape, direction, and location (Serrano-Ausejo & Mårell-Olsson, 2024). Without good spatial ability, students will have difficulty connecting abstract concepts with visual representations (Nadzeri et al., 2024).

Despite its important, most Indonesian students do not have good spatial abilities and tend to memorize formulas (Qhorisa et al., 2025). As many as 60.86% of students have difficulty answering geometric transformation questions because they cannot visualize shifts and positions on the coordinate plane (Yuliardi & Rosjanuardi, 2021). This is supported by PISA data which shows Indonesia's low ranking in visual spatial understanding (OECD, 2023). This situation shows that there needs to be a visual and contextual learning approach to improve students' spatial abilities.

Ethnomathematics is one approach that has the potential to improve spatial abilities. In 1977, Ubiratan D'Ambrosio introduced ethnomathematics as an approach that links mathematical concepts to the local cultural context of students (Hanik et al., 2024). In ethnomathematics, students analyze cultural objects to understand spatial relationships (Pujiastuti et al., 2025; Turmuzi et al., 2023). This activity helps improve spatial abilities and trains problem-solving in visually-spatially challenging cultural contexts (Sukestiyarno et al., 2023). This approach is relevant for learning geometric transformations, especially translation, which is a shift in the position of an object without changing its shape or size. Understanding translation requires the ability to visualize the movement of objects on the coordinate plane. However, translation is often difficult to understand because it is abstract and has little to do with everyday life (Prahmana & D'Ambrosio, 2020; Yanik, 2014).

Research shows that ethnomathematics can improve students' understanding of translation material. Using culture, such as batik motifs that have systematic repetition of shapes, can help students improve their visual and spatial abilities through activities such as observing and mapping the direction of object shifts. One example of a motif that is relevant to the concept of translation is Gedog batik from Tuban (Zahardjil et al., 2023). The Gedog batik motif, which consists of repeating geometric patterns with consistent spacing and directional shifts without changing the basic shape of the motif, has the potential to serve as a visual and cultural context that supports a more concrete understanding of the concept of translation. Along with the development of technology, ethnomathematics learning media can be developed more innovatively. Research states that GeoGebra Classroom and Lectora Inspire can help improve spatial abilities, but have technical limitations (Priyantini et al., 2023) and are linear and less interactive (Fiangga & Sari, 2024). Therefore, a more interactive and narrative media approach is needed, such as educational games based on Role Playing Games (RPG).

Educational RPG games enable the integration of ethnomathematics in contextual learning, for example through the insertion of local culture in stories, characters, and settings (Venketsamy, 2024). This results in a stronger relationship between mathematics, culture, and games. Through the role of the main character, students can actively learn mathematics by exploring visual spaces, completing missions, and facing problem-based challenges (Fikriah & Fiangga, 2024). RPGs integrated with ethnomathematics not only encourage critical thinking but also develop spatial abilities through visualization of movement in space (Huynh et al., 2021). In addition, the pleasure of learning through games also reduces students' anxiety about mathematics (Hui & Mahmud, 2023). Although the

integration of ethnomathematics, spatial abilities, and RPG media in translation materials has great potential, it is still rarely developed explicitly in education. Instead of helping students develop their mathematical skills through meaningful exploratory activities, the majority of educational games that have been created concentrate more on drill-and-practice activities or strengthening procedural skills, such as solving routine problems and calculation skills (Beserra et al., 2019; Herlambang et al., 2022; Liu & Tse, 2023). Furthermore, cultural components are still typically used as a supporting backdrop to boost learning motivation and cultural preservation in many culturally oriented game development projects rather than being completely employed as the primary pedagogical mechanism in developing knowledge of mathematical concepts (Gök, 2020; Pawartani et al., 2024). These criteria point to study gaps in the creation of instructional games that concurrently incorporate RPG-based game mechanics, ethnomathematics background, and exercises intended to improve students' spatial skills on translational materials. In fact, research results show that students find it easier to understand mathematical concepts when presented in the form of interesting games that are close to their experiences (Nurnberger-Haag et al., 2023).

Before educational games can be used more widely, they must go through a validation procedure to ensure that they are of good quality and suitable for use (Landers & Sanchez, 2022). Validation carried out by material and media experts is an important initial step in assessing the feasibility of content and techniques, because media quality has a major impact on research results (Rosyidi et al., 2024). Based on this, this study aims to develop and test the validity of an RPG-based educational game integrated with ethnomathematics to improve the spatial abilities of junior high school students in translation material. Unlike previous studies that made games that mainly focused on procedural exercises or used culture only as a supporting illustration, ethnomathematics in this game is realized through the use of Gedog batik motifs from Tuban as the main visual and narrative context, which is integrated into the game environment design, geometric objects, and mission-based challenges that represent the concept of translation. The novelty of this research lies in the use of Gedog batik as the main context for learning activities in RPG-based educational games, rather than merely as supporting visual illustrations. The results of this study are expected to provide an alternative contextual learning media to teachers to teach translation materials and can contribute to the development of technology-based learning media integrated with ethnomathematics that help improve students' spatial abilities more contextually and interestingly.

Method

This research is part of the development research with Thiagarajan's 4D model, which consists of four sequential stages, namely define, design, develop, and disseminate (Thiagarajan, 1974). This model was chosen because it is able to provide a systematic and organized framework for developing and evaluating interactive learning media in the form of educational games integrated with technology and ethnomathematics. However, the focus of this research is limited to the development stage, namely the validation of the educational game content developed to ensure its quality and feasibility before being tested or used further, as in Figure 1. This study did not include trials involving students, including field tests, practical tests, and effectiveness tests.

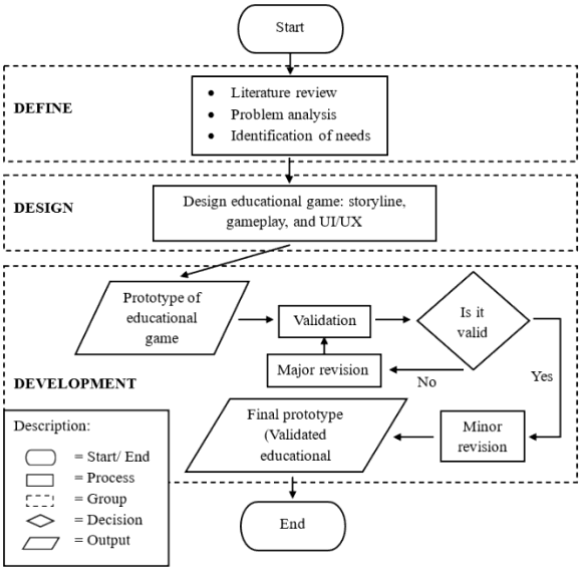

Figure 1. Research and development flow of the 4D model (implemented up to the develop stage)

At the define stage, a literature review and analysis of problems and students' needs in understanding geometric transformations are conducted. The results of this stage are the basis for designing educational games that are based on the characteristics and needs of students. Furthermore, the design stage focuses on creating UI/UX (User Interface/User Experience) designs as in Figure 2, and designing educational game concepts such as storylines, characters, and gameplay mechanisms integrated with ethnomathematics. In designing challenges and game mechanisms, spatial ability indicators are used as the basis for compiling content. This indicator refers to the opinion (Ramful et al., 2016), which includes: (1) Spatial visualization, the ability to visualize objects in two-dimensional space by imagine the shape and position of objects on a flat plane; (2) Mental rotation, the ability to manipulate shapes or mental transformations, such as the ability to shift, rotate, or imagine changes in the position of objects without using real tools; and (3) Spatial orientation, the capacity to understand the location of an object and the direction of its movement in space.

(a) (b)

Figure 2. UI/UX Design: (a) Game Start Menu View; (b) Map Dialog and Exploration View

The game devised in this study is Tapak Citra. Tapak Citra was developed utilizing the RPG Maker MV platform, which facilitates the construction of Role-Playing Games (RPGs) featuring a map system, interactive dialogues, and event-driven gameplay mechanisms (Nasution et al., 2024). This platform was selected due to its ability to facilitate the incorporation of narratives, visuals, and interactions that align with the requirements of ethnomathematics-based educational game development. RPG Maker MV facilitates game development through the use of HTML5 and JavaScript technologies. These features enable the developed game to operate as a standalone application on a computer or laptop running Windows, without requiring high hardware specifications (Gunawardhana, 2022), thereby indicating its suitability for use in a school setting.

The game developed is Tapak Citra. Tapak Citra presents an adventure story that involves cultural

elements and geometric transformations implicitly. In Tapak Citra, students play as fictional characters (Role Playing Game) in a culture-based world, where students can interact with NPCs (Non-Playable Characters) who provide missions, challenges, or instructions related to geometric transformations integrated with culture. The challenges or missions given in Tapak Citra aim to improve the spatial abilities of junior high school students in translation material. Each challenge is designed by integrating culture, especially the Gedog batik pattern which reflects the concept of geometric translation in contextual problems that require students to apply spatial abilities in solving or developing problem-solving strategies. As the game progresses, the challenges in the game will become more complex and test students' spatial abilities more deeply before the game continues to the final stage. Gradually, Tapak Citra helps students to improve their spatial abilities related to geometric transformation material through interactive learning experiences. Through Tapak Citra, students not only memorize concepts, but also understand how to apply them in contextual situations through exploration and problem solving in the game.

At the develop stage, the research focuses on testing the validity of the educational game that has been developed, but does not include direct trials with students. This step is taken to ensure that the product developed meets the standards of eligibility and accuracy of the content before further testing and widespread use. The validation process was carried out using assessment instruments that had undergone expert judgment to ensure that the validation results accurately represented the level of feasibility and quality of the product. Trials involving students were scheduled as a follow-up stage in the next study after the product was refined based on validator feedback.

In this study, data were obtained through a questionnaire instrument, namely the material validation instrument and media validation instrument. The material validation instrument consists of 16 items distributed across four aspects, while the media validation instrument consists of 16 items distributed across two aspects, presented in Table 1 and Table 2.

Table 1. Blueprint of Material Validation Indicators

Aspect	Indicator	Item Number	Number of Items
Material Coverage	Completeness, accuracy, and integration of translation, spatial ability, and ethnomathematics content	1-5	5
Conformity to Learning Outcomes	Alignment with learning objectives, ethnomathematics content, and spatial ability development	6-11	6
Language	Clarity and communicativeness of language	12-13	2
Illustration	Suitability and attractiveness of visual representations	14-16	3
	Total		16

Table 2. Blueprint of Media Validation Indicators

Aspect	Indicator	Item Number	Number of Items
Content	Clarity of content presentation and narrative	1-7	7
Construction	Navigation, functionality, and technical quality of the game	8-16	9
	Total		16

The validation instrument was designed to assess the quality of content, visual appearance, gameplay interactivity, and the relevance of the game to spatial ability and ethnomathematics. The

instruments were developed by integrating spatial ability indicators proposed by Ramful et al. (2016), namely spatial visualization, mental rotation, and spatial orientation, with the principles of educational game design integrated with ethnomathematics. The material validation instrument was developed to assess whether the content, challenges, and cultural narratives in the game are able to support students in visualizing object positions, mentally manipulating geometric transformations, and understanding object location and direction of movement. Meanwhile, the media validation instrument was developed to assess whether visual design, navigation, interaction, and gaming environments facilitate the development of spatial abilities.

The questionnaire used a four-point rating scale, ranging from 1 (not suitable) to 4 (very suitable), to represent the level of suitability of each indicator to the established criteria. The questionnaire was given to media experts and material experts to be validated in order to obtain an assessment of the feasibility and suitability of the developed product. Media and material experts each consisted of two people. Material experts consisted of students' mathematical understanding experts and geometric transformation experts, while the media experts had expertise in developing and evaluating digital learning media. The use of two validators in each aspect is based on Gregory's content validity approach, which requires a minimum of two experts to determine the level of agreement between validators (Retnawati, 2016). The involvement of two media experts and two material experts was considered to have met the minimum requirements for obtaining relevant professional assessments and enabled comparisons between validators' assessments and comprehensive input on each aspect assessed.

Prior to the validation process, validators were explained the research objectives, scope of validation, and guidelines for completing the questionnaire. The purpose of this explanation was to ensure that the indicators and assessment criteria used were universally understood, so that the data collected could represent an objective and consistent assessment of the educational games created.

Data analysis was conducted separately for content validity and media validity. The scores given by the validators were categorized into two classifications, namely “strong” and “weak”. The Scores were classified as “strong” if the scores fell into the high suitability category (scores of 3 or 4), while the scores were classified as “weak” if they fell into the low suitability category (scores of 1 or 2). The categorizations of validator’s scores of each aspect analyzed are presented in the form of a contingency table, as shown in Table 3, which is then analyzed using Gregory formula to show the content validity index (Retnawati, 2016). Here is the Gregory formula:

$$Validity\ Index\ = \frac{D}{A+B+C+D} \quad (1)$$

The Gregorian Content Validity Index ranges from 0 to 1. The closer the content validity index is to 1, the stronger the agreement between experts on the content validity of the instrument developed. Interpretation of the Gregory Index:

- 0 – 0.40 = Low validity
- 0.41 – 0.70 = Moderate validity
- 0.71 – 1.00 = High validity

In this study, it was determined that educational games were declared eligible for testing if the minimum content validity index value was in the "moderate" category, which was ≥ 0.41. This determination was based on the opinion of (Retnawati, 2016), who stated that content validity with a moderate category was sufficient to proceed to the trial stage, with the note that changes and improvements were made according to input from the validator. This determination aims to ensure that the educational games developed have adequate feasibility and quality as determined by experts before being implemented further.

Table 3. Gregory Formula Tabulation

Expert	1st Combination	2sd Combination	3rd Combination	4th Combination
Expert 1	Weak	Strong	Weak	Strong
Expert 2	Weak	Weak	Strong	Strong
Total	A	B	C	D

At the define stage, the research focused on identifying the specific needs and problems faced by prospective mathematics teachers in designing STEM-based lesson plans. The need analysis involved initial surveys, interviews, and literature review to understand the needs and challenges faced by the prospective mathematics teachers. After identifying the needs, the researchers designed STEM-based learning training using CL approach. This design included systematically organized training materials, learning strategies that support collaboration, and assessment instruments that are suitable to the context and objectives of the research.

The design then validated by three experts in STEM-based learning through Focus Group Disscussion (FGD). Experts' suggestions were used to revise the design. These were done in the develop stage. Then, the design was implemented to the prospective mathematics teachers at the disseminate stage. Prospective mathematics teachers filled a questionnaire of practicality of the training design and the training module, also held a small exhibition of the lesson plan they have created collaboratively. Their designed lesson plan then assessed to see the training design and the training module' effectiveness.

Result and Discussion

The educational game Tapak Citra is a Role Play Game (RPG) set in a fictional village called Citraloka Village, which is full of local cultural values typical of Tuban, especially Gedog batik. The integration of local culture in Tapak Citra is not only present in the setting and characters, but also in educational challenges based on translation by using Gedog batik motifs as the main visual media in game activities that represent object shifts. The use of visually familiar batik motifs aims to help students develop more stable mental representations, thereby facilitating the process of visualization, direction estimation, and determination of object displacement distance in the concept of translation.

Players act as the successors of the ancestral pattern protector called Tapak Citra. They are gradually led to complete four main missions designed to develop spatial abilities through cultural context-based translation activities, such as batik fabrics, batik motifs, and sacred stone arrangements inspired by gedog batik motifs.

1. Scattered Gedog Batik Cloth

   In this quest, players must arrange pieces of Gedog batik cloth with Kembang Randu motif scattered around the room by identifying the direction and distance of the shift, thus practicing spatial visualization skills and spatial orientation, as seen in Figure 3.

(a) (b)

Figure 3. Quest for the Scattered Gedog Batik Cloth: (a) NPC explains the meaning of the Kembang Randu batik motif and mission instructions; (b) Pieces of batik cloth as clues for direction and distance of movement

2. Shifting the Gedog Batik Print

In this quest, players must shift the Gedog batik mold with a Liris to a certain coordinate point, thereby encouraging to develop the ability of mental manipulation and Vector translation as shown in Figure 4.

(a) (b)

Figure 4. Gedog Batik Printing Quest: (a) NPC explains the meaning of the Liris batik motif as an introduction to the quest; (b) Tasks involving direction and distance using Gedog batik stamps

3. Ancestral Pattern Map

In this Section, players are asked to rearrange the position of sacred stones to form the Lok Can motif by identifying the relative position and shift of objects in two-dimensional space, as seen in Figure 5.

(a) (b)

Figure 5. Ancestral Pattern Map Quest: (a) NPC explains the quest; (b) Instructions for shifting stones to match the lok can motif

4. Serat Citra

In this Section, players will re-learn the concept of translation in the context of batik gedhog through a book entitled Serat Citra. Then the player will be given 10 questions designed to strengthen the understanding of Translational concepts and spatial abilities, as seen in Figure 6.

Translation of text:
The image shows a gedog batik with a kembang randu motif.
This motif originates from Kerek Village, Tuban, East Java. The name "kembang randu" refers to the randu tree (kapok), a tree that is familiar in people's lives. The kembang randu motif symbolizes fertility, balance in nature, and steadfastness in life.
The repeating flower pattern following a specific direction on the fabric is a clear example of two-dimensional translation, where the flowers appear identical but are simply shifted in position.

(a)

Translation of text:
Translation or shift is the movement of a shape to a new position without changing its original shape,
size, or direction.
To translate point (x, y), a shift vector (a,b) is needed to indicate how far the point is shifted horizontally and vertically.
When point (x, y) is translated by (a, b), the image point (x', y') is

$$(x', y') = (x + a, y + b)$$

Conversely:
Determining translation:

$$(a, b) = (x' - x, y' - y)$$

Determining the initial point:

$$(x,y) = (x' - a, y' - b)$$

(b)

Translation of text:
The liris pattern print is located at coordinates (-1,4). Then the print is translated by (3,-2). Determine the location of the print after translation.

(c)

Figure 6. Serat Citra Quest: (a) Translation Concept; (b) Translation in Batik Gedog; (c) Questions

Each quest is structured to help students develop spatial visualization, mental rotation, and spatial orientation skills through problem-based challenges that open up new storylines. The diversity of batik motifs in each mission is presented contextually according to their characteristics, making learning more meaningful, contextual, and free from cultural stereotypes.

According to Ramful et al. (2016), spatial ability is the ability to represent and use objects and

their relationships in two or three dimensions. In this case, the elements in the Tapak Citra game are specifically designed to improve these abilities through integrated translation-based activities of Gedog Tuban batik culture. Table 4 below shows the mapping between the components of spatial ability and the elements in Tapak Citra.

Table 4. Spatial Capability Components and Their Implementation in the Tapak Citra

Spatial Ability Components	Implementation in the game Tapak Citra	Example
Visualization	Players observe the coordinates of an object, then are asked to visualize where the object will move based on the concept of translation.	 Translate: "Do I have to move six steps to the right and one step up to get back?"
Mental Rotation	Players use coordinate-based translation commands to shift objects, training players to mentally transform shapes.	 Translate: "Descendant of the noble Sri Gatra, how far must I go to reach coordinates (4,-1)?"
Spatial Orientation	Players must determine the final position of an object after it is shifted, understand the direction (right, left, up, down), and the distance of the shift in a flat plane.	 Translate: "If I am currently at coordinates (0,2), and then I am moved (-3,1) away, where will I be after the shift?"

Validity testing was carried out by two material experts and two media experts to determine the validity and feasibility of the educational game "Tapak Citra". The assessment was carried out based on a validation instrument consisting of several aspects, such as content, construction, material coverage, suitability of the game to learning outcomes, language, and illustrations in the game. Each assessment aspect was given a score of 1 to 4, then categorized into two categories, namely weak (score

1-2) and strong (score 3-4). Furthermore, the assessment results from the two experts were analyzed using the Gregory formula and presented in Table 5 and Table 6. Overall, educational games tread image has a high level of media validity of 0.72 and the validity of the material is perfect with an index of 1.00. These results indicate that educational games developed, in general, have met the eligibility criteria based on expert assessment.

Table 5. Media Validity Results

Expert	1st Combination	2sd Combination	3rd Combination	4th Combination	Validity Index
Expert 1	Weak	Strong	Weak	Strong	
Expert 2	Weak	Weak	Strong	Strong	
Content	-	-	-	7	1
Construction	3	2	-	4	0.44
Total	3	2	-	16	0.72

Table 5 shows the results of the validity test of the Tapak Citra educational game media by two media experts, analyzed using the Gregory formula. The results of the media validity test refer to the consistency of assessments between validators on the content and construction aspects. The validity index value of the content aspect is 1.00, which indicates that all content indicators are included in the high validity category. Meanwhile, the opinions of media experts on the construction aspect are still different. This can be seen from the validity index of 0.44 for this aspect, which is included in the moderate validity category.

Even though the construct aspect has a medium validity index (0.44), the value still meets the minimum validity criteria (≥ 0.41) to proceed to the trial phase (Retnawati, 2016). However, the relatively low construct validity index indicates that some technical aspects still need improvement before being tested on students. If these weaknesses are not corrected, it has the potential to disrupt students ' interaction with the game and affect the quality of the learning experience and subsequent test results (Huynh et al., 2021).

Overall, the media validity index is 0.72, which is included in the high validity category. This means that the educational game media is considered feasible to use, but still requires improvements or repairs in the construction aspect, such as ease of navigation and instructions, or bugs and technical problems in the game to optimize the quality of the media before being used in further trials.

Table 6. Material Validity Results

Expert	1st Combination	2sd Combination	3rd Combination	4th Combination	Validity Index
Expert 1	Weak	Strong	Weak	Strong	
Expert 2	Weak	Weak	Strong	Strong	
Coverage of Material	-	-	-	5	1
Conformity to Learning Outcomes	-	-	-	6	1
Linguistics	-	-	-	2	1
Illustration	-	-	-	3	1
Total	-	-	-	16	1

Based on the results of the validation of the material by two material experts shown in Table 6, a

validity index of 1.00 was obtained for all aspects assessed, namely material coverage, suitability to learning outcomes, language, and illustrations. These results indicate that all aspects have high validity and there are no differences of opinion between assessors. This full validity reflects that the material in the Tapak Citra game is in accordance with learning objectives, learning outcomes, language clarity, and effective illustrations.

The results of the media and material validation of the Tapak Citra game are in line with the interpretation used by other researchers, namely that an instrument or media is considered valid if its validity aspect is between 0.71 and 1.00 (Retnawati, 2016; Rosyidi et al., 2024). Thus, the validation results provide certainty that the Tapak Citra educational game has successfully passed the feasibility evaluation process by experts. Overall, this media is considered feasible and practical to be tested in helping junior high school students improve their spatial abilities through local culture-based translation learning, although there is still room for improvement in the construction elements.

This study developed the Tapak Citra educational game as a local culture-based mathematics learning media to improve junior high school students' spatial abilities in translation material. Based on the assessment of two media experts, this game was declared feasible with an overall media validity index of 0.72. However, several aspects of the construction require improvement. Expert comments indicate that several parts of the game, especially those related to navigation and instructions, are still not clear enough for users and require improvement or repair. In addition, certain technical elements were also found that could cause confusion or errors during the game. Therefore, revisions were made to improve the clarity of instructions, navigation flow, and ensure that each challenge or question in the game accurately represents the application of the translation concept in a cultural context.

The revisions made aim to make the Tapak Citra educational game more effective as a contextual learning medium. Details of improvements and suggestions from the validators have been systematically arranged and presented in Table 7. This revision is expected to improve the quality and feasibility of the game, so that its use in learning can be more optimal.

Table 7. Example of Revision of Tapak Citra Educational Game According to Media Experts

Before Revision	**Comment**	**Repair**
	There is a typo	
A typo exists in the term "buni," which should be spelled "bumi" or earth. The opening prologue of the game contains this error, which may impede the readability and comprehension of the narrative by players.		Translation of text: “They dance on the ground, weaving and embroidering the earth with patterns and directions.” Revised Result: The typo in the word “buni” has been corrected to “bumi” (earth), so that the prologue text complies with linguistic rules.

Before Revision	Comment	Repair
 Translation of instruction text: "Enter the elder's house, heading towards the back left corner. Then the path connecting you to Datuk Natawirya will open." In the game, important instructions are presented in the same format as narrative dialogue. This has the potential to make players less aware of the clues they need to follow.	Important dialogues/instructions are bolded or marked differently.	 The instruction text has been given visual markers so that it is easier to recognize as game instructions.

Based on the results of the material validation by two material experts, all aspects received a validity index of 1.00, indicating that the scope of the material, suitability to learning outcomes, language, and illustrations were considered very good. However, the experts still provided some minor notes for improvement. The input has been followed up by revising the related sections. Details of the changes are shown in Table 8.

Table 8. Example of Revision of Tapak Citra Educational Game According to Material Experts

Before Revision	Comment	Repair
 The material is presented in long texts without background information, resulting in low text readability.	Add visualization for translated materials and Books are displayed visually in the form of ancient books	 The translated material is presented in the form of an ancient book containing a combination of text and visualizations. The use of a book background improves the readability of the material and is more in line with the concept of ethnomathematics in games.

Tapak Citra educational game integrates Gedog batik motifs into narrative-based translation material challenges that require students to visualize, manipulate, and interpret object movements in a cultural context. The design of this game is made in line with the principle of ethnomathematics that

positions culture as a meaningful learning context (Lidinillah et al., 2022) and encourage students to construct mathematical understanding through direct interaction with cultural objects (Kabuye Batiibwe, 2024). Such exploratory activities have the potential to promote deeper conceptual understanding and support the development of spatial abilities (Huynh et al., 2021; Kabuye Batiibwe, 2024). In addition, challenges in educational games are designed to encourage players to identify objects, directions, and displacement vectors, thus potentially supporting the development of spatial abilities (Ramful et al., 2016; Xie et al., 2019).

The use of narrative and in-game challenges has the potential to encourage students to engage emotionally and cognitively in the learning process through narrative engagement. Previous research has shown that meaningful narratives and interactive challenges in game-based learning can increase motivation, maintain attention, and enhance students' learning experiences (Fikriah & Fiangga, 2024; Huynh et al., 2021). In addition, RPG-based learning environments allow students to gain an understanding of mathematical concepts through contextual experiences and active engagement, in contrast to traditional learning media that focus mostly on procedural exercises (Payadnya et al., 2024).

The validation results by two material experts showed that the material validity index was 1.00, which means that the material in Tapak Citra is in the high validity category. This shows that the material from the Tapak Citra educational game is fully in accordance with the learning outcomes, student development stages, and learning objectives of transformation geometry, especially translation. These results are supported by the opinion of Retnawati (2016), who stated that the validity index between 0.71 and 1.00 is classified as high and indicates that the product can be used in learning without major revisions. The fact that the material in this game is valid also supports the findings of Hartindya et al. (2022), that the integration of cultural elements such as batik can help students improve their spatial abilities.

In terms of media, the validation results show that the media validity index is 0.72, which indicates that this media is in the high validity category and is suitable for use, but still needs to be improved. The content aspect of the media received a perfect validity value of 1.00, while several indicators in media construction, such as interface display, navigation, and interactive components, only received a validity value of 0.44. Although this value still meets the minimum validity criteria (≥ 0.41) for proceeding to the trial phase (Retnawati, 2016), the relatively low construction index indicates that some technical aspects still require improvement before implementation with students.

The improvement of these technical aspects is important because difficulties in navigating the game or understanding instructions can potentially interfere with student interaction with the game as well as affect the quality of the learning experience and subsequent test results (Huynh et al., 2021). Likewise, clear visual representations and fluid interactions are essential to support the student's spatial reasoning and facilitate the formation of mental representations of the movement of objects (Del Cerro Velázquez & Méndez, 2021). Therefore, the future version of Tapak Citra should improve these technical aspects to optimize the learning experience and student learning outcomes.

Compared to other technology-based learning media, such as GeoGebra Classroom (Rosyidi et al., 2024) and AR (Winarni et al., 2023), Tapak Citra offers a more immersive learning environment through the integration of narrative, cultural context, and interactive exploration. Previous research has shown a game-based learning approach that combines narrative and interactivity has also been shown to increase student engagement and motivation (Fikriah & Fiangga, 2024; Huynh et al., 2021; Winardy & Septiana, 2023). Furthermore, the incorporation of local cultural contexts into educational activities is in line with the findings of Turmuzi et al. (2023) and Prahmana & D'Ambrosio (2020), which show that ethnomathematics can help students develop a deeper understanding of mathematical concepts through contextual learning experiences. Therefore, the Tapak Citra has the potential to support the development of students' spatial abilities and translation learning, even though there has been no direct testing with students.

The weakness of this study lies in the limited number of validators which only involved four experts, namely two material experts and two media experts, and the fact that limited trials have not been conducted on students directly. Therefore, further research can increase the number of validators so that the assessment is more accurate and conduct limited trials on students to determine the impact of the Tapak Citra game on spatial abilities. This suggestion is in line with research, which shows that increasing the number of respondents in the validity and reliability test of the instrument can produce more accurate results (Gisev et al., 2013; Golafshani, 2003; Ritchie & Lewis, 2003; Vasileiou et al., 2018). In line with this, learning media also needs to be developed sustainably so that learning potential can be realized optimally (Nadzeri et al., 2024; Serrano-Ausejo & Mårell-Olsson, 2024) and tested in various conditions to ensure its practicality and effectiveness (Herlambang et al., 2022; Putri et al., 2025; Qhorisa et al., 2025), as well as its appeal (Fikriah & Fiangga, 2024; Nurnberger-Haag et al., 2023) in the context of real learning. Therefore, it is recommended to conduct trials with students in subsequent studies to confirm the results of expert validation in the context of real learning, and to ensure that games that have been declared valid are able to support the learning process and the achievement of learning objectives. In the trial process, students are expected to not only actively participate in completing the game, but also in visualizing, manipulating, and evaluating the movement of objects through the game, so that these activities can improve students' understanding of the concept of translation, spatial abilities, and learning motivation.

Conclusion

This study produced a product in the form of an educational game RPG Tapak Citra that integrates ethnomathematics of Gedog Tuban batik to improve the spatial abilities of junior high school students in translation material. This game is designed with a narrative and visual approach based on spatial ability indicators. The validation results showed a high level of validity with a material validity index of 1.00 and a media of 0.72, which indicates that the game deserves to continue to the testing phase after improvements are made to some technical aspects. However, the findings of this study need to be interpreted carefully because the study involved only two material experts and two media experts, so the scope of the validation results is still limited. In addition, the lack of trials involving students led to the unavailability of empirical evidence on the effectiveness, practicality, and appeal of educational games in real learning situations. Therefore, further research is recommended to add validators and conduct limited trials on students to ensure its practicality, effectiveness, and appeal, as well as the potential impact of Tapak Citra on students' spatial abilities.

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