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Development of "Smart Literacy" Media Based on Tri-Nga Integrated Ethnomathematics in Elementary School Geometry Learning: Validity and Practicality Study

Siti Toifatun Khasanah[1], Sukiyanto[2], Ana Fitrotun Nisa[3], Akbar Al Masjid [4]
[1,2,3,4]Universitas Sarjanawiyata Tamansiswa Yogyakarta, Indonesia
sttoifatunk08@gmail.com

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ABSTRACT

This study aims to develop Smart Literacy media based on Tri-Nga integrated ethnomathematics in elementary school geometry learning and to determine the level of validity and practicality of the developed media. This study uses a research and development (R&D) approach with the ADDIE model which limits it to four stages, namely analysis, design, development, and implementation. In the analysis stage, it is carried out through analysis of needs, student characteristics, curriculum, and local cultural potential. In the design and development stage, it has produced Smart Literacy media that integrates the ethnomathematics context and the Tri-Nga stages (ngerti-ngrasa-nglakoni). The validity of the media in this study was carried out by material experts, media experts, and language experts. The validation results show that the media obtained a percentage of 92.8% from material experts, 96.8% from media experts, and 91.6% from language experts, where all are in the very valid category. The implementation stage was carried out through a limited trial involving 3 teachers and 9 students to determine the level of practicality of the media. The results of a limited trial indicate that the Smart Literacy media is highly practical. This media is able to present geometry learning through the integration of local cultural contexts and comprehensive learning, encompassing cognitive, affective, and psychomotor aspects. Thus, the Smart Literacy media is declared valid and practical, and suitable for use as a geometry learning medium in elementary schools. This research is recommended for further testing the media's effectiveness on a broader scale and for developing similar media for other mathematics materials.

A. BACKGROUND

21st-century education demands the development of high-level cognitive competencies, including logical thinking, critical reasoning, and analytical skills, which are essential in facing the challenges of the Industrial Revolution 4.0 and Society 5.0 eras. (OECD, 2019) . This demand is reinforced by the latest report from the World Economic Forum (WEF) which confirms that analytical thinking and creative thinking are two of the ten most needed and fastest growing skills in the future world of work. (World Economic Forum, 2023).

Mathematics, particularly geometry, in elementary school provides an important foundation for developing these skills. Recent studies have clearly demonstrated that geometry involves the development of spatial thinking. This importance is further supported by research that concludes that educational efforts can improve mathematics achievement by strengthening spatial thinking through spatial skills training and encouraging the use of spatial tools to solve mathematical problems (Bates et al., 2023).

One effective approach to addressing the problem of abstraction and relevance in mathematics is ethnomathematics. Ethnomathematics is the result of the relationship between

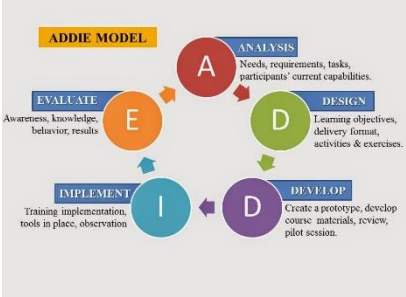
culture and mathematics, which studies aspects of mathematics based on the culture, values, and beliefs of human groups (Fauzi, 2022). This approach is crucial for improving the effectiveness of the mathematics learning process. Empirically, recent research confirms the relevance of Ethnomathematics in two crucial aspects: First, Ethnomathematics provides a very suitable basis for developing learning designs and teaching materials for Geometry (Najwa et al., 2025). Second, the integration of Ethnomathematics through real cultural contexts such as traditional houses (Pratiwi et al., 2025) or local crafts have been proven effective in developing Mathematical Critical Thinking Skills and deepening students' understanding of Geometry (Syaripah, 2025). By contextualizing geometry in cultural objects, students are encouraged to not only memorize formulas, but also discover and analyze mathematical concepts from their own environment.

Holistic media development requires not only a relevant content base (Ethnomathematics), but also a strong philosophical framework, thus the need to integrate the Tri-Nga Teachings (Ngerti, Ngrasa, Nglakoni) of Ki Hadjar Dewantara, which are in line with the Merdeka Curriculum. The Tri-Nga teachings emphasize that learning must involve three domains in a balanced manner, starting from Ngerti (Cognitive/Understanding), Ngrasa (Affective/Experiencing values and motivation), and Nglakoni (Psychomotor/Practice and real experience) (Al Masjid et al., 2019). The integration of Tri-Nga into learning media is essential to ensure that students not only "understand" geometric concepts but also "feel" cultural values and "carry out" practices and analyses in real-life contexts.

Given the complexity of integrating Ethnomathematics content and the Tri-Nga philosophical framework, innovative, interactive, and structured learning media are required. The use of digital technology is crucial for presenting geometric concepts visually, while facilitating the exploration of authentic ethnomathematics cases. With the main objective to describe the process and results of the Development of "Smart Literacy" Media Based on Ethnomathematics and Tri-Nga Approaches for Elementary School Geometry Learning. The focus of this research is on the validity and practicality of the developed media, as a basis for product feasibility before further testing its effectiveness, in order to improve the quality of mathematics learning at the Elementary School level.

B. METODE

This research uses a research and development approach which aims to produce learning media products and test their feasibility before being implemented more widely. (Irawan Pratama & Shomedran, 2023). This approach was chosen because it is suitable for developing contextual and needs-based learning media in elementary schools. The media development procedure in this study adapts the ADDIE model, which conceptually includes five main stages: analysis, design, development, implementation, and evaluation (Richardo et al., 2023). However, taking into account time constraints and research focus, the implementation of development is limited to the implementation stage. However, taking into account time constraints and research focus, the implementation of development is limited to the implementation stage. development is limited to the implementation stage. However, taking into account time constraints and research focus, the implementation of development is limited to the implementation stage.



In the analysis stage, researchers collect the necessary data (Amalia Dhiaul Zaini & Ekawati, 2023). In this stage, researchers follow up on the results of the analysis phase, resulting in the formulation of media development objectives, the design of structures and stages that reflect Tri Nga, the development of content and learning materials, and the design of research instruments (Setiyadi, 2021). In the development stage, this is done to assess its suitability to the geometry material, the quality of the media design, the clarity of the language, and the integration between ethnomathematics and Tri Nga (Kurniawati et al., 2025) and the implementation stage aims to determine the practicality of Smart Literacy media in learning. At this stage, researchers conducted several activities, including implementation or limited trials of the media (Mabruroh, 2022)

The research was conducted at Candirenggo 3 Elementary School, Ayah District, Kebumen Regency, Central Java Province. Prior to the limited trial, the Smart Literacy media underwent a validation process by language experts, media experts, and content experts. The validator team, consisting of three experts, provided assessments and input for improvements to the Smart Literacy media, which the researchers would then implement. The revised Smart Literacy media was then trialed on a small group basis.

The research instruments used in this study were questionnaires and validation sheets. In the analysis stage, a teacher questionnaire was used to analyze needs as a basis for media development. To analyze student characteristics, a questionnaire was used to determine visual design and activities. Meanwhile, to analyze the curriculum, a document analysis was conducted to determine the suitability of the geometry material. Cultural analysis used an ethnomathematics identification instrument to determine the context of the Smart Literacy media. An expert validation sheet was used to assess the feasibility of the Smart Literacy media before limited testing. The assessment used a four-level Likert scale (1-4). The use of expert validation was to ensure the validity of the Smart Literacy media content in accordance with the principles of development research (Nieveen, 1999). To determine the practicality of the Smart Literacy media, measured from the perspective of teachers and students, a four-level Likert scale was used and analyzed descriptively quantitatively. This refers to the quality of the product. (Nieveen, 1999). The assessment uses a four-level Likert scale, with a score of 1 indicating poor, 2 indicating adequate, 3 indicating good, and 4 indicating excellent.

The media validity percentage is calculated by comparing the obtained score to the maximum score using the following formula:

$$\text{Persentase Validitas} = \frac{\sum \text{Skor Perolehan}}{\sum \text{Skor Maksimal}} \times 100\%$$

The obtained score is the score given by the validator. The maximum score is the number of questions x the highest score x the number of validators. 100% is a constant for converting the score to a percentage. The criteria for interpreting the validity percentage results are as follows:

Percentage (%)	Eligibility Category	Decision
85 – 100	Very valid	Suitable for use without revision or minor revision
70 – 84	Valid	Suitable for use with revision
50 – 69	Somewhat valid	Requires major revision
< 50	Not valid	Not suitable for use

C. RESULTS AND DISCUSSION

1. Analysis Stage

In this analysis stage, respondents completed a questionnaire provided via a Google Form link to analyze teacher needs. The questionnaire consisted of six questions and is presented in the following table:

Tabel 1. Teacher Needs Analysis

No	Statement	Average Score	Interpretation
1	Existing geometry learning media are contextual.	2	Good Enough
2	Geometry material is easy for students to understand.	3	Good Enough
3	Geometry learning connects mathematical concepts with local culture.	2	Good
4	The media used can increase student interest in learning.	3	Good Enough
5	Geometry learning involves student activity.	3	Good Enough
6	Teachers need innovative, contextual, and interactive learning media.	4	Very Necessary

Based on the results of the teacher needs analysis using a questionnaire, teachers assessed that geometry learning was progressing quite well in terms of conceptual understanding, student engagement, and learning interest. The highest score was for statement number 6, which concerns the need for innovative learning media. This indicates that the media currently used do not connect geometry material to the local context.

In the analysis phase, students, as respondents, completed a questionnaire provided via a Google Form link to analyze student characteristics. The questionnaire consisted of five questions and is presented in the following table:

Tabel 2. Analysis of Student Characteristics

No	Statement	Yes	no	Percentage "Yes"
1	I learn best with pictures and colors.	8	1	88,9%
2	I enjoy learning through practice or play.	9	0	100%
3	I'm more interested in learning geometry if it's related to objects around me.	7	2	77,8%
4	I get bored quickly if I only read books.	8	1	88,99%
5	I enjoy learning with stories and real-life examples.	9	0	100%

Based on the analysis of student characteristics, most students learn more easily with the aid of pictures and colors. All students greatly enjoyed hands-on and playful learning and expressed enjoyment when learning through stories and real-life examples. Conversely, most students felt bored when learning solely from textbooks. This indicates the need for contextual and innovative learning (Wirawan, 2023).

Teachers as respondents completed a questionnaire to analyze the curriculum and the appropriateness of the geometry material. The questionnaire was also provided via a Google Form link, consisting of five questions, presented in the following table:

Table 3. Curriculum Analysis

No	Curriculum Components	Suitable/ available	No	Percentage
1	Geometry Learning Outcomes	3	0	100% in accordance
2	Learning Objectives	3	0	100% in accordance
3	Geometry Core Material	2	1	66,7% in accordance
4	Students' Concrete Activity Needs	3	0	100% in accordance
5	Opportunities for Ethnomathematics Integration	3	0	100% in accordance

The curriculum analysis results indicated that all teachers assessed that the primary school geometry learning outcomes and objectives were aligned with the curriculum. They also assessed that students needed concrete activities in their learning and stated that there were opportunities to integrate ethnomathematics into geometry learning. However, one teacher assessed that the geometry core material still needed adjustments.

At the analysis stage, teachers and students as respondents filled out a questionnaire to analyze culture using an ethnomathematics identification instrument to determine the context of Smart Literacy media and presented in the following table:

Table 4. Ethnomathematics Identification Analysis

No	Local Cultural Elements	Geometry Concepts	Relevance	Interpretation
1	Traditional Food	Planetary/Spatial Figures	High	very relevant
2	Batik or Woven Motifs	Patterns, Symmetry	High	very relevant
3	Traditional Household Items	Spatial Figures	Medium	quite relevant
4	Traditional Games	Patterns and Shapes	Medium	quite relevant

The questionnaire results showed that local cultural elements are highly relevant to geometry learning. Traditional foods, batik motifs, and weaving were deemed highly relevant for teaching the concepts of geometric and geometric shapes. These findings demonstrate that ethnomathematics integration has the potential to enhance concepts and instill local cultural values in students.

2. **In this planning stage**

In this planning stage, researchers systematically designed the Smart Literacy media before developing it into a real product. Researchers followed up on the results of the analysis stage, compiled content and learning materials, and designed research instruments (Setiyadi, 2021)

Smart Literacy Media is an acronym for interactive screens, educational themes, story wheels, and school digital access. The components of Smart Literacy media consist of interactive screens that serve as visual displays in the classroom. Educational themes include various QR Codes containing learning resources. Story wheels serve as a game medium for presenting interactive case analysis. School digital access connects to digital books that can be used as learning resources both at school and at students' homes. The concept of Smart Literacy media can be described as follows:

1. The Interactive Screen is a digital geometry visualization containing QR codes for learning resources. It measures 120 x 60 cm and is made of a banner that reads "Smart Literacy." The learning resources on the interactive layer are diverse.
2. The Educational Thematic contains learning resource content tailored to geometry material based on Tri Nga's integrated ethnomathematics.
3. The Story Wheel is a game medium in the form of a circular wheel made of plywood with a diameter of 60 cm and is divided into 8 sections containing numbers 1 to 8. There is a rotating needle on the bottom edge of the wheel that functions as a number indicator. The story wheel pole with a length of 130 cm is made of wood. And there are 8 challenge card places placed under the wheel circle. There are 4 challenge cards in each challenge box.
4. The school's digital access is equipped with a reflection tree. The school's digital access not only provides QR codes containing learning resources that students can access both at school with teacher guidance and at home with parental guidance. It also provides a platform for students to upload their work to the school's social media platforms.

3. **Development**

In the development stage, researchers developed a Smart Literacy media product design based on the design developed in the previous stage and conducted a validity test by an assessment team consisting of language experts, media experts, and material experts. This was done to assess its suitability to the geometry material, the quality of the media design, the clarity of the language, and the integration between ethnomathematics and Tri Nga (Kurniawati et al., 2025) in Smart Literacy media.

After media development, as shown in the image above, validation was conducted to determine the feasibility of the Smart Literacy media. The first validation was conducted by a linguist. The linguist who served as the validator was Dr. Akbar Al Masjid, M.Pd., a lecturer in the Indonesian Language Learning Innovation course for elementary school. The validation results are shown in Table 5.

Table 5. Results of Validation by Linguists

No	Indicators	Feasibility Scale
1	Use of language according to good and correct rules	Very good
2	Language is communicative and easy to understand	Very good
3	Use of mathematical terms is correct and consistent	Good
4	No spelling or punctuation errors	Very good
5	Language reflects local character and cultural values	Very good
6	Instructions are clear and convey the message	Good
	Total skor	26
	Persentase	91.6%
	Skala Kelayakan	Very feasible (very valid)

(Source: questionnaire data by language expert validator)

The assessment conducted by a linguist yielded a score of 91.6%, which, as stated by Arikunto (in Supriadi, 2019), falls within the criteria of "very appropriate."

Then, validation was conducted by a media expert, conducted by Dr. Kristi Wardani, M.Pd., a lecturer in the Pancasila Education Innovation course for Elementary Schools. The validation results are shown in Table 6.

Table 6. Media Expert Validation Results

No	Indicators	Eligibility Scale
1	Attractive design that suits student characteristics	Very good
2	Layout, colors, fonts, and images are harmonious and support learning	Very good
3	Illustrations aid understanding of geometric concepts	Very good
4	Suitability of text, images, and cultural elements	Very good
5	Navigation is easy for students to understand and use	Good
6	Innovative media	Very good
7	Media supports independent and collaborative learning activities	
8	Design reflects local wisdom and cultural values	Very good
	Total Score	31
	Percentage	96,8 %
	Eligibility Scale	Very worthy (very valid)

(Source: questionnaire data by media expert validator)

The assessment conducted by media experts yielded a score of 96.8%, which, as stated by Arikunto (in Supriadi, 2019), falls within the very appropriate criteria.

Validation by material experts was conducted by lecturers in the Postgraduate Program at Sarjanawiyata Tamansiswa University, Yogyakarta. The validation results are shown in Table 7.

Table 7. Media Validation Results

No	Indicators	Eligibility Scale
1	Content alignment with CP and Learning Objectives	Very good
2	Mathematical concept accuracy and precision	Good
3	Materials foster students' logical, critical, and analytical thinking skills	Very good
4	Ethnomathematics relevance (traditional foods, games, and local contexts) to geometry materials	Good
5	Integration of Tri-Nga values	Very good
6	Material complexity level appropriate to elementary school characteristics	Very good
7	Materials foster students' interest in learning mathematics	Very good
	Total Score	26
	Percentage	92,8 %
	Eligibility Scale	Very worthy (very valid)

(Source: questionnaire data by media expert validator)

The assessment carried out by media experts obtained a percentage of 92.8%, in accordance with what Arikunto (in Supriadi, 2019) stated, which is included in the very appropriate criteria.

4. **Implementation**

The implementation stage is the fourth stage, involving the implementation or limited trial of the media (Mabruroh, 2022) this limited trial involved approximately 6–12 respondents. The researchers selected 12 respondents, consisting of 3 teachers and 9 students in the same class, to determine the practicality of the Smart Literacy media in learning. The results are shown in Table 8.

Table 8. Results of Media Practicality Test

No	Indicators	Percentage	Category
1	Ease of use of Smart Literacy media	93,7	Very Practical
2	Suitability to Learning Objectives	91,6	Very Practical
3	Clarity of material presentation	95,8	Very Practical
4	Ethnomathematics integration	91,6	Very Practical
5	Integration with Tri-Nga stages	93,7	Very Practical
6	Media usefulness and meaningfulness	95,8	Very Practical
	Average	93,4	

The results of the media practicality test indicate that the Smart Literacy media is categorized as very practical, based on teacher responses. Teacher respondents assessed that the Smart Literacy media is easy to use, relevant to learning objectives, and integrated with Tri-Nga (Tri-Nga) learning.

Students also conducted a practicality test of the media. The questionnaire results are presented in Table 9.

Table 9. Media Practicality Test Results

No	Indicators	Percentage	Category
1	Ease of use of Smart Literacy media	94,4	Very Practical
2	Interest in media displays	96,3	Very Practical
3	Understanding of geometry material	92,5	Very Practical
4	Interest in cultural context	95,3	Very Practical
5	Activity in learning	93,5	Very Practical
6	Enthusiasm for using media	96,3	Very Practical
	Rata-rata	94,7	

Student respondents gave excellent feedback on the use of Smart Literacy media. They found it engaging, easy to use, and helpful in understanding geometry material through contextual cultural integration.

Discussion

The results of a questionnaire administered to three teachers indicated that geometry instruction at the school was going well. Respondents, including teachers, assessed that the media used significantly helped students understand the geometry material and increased their learning interest. The highest score was seen in the statement about the need for innovative and contextual learning media. This indicates that teachers still feel limited in connecting geometry material to students' real lives, integrating local culture, and providing meaningful learning experiences.

The results of a questionnaire administered to nine students indicated that the majority of students expressed greater enthusiasm for learning with images and colors, enjoyed hands-on learning and games, were interested in objects around them, got bored quickly with only reading, and were highly enthusiastic about learning through stories and contextual learning (real-life examples). This analysis suggests the need for innovative, contextual, and interactive learning media.

The results of the curriculum analysis questionnaire with teacher respondents indicated that learning outcomes and objectives were aligned with the curriculum, the need for learning with concrete media and activities was important, and geometry material needed to be adapted to students' real lives/contextual contexts (Trisnani et al., 2021) There is a significant opportunity to integrate ethnomathematics into geometry.

The results of a questionnaire analyzing local cultural elements in geometry learning with teacher and student respondents indicate that traditional foods are highly relevant to both plane and solid geometry, batik and woven motifs are highly relevant to patterns and symmetry, and traditional household tools and games are quite relevant to patterns and shapes (Prahmana & D'Ambrosio, 2020). The integration of ethnomathematics into geometry learning has the benefit of helping students understand geometric concepts and instilling a love for local culture.

The results of practicality tests with teacher and student respondents indicate that the Smart Literacy media based on Tri-Nga integrated ethnomathematics has a very high level of practicality. These findings indicate that the Smart Literacy media developed is easy to use, aligns with learning objectives, and has pedagogical benefits. The ethnomathematics context plays a crucial role in making geometric concepts easier to understand and more concrete (Sari et al., 2024).

The Tri-Nga (ngerti-ngrasa-nglakoni) integration has provided a comprehensive learning experience, because it not only provides conceptual understanding but also involves emotional elements and direct practical activities experienced by students. This is very much in line with Ki Hajar Dewantara's thinking that meaningful learning will involve the cognitive, affective, and psychomotor domains in an integrated manner (Suyanto et al., 2025). The results of this study support the findings of (Nieveen, 1999) and (Fitrotun Nisa et al., 2025) which state that innovative learning media is media that is easy to use effectively by both teachers and students (Pratama & Yelken, 2024). Smart Literacy Media has the criteria as a product or media that is worthy of being utilized, used, and further developed at the effectiveness testing stage.

D. CONCLUSION AND SUGGESTIONS

Based on the results of development research that started from the needs analysis stage then systematically designing Smart Literacy media, developing Smart Literacy media product designs according to the designs that have been designed and conducting validity tests by an

assessment team consisting of language experts, media experts, and material experts so that the assessment by language experts obtained a percentage of 91.6% with a very valid category, the assessment carried out by media experts obtained a percentage of 96.8% with a very valid category, and the assessment carried out by material experts obtained a percentage of 92.8% with a very valid category, and limited media trials also showed that Smart Literacy media has a very practical category, this is based on the responses of teachers and students.

Smart Literacy media helps the geometry learning process through the integration of ethnomathematics and Tri-Nga. Thus, Smart Literacy media meets the criteria for valid and practical learning products or media, thus it is suitable for use as a geometry learning media in elementary schools and can be followed up in the next research stage, namely testing the effectiveness on a wider scale to improve student learning outcomes, as well as developing similar media on other mathematics materials.

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