
Probabilo Tour: Ethnomathematics-Based Learning Media to Support High School Students' Mathematical Problem-Solving Skills

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Abstract. *Mathematics learning at the high school level, particularly in probability, is often considered challenging because it is abstract and lacks real-world context. As a result, many students memorize formulas without understanding their applications, which makes it difficult to solve problems. To address these challenges, innovative learning media are needed that not only provide a variety of practice questions but also link local culture through an ethnomathematics approach, bridging abstract concepts with students' real-life experiences to make learning more meaningful, engaging, and effective in improving problem-solving abilities. This study aims to describe the development process of Probabilo Tour, an ethnomathematics-based learning media designed to support the problem-solving abilities of high school students. The research method used is research & development, utilizing the ADDIE development model (analyze, design, develop, implement, evaluate). The trial involved expert validation and practicality testing through student response questionnaires and learning outcome tests administered to 35 10th-grade students. The results showed that Probabilo Tour obtained an average validity score of 82.94% (very valid), a student response rate of 84.5% (efficient), and a learning completion rate of 91.18% among students, with a classical average of 88 (effective). The N-gain analysis produced 0.73 (high category), indicating a significant increase in problem-solving ability. Thus, Probabilo Tour is suitable for use as an ethnomathematics-based learning medium that supports high school students' mathematical problem-solving abilities.*

Keywords: *Learning media, Ethnomathematics, Problem Solving*

INTRODUCTION

Mathematics learning at the Senior High School (SMA) level remains a challenge for most students (Rahmawati, Prayito, & Salsabilla, 2023). Many students perceive mathematics as a complex, abstract, and irrelevant subject to daily life (Annisa, Syamsuri, & Khaerunnisa, 2024; Rambe, Rahmah, & Aqfi, 2023). One of the causes is conventional teaching methods that tend to focus only on memorizing formulas and delivering material theoretically without providing

contextual learning experiences (Rahayu, Kurniasih, Hudori, Yahya, Kumala Sari, & Nurbaeti, 2023). As a result, students tend to be passive in the learning process and struggle to understand concepts deeply.

One of the mathematics materials that often causes difficulty is probability (Saniyah & Alyani, 2022). Although probability is closely related to daily life, such as estimating weather, playing dice, or determining strategies in decision-making, students' understanding of this concept is still relatively low, as reflected in National Exam scores of around 57-65% on probability material (Andini et al., 2024). Research results indicate that many students struggle with solving probability problems, particularly in the stages of understanding the problem, transformation, processing, and drawing conclusions, suggesting that students' mathematical problem-solving abilities remain relatively low (Annisa & Abadi, 2021; Putri et al., 2024).

Similar conditions were also found in several schools, including one of the Islamic Senior High Schools in Tulungagung. Based on observations in Grade X classrooms, it was found that students tend to only memorize formulas without understanding their meaning and application. Additionally, based on interviews with one mathematics teacher, the learning process in schools is still dominated by lecture methods and monotonous exercise drills, making it difficult for students to connect the material with their real-life experiences. Furthermore, teachers have not yet utilized innovative and interactive learning media to help explain the material visually, interactively, and contextually. As a result, learning becomes boring, challenging to understand, and does not provide meaningful learning

experiences for students (Rambe, Rahmah, & Aqfi, 2023; Rambe, 2023; Purnacita, 2024).



Figure 1. Classroom Observation

To address these challenges, one relevant approach is the integration of ethnomathematics in learning. Ethnomathematics connects mathematical concepts with local culture, making learning more meaningful and relevant for students (D'Ambrosio, 2001). Through the integration of ethnomathematics, learning not only strengthens mathematical understanding but also fosters an appreciation for national culture (Masruroh, Zaenuri, Walid, & Waluya, 2022). Recent research indicates that incorporating batik motifs into the introduction of concepts of symmetry and geometric patterns can enhance high school students' interest and understanding (Purwaningsih & Hartati, 2024). Additionally, ethnomathematics-based digital media, such as digital modules on probability materials and Android-based interactive applications, have been proven effective in improving students' mathematical understanding (Setiyaningsih & Kumala, 2024; Suryani, Wanabuliandari, & Riswari, 2023).

On the other hand, the use of educational game-based learning media has become an attractive and potential strategy to make learning more enjoyable and interactive (Ananta, Nurmayanti, & Syamsunir, 2024). Educational games have been proven to increase student engagement, promote social interaction, and develop critical and creative thinking skills in a pleasant learning environment (Yusup & Mastoah, 2023; Isnanita et al., 2024). However, educational games are more optimal when designed within a systematic and structured learning framework

(Putra, Nindiasari, & Fathurrohman, 2024). Without a clear pedagogical design, games often become merely additional activities that fail to truly support learning objectives truly.

Research conducted by Hasryani and Ariani (2024) indicates that integrating games with cooperative learning models, such as Teams Games Tournament (TGT), can enhance student learning outcomes compared to standalone games. Therefore, educational games should be integrated into a structured, collaborative learning design that focuses on developing students' critical thinking abilities and social skills. One relevant cooperative learning model is Teams Games Tournament (TGT) (Dwi Ratnasari et al., 2023). The Teams Games Tournament (TGT) model combines group learning with tournament-based games, allowing students to learn collaboratively while being motivated through enjoyable competition (Nada et al., 2025).

Based on this background, Probabilo Tour was developed as an ethnomathematics-based learning medium in the form of a board game, designed to support high school students' mathematical problem-solving abilities, particularly in the area of probability. The Probabilo Tour combines Indonesian cultural elements, including batik motifs, regional dances, and traditional games, by applying active learning principles through the TGT model. Thus, this medium serves not only as a practice tool but also encourages students to understand problems better, design effective strategies, manage information, and draw logical conclusions.

This innovation presents novelty as it focuses on developing problem-solving abilities through ethnomathematics-based board games on high school probability material, something that is still rarely researched. This innovation is significant because most previous research has only developed board games for arithmetic, exponents, or basic geometry at the elementary school level, without thoroughly addressing probability learning at the high school level (Fathurrohman, Nindiasari, & Rahayu, 2022; Wahyuningsih & Setyadi, 2024). Additionally, although ethnomathematics research has been conducted through traditional games such as hompimpa for introducing probability and engklek for concepts of flat

shapes, this research remains descriptive and has not yet been developed into systematic educational game media (Putri, 2025; Andari, 2025).

Therefore, this research focuses on the development process of ethnomathematics-based learning media, aiming to describe its validity, practicality, and effectiveness in supporting mathematical problem-solving skills for 10th-grade high school students. Additionally, it provides an innovative alternative for teachers in the learning process, which is subsequently developed under the name Probabilo Tour.

RESEARCH METHODS

This research employs the Research and Development (R&D) method, utilizing the ADDIE development model, which comprises five stages: Analysis, Design, Development, Implementation, and Evaluation. According to Sugiyono (2013), the R&D method is a systematic and iterative approach to produce products that are valid, effective, and in accordance with student needs. In line with Rustandi and Rismayanti (2021), the ADDIE model is flexible and oriented toward continuous improvement. Therefore, the application of the R&D method with the ADDIE model is considered appropriate for the development of mathematical manipulative media, ensuring that the resulting product is innovative, valid, practical, and effective (Nasution & Taufik, 2025).

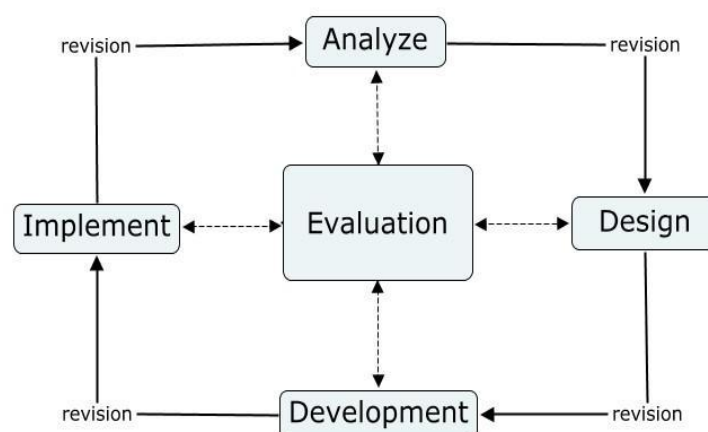


Figure 2. ADDIE Development Stages
Source: Chowdhury dkk. (2022)

1. Analyze

Analysis is the initial stage in the ADDIE development model. At this stage, researchers analyze the curriculum and materials taught in Grade 10 of senior high school to ensure alignment with the learning objectives. Additionally, media needs analysis is conducted through direct observation of the learning process in grade 10 across three different classes, as well as interviews with mathematics teachers. This aims to identify difficulties experienced by students, particularly in solving probability problem-solving questions, limitations in the media used by teachers, and the need for more innovative, interactive, and contextual learning media. This stage is conducted to ensure that the developed media truly meets the needs of students, aligns with their learning objectives, and incorporates content and learning strategies that support the achievement of learning outcomes (Nasution & Taufik, 2025).

2. Design

At the design stage, the researcher began developing the Probabilo Tour media concept, which included creating the media name, philosophy, design, user guide, and game flow. This design was created based on observation results and needs analysis, ensuring that the developed media is relevant to learning, visually appealing, easy to use, and supports active and collaborative learning activities.

3. Development

In the development stage, the researchers realized the Probabilo Tour media concept design into a tangible product. This process began with creating a board game design with ethnomathematics elements, followed by compiling game components, including the game board, question cards, challenge cards, pawns, and dice. Additionally, the researchers also developed research instruments, including media validation sheets, student response questionnaires, and test questions. After the media was developed, validation was conducted by two experts, namely a content expert and a media expert, to assess the validity aspects in terms of content, appearance, language, and suitability in relation to the learning objectives.

The media validation results are presented by dividing the total score by the maximum score of the assessment, then multiplying by 100% as follows:

$$P = \frac{\sum x}{\sum x_1} \times 100\%$$

Notes:

P = Percentage of score obtained

x = Score obtained

x_1 = Maximum score obtainable

After obtaining the validity percentage, the researcher then adjusted it with the media validity indicators shown in Table 1. The media is considered valid for use if the Percentage achieved is more than 60% with a good qualification.

Table 1. Media Validity Indicators

Achievement	Qualification
$80\% < P \leq 100\%$	Very good/Very valid
$60\% < P \leq 80\%$	Good/Valid
$40\% < P \leq 60\%$	Good enough / Quite valid
$20\% < P \leq 40\%$	Poor/Invalid
$0\% < P \leq 20\%$	Invalid

Source: Siregar dkk. (2024)

4. Implementation

The implementation phase was conducted through trials of using the Probabilo Tour media in probability learning with the cooperative Teams Games Tournament (TGT) model. After use, the researcher evaluated two main aspects, namely the practicality and effectiveness of the media. Practicality was measured through student response questionnaires regarding ease of use, appearance, and engagement, while the questionnaire results were calculated in the form of percentages by dividing the total score obtained by the maximum score, then multiplying by 100% as follows:

$$P = \frac{\sum x}{\sum x_1} \times 100\%$$

Notes::

P = Percentage of score obtained

x = score obtained

x_1 = Maximum score obtainable

The percentage results of practicality were then adjusted to align with the practicality indicators presented in Table 2. The media is declared practical for use if the Percentage achieved is more than 60% with a good qualification.

Table 2. Practicality Media Indicator

Achievement	Qualification
$80\% < P \leq 100\%$	Very Good/Very Practical
$60\% < P \leq 80\%$	Good/Practical
$40\% < P \leq 60\%$	Good enough/Quite practical
$20\% < P \leq 40\%$	Poor/Impractical
$0\% < P \leq 20\%$	Not good/Not practical

Source: Siregar dkk. (2024)

Meanwhile, the effectiveness of the Probabilo Tour media was measured through pretest and posttest of problem-solving abilities based on the four stages of Polya. The improvement results were analyzed using normalized gain (N-gain), calculated with the formula:

$$g = \frac{Posttest - Pretest}{Skor Maks - Pretest}$$

Table 3. N-gain Category Based on Hake (1999)

N-gain Category	N-gain Range	Notes
Low	$g < 0,30$	Low ability improvement
Currently	$0,30 \leq g < 0,70$	Moderate improvement
Height	$g \geq 0,70$	High improvement capability

Source: Hake (1999)

Media is considered adequate when the average N-gain is ≥ 0.30 (minimum medium/high category) and $\geq 60\%$ of students are in the medium or high category.

5. Evaluation

The evaluation phase is the final stage in the ADDIE development model. In this phase, researchers conduct a comprehensive evaluation of the Probabilo Tour media, including both the media development process and the results of classroom trials. This evaluation is based on three main aspects. First, the validation results from experts are used to ensure that the media is suitable for

implementation in learning. These validation results are crucial in ensuring that the media are genuinely aligned with the mathematics learning needs of high school students. Second, student responses obtained through questionnaires are analyzed to determine the practicality level of the media. Third, the results of the pre-test and post-test on problem-solving abilities. According to Hake (1998), the N-gain test is used to measure learning effectiveness by comparing pretest and posttest scores, where a high N-gain value indicates a significant improvement in learning outcomes. Through these three aspects, researchers can assess whether the developed media is truly valid, practical, and effective in supporting the learning process.

RESULTS AND DISCUSSION

The results of this research indicate that the ethnomathematics-based Probabilo Tour learning media, developed through the ADDIE model —namely, Analysis, Design, Development, Implementation, and Evaluation —have met the validity, practicality, and effectiveness criteria. Below is a description of the Probabilo Tour media development results.

1. Analyze

Researchers analyzed the materials, curriculum, and student needs through observation and literature review. Based on the curriculum analysis, one of the materials studied in the second semester of grade 10 in senior high school is probability, using the Merdeka Curriculum as a reference, which emphasizes contextual learning. In its implementation, the learning objectives to be achieved include: (1) Students can understand the concept of probability and determine the probability of an event through class discussion and question-and-answer activities correctly; (2) Students can solve problems related to probability material by properly utilizing the educational game media Probabilo Tour; and (3) Students can connect mathematical concepts with local culture contextually to gain a more meaningful learning experience. Observation results in grade 10 of one of the Islamic Senior High Schools in Tulungagung show that many students experience

difficulties in understanding probability material. The main difficulty lies in problem-solving ability, especially in identifying sample space, determining events, and formulating appropriate solution strategies. This finding is reinforced by interview results with mathematics teachers, who explained that students tend to memorize formulas without a deep understanding of probability concepts, thus experiencing difficulties when faced with contextual story problems. This was expressed in their statement: "So far, students have focused more on memorizing probability formulas, but when faced with story problems or real contexts, they often struggle to determine the solution steps." This condition aligns with the research findings of Maharani, Dasari, and Nurlaelah (2022), which state that low understanding of probability concepts directly impacts weak mathematical problem-solving skills.

Based on the analysis results, researchers propose a solution in the form of developing the Probabilo Tour learning media, a manipulative medium that integrates probability exercises with Indonesian culture through an ethnomathematics approach. This medium is designed to bridge abstract probability concepts with students' real-life experiences, while fostering awareness of local culture, making learning more interactive and enjoyable, and systematically training problem-solving skills in accordance with the principles of the Merdeka Curriculum.

2. Design

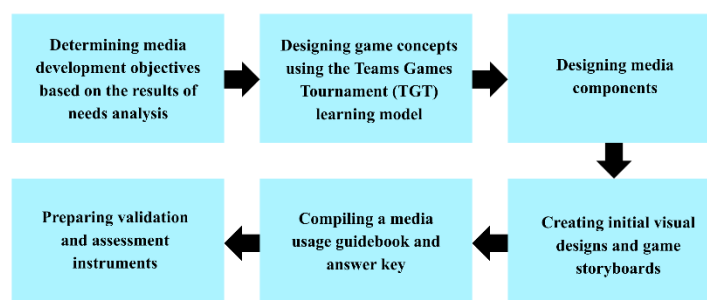


Figure 3. Probabilo Tour Media Design Scheme

Based on the results of needs analysis and literature review conducted in the analysis phase, the researcher identified the need for innovative learning media that

can connect probability concepts with local cultural contexts to make learning more meaningful. Based on these findings, the researcher then developed the concept of a learning media platform named Probabilo Tour. This media is the researcher's creation, inspired by the concept of game-based learning and the ethnomathematics approach to integrate Indonesian cultural elements into mathematics learning on probability material. Through this medium, 10th-grade high school students are expected to be able to solve probability problems correctly while also learning about Indonesian culture. Additionally, students are expected to develop collaboration and mathematical problem-solving skills by formulating appropriate strategies to win the game.

The researcher then created the Probabilo Tour media design using Canva software. The researcher began by creating the media packaging design, including the media itself and all its components, and then developing the media application flow. The developed media can be seen as follows:

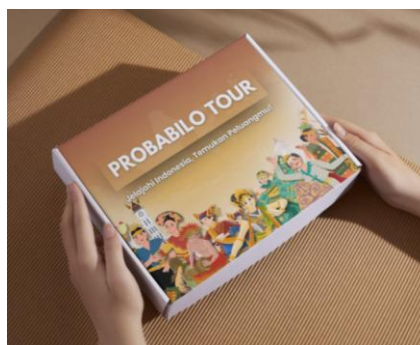


Figure 4. Probabilo Tour Packaging Design

Based on the criteria for effective learning media, it is essential to consider the media packaging model. Probabilo Tour is packaged neatly and effectively, making it easy to carry anywhere. The Probabilo Tour learning media will be packaged in a single box containing several Probabilo Tour media components, as shown in Figure 4. These components include a game board, question cards, educational challenge cards, penalty challenge cards, pawns, and dice, a guidebook, and an answer key book.



Figure 5. Probabilo Tour Board Game Design

The design of the Probabilo Tour board game is tailored to its purpose of creating media, which is to enhance students' knowledge of Indonesian culture. Therefore, the route used in the board game is in the form of a map of Indonesia with 38 points representing the provinces of Indonesia, as shown in Figure 5



Figure 6. Probabilo Tour Guide Design

Each game requires instructions for preparing and playing the game. The Probabilo Tour comes with a user manual that contains a general description of the game, including game objectives, components, procedures, scoring and winning system, integrated values, and a conclusion, as shown in Figure 6.



Figure 7. Design of the Probabilo Tour Answer Key Book

The Media Probabilo Tour is also equipped with an answer key book. The answer key book contains the answer keys to the probability questions on the question cards. These answer keys are differentiated according to the type of question card (easy, medium, and difficult) and have been adjusted to match the numbers indicated on the question cards shown in Figure 7.



Figure 8. Design of Educational Challenge Card

Educational challenge cards are cards that players receive when they land on the KP Bangka Belitung and Southeast Sulawesi provinces with pink location symbols. Players will receive a reward when they can answer educational questions about the culture on the card, as shown in Figure 8.



Figure 9. Fine Challenge Card Design

Challenge penalty cards are cards that players receive when they land on the East Kalimantan or West Papua provinces with the purple location symbol. Players must follow the instructions on these penalty cards, as shown in Figure 9.



Figure 10. Probabilo Tour Question Card Design

The question cards are divided into three categories: green cards (easy-type questions), yellow cards (medium-type questions), and red cards (difficult-type questions). The questions given are ethnomathematics-based, so they not only train probability calculation skills but also support the development of high school students' mathematical problem-solving abilities, as shown in Figure 10.



Figure 11. Probabilo Tour Dice



Figure 12. Probabilo Tour Pawn Design

For the game to run, supporting components such as pawns and dice, as shown in Figures 11 and 12, are required. The pawns used are doll characters wearing traditional Indonesian clothing.

3. Development

At this stage, the researcher developed the Probabilo Tour media through the physical design process and material selection. The researcher also compiled

research instruments in the form of media validation sheets, response questionnaires, and validated test questions, which were reviewed and approved by media and material experts.



Figure 13. Media Probabilo Tour

Validation is conducted to determine whether the learning media are suitable for use. At this stage, the learning media is validated by validators or experts. Three validators validate the media: one mathematics lecturer from Universitas Negeri Malang and two high school mathematics teachers. The three validators conduct validation according to the validation sheets determined by the researcher.

The results obtained from the three validators can be seen in the following table:

Table 4. Media Validation Analysis Results

Statement	Validator 1	Validator 2	Validator 3
1. Clarity of the Probabilo Tour media user guide	4	4	4
2. Ease of use of Probabilo Tour media	4	4	4
3. Utilizing Probabilo Tour media for student use	5	4	5
4. Suitability of Probabilo Tour media with basic competencies of probability material	4	4	4
5. Suitability of Probabilo Tour media to support the achievement of learning objectives	4	4	4
6. Accuracy of Probabilo Tour media in increasing students' learning motivation	4	4	5
7. Accuracy of the Probabilo Tour media design	4	4	4
Total Validity Score	29	28	30
Average Validity Score	4,14	4	4,29
Average Validity Score Percentage	82,86%	80%	85,72%
Validity Criteria	Very Good	Good	Very Good

Based on Table 4, it can be seen that the average validity score percentage for validator 1 is 82.86%, which falls into the very good/very valid category. The average validity score percentage for Validator 2 is 80%, which falls into the 'good/valid' category. Moreover, the average validity score percentage for validator 3 is 85.72%. Thus, the average Percentage of the three validators is 82.86% and falls into the excellent/very valid category.

Table 5. Material Validation Analysis Results

Statement	Validator 1	Validator 2	Validator 3
1. Suitability of material in Probabilo Tour media with learning outcomes	4	4	5
2. Suitability of material in Probabilo Tour media with learning objectives	4	4	5
3. The material on the Probabilo Tour media is easy for students to understand	4	4	4
4. The material in the Probabilo Tour media is appropriate for students' abilities	4	4	4
5. The material on the Probabilo Tour media helps students understand the concepts	4	4	4
6. The material on the Probabilo Tour media is explicit and presented in a simple way	4	4	5
Total Validity Score	24	24	27
Average Validity Score	4	4	4,5
Average Validity Score Percentage	80%	80%	90%
Validity Criteria	Good	Good	Very Good

Based on Table 5, it can be seen that the average Percentage of validity scores for validator 1 and validator 2 is 80%, which falls into the good/valid category. Moreover, the average Percentage of validity scores for validator 3 is 90%. Thus, the average Percentage of the three validators is 83.3% and falls into the excellent/very valid category.

Table 6. Language Feasibility Validation Analysis Results

Statement	Validator 1	Validator 2	Validator 3
1. The language used in Probabilo Tour media is easy for students to understand	4	4	4
2. The sentences used in the Probabilo Tour media are simple	4	4	5
3. The spelling of sentences in the Probabilo Tour media is correct	4	4	4
4. The wording in the Probabilo Tour media user guide is precise and not confusing	4	4	4

Statement	Validator 1	Validator 2	Validator 3
5. The language used has no double meaning	4	4	5
Total Validity Score	20	20	22
Average Validity Score	4	4	4,4
Persentase Rata- Validity Criteria	80%	80%	88%
	Good	Good	Very Good

Based on Table 6, it can be seen that the average Percentage of validity scores for validator 1 and validator 2 is 80%, which falls within the sound/valid category. The average Percentage of validity scores for validator 3 is 88%, which falls within the very good/very valid category. Therefore, the average Percentage of the three validators is 82.67%, which falls within the perfect/very valid category.

After further analysis of the three tables above, the average validity score for all aspects was 82.94%. This indicates that the Probabilo Tour media falls into the very good to very valid category. Therefore, the Probabilo Tour media is suitable for use and implementation in schools. This aligns with research by Rohmah and Bukhori (2020), which states that media that meet valid criteria are suitable for use in mathematics learning.

Prior to validation, several aspects of the media were unclear and potentially confusing for students, including the limited pretest and posttest options and lengthy instructions for using the media. After validation and revision based on the validator's feedback, the media was enhanced by adding answer options, simplifying instructional sentences, and refining the display to make it easier to understand and more engaging for students.

With these improvements, Probabilo Tour not only meets the validity criteria but is also better equipped to support ethnomathematics-based contextual learning in schools. However, the validators also suggested developing a digital version of this tool in the future to provide greater flexibility for use in various learning environments and reach a broader range of students.

4. Implementation

The implementation of the Probabilo Tour media was carried out on 35 students of class X at one of the MAN in Tulungagung. This implementation was carried out on Saturday, May 24, 2025, during mathematics class. Before starting to learn using the Probabilo Tour media, students were asked to complete a pretest. At the end of the implementation activity, students were asked to complete a response questionnaire and take a posttest. The test questions given during the pretest and posttest were the same, consisting of 5 multiple-choice questions.



Figure 14. Implementation of Probabilo Tour Media

The results of the student response questionnaire were used to measure the practicality of using the Probabilo Tour media. In line with the opinion of Toma & Reinita (2023), the practicality of the media is determined by the results of user assessments. The results obtained from the student response questionnaire can be seen in the following table:

Table 7. Analysis of Student Response Questionnaire Results

Aspect	Average Score
1. I do not get bored using the Probabilo Tour media in learning probability material.	3,37
2. I am more encouraged to discuss with friends after using the Probabilo Tour media	3,46
3. It is easy for me to understand how to play and use the Probabilo Tour media	3,29
4. Probabilo Tour Media has an attractive and fun appearance	3,49
5. I am more motivated to learn after using the Probabilo Tour media	3,43
6. Using Probabilo Tour media is a new experience for me	3,43
7. Media Probabilo Tour helped me understand the concept of probability better	3,17
8. Cultural elements included in the Probabilo Tour media make learning more interesting	3,37

Aspect	Average Score
Total Practicality Score	27,01
Average Practicality Score	3,38
Percentage of Practicality Score	84,5%
Practicality Criteria	Very Good/Very Practical

Based on Table 6, it can be seen that the average Percentage of student response questionnaire scores to assess the practicality of the media was 84.5%, which falls within the perfect/efficient category. This indicates that the Probabilo Tour media is practical for implementation in learning activities.

In addition, the researcher also evaluated the effectiveness of media use, which was measured by using the results of the pretest and posttest obtained by the students, as shown in the following table:

Table 8. Analysis of Pretest and Posttest Results

Score	Pretest	Posttest
Minimum	0	40
Maximum Value	100	100
Rata-Rata	48,57	88
Number of Students	35	35

Based on the pretest and posttest analysis results, the average pretest score was 48.57, and the average posttest score was 88 for a total of 35 students. This improvement was then analyzed using the N-gain formula:

$$g = \frac{(Posttest - Pretest)}{(Skor Maks - Pretest)}$$

$$g = \frac{(88 - 48,57)}{(100 - 48,57)}$$

$$g = \frac{39,43}{51,43} \approx 0,77$$

The analysis results show that the average value is 0.77. Based on the N-gain interpretation criteria, this value is included in the high category (≥ 0.70), which indicates that the Probabilo Tour learning media is effective in supporting students' mathematical problem-solving abilities in probability material by providing a more contextual learning experience through the integration

of local culture, presenting problems in the form of interesting games, and encouraging active interaction between students. Thus, students not only memorize formulas but are also trained to understand problems, design strategies, and evaluate solutions systematically. Thus, the integration of ethnomathematics elements in this media not only makes learning more contextual and interesting but also supports the achievement of the learning objectives of the Independent Curriculum, which emphasizes the development of problem-solving abilities.

5. Evaluation

At this stage, the researcher conducted *an evaluation*. The evaluation results showed that the ethnomathematics-based Probabilo Tour media on probability material can be said to meet the criteria of validity, practicality, and effectiveness. Thus, the media developed by the researcher can be implemented in mathematics learning, especially in probability material. Expert validation confirmed that the content and appearance of the media align with the learning objectives. At the same time, student responses through questionnaires indicated that Probabilo Tour is interesting, easy to use, and effective in increasing learning motivation. In fact, one comment on the student response questionnaire stated that learning with Probabilo Tour feels fun and makes them more interested in understanding probability. This proves that the media not only helps students practice questions but also encourages them to develop problem-solving skills and strategies (Polya, 2023). During the evaluation stage, important findings were obtained that Probabilo Tour, as an ethnomathematics-based learning medium, was proven to be valid, practical, and effective in improving the quality of mathematics learning on probability material. However, the researcher assessed that Probabilo Tour still requires revision, especially on several ethnomathematics-based questions that remain ambiguous and therefore less understandable to students. Revisions to the questions are necessary to measure problem-solving indicators optimally. In addition, a review of the suggestions and input provided by the validator is also needed to improve the media, so that probability is increasingly relevant as a mathematics learning

medium that is not only contextual and fun, but also truly supports the improvement of high school students' problem-solving abilities.

CONCLUSION

Based on the research and development results, it can be concluded that the Probabilo Tour media meets the valid, practical, and effective criteria for use in mathematics learning on probability material. Expert validation obtained an average score of 82.94% which indicates a very valid category; student responses reached 84.5% showing an efficient category, and the pretest and posttest results analyzed using N-gain showed an average of 0.77 (high category), which indicates media effectiveness. Therefore, the Probabilo Tour media is suitable for use in learning activities after revision.

However, this medium has limitations, including several ambiguous questions and its limited use to printed form, making it less flexible in digital learning contexts. Therefore, further research could focus on improving question quality and developing Probabilo Tour in an interactive digital format, making it more accessible, adaptable to various learning styles, and able to reach a broader range of students.

REFERENCES

- Andandi, S. (2025). Development of ethnomathematics-based educational games to improve the metacognitive abilities of fifth-grade elementary school students [Thesis, Ganesha University of Education]. Undiksha Institutional Repository. <https://repo.undiksha.ac.id/id/eprint/23503>
- Andini, P., Siregar, R. S., Saragih, S. R. D., & Harahap, S. (2024). Analysis of junior high school students' mathematical connection abilities in probability material. *Basicedu: Journal of Basic Education*, 8(4), 847–860. <https://doi.org/10.31004/basicedu.v8i4.8478>.
- Annisa, A., Syamsuri, S., & Khaerunnisa, E. (2024). Students' difficulties in the process of mathematizing story problems on flat-sided shapes. *Wilangan: Journal of Innovation and Research in Mathematics Education*, 7(1), 1–12.
- Annisa, F., & Abadi, A. M. (2021). High school students' difficulties in solving mathematics problems on probability. *Journal of Mathematics Education Research*, 8(1), 96–105. <https://doi.org/10.21831/jrpm.v8i1.17004>

- Cendekia, J. (2024). The relationship between ethnomathematics of the traditional house "Rumah Bolon" and the game of engklek. *Cendekia: Scientific Journal of Education*, 4(1).
- Chowdhury, N., Katsikas, S., & Gkioulos, V. (2022). Modeling effective cybersecurity training frameworks: A delphi method-based study. *Computers & Security*, 113, Article 102551. <https://doi.org/10.1016/j.cose.2021.102551>
- D'Ambrosio, U. (2001). What is ethnomathematics, and how can it help children in schools? *Teaching Children Mathematics*, 7(6), 308–310.
- Dwi Ratnasari, O. D. W., Widiarto, T., Sitorus, D. S., & Faresta, R. A. (2023). The effective
- Dwi Ratnasari, O. D. W., Widiarto, T., Sitorus, D. S., & Faresta, R. A. (2023). The effectiveness of the Team Games Tournament (TGT) cooperative learning model on learning outcomes of students in SMA Negeri 3 Salatiga. *Jurnal Tatsqif*, 21(2), 189–200.
- Fathurrohman, M., Nindiasari, H., & Rahayu, I. (2022). A conventional and digital mathematical board game design and development for use by students in learning arithmetic. *Journal on Mathematics Education*, 13(4), 631–660. <https://doi.org/10.22342/jme.v13i4.pp631-660>
- Fareza, R., & Zuhdi, M. (2023). [The relevance of game-based mathematics learning media to high school students' problem-solving abilities]. *Journal of Mathematics Education*.
- Fasaenjori, H., Maimunah, M., & Yuanita, P. (2023). Development of Filmora-based interactive media to facilitate mathematical comprehension skills of 12th grade high school/MA students. *Cendekia Journal: Journal of Mathematics Education*, 7(2), 1840–1854.
- Hasryani, N., & Ariani, T. (2024). Teams Games Tournament (TGT)-based learning model to improve student learning outcomes: Literature review. *Anthor: Education and Learning Journal*, 3(5), 16–20.
- Hake, R. R. (1998). Active interaction versus traditional methods: A survey of mechanics exam data from 6,000 students in a basic physics course. *American Journal of Physics*, 66(1), 64–74. <https://doi.org/10.1119/1.18809>
- Isnanita, N., Rakhmawati, F., & Reflina. (2024). Development of "Truth or Dare" game-based learning media to improve critical thinking skills. *Relevan: Journal of Mathematics Education*, 4(4). <https://ejournal.yana.or.id/index.php/relevan/article/view/1122>
- Maharani, R. D., Dasari, D., & Nurlaelah, E. (2022). Analysis of learning obstacles for junior high school students in probability material. *AKSIOMA: Journal of Mathematics Education Study Program*, 11(4), 1–12. <https://doi.org/10.24127/ajpm.v11i4.6214>

- Masruroh, M., Zaenuri, Z., Walid, W., & Waluya, S. B. (2022). Mathematical problem-solving skills in ethnomathematics-based learning. *Cendekia Journal: Journal of Mathematics Education*, 6(2), 1751–1760. <https://doi.org/10.31004/cendekia.v6i2.1056>
- Nasution, N., & Taufik, B. (2025). Effectiveness of ADDIE model implementation in the development of learning media based on digital teaching materials. *Proceeding International Seminar of Islamic Studies*, 7(1), 1–10.
- Nada, N. K., Akmal, M. K., Latifah, U. N., Nisa, U., & Fitria, A. N. (2025). The influence of the Teams Games Tournament (TGT) model on students' motivation and collaboration skills in learning acid-base concepts. *Journal of Science Learning*, 8(2).
- Polya, G. (2023). *How to solve it: A new aspect of mathematical method*. Princeton University Press.
- Purwaningsih, A., & Hartati, L. (2024). Literature review on ethnomathematics representation in Central Java Batik. *Himpunan: Journal of Education*, 4(2), 261–270.
- Putra, D. D., Nindiasari, H., & Fathurrohman, M. (2024). Systematic literature review: Game-based learning in mathematics education on its effectiveness and implementation strategies. *SIGMA: Journal of Mathematics Education*, 17(1), 1–12. <https://doi.org/10.26618/sigma.v17i1.18403>
- Putri, A. R. (2025). The effect of ethnomathematics learning through engklek games on the visual-spatial mathematical abilities of elementary school students [Thesis, Indonesia University of Education].
- Rambe, A. F., Rahmah, A., & Aqfi, F. (2023). A study of students who have difficulty understanding mathematics learning. *Algebra: Journal of Education, Social and Science*, 3(2), 152–160.
- Rambe, I. W. (2023). A case study of junior high school students' perceptions of mathematics learning based on the brainstorming method at school. *Jurnal Math-UMB*, 9(3), 108–114. <https://doi.org/10.36085/mathumbedu.v9i3.3454>
- Rahmawati, N. D., Prayito, M., & Salsabilla, A. P. (2023). Analysis of high school students' difficulties in learning mathematics in solving trigonometric function derivative application problems based on didactic design. *Proceedings of the UNNES Postgraduate National Seminar*, 6(1), 556–560.
- Rahayu, S., Kurniasih, E., Hudori, A., Yahya, A., Kumala Sari, R., & Nurbaeti, U. (2023). Contextual learning model and mathematical concept understanding: A quasi-experimental study. *Edukatif: Journal of Educational Science*, 5(5), 1547–1557. <https://doi.org/10.31004/edukatif.v5i5.5357>
- Rohmah, S., & Bukhori, M. (2020). Feasibility test of Android-based interactive learning media using Articulate Storyline 3 on correspondence material. *Journal of Natural Science Educational Research*, 5(2), 52–53.

Rustandi, A., & Rismayanti, R. (2021). Application of the ADDIE model in the development of learning media at SMPN 22 Samarinda City. Jurnal Fasilkom, 11(2), 1-10. <https://doi.org/10.37859/jf.v11i2.2546>