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Integration of Ethnomathematics in *Galasin* Game on The Teaching Material of High School Students

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Abstract

It turns out that mathematics isn't just about the material in the classroom, but it's very close to our everyday lives. Even in the traditional games of *Galasin* or *Gobak Sodor* that we have played since childhood can be found a mathematical concept. Concepts of mathematics associated with cultural elements can attract the curiosity of learners to blend mathematical concepts with existing cultures and they can feel that math is part of their own culture. The purpose of this study is to develop a valid and effective product of teaching materials integrated with ethnomathematics of *galasin* games on vector material using PowerPoint for mathematics learning in Senior High School so that it can help teachers and students recognize, learn, and understand mathematics learning in the classroom. This study used a research and development method (RnD) referring to the Thiagarajan model or 4D model. This research was conducted at Bakti Idhata South Jakarta High School. Data collection included media expert validation tests, material, and elevation of student response. The result of the product development is a PowerPoint that integrates the ethnomathematics of the game with vector material. The results of the validation of the media and the material obtained an average score of "very good". So it can be concluded that the teaching material integrated with the ethnomathematics of this game is worthy to be used as a mathematical learning materials.

1. Introduction

Mathematics is one of the most important subjects in education that is taught from elementary school to high school, even continuing to the classroom (Nurmaya, 2021). Often students find it difficult to understand a mathematical subject taught by a teacher in the classroom. A teacher really plays an important role in stimulating the ability of the student and allowing the student to ask questions that are constructive, open-minded, and able to use his imagination, so that new ideas are created. A teacher must have his skills in mastering the learning situation and conditions in the classroom in order to create students that correspond to the characteristics of mathematical learning (Hanik & Nurtamam, 2019).

With the advancement of technology, teachers must have taken advantage of the circumstances to innovate in mathematical learning in classrooms. In general, what happens in the field of mathematical learning is done focusing only on the target material according to the existing curriculum, not emphasizing on the understanding of the material studied. This leads students to memorize only mathematical formulas and concepts but not to understand the meaning and content of the material (Hidayatulloh, 2019). A teacher must be able to provide the understanding and learning of mathematics that students want, so that they can feel that it means so much to their lives.

It turns out that mathematics isn't just about the material in the classroom, but it's very close to our everyday lives. Even in the traditional games that we have played since childhood can be found a mathematical concept. An activity to associate, align, and connect mathematics with a cultural element

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called ethnomathematics. (Dahlan & Permatasari, 2018). The existence of ethnomathematics can be seen in terms of the aspects that apply mathematical concepts in a cultural element, as well as the way to teach mathematics concepts that are connected with local cultural elements so that it can attract the curiosity of learners to be able to blend mathematic concepts with existing cultures, and learners feel that Mathematics is part of the culture that they have.

The Indonesian nation has a huge cultural diversity, one of which in Jakarta there is a traditional game of *Galasin*. These traditional games are commonly played outdoors by children, teenagers, and adults. As a nation, we must preserve our culture by preserving this traditional game so that it remains eternal. The uniqueness of this game is found some mathematical concepts, namely the concepts of vector mathematics (Setyawati et al., 2023). With these findings, the researchers wanted to integrate mathematical concepts into mathematics learning materials to help teachers to find the right mathematic learning methods and models in accordance with the students' abilities that are very diverse so that the learning material will be delivered as much as possible (Aprilia et al., 2019). Because it is so close to everyday life when it is used as a mathematical learning material will make the student more interested in studying it and add a sense of curiosity.

A learning material is a learning device in which there is information about the purpose of learning as well as the content of the learning material used by the student to understand the purpose and learning material that is printed or available in various media (Cahyadi, 2019). The teaching materials are designed taking into account all forms of thinking and characteristics of the student, so that they can help the teacher in the learning process by paying attention to the curriculum that is currently in use (Suprana & Farida, 2019). The teaching material is a learning material that is systematically organized with the attention of existing curricula and used by teachers and pupils in the learning process in the classroom.

As for the principle of the integration of teaching materials, there is validity, relating to the existing interests and tested material with its competence (Significance), its usefulness (Utility), and the possibility of learning (Learnability) (Subando et al., 2021). With the presence of mathematical learning materials that are integrated with ethnomathematics in the game, especially on vector material, this is expected to be a material for interesting learning and can add to the curiosity of the students to better understand mathematics. It can make the students have reasoning as well as creative thinking because of having an overview of visualization of the mathematic concepts of the game so that they better understand about the Mathematical material taught by the teacher in class. This material is also expected to help the teachers in the process of learning Mathematics especially on the vector matter.

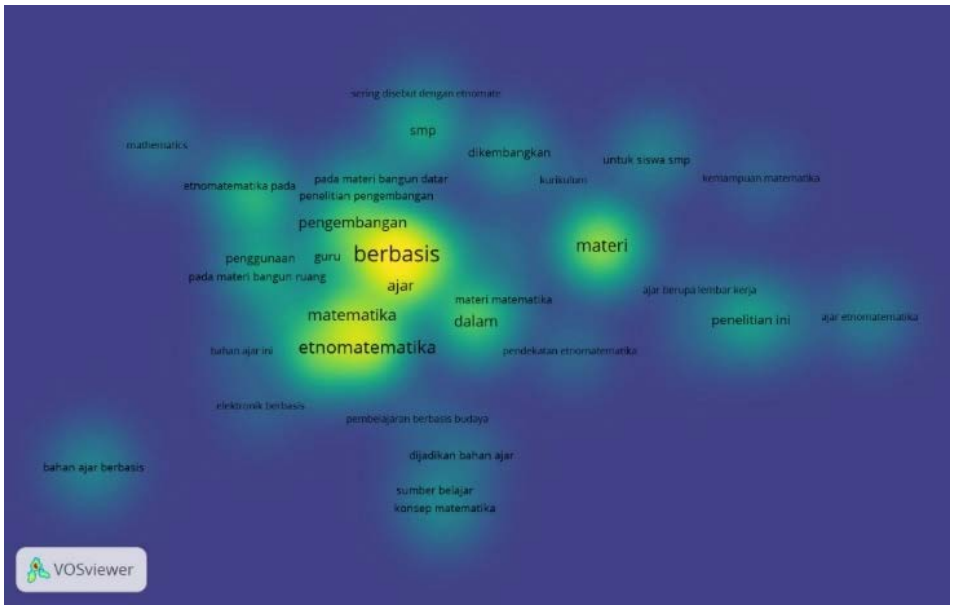


Figure 1. Density Visualization

According to Figure 1. That is, Density Visualization of the VosViewer software obtained results that showed variables based, ethnomathematics, and mathematics of bright yellow that a lot of research has

been done, while ethnomathematics on, teaching materials based, this teaching material, and other blue-coloured means that it is still rare to do research on such variables.

So with the findings in the Ethnomathematics article on this *galasin* game, researchers want to develop these findings into products for learning mathematics, which aims to make it easier for students to learn and understand learning mathematics in class, especially on vector material because with this *galasin* game students feel that math is very close to their lives.

In the game of *galasin* can be found a mathematical concept by paying attention to the movement of each player in the arena of the game and from the way of playing the attacking team as well as the guard team in the game *galasin* (Almabruri et al., 2020). Starting from the form of the arena and the placement of each player can be found mathematical concepts namely vectors, then from that mathematics indirectly very close to this *galasin* game. With these findings, the researchers wanted to create a learning material that is integrated with ethnomathematics in the game, especially in the vector material.

This teaching material is accompanied by the purpose of learning, access to learning, a summary of the material, examples of the subject, and the practice of the matter that is structured by focusing on the content of the non-flawed material alongside the appearance of the interesting teaching materials, and delivery to the material associated with something like ethnomathematics to practice a matter to be more interactive. Some tools related to displaying the visualization of the *galasin* game will be displayed on this tutorial to provide clear information about the mathematical concepts of *galasin* games on vector matter.

The vector mathematical concept primarily counts the number of vectors present in the game of *galasin* found in the way as well as the rules of play in which the attacking team must reach the target back to the starting point of the game, and the guard team has the target to touch the attack team to win the game. To calculate the amount of vector of the attacker player who wants to pass the fence this guard player can be supported by the numerous condition of the guard teams, because the guard group has a safe radius with the range of hands used to touch an attacking group's body. Here's the researcher presenting the visualization in his game:

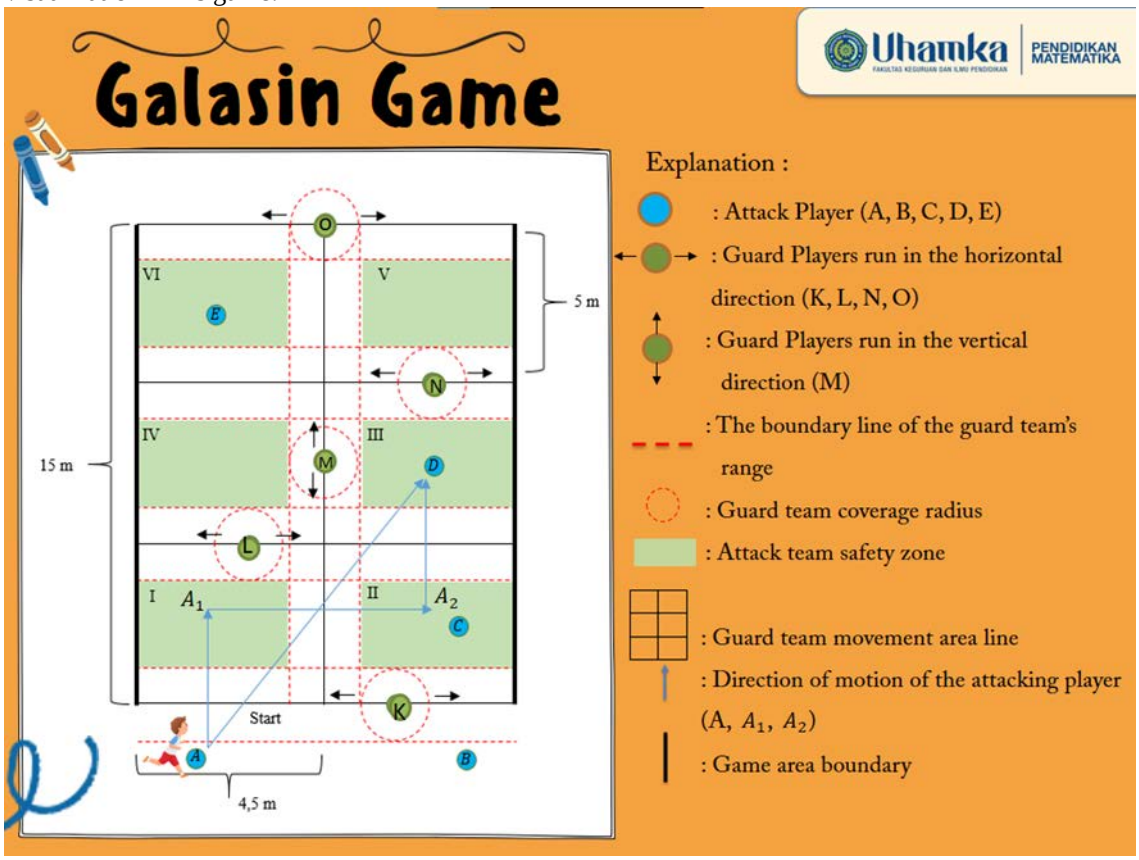


Figure 2. Arena Game & Strategy Team Attacker Game

In Figure 2. There is a game arena played with a number of 3-5 players each team so there is a range line owned by the guard, the radius of the guard team, and the safe zone of the attacking team. On the line of

the guard player there are horizontal and vertical range lines, each attacking player must pass through the care by passing the horizontal or vertical reach line, as well as the range of the guards' team on condition that it is not touched by a guard team and can enter the end line provided no attacking players members are still in the safe start zone. The area of the attack team is the safest zone for the attacker's team so that it does not hit the guard team, for an attacker who tries to cross the range line of that guard team after having positioned himself in a safe zone so as not to be hit by the guard. If that happens, then the game will change the team's positions (Imaniyah & Zuroida, 2020).

Based on the rules of play and how to play in the game, as well as based on the article on the exploration of the game in Jakarta, the researchers found one of the most realistic mathematical concepts with life and in the implementation of the mathematics concept that is on vector matter. On the vector material in this game the scientists suggested that in the way to play can be known the number of vectors present in each attacking player that performs an experiment to reach the finish line. In Figure 2. there are a number of conditions to determine the number of vectors that are present in attacking player A who wants to move positions to attack player D. Here are some conditions in the picture:

- Condition 1, If the guard player K in figure 2 shifts to the horizontal direction

  If in such conditions with the range radius as well as the limit line of the range of the guard K, then the attack player A can run towards A_1 first. After being in the position A_1, the attack player A may move to the A_2 position with the record of the position of the guard player M not so close to the safe zone I and II. After successfully moving to the location A_2, player A is allowed to move into the attack player D position with a note that the guard player L is far away from the safe area II. So there is the number of vectors obtained from the positions of attack player A to attack player D, which is the total of 3 vectors.
- Condition 2, If the position of guard player K is exactly as shown in figure 2

  If in such conditions with the range radius and range limit of guard player K Attack player A can run to the position of attack player D, with a record supported by attack player B to fish guard player K so as not to touch attack player A. Player A must also pay attention to guards M and L, because if the speeds of guards m and l are so fast then attack player A will be touched easily. If attack player A is able to escape from guards player K, L, and M, then the attack player A may move to the positions of guard player D. So the number of vectors available on attack player A who moves to attack player D is 1 vector.

With this illustration, a mathematical concept was found to know the number of vectors of the game in Jakarta, namely the way of playing and the strategy of playing. Furthermore, with the presence of this mathematical concept, the researchers want to integrate the concepts of mathematics from the traditional games into the teaching material that can later be used as a medium of learning in the classroom. By compiling teaching materials that correspond to the criteria of writing as well as the characteristics of the needs of the pupils, then can increase the interest and insight of pupils towards the understanding of the mathematic concepts in particular on vector materials.

2. Methods

This study used the research and development (RnD) method. By referring to the Thiagarajan model or known as 4D to produce a product and then test the feasibility and effectiveness of the product that had been developed was the goal of this research and development method. Research and development had the intent and purpose of producing products that were able to assist teachers and students in identifying, studying, and understanding mathematics learning in the classroom. The development of teaching materials used the 4D model, as follows (Thiagarajan & Umamaheswari, 2022).

2.1. Define

At the defining stage of the 4D model, this is the stage for analysing, defining, and defining all the requirements required in research. The researchers will define the need by doing the definition of an article on the theme of Ethnomathematics in the game of the *galasin* whose concept the discovery wants to be developed into a learning medium or teaching material used in mathematical learning. After that, the researchers determine the concept of the media to be used.

2.2. Design

At this stage, the researchers have already identified concepts that match the initial problems that have been analyzed. By designing the media that wants to be used for the development of products that exist on the Internet as a benchmark for media creation. After that, the researchers compiled the stage of media creation including creating the opening, the content, and the closing with a summary of the material to describe that has been integrated ethnomathematics of the game *galasin* on the teaching material through the level of need, according to the curriculum, and characteristics of the student. Researchers used Canva to develop exciting designs and Power Point to create views that would be used in mathematics learning.

2.3. Develop

At this stage, researchers begin to develop the products they want to make with the ingredients that have been prepared and designed at the design stage. The researchers typed and edited the entire concept prepared by paying attention to draft writing according to the framework of the text containing the opening, the content of the material summary, and the closing. Then the researchers conducted a validation test on a product that had already been developed, namely Prototype I, to measure the validity of the product produced with the help of material experts and media experts.

2.4. Disseminate

At this stage, the product has already passed the development phase, which will be the final product. The researchers distribute the finished product that has passed several stages of design, validation, and trial as well as revision. The final product is subsequently given to the respondents. Then the researchers will evaluate the developed product from feedback given to respondents in order to identify and measure the effectiveness and interest of the teaching material that has been integrated into the ethnomathematics of this game.

The researchers sought to integrate teaching materials aimed at inserting culture and mathematics in depth that are close to the daily life of the students so that it could be easier for teachers in giving mathematical learning as well as the students to be more interested in understanding, identifying, and solving problems in mathematic lessons especially on vector materials. In the assessment sheet for the material expert validation test and media expert validation, researchers used Likert scale measurements, with the criteria presented in Table 1 (Fitri & Pahlevi, 2020).

Table 1. Product Validation Rating Scale and Product Trial

Score	Criteria
1	Very Unsuitable
2	Not Suitable
3	Enough
4	Suitable
5	Very Suitable

Analysis of validation data and learner response questionnaires is used to analyze data that has been obtained from the assessment of material experts and media experts. The data was analyzed using the following calculation formula :

$$Percentage = \frac{total\ score\ of\ validator}{The\ ideal\ number\ of\ score} \times 100\% \qquad (1)$$

After getting the calculation score results from each material expert and media expert, the percentage calculation stage is continued which aims to determine the feasibility and determination of the validity of the teaching materials that have been developed. Then the percentage results are implemented with the score interpretation criteria in Table 2. (Restu Kurnia & Sunaryati, 2023).

Table 2. Percentage Validity Test Score Criteria

Score	Criteria
$\mathbf{0\% - 20\%}$	Very Invalid
$\mathbf{20\% - 40\%}$	Invalid
$\mathbf{40\% - 60\%}$	Less Invalid
$\mathbf{60\% - 80\%}$	Valid
$\mathbf{80\% - 100\%}$	Very Valid

Based on table 2, the validation test of material experts and media experts on teaching materials that have been developed with the ethnomathematics of *galasin* games can be categorized as valid if the score criteria range reaches more than 60%.

After passing the validation test stage to material experts and media expert validation, researchers will revise, update, and evaluate the product which will later be tested on students to get some responses and measure validity when implementing teaching materials that have been developed ethnomathematics during mathematics learning in the classroom.

Evaluation of teaching materials that have been developed with ethnomathematics is carried out several times according to the research method used. In this study, the evaluation was carried out after design validation using material test experts and media test experts. Furthermore, from the description of the evaluation results that have been given by the material expert validation and media expert validation, the researcher makes improvements with the suggestions given by the validator. Therefore, prototype II or a development product that has been tested for validity can be produced which will later be tested on students to assess its effectiveness in increasing students' curiosity about learning mathematics. In testing the effectiveness of this product, researchers used a Likert scale in Table 1.

Data analysis of teaching material trials to students is used to measure the effectiveness of data that has been obtained from student responses. The data was analyzed using the following calculation formula:

$$\text{Percentage} = \frac{\text{total score of validator}}{\text{The ideal number of score}} \times 100\% \qquad (2)$$

After getting the percentage results of the trial of teaching materials to students, the results are then implemented with the criteria for interpreting the effectiveness score in Table 3 (Haeriyah & Pujiastuti, 2022).

Table 3. Percentage of Effectiveness Score Criteria

Score	Criteria
$\mathbf{0\% - 20\%}$	Very Ineffective
$\mathbf{20\% - 40\%}$	Ineffective
$\mathbf{40\% - 60\%}$	Less Effective
$\mathbf{60\% - 80\%}$	Effective
$\mathbf{80\% - 100\%}$	Very Effective

Based on table 5, the percentage of the effectiveness of a product developed can be categorized as effective if the score criteria range is more than 60%.

After testing the effectiveness of the product to students, if the results obtained do not meet the effective criteria, the researcher will make improvements to the product developed. That way the product developed can be an effective product to be implemented and disseminated. For the implementation stage, researchers disseminate teaching material products that have been developed with ethnomathematics *galasin* games on mathematical vector material to one of the schools in Jakarta.

3. Results and Discussion

3.1. Validity Test

The validity test in this study is an expert validation test, namely the Media Expert Test and the Material Expert Test. In the media expert test, researchers used two experts, namely UHAMKA Mathematics Education Lecturers, while for the material expert test, researchers used one UHAMKA Mathematics Education Lecturer Expert and one Mathematics Teacher Expert. From these experts, researchers get an assessment of the teaching materials that have been made and get the results of improvements so that the teaching materials integrated by this *galasin* game can be maximized for dissemination in research, the following are the results of the Validity Test of Teaching Materials that have gone through the Validation stage of media experts and material experts.

Table 4. Results of Media Expert Validation Test

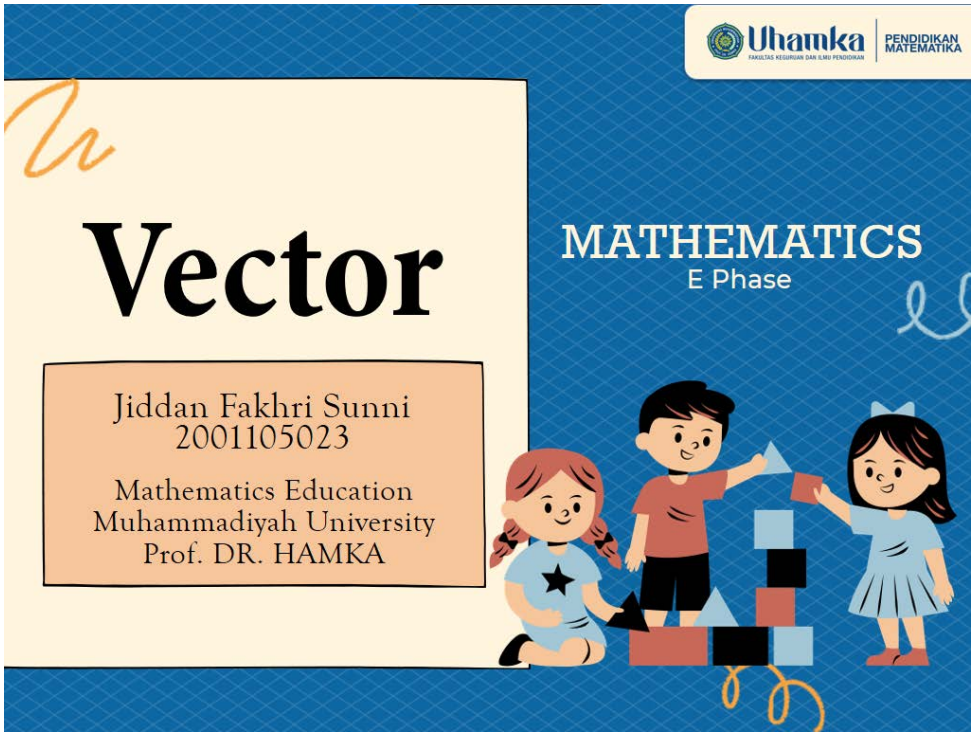
Validator	Total Validator	Evaluation Indicator	Total Items	Total Validator Score	Ideal Total Score	Percentage (%)	Criteria
Media Expert	2	Media Quality	5	43.00	50.00	86.00	Very Valid
		Media Display	4	36.00	40.00	90.00	Very Valid
		Media Content Design	6	51.00	60.00	85.00	Very Valid
Amount				130.00	150.00	261.00	
Average				43.33	50.00	87.00	Very Valid

Table 5. Result of Material Expert Validation Test

Validator	Total Validator	Evaluation Indicator	Total Items	Total Validator Score	Ideal Total Score	Percentage (%)	Criteria
Material Expert	2	Content Quality	6	52.00	60.00	86.67	Very Valid
		Coverage Settings	3	25.00	30.00	83.33	Very Valid
		Executable	6	51.00	60.00	85.00	Very Valid
Amount				128.00	150.00	255.00	
Average				42.67	50.00	85.00	Very Valid

Based on the percentage of validation test scores by media experts is 87.00% shown in Table 3. This shows that teaching materials integrated by ethnomathematics in *galasin* games fulfill aspects of media quality, media display, and media content design. As for the percentage score of the validation test by the Material Expert shown in Table 4. The resulting score is 85.00%, indicating that the teaching materials developed have met the criteria for content quality, coverage provision and implementation. With the presentation criteria for the validation scores of media experts and material experts, namely 87.00% and 85.00%, the results of the validity test of the teaching materials developed can be categorized as very valid so that the teaching materials developed can be categorized as suitable for use in learning Mathematics. The following is an illustration of the appearance of the teaching material products that have been developed with ethnomathematics in the *galasin* game.

a.



b.

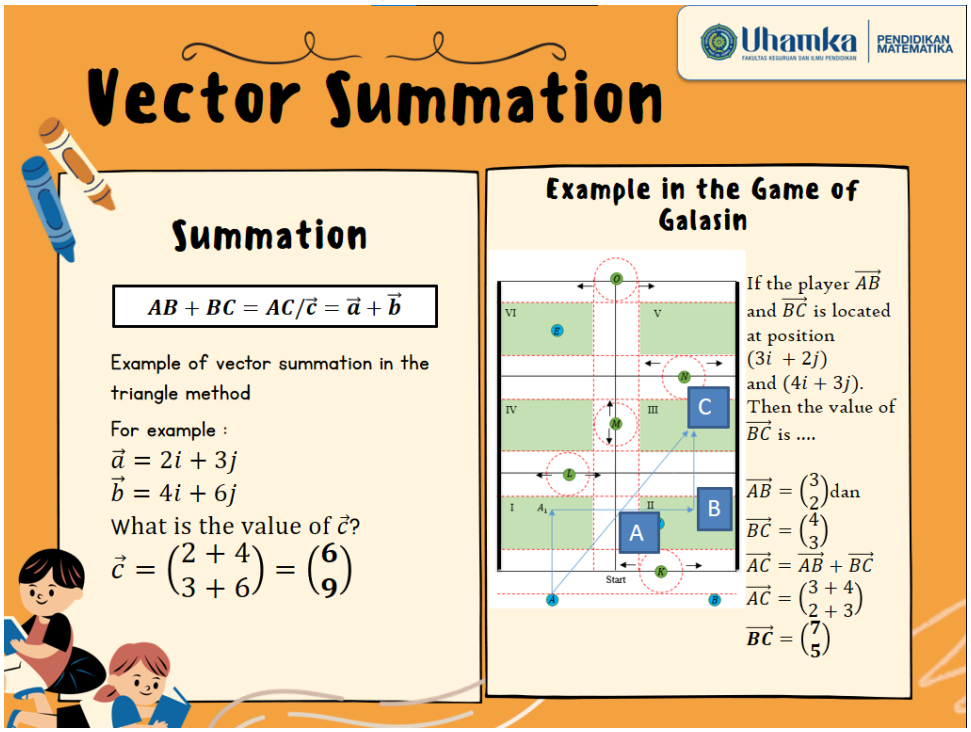


Figure 3. (a) Cover of Educational Materials Developed; (b) Vector Summary Material

After improving the product, the researchers conducted a product test against the students of the Higher High School in South Jakarta. After that, the validity test was calculated against the materials that were already tested, so that the product test results were obtained:

3.2. Effectiveness Test

After making improvements to the teaching material products that have been developed, the researchers then conducted product trials on high school students in South Jakarta. This trial was carried out by conducting mathematics learning using teaching materials that had been integrated with the

ethnomathematics of *galasin* games with Power Point. Then the researcher gave a questionnaire sheet for students' responses to mathematics learning using teaching materials that had been integrated with the ethnomathematics of *galasin* games on the vector material. This student response questionnaire sheet contains 3 indicators, namely appearance, presentation of material, and benefits. Of the three indicators, the total number of question items is 16 question items. After that, calculations are carried out to see the effectiveness value of the teaching materials that have been developed, so that the results of the effectiveness of the product trial are obtained:

Table 6. Product Trial Effectiveness Results

Respondents	Total Respondents	Evaluation Indicator	Total Items	Total Respondents Score	Ideal Total Score	Percentage (%)	Criteria
Student XI grade IPA 3 High School Widuri Jakarta	24	View	4	416.00	560.00	74.29	Effective
		Substantive presentation	6	595.00	840.00	70.83	Effective
		Benefits	6	625.00	840.00	74.40	Effective
Amount				1636.00	2240.00	220.00	
Average				545.33	746.67	73.17	Effective

In Table 6. This effectiveness test obtained a percentage result of 73.17% which met the criteria for appearance, presentation of material, and benefits. In accordance with Table 3, namely the presentation criteria for the effectiveness score, the percentage of 73.17% has effective results. So that with these results the teaching materials that have been developed have an effective value and can be continued to the next stage, namely dissemination or implementation to other High Schools so that the teaching material products that have been developed can be used in learning mathematics in Senior High Schools.

3.3. Product Implementation

At this stage the researcher has improved the teaching material products that have been developed with ethnomathematics *galasin* games on vector material, after improvements are made the researcher has a final product, namely teaching materials that have been developed with ethnomathematics. Researchers will also measure the effectiveness of teaching material products that have gone through various stages and to compare whether the effectiveness value will be better than before or not. This implementation was carried out in different schools from the product trials previously conducted by researchers. Researchers carry out this activity optimally because to achieve the objectives of this study, namely developing teaching material products integrated with ethnomathematics of galasin games that are valid and effective in helping teachers and students identify, learn and understand mathematics learning on vector material in the classroom. Furthermore, researchers implemented this product into one of the schools in South Jakarta and obtained research results, namely:

Table 7. Results of Final Product Research

Respondents	Total Respondents	Evaluation Indicator	Total Items	Total Respondents Score	Ideal Total Score	Percentage (%)	Criteria
Students of Class X IPA 6 High School Bakti Idhata Jakarta	28	View	4	486.00	560.00	86.79	Very Effective
		Substantive presentation	6	709.00	840.00	84.40	Very Effective
		Benefits	6	689.00	840.00	82.02	Very Effective
Amount				1884.00	2240.00	253.00	
Average				628.00	746.67	84.40	Very Effective

With the results of the effectiveness value in Table 7, the average percentage obtained is 84.40% (Very Good) from the display criteria, presentation of material, and benefits in accordance with the percentage score criteria in Table 3. And the results of this effectiveness value have increased from the previous 73.17% to 84.40%, an increase of 11.23%. So it can be concluded that teaching materials integrated with the ethnomathematics of *galasin* games on vector material are said to be feasible and effective for use in Mathematics Learning, especially in Senior High Schools.

4. Conclusion

With the research background and objectives of this study, it can be concluded that in the *galasin* game can be found mathematical material, namely vectors that can be used as teaching materials for learning mathematics seen from how to play and game strategies, with various certain conditions. This developed product aims to facilitate teachers and students in identifying, learning, and understanding vector material integrated with *galasin* games in mathematics learning. The process of developing this teaching material product is done by analyzing product needs, designing products, developing products, and disseminating products that have been developed. By going through the validity test stage by media and material experts to get maximum product results.

The results of the experts' validity test, namely media experts, obtained a percentage score of 87.00% for which included indicators of media quality, media display, and media content design. Meanwhile, the validity test of the material experts obtained a percentage score of 85.00% which included indicators of content quality, coverage provisions, and applicability. So that with the results of this validity test it can show that the teaching material products integrated with *galasin* games on vector material are declared very valid and very suitable for use in learning mathematics in class. Then the researcher has the results of product trials by obtaining a percentage value of effectiveness of 73.17% (effective) and the results of product implementation which obtained a percentage value of product effectiveness of 84.40% (very effective). With the results of product trials and implementation, researchers found an increase in the percentage value of product effectiveness by 11.23% which stated that the effectiveness of the product increased from effective to very effective.

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