International Conference on Global Innovations in Education, Science, and Technology
Mataram, September 25-26, 2025

Faculty of Teacher Training and Education
Universitas Muhammadiyah Mataram
Mataram City, Indonesia

Integration of Ethnomathematic Values of the Mabbilang Esso Tradition into Understanding Series and Number Patterns

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Abstract: Mathematics learning at the junior high school level still faces major challenges, particularly in sequences and series, which are often considered abstract and difficult for students to master. Test results in Bone Regency for the 2024/2025 academic year showed that only 28% of students reached the Minimum Learning Mastery Criteria, with an average score of 55 out of 100. This underscores the urgency of contextual innovations that connect mathematics with local culture. This study developed and implemented EssoMath Card, a learning media inspired by the Bugis tradition of Mabbilang Esso, to strengthen mathematical understanding through an ethnomathematical approach. The research applied a Mixed-Methods Sequential Exploratory design with the ADDIE model, involving students from SMP Satap 2 Patimpeng (limited trial) and SMP Negeri 2 Tonra (effectiveness testing). Data were gathered through tests, questionnaires, interviews, and observations, then analyzed using descriptive statistics, t-tests, and thematic analysis with NVivo. Results showed that the media achieved a validity score of 88.2% (very valid), practicality 84.7% (highly practical), and effectiveness 82.9% (effective). The experimental class improved by 73% compared to 46% in the control class. In conclusion, EssoMath Card effectively improves numeracy literacy while preserving Bugis culture, offering meaningful implications for ethnomathematics and local wisdom-based learning.

Keywords: Ethnomathematics, Mabbilang Esso, EssoMath Card, Numeracy Literacy, Local Wisdom.

Article History:
Received: 02-09-2025
Online : 04-10-2025

A. INTRODUCTION

Education is a crucial pillar in shaping the quality of human resources that are competitive in the era of globalization. One subject that plays a significant role in developing logical, critical, and systematic thinking is mathematics (Agustina, 2019). However, field observations show that mathematics is often perceived as a difficult, abstract, and monotonous subject by most students. This condition leads to low learning motivation and academic achievement, particularly in the topic of number patterns and sequences, which require a relatively high level of abstraction. The lack of connection between the material and everyday reality makes it difficult for students to understand the concepts, resulting in less optimal learning outcomes. On the other hand, each region in Indonesia has a wealth of culture rich in educational values,

including mathematical ones. One example is the Mabbilang Esso tradition of the Bugis community, a practice of counting days to determine favorable times for carrying out important activities such as weddings, moving houses, and traditional ceremonies. This tradition is not merely a ritual but contains certain numerical structures and patterns that have been passed down from generation to generation. The mathematical patterns embedded in it demonstrate that local culture holds great potential to be used as a contextual and meaningful learning resource (Nawir, Sultan, and Kahar, 2024).

Integration of local culture into mathematics learning is known as ethnomathematics. According to Barton-Bill, mathematics is not a discipline detached from culture, but rather a social construct born from human life experiences in interacting with their environment (Barton et al., 2015). Therefore, linking mathematics learning with local traditions such as *Mabbilang Esso* will help students understand that mathematics is not only about numbers and formulas but also exists in real life. This approach is in line with the curriculum's demand for context-based learning and local wisdom (Arwien, 2025). Initial observations at SMP Satap 2 Patimpeng showed that most students encountered difficulties in mastering the topic of number patterns and sequences. The average score of daily assessments remained below the Minimum Learning Mastery Criteria (KKTP). This condition indicates the need for innovation in learning strategies. One possible effort is to design learning media that connects the material with local culture that is closely related to students' lives (Winangun, 2020). In this way, students can more easily grasp the concepts while also fostering pride in their regional culture.

Based on this need, this research develops a learning medium called *EssoMath Card*, a set of learning cards that integrate number patterns and sequences with the *Mabbilang Esso* tradition. This medium is expected to serve as an effective tool to facilitate conceptual understanding through interactive activities, joyful learning, meaningful learning, and mindful learning. In addition, the use of *EssoMath Card* will help students sharpen their logical thinking skills while reinforcing the connection between mathematics and culture. The urgency of this research is further reinforced by the fact that the younger generation tends to be less familiar with and less engaged in preserving local traditions. Without integration into education, traditions such as *Mabbilang Esso* risk extinction due to the forces of modernization and globalization. Thus, this research not only contributes to the field of mathematics education but also to the preservation of Bugis culture as part of national identity. In addition to directly improving students' understanding of mathematical concepts, this research also has implications for strengthening numerical literacy and character building. Students are not only encouraged to think mathematically but also to appreciate local wisdom that is rich in philosophical values. The results of this research are expected to serve as recommendations for teachers, schools, and policymakers to adopt ethnomathematics-based learning models as innovative strategies to enhance the quality of education.

This research builds on previous studies that have highlighted the role of culture and folklore in education, including the use of ethnomathematics in mathematics learning. Firmansyah and Novita (2020) demonstrated that ethnomathematics can increase students' learning interest, while Pratama and Susilawati (2023) found that culture-based media effectively strengthen cognitive understanding while fostering pride in local culture, although

they had not developed card-based media. Furthermore, Suryawan and Cahyani (2024) emphasized that local wisdom significantly contributes to the development of critical thinking skills, while Ismail et al. (2022) proved that linking number concepts with culturally familiar contexts can facilitate conceptual understanding. Although these studies show the great potential of ethnomathematics, none have specifically integrated the Bugis tradition of *Mabbilang Esso* into the teaching of number patterns and sequences through interactive media such as *EssoMath Card*. Therefore, this research offers novelty in this aspect.

B. METHOD

This research employs a **Mixed Methods approach** with a **Sequential Exploratory design**, which is carried out in two consecutive stages (Azhari *et al.*, 2023). The first stage is qualitative, while the second stage is quantitative. This approach was chosen because the research begins with the exploration of local culture that has not been well-documented, followed by testing the effectiveness of the learning media developed from the results of that exploration.

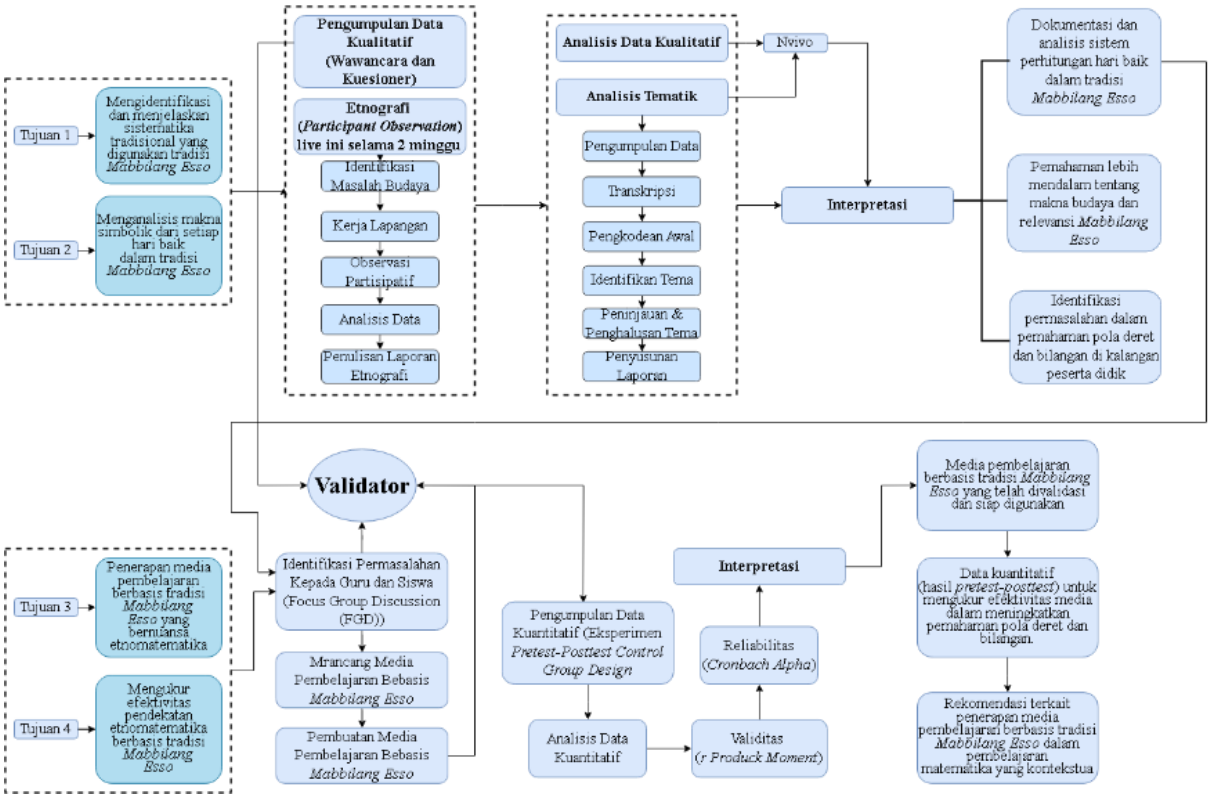

Figure 1. Research Stages

This research began with a qualitative approach using a descriptive ethnographic design. The main objective was to explore the *Mabbilang Esso* tradition in Pationgi Village, Patimpeng Subdistrict. The exploration was conducted through participatory observation, in-depth interviews with traditional leaders, teachers, and students, as well as Focus Group Discussions (FGD). The data obtained consisted of documentation, cultural narratives, and community understanding of the practice of determining auspicious days in Bugis tradition. All

qualitative data were then analyzed using thematic analysis through the processes of transcription, initial coding, theme identification, and drawing conclusions. The results of the analysis provided an overview of cultural values, number patterns, and the potential integration of the *Mabbilang Esso* tradition into mathematics learning.

Based on the findings from the qualitative exploration, the next step was to design the *EssoMath Card* learning media using the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation) (Faris, Saputro and Rubiati, 2024). The analysis stage began by identifying problems in mathematics learning, particularly in the topic of sequences and series, which are often considered abstract and difficult for students to understand. The results of observations and interviews indicated that students' low comprehension of this material requires more contextual and life-related learning innovations. Therefore, the *Mabbilang Esso* tradition, as one of the Bugis cultural heritages, was considered relevant to be integrated into learning media, enabling the bridging of abstract concepts with real-life experiences based on local culture.

The design stage was carried out by developing the concept of the interactive learning media *EssoMath Card*. The design concept was formulated based on the qualitative exploration of the *Mabbilang Esso* tradition, which was found to contain number patterns and cultural values that could be adapted into mathematics learning. At this stage, the learning objectives were determined, mathematical content was integrated with Bugis cultural values, and the initial draft of the card design was created. The result of this stage was a draft of the *EssoMath Card* ready to be developed further.

The development stage was conducted by creating a prototype of the *EssoMath Card* based on the design draft. The prototype was then validated by three experts: subject matter experts, media experts, and design experts. The validation process aimed to assess the feasibility of the mathematical content, the appropriateness of the Bugis cultural integration, the quality of the media's visual design, and the clarity of the instructional presentation. Feedback and suggestions obtained from the validation were used to refine the media before field testing.

The implementation stage involved testing the *EssoMath Card* in stages. The initial or limited trial was conducted at SMP Satap 2 Patimpeng to evaluate the practicality and initial acceptance of the media by students and teachers. After revisions, the media was then implemented more widely at SMP Negeri 2 Tonra as the site for effectiveness testing. At this stage, comparisons were made between the experimental class using *EssoMath Card* and the control class using conventional methods.

The evaluation stage was carried out throughout each development process, both from expert validators and field test results. Formative evaluation was conducted to improve the media based on expert assessments and user responses, while summative evaluation emphasized measuring the effectiveness of the media through pretest–posttest, observation, and student response questionnaires. Through this evaluation process, the *EssoMath Card* was ensured to be valid, practical, and effective in supporting mathematics learning based on ethnomathematics and Bugis local wisdom.

The research continued to the quantitative stage using a Pretest-Posttest Control Group Design. At this stage, one class was designated as the experimental group using *EssoMath Card*,

while the other class was designated as the control group using conventional learning methods. Both groups were given a pretest to measure their initial ability, followed by different treatments according to their group, and finally a posttest at the end of learning to measure improvement. Quantitative data were collected through pretests, posttests, questionnaires, and observations. Test results were used to measure the improvement of students' conceptual understanding, critical thinking skills, and numerical literacy. Quantitative data were then analyzed using descriptive statistics, independent sample t-tests, and N-Gain calculations to assess the effectiveness of the developed media.

This research was conducted at SMP Satap 2 Patimpeng and SMP Negeri 2 Tonra, Bone Regency, South Sulawesi Province. The research implementation lasted three to four months, starting from cultural exploration to media effectiveness testing. The population consisted of all ninth-grade students and mathematics teachers at both schools. Samples were selected using purposive sampling, based on the suitability of class characteristics with the research objectives. From this population, one class was designated as the experimental class using *EssoMath Card*, while another class was designated as the control class using conventional methods.

The data sources in this study consisted of primary and secondary data. Primary data included qualitative data obtained from participatory observations, in-depth interviews with traditional leaders, teachers, and students, as well as Focus Group Discussions (FGD) to explore the cultural values of the *Mabbilang Esso* tradition. Quantitative data were obtained from learning achievement tests (pretest–posttest) and student response questionnaires to measure conceptual understanding and media effectiveness. Secondary data were obtained from school documents, academic achievement reports, and literature searches through Google Scholar, Publish or Perish, and bibliometric analysis using VOSviewer.

The data collection techniques were carried out in two main stages according to the Mixed Methods Sequential Exploratory design. The first stage was qualitative with a descriptive ethnographic design to investigate the *Mabbilang Esso* tradition. The second stage was quantitative with a Pretest-Posttest Control Group experimental design to test media effectiveness. The media development process followed the ADDIE model, starting from problem identification, design, validation, limited trials at SMP Satap 2 Patimpeng, to large-scale trials and experimental testing at SMP Negeri 2 Tonra.

The data analysis employed both qualitative and quantitative approaches. Qualitative data were analyzed using thematic analysis with the assistance of NVivo software, including transcription, coding, theme identification, and category formulation to reveal cultural values and the relevance of the *Mabbilang Esso* tradition in learning. Quantitative data were analyzed using descriptive statistics to describe score distributions and independent sample t-tests to examine significant differences between the experimental and control classes. Instrument analysis included reliability testing (Cronbach's Alpha) and validity testing (Product Moment). The results from both approaches were then integrated to provide a more comprehensive understanding of the practicality, validity, and effectiveness of *EssoMath Card*.

C. RESULTS AND DISCUSSION

1. Development of Interactive Learning Media

The development of the interactive learning media *EssoMath Card* by integrating the *Mabbilang Esso* tradition was carried out to support students' understanding of number pattern material while also preserving Bugis local wisdom. Before being tested on students, the media was first validated through expert judgment to determine its level of validity based on assessments from subject matter experts, design experts, and media experts.

a. Media Validity Test

The media validity test involved three groups of validators: subject matter experts, design experts, and media experts. They assessed the content relevance, cultural integration, readability, visual design, technical quality, and overall practicality of the *EssoMath Card*.

Table 1. Results of Media Validity Testing

Assessment aspects	Expert Score 1	Expert Score 2	Average Score	Category
Material Expert				
Language	3.80	3.60	3.70	Very Valid
Content Accuracy	3.90	3.80	3.85	Very Valid
Learning Relevance	3.95	3.75	3.85	Very Valid
Total Average			3.80	Very Valid
Design Expert				
Layout & Display	3.70	3.65	3.68	Very Valid
Illustration/Image	3.80	3.75	3.78	Very Valid
Total Average			3.73	Very Valid
Media Expert				
Display Quality	3.65	3.55	3.60	Very Valid
Media Engineering	3.90	3.70	3.80	Very Valid
Implementation	3.85	3.75	3.80	Very Valid
Total Average			3.73	Very Valid

Based on the validation results, the total average score from subject matter experts was 3.80, categorized as *very valid*. This indicates that the *EssoMath Card* is appropriate in terms of language, content accuracy, and alignment with mathematics learning objectives, particularly on the topic of number patterns and sequences. From the design aspect, the average score was 3.73, also categorized as *very valid*, meaning that the layout, appearance, and illustrations effectively support junior high school students' readability. Meanwhile, the media aspect obtained an average score of 3.73 with the same category, covering visual quality, media engineering, and ease of classroom implementation. Overall, the validity of the *EssoMath Card* reached 88.2% (*very valid*), confirming that the media meets the feasibility standards to be used in the practicality and effectiveness testing stages.

b. Test the validity of learning tools

Table 2. Test the Practicality of Learning Media

Assessment aspects	Expert Score 1	Expert Score 2	Average Score	Category
Learning Objectives	3.90	3.80	3.85	Very Practical

Teaching Module / Media Guide	3.85	3.75	3.80	Very Practical
Student Worksheet Integration	3.95	3.90	3.93	Very Practical
Ease of Use in Classroom	3.80	3.70	3.75	Very Practical
Student Engagement and Motivation	3.85	3.80	3.83	Very Practical
Teacher Response to Implementation	3.90	3.85	3.88	Very Practical
Total Average			3.82	Very Practical

The practicality validation of the *EssoMath Card* by two experts showed an average total score of 3.82, equivalent to 84.7%, which falls into the *very practical* category. The assessment was based on six main aspects: clarity of learning objectives, feasibility of the media guide, integration with student worksheets, ease of classroom use, student engagement and motivation, and teacher responses to its implementation. These findings indicate that the *EssoMath Card* is not only easy to understand and use by both teachers and students but also enhances active student participation in the learning process. Thus, the media is declared practical for use in mathematics learning, particularly in number patterns and sequences at the junior high school level.

c. Practicality Test

The practicality of the *EssoMath Card* learning media was measured based on teacher and student responses as users, with indicators covering management, activity, knowledge, and effectiveness.

Table 3. Percentage of Practicality Assessment Results (Teachers)

Practicality Test Indicators	**Teacher 1**	**Teacher 2**	**Teacher 3**	**Average Score**	**Criteria**
Management	32	32	31	31.7	Very Practical
Activity	24	23	24	23.7	Very Practical
Knowledge	28	27	28	27.7	Very Practical
Effectiveness	16	16	15	15.7	Very Practical
Total Score Percentage (%)	100	98	98	98.7	Very Practical

The practicality test results showed that the *EssoMath Card* obtained an average score of 84.7%, which falls into the very practical category. Teachers assessed the media as easy to understand, simple to implement, and able to increase student engagement. Student responses also supported this finding, as they felt more motivated and found it easier to understand the concept of number patterns through the card game based on the *Mabbilang Esso* tradition. Thus, the *EssoMath Card* was declared practical and feasible for use in the effectiveness testing stage.

Table 4. Results of Student Practicum

Average Practicality Test Score	Management	Activity	Knowledge	Effectiveness	Total Score	Information
Limited Trial	27.10	11.78	24.63	13.50	77.01	Practical
Percentage (%)	96.78	98.16	94.29	84.37	84.7%	Very Practical
Criterion	Very Practical	Very Practical	Very Practical	Very Practical	Very Practical	
Extensive Trial	26.80	10.58	23.15	16.23	76.76	Practical
Percentage (%)	95.71	88.16	82.67	90.16	82.9%	Effective
Criterion	Very Practical	Very Practical	Very Practical	Very Practical	Effective	
Experimental Class	28.20	12.80	24.60	17.23	62.83	Practical
Percentage (%)	97.24	85.33	91.11	95.72	73% (vs 46% control)	Effective
Criterion	Very Practical	Very Practical	Very Practical	Very Practical	Effective	

Based on Table 4, it can be concluded that the *EssoMath Card* learning media achieved excellent results in the student practicality test. In the limited trial stage at SMP Satap 2 Patimpeng, the average percentage reached 84.7%, categorized as very practical. This indicates that the media is easy to use, capable of motivating students, and aligned with learning objectives. Furthermore, in the large-scale trial at SMP Negeri 2 Tonra, the media obtained a percentage of 82.9%, categorized as effective. This shows that the *EssoMath Card* is not only practical but also has a significant impact on improving students' understanding of number patterns and sequences. The experimental class results demonstrated a 73% achievement increase, which was considerably higher than the control class that only reached 46%. These findings prove that the *EssoMath Card* can significantly enhance students' numerical literacy while simultaneously preserving Bugis culture through an ethnomathematics approach.

d. Effectiveness Test

The effectiveness of the *EssoMath Card* learning media, inspired by the Bugis tradition of *Mabbilang Esso*, can be seen from the improvement in pre-test and post-test results. In the control class, the average student score increased from 55 in the pre-test to 80.3 in the post-test, with a percentage gain of 46%. This increase is relatively low and falls into the less effective category. In the experimental class, however, the average student score increased more significantly, from 54.9 in the pre-test to 95 in the post-test. The percentage gain reached 73%, which is categorized as effective. These results indicate that the *EssoMath Card* is more effective in improving students' conceptual understanding, cognitive skills, and numerical literacy compared to the conventional method used in the control class.

Figure 2. Interactive Teaching Media Display (EssoMath Card)

The results of the effectiveness test show that the EssoMath Card media is not only valid and practical, but also effective in improving students' mathematical understanding, particularly in number patterns and sequences, which were previously considered abstract and difficult. With a learning outcome increase of 73% in the experimental class compared to only 46% in the control class, this media proved to be more successful in fostering active student engagement, strengthening numeracy literacy, and integrating Bugis local wisdom into learning.

2. Implementation of Learning Media through a Deep Learning Approach

The implementation of EssoMath Card in mathematics learning based on a deep learning approach aims to improve students' understanding of number patterns and sequences while instilling character values such as discipline, responsibility, and cooperation. The implementation process was carried out through four stages. In the exploration stage, the teacher introduced the EssoMath Cards through simple narratives and demonstrated cards representing number patterns and problem-solving steps. In the value connection stage, the teacher linked the cards with moral messages and their relevance to students' real-life experiences. In the problem-solving stage, students collaboratively used the cards to solve mathematical problems or puzzles that required reflection on number patterns and sequences. In the reflection stage, students presented their card arrangements and explained the patterns and character values contained within them. This media proved to provide instructional effects in the form of improved conceptual understanding, as well as nurturant effects such as positive learning attitudes including discipline, responsibility, and mutual respect. These effects align with Piaget's theory, which emphasizes character development and thinking abilities in the concrete operational stage. In addition, there was an increase in students' learning motivation and active participation, making the learning process more engaging, enjoyable, and meaningful. The effectiveness of EssoMath Card was evaluated through pre-tests and post-tests as well as observation of student behavior, which showed improvements in both conceptual understanding and positive attitudes during the learning process.

The effectiveness of the EssoMath Card learning media in improving students' understanding of number patterns and sequences as well as fostering positive character values can be seen from the overall evaluation results. This media was developed based on the Bugis cultural context and the concept of pattern recognition, integrating mathematical problem-solving with character values such as discipline, responsibility, and cooperation. Its

implementation in learning was carried out through four stages: the Concept Exploration Stage, the Value Connection Stage, the Problem-Solving Stage, and the Reflection Stage. Through the use of EssoMath Card, students gained meaningful and interactive learning experiences, which had a positive impact on their motivation and active participation. This is supported by student and teacher responses, most of which ranged between 80% and 100%. The increase in motivation and engagement also contributed significantly to the development of students' character values.

In addition, this media helps students develop skills in planning (designing problem-solving strategies with the cards), monitoring (observing the steps taken), and evaluating (assessing the accuracy of the solutions). These skills are fostered through various card-based problem scenarios provided by the teacher. Based on the structured stages of learning, it can be concluded that the implementation of the EssoMath Card learning media has a significant positive impact on students' mathematical concept comprehension and the development of character values. The card system is designed in a step-by-step manner, where students can only proceed to the next problem after successfully completing the previous one. This mechanism not only trains critical and logical thinking skills but also instills discipline, responsibility, and mutual respect, as students must complete one stage before moving on to the next. Each card contains several guiding questions as mini-quizzes, allowing students to practice independently and strengthen their understanding of number patterns and sequences, especially through contextual and concise material.

Figure 3. The application of the media of SMPN Satap 2 Patimpeng SMP Negeri 2 Tonra

D. CONCLUSIONS AND SUGGESTIONS

The interactive learning media EssoMath Card has been proven valid, practical, and effective in enhancing students' understanding of number patterns and sequences while instilling character values such as discipline, responsibility, and cooperation. Its validity was rated very high by experts, and supporting tools such as modules, worksheets, and test grids were also deemed feasible for use. The media received positive responses from students (3.85) and teachers (3.78), while the effectiveness test showed a gain score increase of 28% in the control class and 75% in the experimental class. This media improves conceptual understanding, learning motivation, active participation, and the internalization of character values. It is recommended that junior high school teachers use interactive media based on local cultural contexts as an alternative strategy for mathematics learning. Further research may test this media in other classes or integrate it with application-based technology to expand its reach.

ACKNOWLEDGMENTS

We would like to express our gratitude to the Directorate General of Higher Education, Science, and Technology for funding the Student Creativity Program (PKM), to Universitas Muhammadiyah Bone as the implementing university, and to SMP Satap 2 Patimpeng and SMP Negeri 2 Tonra for their support in the implementation of the EssoMath Card research until its completion.

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