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

Development of Local Wisdom-Based Media through Maggalasyeng and Expanded Reality for Enhancing Mathematical Reasoning

Sunarti[1], Andi Muhammad Irfan Taufan Asfar[2], Andi Muhamad Iqbal Akbar Asfar[3], Nurhaerani Ramli[4], Anita[5], Andi Nurannisa[6]
[1,2,5,6]Department of Mathematics Education, Universitas Muhammadiyah Bone, Indonesia
[3]Department of Chemical Engineering, Politeknik Negeri Ujung Pandang, Indonesia
[4]Department of Indonesian Language Education, Universitas Muhammadiyah Bone, Indonesia
sunarthi2704@gmail.com[1], tauvanlewis00@gmail.com[2], andiifalasfar@gmail.com[3], nurhaeraniramli03@gmail.com[4], ramadanianita49@gmail.com[5], andinurannisa30@gmail.com[6]

Abstract: Mathematical reasoning is a fundamental competency for problem-solving and decision-making, yet Indonesian students' performance in this domain remains low according to national and international assessments. This study introduces Mathgalasyeng-VR, an innovative learning media that combines the Bugis traditional game Maggalasyeng with expanded reality technology to enhance students' reasoning skills in mathematics. The objectives are: (1) to develop a valid, practical, and effective media; (2) to examine its impact on mathematical reasoning; and (3) to explore the integration of local wisdom in learning mathematics. The research employed a Research and Development (R&D) approach with the ADDIE model, conducted for four months in junior high schools in Bone, South Sulawesi. Data were collected through expert validation, pre- and post-tests, questionnaires, observations, and interviews. Results revealed that Mathgalasyeng-VR met validity criteria (mean score 3.72–3.85), practicality (teacher response 100%; student response 76–79%), and effectiveness (significant N-gain improvement in the experimental group). These findings demonstrate that integrating local culture with immersive technology can strengthen mathematical reasoning, create meaningful and joyful learning experiences, and contribute to cultural preservation.

Keywords: Mathematical Reasoning, Local Wisdom, Expanded Reality, Traditional Game, Mathgalasyeng-VR.

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

A. INTRODUCTION

Mathematical reasoning is a crucial foundation for problem-solving and decision-making based on logical evidence. However, Indonesian students' reasoning ability remains relatively low. According to the Trends in International Mathematics and Science Study (TIMSS), Indonesia ranked 44th out of 49 participating countries in mathematics achievement (Siregar et al., 2024). The 2022 Minimum Competency Assessment (AKM) also indicated that students' numeracy skills only reached 50% of the minimum standard (Pusmendik, 2022). This situation illustrates that many students still struggle to understand and apply mathematical concepts, especially in contextual problems that require reasoning skills.

Difficulties in mathematical reasoning are particularly evident in number pattern topics. Students often fail to identify regularities, determine subsequent terms, or formulate

generalizations of numerical patterns (Ariyanti & Setiawan, 2019). Other factors, such as excessive gadget use, also affect learning focus and lower academic performance (Hendini, 2024). Therefore, an innovation in learning media is needed—one that is not only joyful but also meaningful and able to strengthen higher-order thinking skills.

One promising alternative is the integration of traditional games into learning. The *Maggalasyeng* game, a Bugis traditional game, is rich in numerical activities, strategy, and logical thinking. However, its direct application in the classroom is often limited by physical media and space. In the digital era, these limitations can be addressed by utilizing expanded reality (XR) technology, which provides interactive and immersive visualization (Fitria, 2023).

Therefore, the development of Mathgalasyeng-VR, a learning media that combines the Bugis traditional game *Maggalasyeng* with expanded reality technology, offers an innovative solution to enhance students' mathematical reasoning. The novelty of this study lies in the integration of local culture and modern technology, which not only supports mathematics learning but also contributes to cultural preservation and the achievement of Sustainable Development Goals (SDG) 4 on quality education.

B. METHOD

This study employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), which was first introduced by Dick and Carey (1978) as a systematic framework for instructional design. The ADDIE model was chosen because it provides structured steps in developing, testing, and refining instructional media. The product developed in this research was *Mathgalasyeng-VR*, a digital learning media that integrates the Bugis traditional game *Maggalasyeng* with expanded reality technology.

The research was conducted for four months (July–October 2025) in Bone Regency, South Sulawesi, specifically at SMPN 1 Patimpeng and SMPN Satap 2 Patimpeng. The participants included Grade VIII students and mathematics teachers selected through purposive sampling. The experimental stage used a non-equivalent control group design, which belongs to quasi-experimental research (Campbell & Stanley, 1963; Sugiyono, 2019). The control class was taught using conventional project-based learning (PBL), while the experimental class was taught using *Mathgalasyeng-VR*. Both groups received a pre-test and post-test to measure changes in mathematical reasoning.

Table 1. Non-Equivalent Control Group Design

Group	Pre-test	Treatment	Post-test
Control	O1	Project-Based Learning	O2
Experiment	O3	*Mathgalasyeng-VR*	O4

The data were obtained from both primary and secondary sources. Primary data included expert validation results, pre-test and post-test scores, questionnaires from teachers and students, classroom observations, and interviews. Secondary data consisted of literature reviews and documentation supporting the development process. The instruments used were validation sheets, student worksheets (LKPD), learning modules, and achievement tests.

The mathematical reasoning test was designed in the form of essay questions based on validated reasoning indicators. According to Sumarmo (2013), mathematical reasoning skills include the ability to propose conjectures, perform mathematical manipulations, draw logical conclusions, and examine the validity of arguments. These indicators were adopted in this study to measure students' reasoning improvement.

Table 2. Indicators of Mathematical Reasoning

Indicator	Description
Proposing Conjectures	Ability to formulate hypotheses or tentative generalizations.
Performing Mathematical Operations	Ability to manipulate numbers, symbols, and mathematical structures.
Drawing Conclusions	Ability to make logical inferences from patterns or data.
Examining Validity of Arguments	Ability to evaluate correctness of reasoning and justify solutions.

Data analysis applied a **mixed-method approach**, combining quantitative and qualitative techniques. Quantitative analysis involved descriptive statistics, the N-gain test, and hypothesis testing using SPSS. The N-gain scores were categorized as high (≥ 0.70), moderate ($0.30 \leq g < 0.70$), or low (< 0.30) following Hake (1999). Qualitative analysis was conducted with Nvivo software to code data from observations and interviews, focusing on themes such as student engagement, cultural integration, and learning motivation.

C. RESULTS AND DISCUSSION

The development of *Mathgalasyeng-VR* was evaluated through three main aspects: validity, practicality, and effectiveness.

1. Validity

The results of expert validation showed that the learning media met the criteria of validity. The average scores given by material experts, media experts, and instructional design experts ranged between 3.58–3.85, which are categorized as *very valid*. This indicates that the content was appropriate, the interface design was clear, and the functionality supported learning activities effectively.

2. Practicality

Practicality was measured through teacher and student responses. Teachers rated the practicality at 100% (very practical), emphasizing that the media was easy to implement and aligned with the curriculum. Student responses during limited trials, wider trials, and the experimental phase showed practicality values between 76% and 79%, classified as *practical*. These findings highlight that *Mathgalasyeng-VR* is user-friendly, engaging, and able to stimulate active participation.

3. Effectiveness

Effectiveness was measured using pre-test and post-test results in both control and experimental classes. The control class achieved a gain score of 0.37 (low), while the experimental class reached a gain score of 0.88 (moderate–high). This significant difference demonstrates that students taught with *Mathgalasyeng-VR* had greater improvement in mathematical reasoning compared to those taught conventionally.

Table 3. Average Pre-test and Post-test Scores

Class	Pre-test	Post-test	N-gain	Category
Control	55.0	70.0	0.37	Low
Experiment	50.0	87.0	0.88	Moderate

4. Discussion

The findings reveal that *Mathgalasyeng-VR* significantly enhanced students' mathematical reasoning skills. The effectiveness can be attributed to two main factors. First, the integration

of the traditional Bugis game Maggalasyeng provided familiar cultural contexts, allowing students to connect abstract mathematical concepts with concrete cultural practices. Second, the use of expanded reality technology created an immersive and interactive learning environment, making patterns and problem-solving processes more engaging. These results are consistent with previous studies. Dewi et al. (2024) reported that ethnomathematics-based Augmented Reality using the Bola Soba character facades improved students' logical thinking skills with a high gain score (0.70)

Similarly, research by Asfar et al. (2022) emphasized that embedding local wisdom in mathematics education strengthens students' higher-order thinking while also contributing to cultural preservation. In line with Vygotsky's social constructivist theory, learning tools rooted in cultural practices act as mediating instruments that scaffold cognitive development. The results of this study further confirm that the dual integration of local wisdom and digital technology not only improves cognitive outcomes but also nurtures student motivation and appreciation for cultural heritage. Thus, Mathgalasyeng-VR contributes to achieving Sustainable Development Goal 4 (Quality Education) by promoting innovative, inclusive, and culturally relevant education.

D. CONCLUSIONS AND SUGGESTIONS

Based on the results and discussion, it can be concluded that the development of *Mathgalasyeng-VR* as a learning media that integrates the Bugis traditional game *Maggalasyeng* with expanded reality technology has met the criteria of validity, practicality, and effectiveness. The expert validation scores indicated that the media is very valid, teacher and student responses showed that it is practical and user-friendly, and the N-gain analysis revealed that it is effective in improving students' mathematical reasoning. The reasoning indicators conjecturing, performing mathematical operations, drawing conclusions, and examining validity of arguments—were significantly enhanced in the experimental class compared to the control class.

The novelty of this study lies in the dual contribution of enhancing students' reasoning skills while also preserving local cultural heritage. The integration of traditional games and digital technology provides meaningful learning experiences that align with the goals of Sustainable Development Goal 4 on quality education. Suggestions for future research include further development of Mathgalasyeng-VR with more advanced interactive features, testing its application in different mathematical topics, and applying it in wider educational contexts beyond junior high schools. Future researchers are also encouraged to investigate how similar models combining local wisdom and digital technology can support other aspects of higher-order thinking skills.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to the Directorate of Research, Technology, and Community Service, Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia for funding support. Special thanks are also extended to Universitas Muhammadiyah Bone, mathematics teachers, and students of SMPN 1 Patimpeng and SMPN Satap 2 Patimpeng who actively participated and contributed to this research.

REFERENCES

Ariyanti, R., & Setiawan, T. (2019). Analisis kesulitan siswa dalam memahami pola bilangan. *Jurnal Pendidikan Matematika, 13*(1), 45–55.

Asfar, A. M. I. T., & Asfar, A. M. I. A. (2021). Analisis kemampuan koneksi matematis siswa melalui strategi pembelajaran berbasis local wisdom. *Journal of Innovation Research and Knowledge, 1*(5), 687–698.

Asfar, A. M. I. T., Sumiati, S., Asfar, A. M. I. A., & Nurannisa, A. (2022). Analysis of students' mathematical connection ability through learning strategies based on local wisdom. *Jurnal Didaktik Matematika, 9*(1), 170–185.

Dewi, S. S., Asfar, A. M. I. T., Asfar, A. M. I. A., Nurannisa, A., Damayanti, W., & Wahyuni, N. (2024). Enhancing students' logical thinking through ethnomathematics-based augmented reality of Bola Soba character facades. *Journal of Innovation in Educational and Cultural Research, 5*(3), 520–528. https://doi.org/10.46843/jiecr.v5i3.1033

Fausett, L. (1994). *Fundamentals of neural networks*. New York: Prentice Hall.

Fitria, M. (2023). Pemanfaatan teknologi XR dalam pembelajaran abad 21. *Jurnal Teknologi Pendidikan, 15*(2), 120–132.

Hake, R. R. (1999). Analyzing change/gain scores. *Unpublished manuscript, Indiana University*. Retrieved from http://www.physics.indiana.edu/~sdi/AnalyzingChange-Gain.pdf

Hendini, D. (2024). Dampak penggunaan gawai terhadap fokus belajar siswa. *Jurnal Pendidikan dan Teknologi Informasi, 8*(1), 15–22.

Mandailina, V., Saddam, S., Ibrahim, M., & Syaharuddin, S. (2019). UTAUT: Analysis of usage level of Android applications as learning media in Indonesian educational institutions. *IJECA (International Journal of Education and Curriculum Application), 2*(3), 16–23.

OECD. (2019). *PISA 2018 results: What students know and can do (Volume I)*. OECD Publishing. https://doi.org/10.1787/5f07c754-en

Pusmendik. (2022). *Laporan hasil Asesmen Kompetensi Minimum*. Pusat Asesmen Pendidikan, Kemendikbudristek RI.

Siregar, N., Ramadhani, R., & Harahap, M. (2024). Mathematical reasoning skills of Indonesian students: A comparative analysis based on TIMSS. *International Journal of Education and Research, 12*(1), 25–34.

Sumarmo, U. (2013). *Berpikir dan disposisi matematik serta pembelajarannya*. Bandung: FMIPA UPI.

Syaharuddin, S., Fatmawati, F., & Suprajitno, H. (2023, May). Accuracy rate of ANN back propagation architecture with modified algorithm: A meta-analysis. In *AIP Conference Proceedings* (Vol. 2720, No. 1). AIP Publishing.