

## **Hypothetical Learning Trajectory (HLT) Based on STEM-Ethnomathematics Puru Timbu to Improve Elementary School Students' Mathematical Communication Skills**

**Sukma Mawaddah<sup>1</sup>, Ahyansyah<sup>2</sup>**

<sup>1,2</sup>Program Studi Pendidikan Guru Sekolah Dasar, FKIP, Universitas Nggusuwaru

---

### **Article Info**

#### **Article history:**

Accepted: 17 Juni 2026

Publish: 26 Juni 2026

---

#### **Keywords:**

Hypothetical Learning Trajectory;  
STEM;

Ethnomathematics;

Puru Timb;

Mathematical communication;

Elementary school.

---

### **Abstract**

*This study aims to develop and test the effectiveness of the Hypothetical Learning Trajectory (HLT) based on STEM-Ethnomathematics Puru Timbu in improving the mathematical communication skills of elementary school students. The background of this study is based on students' low mathematical communication skills as indicated by difficulties in explaining the solution process, using mathematical symbols consistently, and communicating mathematical ideas orally and in writing. The study uses a Design Research approach that includes three stages, namely preliminary design, teaching experiment, and retrospective analysis. The subjects of the study were 20 fifth-grade elementary school students in Bima Regency who were selected by purposive sampling. Data were collected through mathematical communication skills tests, observations, interviews, documentation, and student worksheets. The developed HLT integrates the STEM approach with Puru Timbu ethnomathematics through cultural observation activities, traditional and modern measurement experiments, making miniature bamboo models, compiling contextual questions, as well as presentations and group discussions. The results of the study indicate that the developed HLT has contextual, collaborative, and student-centered characteristics and is able to facilitate the development of mathematical communication through representation, argumentation, and reflection. Quantitatively, there was an increase in the average score of students' mathematical communication skills from 62.15 in the pretest to 81.40 in the posttest. The results of the paired t-test showed a significance value of  $p = 0.000 < 0.05$ , which indicated a significant increase after the implementation of HLT. These findings indicate that HLT based on STEM-Ethnomathematics Puru Timbu is effective in improving the mathematical communication skills of elementary school students and can be an alternative design for contextual, meaningful, and local wisdom-based mathematics learning.*

*This is an open-access article under the [Creative Commons Attribution-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/)*



---

### **Corresponding Author:**

**Sukma Mawaddah**

Program Studi Pendidikan Guru Sekolah Dasar, FKIP, Universitas Nggusuwaru

Email Coresspondent: [sukma.mawaddah@unswa.ac.id](mailto:sukma.mawaddah@unswa.ac.id)

---

## **1. INTRODUCTION**

Mathematical communication skills are one of the essential competencies that students must possess in the 21st century. This ability includes not only the ability to convey mathematical answers, but also the ability to explain ideas, construct arguments, use mathematical symbols and representations, and communicate problem-solving processes systematically. The National Council of Teachers of Mathematics (NCTM, 2020) places mathematical communication as one of the important process standards in mathematics learning because it plays a role in building conceptual understanding and developing students' thinking skills. It is an integral part of mathematical literacy needed to face various problems. In line with this, the OECD (2023) states that mathematical communication skills are part of real life. Therefore, developing mathematical

communication skills is one of the important goals in mathematics learning in elementary schools as a foundation for mastering 21st-century competencies.

The importance of mathematical communication skills has not been fully reflected in the achievements of Indonesian students. The 2022 Programme for International Student Assessment (PISA) results indicate that Indonesian students' mathematical literacy skills remain below the average for OECD member countries, particularly in mathematical reasoning, interpretation, and communication in everyday contexts (OECD, 2023). These findings are reinforced by the Minimum Competency Assessment (AKM) results, which indicate that most students still experience difficulties understanding numerical information, interpreting data, and explaining the rationale for their solutions (Kemendikbudristek, 2023). This situation indicates that mathematical communication skills, as part of mathematical literacy, still need to be improved through more contextual and meaningful learning innovations.

This problem is also seen at the elementary school level, which is the foundation for the formation of students' mathematical abilities. Several studies show that elementary school students still experience difficulties in expressing mathematical ideas orally and in writing, constructing logical arguments, and using mathematical symbols appropriately and consistently (Arifin & Hutapea, 2025; Ahyansyah, 2019). Research reveals that many students are able to obtain the correct final answer, but have not been able to explain the thought process and the reasons underlying the answer. As a result, students' understanding of concepts tends to be shallow and does not last long (Zega et al., 2025; Novia, 2026). This condition shows that students' mathematical communication skills are still relatively low and require special attention in the learning process.

These findings are supported by the preliminary analysis of students' mathematical communication skills conducted in this study. Based on the analysis of students' answers, it was found that most students were able to copy information from the problem and obtain the correct final answer, but still experienced difficulty in writing down the steps for solving the problem completely and systematically. Some students made errors in copying data, used mathematical symbols inconsistently, and did not provide explanations or reasons for their answers. Some students even only wrote down the final result without showing the solution process. These results indicate that students are not yet accustomed to communicating mathematical ideas completely and structuredly, either in writing or other mathematical representations. Thus, aspects of mathematical communication, including information presentation, symbol use, procedural explanations, and concluding, still need to be improved.

Students' low mathematical communication skills are inextricably linked to ongoing classroom learning practices. Observations indicate that mathematics learning is still dominated by conventional, teacher-centered methods. Teachers tend to explain the material, provide examples, and then ask students to complete exercises using the demonstrated procedures. According to Andriasari et al. (2025), learning that focuses on memorizing formulas and procedures results in students having fewer opportunities to explore ideas, discuss concepts, and develop their ability to explain their thinking processes. As a result, mathematics learning becomes procedural and provides less room for students to develop a deeper understanding of concepts. This condition contributes to students' low mathematical communication skills, as evident in the initial analysis of the study.

To overcome these problems, a learning approach is needed that can encourage students to be actively involved in building knowledge and communicating their mathematical ideas. One relevant approach is STEM (Science, Technology, Engineering, and Mathematics)-based learning. The STEM approach emphasizes the integration of various disciplines in solving real problems through exploration, investigation, design, and reflection activities (Mawaddah et al., 2025). Sartika and Kau (2025) stated that STEM learning can improve students' critical thinking, creativity, problem-solving, and communication skills because it provides authentic learning experiences. In addition, Derajat, L. S. (2025) found that the implementation of project-based STEM can improve mathematical literacy and students' ability to convey ideas orally and in

writing. Therefore, STEM has great potential to develop students' mathematical communication skills through more active and meaningful learning activities.

However, STEM learning will be more effective when linked to a cultural context close to students' lives. From an ethnomathematics perspective, mathematical concepts can be learned through cultural activities that develop in society. Ahyansyah et al. (2025) explain that ethnomathematics is an approach that connects mathematics with cultural practices so that learning becomes more contextual and easier for students to understand. Research by Rosa and Orey (2020) shows that integrating ethnomathematics into learning can improve students' learning motivation, conceptual understanding, and mathematical communication skills. Through this approach, students not only learn mathematical concepts abstractly but also understand how these concepts are used in real life (Syarifuddin et al. (2025). Thus, the integration of STEM and ethnomathematics is a promising alternative to improve the quality of mathematics learning in elementary schools.

One local culture that has great potential to be integrated into mathematics learning is the Puru Timbu tradition of the Mbojo community in Bima Regency. Puru Timbu is a tradition of cooking rice in bamboo that involves various mathematical activities, such as volume measurement, comparison, proportion, capacity estimation, and division of results (Mawaddah, S. 2025). This activity is very relevant to be used as a context for STEM-based mathematics learning because it allows students to directly observe, measure, design models, and solve problems. In addition, Septina, E. A. (2025) explains that the use of local cultural contexts can increase student engagement because the learning material becomes closer to their daily experiences. However, until now, there have not been many learning designs that systematically integrate STEM and Puru Timbu ethnomathematics to improve elementary school students' mathematical communication skills.

Based on this description, a learning design is needed that can bridge students' needs in developing mathematical communication skills through contextual and meaningful activities. One approach that can be used is the Hypothetical Learning Trajectory (HLT). HLT is a hypothetical learning trajectory that includes learning objectives, a series of learning activities, and predictions of students' thinking processes during the learning process (Lantakay et al. 2023). Through HLT, teachers can design learning experiences that are more structured and centered on the development of student understanding (Salmila et al., 2025). Therefore, this study focuses on the development of a Hypothetical Learning Trajectory (HLT) based on STEM-Ethnomathematics Puru Timbu as an effort to improve elementary school students' mathematical communication skills.

This research is novel in its integration of four main components: the Hypothetical Learning Trajectory (HLT), the STEM approach, Puru Timbu ethnomathematics, and elementary school students' mathematical communication skills. To date, research that combines these four aspects in a single learning design is still very limited. Most previous studies have focused solely on the development of STEM or ethnomathematics separately, without developing a hypothetical learning trajectory specifically designed to enhance mathematical communication skills. Therefore, this research is expected to provide theoretical and practical contributions in the development of local culture-based mathematics learning that is relevant to the demands of the 21st century.

Based on this background, this research is directed to answer two main questions, namely: (1) what are the characteristics of HLT based on STEM-Ethnomathematics of Puru Timbu to improve the mathematical communication skills of elementary school students, and (2) how effective is the HLT developed on students' mathematical communication skills? In line with the formulation of the problem, the objectives of this research are to develop HLT based on STEM-Ethnomathematics of Puru Timbu, describe the implementation process, and determine the influence of the HLT developed on the mathematical communication skills of elementary school students. By achieving these objectives, it is hoped that this research can produce innovative learning designs that can be used by teachers in improving the quality of mathematics learning based on local culture.

## 2. METHOD

This study uses the Design Research approach developed by Gravemeijer and Cobb (2006) with the aim of developing and testing a Hypothetical Learning Trajectory (HLT) based on STEM-Ethnomathematics Puru Timbu to improve elementary school students' mathematical communication skills. Design Research was chosen because it allows researchers to design, implement, evaluate, and revise the learning design based on the students' learning process during the learning process.

The research was conducted through three stages: preliminary design, teaching experiment, and retrospective analysis. In the preliminary design stage, needs analysis, students' mathematical communication skills analysis, and the preparation of an initial HLT based on STEM-Ethnomathematics Puru Timbu were conducted. The teaching experiment stage was carried out by implementing HLT in mathematics learning to observe students' responses, activities, and the development of mathematical communication skills. Furthermore, in the retrospective analysis stage, all implementation data were analyzed to compare the designed learning trajectory with the students' actual learning trajectory, which was then used as a basis for revising and refining the HLT.

The research subjects were 20 fifth-grade elementary school students in Bima Regency, selected using a purposive sampling technique. Data were collected through a mathematical communication skills test, observation, interviews, and documentation. The instruments used included essay questions, observation sheets, interview guidelines, and Student Worksheets (LKS) arranged according to the HLT stages.

Data analysis was conducted qualitatively and quantitatively. Qualitative data were analyzed using data reduction, data presentation, and conclusion drawing techniques. Meanwhile, quantitative data were analyzed using descriptive statistics, the Shapiro–Wilk normality test, and a paired sample t-test with the help of SPSS 26 to determine the effectiveness of Puru Timbu STEM-Ethnomathematics-based HLT in improving students' mathematical communication skills.

## 3. RESULTS AND DISCUSSION (12 PT)

### Students' Mathematical Communication Skills

**Table 1. Students' Mathematical Literacy Skills**

Student	Presenting Information	Solution Process	Language/Symbols	Final Conclusion	Special Notes
S1	Copy the correct numbers, according to the question	Clear and consistent steps	The symbols + and: are used appropriately	The final result is correct (1010 & 101)	It's very good
S2	There was a copy error (289 → 282)	The process is less coherent, straight to the results	Inconsistent symbols	Wrong result	Need to be careful when copying
S3	Copy the correct information	Steps exist, but they are short	Correct symbol	Correct result	Need more details to write the steps
S4	Correct information	Just write the final result	Incorrect symbol (use a dot)	The results are correct, but without a reason	Must write reasons/explanations
S5	Complete information	Complete steps (addition & division)	Correct symbol	Correct result	Very good
S6	Wrong in the addition result	Misstep in the middle	Wrong symbol	Wrong result	Need to re-practice the concept of addition
S7	Correct information	Clear and consistent steps	The right symbol	Correct result	Good

S8	Correct information	There are steps, but they are not neat	The right symbol	Correct result	Needs regularity
S9	Wrong information in the final result	Incomplete process (stopped in the middle)	Symbols are less consistent	Not until the final result	Need to be accompanied until completion
S10	Correct information	Complete steps	Correct symbol	Correct result	Very well

The analysis of students' answers revealed a wide range of mathematical communication skills. Most students were able to accurately copy information from the problem and write down the final results, as seen in students in S1, S5, S7, S8, and S10. They presented sequential solution steps, used mathematical symbols consistently, and provided appropriate conclusions. This indicates that students in this category have mastered the basic aspects of mathematical communication, both in terms of information presentation and symbolic representation.

However, some students still encountered difficulties. For example, an S2 student made a mistake when copying numbers from a problem, resulting in an incorrect final result. An S6 student made a procedural error during the addition step, resulting in an incorrect final answer despite attempting to write down the steps. Meanwhile, S4 and S9 students tended to present incomplete processes, only writing down the final result or even stopping midway through the solution. These shortcomings indicate that some students are still inconsistent in conveying their mathematical ideas in writing, both in terms of procedural completeness and accuracy of results.

Analysis of student responses showed that while most students successfully wrote down the problem data and obtained the correct final answer, there was significant variation in mathematical communication. Mistakes in copying numbers, incomplete step procedures, inconsistent use of symbols, and a lack of explanation or rationale for the conclusion were weaknesses that emerged.

**Draft HLT (Hypothetical Learning Trajectory)**

The following is a draft of the Hypothetical Learning Trajectory (HLT), which was specifically designed based on the ethnomathematics of the Puru Timbu Mbojo Tribe, with the main aim of improving students' mathematical communication skills:

**Academic Goals (Learning Goals)**

1. Understanding the cultural context of Puru Timbu as a traditional activity of cooking lemang rice in bamboo (add sticky rice and coconut milk, adjust volume and proportion)
2. Constructing mathematical models (fractions, ratios, proportions) of Puru Timbu activities
3. Writing and presenting mathematical ideas in the form of symbols, tables, diagrams
4. Explaining the process and solution strategies orally and in writing (mathematical communication)
5. Comparing and validating traditional and modern measurement results through discussion

**Starting Point (Initial Knowledge & Experience)**

1. Students are familiar with basic operations (addition, subtraction, multiplication, division)
2. Students have local cultural experience or at least heard about the Puru Timbu tradition.
3. Students are not yet accustomed to presenting solution steps in writing or explaining mathematical reasons.

**Learning Path (Trajectory) — Activities & Assumptions of Thinking Processes**

**Table 2. Learning Path (Trajectory): Activities & Suspected Thinking Processes**

Level	Student Activities	Alleged Thinking Process (Students' Thinking)	Focus on Mathematical Communication
A. Cultural Context / Observation (Ethnomathematics)	The teacher tells or plays a video of Puru Timbu, and students observe the process (soak, fill the bamboo, pour in the coconut milk in proportion)	Students begin to relate the volume of ingredients (rice, coconut milk) to the size of the bamboo container, understanding	Students ask questions and describe the process orally

		that there are divisions of volume and proportion.	
B. Traditional vs Modern Measurement Experiments	Students in groups measure ingredients (rice, coconut milk) using a bamboo (replica of <i>Puru Timbu</i> ) and compare it with a measuring cup / measuring needle	Students estimate volume equivalences (e.g., 1 bamboo $\approx$ x mL), test hypotheses	Students record measurement data in a table, presenting the difference
C. Making a Smart Bamboo Miniature / Model	Each group designs and makes a bamboo miniature of a certain size to be used as a “measuring container”.	Students think about the scale and proportion of height/diameter of the bamboo so that the volume is appropriate	Students draw sketches, present models in writing
D. Formulating Contextual Questions & Solving Them	The group creates questions based on <i>Puru Timbu</i> (for example: “If bamboo A has a capacity of 1,200 mL, coconut milk is poured $\frac{3}{4}$ of the capacity, how many mL? If divided among 5 people, how many mL per person?”)	Students model problems into fractions and proportions, completing them step by step.	Write the process with symbols, explaining the reason for each step.
E. Presentation & Discussion	Each group presents results, strategies, difficulties, and reflections.	Students explain ideas orally, answer questions, and compare strategies between groups.	Demonstrate mathematical communication (language, symbols, reasoning)

### Anticipating Difficulties & Intervention Strategies

1. Difficulty relating traditional bamboo to mL/L volume measurements: Teacher facilitates visual displays and demonstrations using real liquids.
2. Students hesitate to convey the written step process: The teacher provides a step framework (template) that guides the writing structure.
3. Passive discussion / one student domination: Assign roles (writer, presenter, examiner) so that each student is active.
4. Differences in measurement results between groups: Facilitate discussions on data validation and rounding, encourage student argumentation

### Mathematical Communication Achievement Indicators

1. Students are able to present measurement data in tables or diagrams accurately.
2. Students explain strategies for solving contextual problems orally and in writing.
3. Students use mathematical symbols (fractions, “:”, “=” etc.) consistently.
4. Students are able to compare the results of traditional and modern measurements and explain the reasons for the differences. Expected Outcome

After learning, students will not only understand the abstract concepts of fractions or proportions, but will also be accustomed to writing, explaining, and discussing their mathematical ideas in meaningful cultural contexts. Their mathematical communication will improve both symbolically, verbally, and argumentatively through the integration of ethnomathematics *Puru Timbu* in STEM cross-disciplines.

### Student Worksheets (LKS)

## Lembar Kerja Siswa (LKS)

Tema: Etnomatematika Puru Timbu – Komunikasi Matematis dalam STEM

**Identitas**

• Mata Pelajaran	: Matematika
• Topik	: Pecahan, Perbandingan, dan Proporsi melalui Tradisi Puru Timbu
• Kelas/Semester	: .....
• Waktu	: 2 x 35 menit
• Nama Siswa	: .....
• Kelompok	: .....

**A. Tujuan Pembelajaran**

1. Mengetahui tradisi Puru Timbu sebagai bagian budaya lokal Mbojo.
2. Menghubungkan konsep pecahan, perbandingan, dan proporsi dengan praktik memasak Puru Timbu.
3. Menyajikan ide matematis dalam bentuk lisan, tulisan, tabel, dan gambar.
4. Meningkatkan kemampuan komunikasi matematis melalui diskusi dan presentasi kelompok.

**B. Kegiatan**

**1. Observasi Budaya (Etnomatematika)**

Perhatikan cerita/gambar/video tentang tradisi **Puru Timbu** berikut.  
Jawablah pertanyaan di bawah ini:  
a. Apa saja bahan utama yang digunakan dalam Puru Timbu?  
b. Bagaimana cara masyarakat menentukan banyaknya santan dan beras yang digunakan?  
c. Menurutmu, apakah ada konsep matematika dalam tradisi ini? Jelaskan!

**Jawaban Siswa:**

**2. Eksperimen Pengukuran**

Guru menyediakan replika bambu (atau botol sebagai pengganti) dan alat ukur modern (gelas ukur).

- a. Ukurlah **volume bambu** (isi penuh) dengan air → catat dalam tabel.
- b. Hitung perbandingan: jika bambu diisi  $\frac{1}{2}$  santan dan  $\frac{1}{2}$  beras ketan, berapa mL santan dan beras yang dibutuhkan?

Nama Wadah Volume Penuh (mL) Santan (%) Beras (%) Selsih Hasil Ukur Tradisional vs Modern

Bambu A			
Bambu B			

**Analisismu:**

**3. Membuat Model Miniatur**

- Gambarkan sketsa bambu yang kamu gunakan, lengkapi dengan ukuran perkiraan tinggi dan diameter.
- Hitung **volume tabung** bambu dengan rumus:  
[  $V = r^2 \times p \times \pi$  ]
- Bandingkan hasil perhitunganmu dengan hasil pengukuran air.

**Gambar & Perhitungan:**

**4. Soal Kontekstual (Disusun & Diselesaikan oleh Kelompok)**

Buatlah asal berdasarkan Puru Timbu, lalu selesaikan.  
Contoh:  
"Jika bambu berkapasitas 1.200 mL, diisi  $\frac{1}{2}$  santan, berapa mL santan? Jika hasil masakan dibagi rata untuk 5 orang, berapa mL tiap orang?"

**Soal Buatun Kelompok:**

**Langkah Penyelesaian:**

**5. Presentasi & Diskusi**

- Sajikan hasil kelompokmu di depan kelas.
- Gunakan bahasa matematis, tabel, atau diagram untuk memperjelas ide.

**C. Refleksi Individu**

1. Apa hal baru yang kamu pelajari hari ini?  
.....
2. Bagaimana menurutmu penggunaan bambu sebagai alat ukur dibandingkan gelas ukur?  
.....
3. Apakah kamu sudah berani menjelaskan langkah matematismu dengan kata-kata?  
.....

**Figure 1. Student Worksheet (LKS)**

Student Worksheets (LKS) are designed to integrate local traditions of **Puru Timbu**. The Mbojo tribe uses STEM-based mathematics learning to improve students' mathematical communication skills. At the beginning of the activity, students are invited to observe directly or through pictures the Puru Timbu tradition, which involves cooperation in collecting and preparing food ingredients. The teacher then provides stimulus in the form of trigger questions, such as "How does the community calculate the amount of harvest that is divided among each family?" or "What is the strategy for fair distribution?" These questions encourage students to connect with real-world situations with mathematical concepts, particularly number operations, comparison, and data representation.

Next, students are directed to work in small groups to solve contextual problems presented in the worksheets, such as determining the ratio of food ingredients, creating a division model in the form of a table or diagram, or representing distribution patterns in the form of a simple equation. During the discussion process, students are encouraged to explain their thinking steps both orally and in writing, so that aspects of mathematical communication are truly trained. Teachers play an active role in providing guidance, asking guiding questions, and stimulating students to use appropriate mathematical terminology.

In the next stage, students are asked to present the results of their group work in the form of a short presentation to the class. At this moment, their mathematical communication skills are assessed through the clarity of delivery, the accuracy of the use of mathematical language, and the ability to answer questions from peers or the teacher. The worksheet also facilitates students to write a conclusion in the form of a personal reflection on how the Puru Timbu tradition can be connected to the mathematical concepts being studied. Thus, the worksheet is not only an instrument for solving problems, but also a means of building mathematical understanding rooted in local culture while developing better communication skills.

**Hasil HLT (Hypothetical Learning Trajectory)**

**Table 3. Hasil HLT (Hypothetical Learning Trajectory)**

Level	Student Activities (Revised)	Alleged Thinking Process (Students' Thinking)	Focus on Mathematical Communication
A. Cultural Context / Observation (Ethnomathematics)	Students observe videos/images of the Puru Timbu stages (soaking, filling bamboo, pouring coconut milk) while completing a simple observation sheet (column: what is observed – its relationship to mathematics). Students write down any questions that arise.	Students begin to relate the measurements of ingredients (rice, coconut milk) to the volume of bamboo containers. They develop an understanding of volume division, proportion, and contextual relationships.	Students describe the process orally and write questions in the form of simple sentences.
B. Traditional vs Modern Measurement Experiments	Students in groups measure ingredients (rice, coconut milk) using a replica of Puru Timbu and then compare them with measuring cups (a uniform tool). Students take at least three measurements, record the results in a comparison table, and write conclusions.	Students estimate volume equivalence (e.g., 1 bamboo $\approx$ x mL), test hypotheses, and understand differences in results between measurements.	Students record data in tables, write short conclusions, and present the results in the form of numbers and sentences.
C. Making a Smart Bamboo Miniature / Model	Students design a bamboo miniature as a "measuring vessel" by paying attention to scale (using a ruler or millimeter paper). Students draw a sketch, calculate the approximate volume, and write down the calculations.	Students think about the relationship between the height and diameter of bamboo and volume, and how proportions affect capacity.	Students draw, write volume calculations, and explain written ideas in addition to visuals.
D. Formulating Contextual Questions & Solving Them	Students create Puru Timbu-based problems using examples from the teacher, then include complete solutions. Answer format: mathematical model $\rightarrow$ calculation $\rightarrow$ conclusion in a sentence.	Students model problems in the form of fractions, proportions, and step-by-step calculations, and reason out solutions.	Students write questions, present mathematical models, calculation steps, and explain the reasons for the solution.
E. Presentation & Discussion	Each group presented their results according to the guidelines (questions–strategies–results–reflection). The discussion was followed by a strategy comparison session between groups. Afterward, students completed individual	Students explain ideas orally, answer questions, compare strategies, and reflect on experiences.	Students demonstrate mathematical communication through spoken language, symbols, tables, writing, and individual reflection.

---

reflection sheets related to the ideas or strategies of other groups.

---

This study also aims to determine the influence of ethnomathematics-based STEM learning, *Puru Timbu* on the mathematical communication skills of elementary school students. The results of data analysis show that there was a significant increase in students' mathematical communication skills after participating in STEM-based learning with a cultural context of *Puru Timbu*.

Descriptively, the average value of students' mathematical communication skills in the pretest was **62.15** (sufficient category), while in the posttest it increased to **81,40** (good category). This improvement is seen in all indicators of mathematical communication, namely: (1) the ability to express mathematical ideas orally and in writing, (2) the ability to present ideas in the form of pictures, symbols, and models, and (3) the ability to explain the reasons or steps for solving a mathematical problem.

The t-test results show the value **count = 6.87 with significance  $p = 0,000 < 0,05$** , so there is a significant difference between the pretest and posttest results. This means that ethnomathematics-based STEM learning, *Puru Timbu* has a positive influence on improving students' mathematical communication skills.

Qualitatively, observations and interviews also supported these findings. Students were more active in discussions, able to write critical questions, and more easily connected mathematical concepts to everyday cultural experiences. Furthermore, students demonstrated high enthusiasm in activities such as traditional versus modern measurement experiments, creating miniature bamboo models, and developing contextual problems. This demonstrates that integrating local culture through a STEM approach not only improves conceptual understanding but also strengthens the meaningfulness of learning for students.

Thus, it can be concluded that ethnomathematics-based STEM learning, *Puru Timbu* has a significant influence on improving elementary school students' mathematical communication skills, both cognitively and attitudinally. The results of the study indicate that ethnomathematics-based STEM learning, *Puru Timbu* has a positive effect on improving elementary school students' mathematical communication skills. This improvement is evident in the significantly higher average scores for each indicator, including the ability to convey ideas orally and in writing, represent concepts through symbols, images, or models, and explain problem-solving steps. This finding aligns with research demonstrating that ethnomathematics-based student worksheets (LKPD) can improve students' mathematical communication skills (Ramadhana et al. 2024), as well as studies that found ethnomathematics e-modules effectively improve mathematical understanding and communication (Babe et al. 2023).

Similarly, Ramadany's (2024) research using a Betawi ethnomathematics-based Resource-Based Learning model showed significant improvements in students' mathematical argumentation and representation. These results reinforce the theory of social constructivism, which emphasizes that social interaction, discussion, and cultural context can facilitate the formation of more meaningful mathematical concepts. Thus, integrating local cultural contexts such as *Puru Timbu* into the STEM framework not only makes learning more contextual but also effectively fosters mathematical communication skills, which are crucial for the development of elementary school students' numeracy literacy.

#### 4. CONCLUSION

This research has succeeded in developing **Hypothetical Learning Trajectory (HLT) based on STEM-Ethnomathematics *Puru Timbu*** through stages **Design Research**, that is *preliminary design, teaching experiment, And retrospective analysis*. The results of the study showed that the HLT developed was effective in improving the mathematical communication skills of elementary school students, as indicated by an increase in the average value of **62,15** on the pretest to be **81,40** on the posttest and the t-test results with a value  **$p = 0,000 < 0,05$** . The integration of *Puru Timbu* local culture into the STEM approach makes mathematics learning more meaningful, contextual, and close to

students' experiences, thus encouraging students to be more active in conveying ideas, explaining solution steps, using mathematical symbols, and drawing appropriate conclusions.

The results of this study imply that HLT based on STEM-Ethnomathematics Puru Timbu can be used by teachers as an alternative mathematics learning that supports the development of 21st-century skills while strengthening the implementation. **Independent Curriculum based** on local wisdom. Therefore, further research is recommended to test this HLT at different educational levels and with different mathematics materials to achieve broader validity. Furthermore, it is necessary to develop Puru Timbu-based digital learning media, such as e-modules, learning videos, or interactive applications, to make the use of local culture in mathematics learning more engaging, innovative, and appropriate to the needs of education in the digital era.

## 5. ACKNOWLEDGMENTS

The author would like to express his deepest gratitude to the **Ministry of Higher Education, Science, and Technology of the Republic of Indonesia** for their financial support and attention to the development of research and educational innovation in Indonesia. This support has been a significant motivation and contribution to the successful implementation of this research.

The authors also express their gratitude to all parties who assisted in the research, particularly the schools, teachers, and students who actively participated throughout the research process. We hope that the results of this research will benefit the development of mathematics learning, enrich STEM and ethnomathematics studies, and support the improvement of education quality in Indonesia.

## 6. BIBLIOGRAPHY

- Ahyansyah, A. (2019). Kemampuan literasi matematika siswa sekolah dasar ditinjau dari gaya belajar. In *Prosiding Seminar Nasional Lembaga Penelitian Dan Pendidikan (LPP) Mandala* (pp. 78-87).
- Ahyansyah, A., Mawaddah, S., & Sulistyani, S. (2025). Persepsi Guru terhadap Modul Matematika Berbasis Etno-STEAM untuk Meningkatkan Literasi Matematika Siswa Sekolah Dasar. *JagoMIPA: Jurnal Pendidikan Matematika dan IPA*, 5(3), 1161-1175.
- Andriasari, S., Pikri, H., & Helena, E. (2025). ANALISIS KEMAMPUAN BERPIKIR TINGKAT TINGGI SISWA DALAM PEMBELAJARAN MATEMATIKA: EVALUASI DAN TINDAK LANJUT SISWA KELAS 5 SD DI SDN 03 KOTO BALINGKA. *Didaktik: Jurnal Ilmiah PGSD STKIP Subang*, 11(02), 287-303.
- Arifin, A., & Hutapea, N. M. (2025). Analisis Kemampuan Komunikasi Matematis Siswa Pada Materi Statistika. *Lattice Journal: Journal of Mathematics Education and Applied*, 5(1), 14-28.
- Babe, A., Kurniawati, Y., & Prasetyo, A. (2023). Pengembangan e-modul berbasis etnomatematika untuk meningkatkan kemampuan komunikasi matematis siswa sekolah dasar. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 7(3), 2451–2463.
- Gravemeijer, K., & Cobb, P. (2006). Design research from a learning design perspective. In J. van den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.), *Educational Design Research* (pp. 17–51). London: Routledge.
- Lantakay, C. N., Senid, P. P., Blegur, I. K., & Samo, D. D. (2023). Hypothetical learning trajectory: bagaimana perannya dalam pembelajaran matematika di sekolah dasar. *Griya Journal of Mathematics Education and Application*, 3(2), 384-393.
- Mawaddah, S. (2025). Aktivitas etnomatematika pada tradisi Puru Timbu masyarakat Suku Mbojo. *DIKSI: Jurnal Kajian Pendidikan dan Sosial*, 6(2), 58-67.
- Mawaddah, S., Ahyansyah, A., & Daut, D. (2025). Pemahaman dan Tantangan Guru dalam Implementasi Pembelajaran Etnomatematika-STEM di Sekolah Dasar Kabupaten Bima. *JagoMIPA: Jurnal Pendidikan Matematika dan IPA*, 5(4), 1232-1241.

- Novia, H. (2026). Profil Keterampilan Berpikir Kritis Siswa SMA pada Materi Usaha dan Energi: Analisis Berdasarkan Indikator Facione. *Jurnal Pendidikan, Sains, Geologi, dan Geofisika (GeoScienceEd Journal)*, 7(2), 1672-1676.
- Ramadany, L. D., Sujana, A., Sopandi, W., & Hidayat, F. A. (2025). Profiling sustainable environmental awareness of primary school students in Sorong District by gender and school location. *Journal of Science Education Research*, 9(2).
- Rosa, M., & Orey, D. C. (2020). Ethnomathematics and its diverse approaches for mathematics education. In M. Rosa, U. D'Ambrosio, D. C. Orey, L. Shirley, W. V. Alangui, P. Palhares, & M. E. Gavarrete (Eds.), *Current and Future Perspectives of Ethnomathematics as a Program* (pp. 1–19). Cham: Springer. [https://doi.org/10.1007/978-3-030-16335-2\\_1](https://doi.org/10.1007/978-3-030-16335-2_1)
- Salmila, Y., Deswita, R., & Sari, M. (2025). Hypothetical Learning Trajectory (HLT) Berbasis Realistic Mathematics Education Pada Materi Barisan dan Deret Aritmatika. *Jurnal Penelitian dan Pembelajaran Matematika*, 18(1), 73-90.
- Sartika, E., & Kau, M. U. (2025). INOVASI PEMBELAJARAN STEM UNTUK MENINGKATKAN KETERAMPILAN BERPIKIR KRITIS, KOLABORATIF, DAN PROBLEM SOLVING DI ERA INDUSTRI 4.0. *JURNAL PENDIDIKAN DAN KEGURUAN*, 3(10), 1348-1354.
- Septina, E. A. (2025). Korelasi budaya, potensi lokal dan kearifan lokal pada pembelajaran ipa berbasis etnosains. *JOSERI*, 1(1), 25-32.
- Syarifuddin, S., Wirahmad, I., & Mikrayanti, M. (2025). Efektivitas Pendekatan STEM Berbasis Collaborative Learning terhadap Pemahaman Konsep Abstrak Siswa Sekolah Dasar. *Bima Journal of Elementary Education*, 3(1), 1-9.
- Zega, H., Mendrofa, R. N., Telaumbanua, Y. N., & Lase, S. (2025). Analisis Kesulitan Pemahaman Konsep Siswa Dalam Menyelesaikan Soal Peluang Ditinjau Dari Disposisi Matematis. *Emasains: Jurnal Edukasi Matematika Dan Sains*, 14(2), 288-307.