AsTEN JOURNAL OF TEACHER EDUCATION
VOLUME 8, ISSUE NUMBER. 1

Ethnomathematics Mobile Learning for Pre-service Elementary Teachers: Creative Thinking Obstacles and Didactic Design Analysis

Supriadi Supriadi, Muhammad Hanif
Universitas Pendidikan Indonesia

ABSTRACT

Ethnomathematics learning should target students' critical thinking skills and be packaged in an engaging platform. This article aims to analyze the obstacles to creative thinking skills and design the students' worksheets in Sundanese ethnomathematics mobile learning. This mixed-method study used design didactical and Rasch Model analysis that involved 78 pre-service elementary school teacher education students from various educational and ethnic backgrounds. Data were collected through questions about the learning obstacle test. The study revealed that students struggled to create visual models representing mathematical concepts. Students also experienced epistemological obstacles or insufficient knowledge in identifying traditional games associated with mathematical concepts and a deficiency in creativity. The findings led to the design of a Sundanese ethnomathematics mobile learning application to assist students in teaching mathematics concepts through three traditional Sundanese games. The study suggests incorporating Sundanese ethnomathematics in mobile learning environments in elementary schools to enhance creative thinking skills.

Keywords: Creative thinking, ethnomathematics, mobile learning, traditional games

ARTICLE INFORMATION

Article History
Received: May 26, 2024
Revised: December 2, 2024
Accepted: December 7, 2024

Editor-in-Chief
Watsatree Diteeyont, PhD

Managing Editor
Marie Paz E. Morales, PhD

Supriadi, S., & Hanif, M. (2024). Ethnomathematics Mobile Learning for Pre-service Elementary Teachers: Creative Thinking Obstacles and Didactic Design Analysis. *AsTEN Journal of Teacher Education, 8.*

Corresponding Author: Supriadi Supriadi
supriadi.upiserang@upi.edu

Introduction

Ethnomathematics learning in elementary school teacher education lectures aims to guide students toward achieving mathematics learning objectives using an ethno-pedagogical approach. However, students may face challenges or obstacles in learning as they must navigate mathematical concepts while simultaneously providing a cultural-based learning alternatives (Kamidah et al., 2023). Prospective primary school educators are expected to provide fundamental mathematical concepts through a creative cultural lens, ensuring the effective integration of mathematics and culture (Shahidayanti et al., 2024). The insufficient comprehension of cultural elements and creativity hinders the selection of an appropriate ethnomathematics learning methodology in practice (Putra & Mahmudah, 2021). These obstacles arise when significant questions arise, such as what issues should be inquired about, who should ask them, and how they should be inquired (Lupu, 2013). Learning obstacles in ethnomathematics are influenced by three factors: *ontogeny obstacles*, which affect students' mental readiness to learn; *didactical obstacles*, which relate to the teaching methods used by instructors; and *epistemological obstacles,* which relate to students' limited understanding within a specific context (Modestou & Gagatsis, 2013). Recognizing the challenges teachers and prospective teachers face in conveying mathematical concepts is essential, particularly when employing a culturally specific approach.

Developed countries, such as Japan and China, utilize local cultural contexts to address mathematics learning obstacles (Leung et al., 2015). ASEAN countries, including Indonesia, are beginning to integrate diverse cultural forms into learning (Nurhairani et al., 2024). Sundanese culture holds the potential for integration into learning.

Regrettably, the Sundanese culture has been largely neglected, with its traditional games, such as *Endog-Endogan, Engklek*, and *Congklak*, integral to this indigenous heritage, being forgotten by the younger generations of Indonesia (Supriadi, 2020). *Endog-Endogan* is a hand game played by clenching hands like eggs and then shaking and counting while singing. At the same time, *Engklek* is a board jumping game that uses a count as a marker for jumping steps on the ground. It is similar to *Rayuela* in Latin America *Congklak* is a game that uses plant seeds inserted into the hole according to the calculation in turn. In the Philippines, this game is called *Sungka.*

Educators can use those three traditional games to incorporate mathematical learning and cultural elements, as they involve mathematical concepts (Supriadi et al., 2023b). So, incorporating Sundanese ethnomathematics into the curriculum can benefit elementary school teachers by effectively introducing fundamental mathematical concepts to students. Previous implementations of traditional Sundanese games mostly focused on enhancing students' mathematical modelling skills (Nugraha et al., 2020; Supriyadi et al., 2022), with less consideration given to the perspectives of teachers and prospective teachers. Furthermore, the selection of traditional games is predicated on anticipated utilization rather than the formulation of integrated models or media customized to student needs (Supriadi & Arisetyawan, 2020); thus, this research aims to identify the creativity obstacles faced by prospective teachers and subsequently develop a medium that addresses these needs.

Literature Review

Teaching creative thinking skills is crucial in educational programs as it fosters a creative generation capable of solving future problems and disruptions (Asriadi & Istiyono, 2020). Creative thinking is a gathering information to generate new understandings, ideas, or concepts, making it an important skill for the future generation (Srikoon et al., 2018). Creative thinking involves being divergent, with four indicators: *fluency, flexibility, originality, and elaboration.* Fluency involves developing many ideas, flexibility produces ideas in various categories, originality produces unusual or unique ideas, and elaboration adapts abstract ideas into realistic solutions (Kaufman & Sternberg, 2010 in Setiawan et al., 2020).

Mathematics education focuses on logical and systematic thinking, requiring creative thinking. However, most math instruction is based on examples and practice, resulting in limited problem-solving discussions and limited basic concepts understanding among students. Creativity in mathematics learning can be enhanced by incorporating concepts relevant to the real world and students' interests (Ogunkunle & Goerge, 2015). Cultural elements and games are closely associated with students' real lives and contain the potential to stimulate learning interest (Hu et al., 2018). Combining culture, mathematical concepts, and creative thinking can improve outcomes influenced by scientific and practical aspects (Nurzulifa & Dwijanto, 2021). Silvia and Beaty (2012) suggest that effective and enjoyable mathematics learning is attributed to students with strong imagination and creativity. Sundanese ethnomathematics learning can be used in elementary school teacher education to enhance creative skills and cultural sensitivity in mathematics, potentially enhancing teacher education (Supriadi et al., 2019).

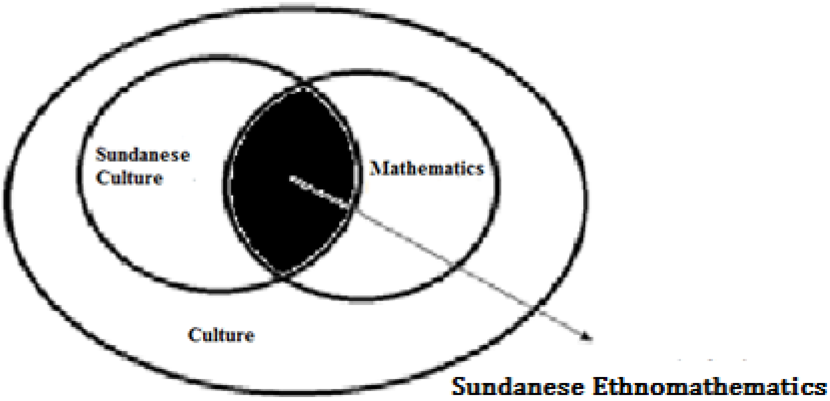
Sundanese ethnomathematics is the intersection of mathematics and Sundanese culture reflected in the content of cultural products (see Figure 1). Sundanese ethnomathematics refers to the cultural views and values that shape mathematical thinking, viewing mathematics as a cultural product. Sundanese culture has some unique treasures that intersect with mathematics in the form of songs and games. Among the games relevant to primary school mathematics teaching are *Endog-Endogan, Engklek* and *Congklak* (Asrial et al., 2020; Supriadi et al., 2023b). Previous research has shown that these three games are used to improve basic concept understanding and higher-order thinking skills in mathematics learning (Fitri & Supriadi, 2023b; Kamid et al., 2021; Wijayanti & Trisiana, 2018).

Research on students' mathematical creative thinking skills developed through this cultural-based learning is relatively new (Hadar & Tirosh, 2019). Utilizing Sundanesenese cultural context as students' thinking ideas can help bridge the gap in learning approaches by combining various learning approaches. This approach can enhance pre-service students' and teachers' creative mathematical thinking processes by highlighting their unique mathematical thinking processes (Hwang et al., 2007; Simamora et al., 2018; Skovsmose, 2020).

Specific models, steps or integrative environments need to be designed according to learner requirements to enhance the learning process. Before implementing learning interventions, it's crucial to identify learning obstacles (error-solving problems). Different obstacles require different development solutions because the complexity of integration in ethnomathematics varies greatly between cultural, mathematical, and general learning environments. Learning developers should then create teaching materials that improve

Figure 1

Sundanese Ethnomathematics Concept



the learning trajectory (syntax or structure of delivering concepts) based on the data on these obstacles (Bayu et al., 2023).

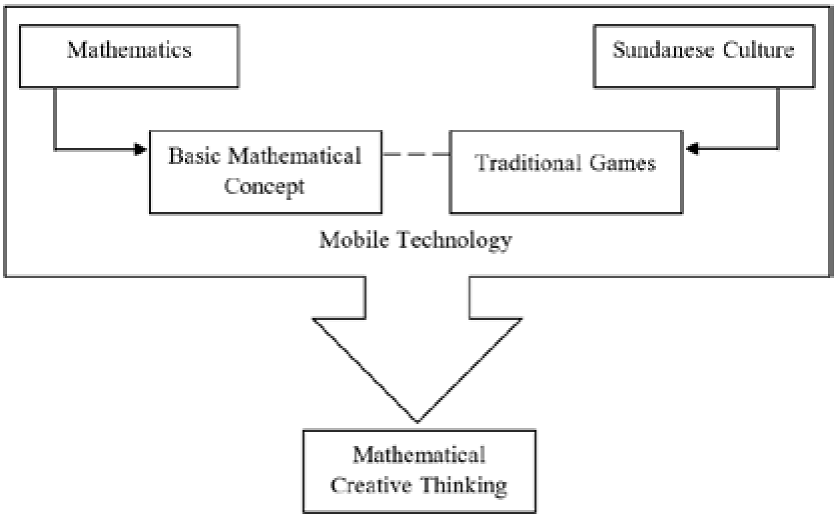
This research introduces Sundanese ethnomathematics learning through mobile learning. It modified Sundanese culture to incorporate mathematical concepts with a mobile learning environment (see Figure 2). The mobile learning trend has grown due to the increasing demand for wireless and mobile computing technologies. The innovative approach to teaching and learning is a paradigm shift that traditional classrooms may need to provide. School education is urged to foster a creative, knowledgeable, and meaningful society with flexible information and skills (Dzhurylo & Shparyk, 2019; Sharples et al., 2015; Yunianta et al., 2012). Ethnomathematics learning can benefit from mobile learning, as it enhances the cultural-based approach by fostering students' shared interests (Salim et al., 2023).

Combining ethnopedagogy with technology is a challenge. Both have advantages and drawbacks, and it is assumed that culture-based approaches make little use of information and communication technology. There are very few examples of the combination of ethnopedagogy with technology in its utilisation. For example, research of Rohaeti et al. (2020), which developed the use of Visual Basic Application for Microsoft Excel with ethnomathematics content or Suryawan et al. (2023a), which developed ethnomathematics-based digital modules as independent teaching materials. Some previous research include ethnomathematical elements with technology only as media content but did not make it the main learning activity (Sitokdana et al., 2019; Wawan et al., 2023).

Much of the ethnopedagogical content is presented in digital media, making it a conceptual and limited-use object (Gandana et al., 2022; Majid & Warman, 2022). The portion between technologies used in learning and ethnopedagogy should be balanced and synchronised to cover the weaknesses of didactic practices (Silitonga et al., 2021). The combination of these two factors in learning practice has the potential to increase effectiveness. However, cultural forms and

Figure 2

Sundanese Ethnomathematics Mobile Learning Concept



features must be highly customised to the needs and forms of activities or cultural entities raised in learning (Rochmah et al., 2021; Wijayanti et al., 2024).

The few studies integrating ethnomathematics with technology-based media platforms are limited to digital mediums, but none have incorporated it into integrated activities such as mobile learning. This is because the cultural attributes raised are generally difficult to turn into activities facilitated by learning technology (Suryawan et al., 2023b). However, in this research, a mobile learning mode designed to integrate the activities and concepts of Sundanese ethnomathematics theory is offered and tested for its suitability to the needs and effectiveness.

Mobile technology has ubiquitous features that allow ethno-pedagogical approaches to be implemented outside of specific cultural sites and make learning situations manageable (Cahyana et al., 2020). In addition, the flexibility that is the advantage of mobile learning is expected to support the reality of the concept and the closeness of the material from the ethnomathematical elements developed into the advantages of the medium to be developed.

Research Questions

This research aims to analyze the extent of (a) the learning obstacles of creative thinking skills in Sundanese ethnomathematics and (b) the didactic design of the Sundanese ethnomathematics mobile learning based on the student's creative thinking obstacles. The preliminary information will aid in creating a comprehensive mobile learning program for Sundanese ethnomathematics to enhance students' creative thinking skills.

Participants

The study involved 78 elementary school teacher education program students who got a one-month exposure to ethnomathematics instruction incorporating Sundanese cultural elements. They are third-year students in the department aged 20-21 years old who have completed all mathematics learning courses in primary schools and specialised in ethnopedagogy.

The participants were purposively selected from a total of 120 students population in a university based on ethnic background and major specialisation to see the feasibility of didactic design in different groups. The selected participants filled out a consent form to voluntarily participate as subjects of this study. In this study, participants were grouped based on Sundanese (45) and non-Sundanese (33) ethnicity and based on science (39) and non-science (39) majors.

Methodology

Research Design

This study utilized a mixed method by the didactical design method (Rudi et al., 2020; Salinas et al., 2013) to analyze the learning obstacle and create a students' worksheet of Sundanesenese ethnomathematics learning in a mobile environment.

Data collection

This research employed quantitative and qualitative data collection. In the quantitative phase, the study utilized four question items, worksheet learning, and creative thinking instruments to investigate the learning obstacles, adapted to *Endog-Endogan, Engklek*, and *Congklak* games. Students are asked to do a creative thinking test through a paper-based test. The data on the mathematics learning obstacles were assessed after a month of ethnomathematics learning with Sundanese culture and analyzed using the Rasch Model (Chan et al., 2021). Qualitative data was obtained from focus group discussions (FGD) on developing Sundanese ethnomathematics learning applications with two learning design experts, one mathematics learning expert, and five student volunteers. The data obtained is realised in the form of mobile application design. Figure 3 shows the initial

Figure 3

Interface Cover of Mobile Sundanese Traditional Games

Table 1

Questions of Mathematics Learning Obstacle

No	Questions	Creative Thinking Indicator
1	How do you teach the concept of addition 5+2=7 using one of the traditional games you know?	Fluency
2	Write down some ways to explain the concept of subtraction 4-1=3 with other traditional games!	Flexibility
3	Do you know the *Congklak* game shown in the picture below? Come up with an idea from this game to explain the addition of integers! If the above problem can be extended, make it for several cases in the addition of integers!	Elaboration
4	Make other forms of the game below! Can you give an idea that can be related to a concept in learning math related to numbers?	Originality

design of mobile learning with the icon of a child and three traditional Sundanese games that will be completed according to the results of learning obstacles.

Instrument

The instrument of learning obstacles is derived from Kaufman and Sternberg's creative thinking criteria (Setiawan et al., 2020). It is a mathematical question aligned with the previous instalment, ensuring validity and reliability. The instrument underwent expert content and construct validation and achieved a Cronbach's alpha reliability coefficient of .79. Table 1 presents the test instrument for the mathematics learning obstacle.

Data Analysis

The quantitative analysis of learning obstacles was conducted using the Rasch Model, while the qualitative part was used for descriptive analysis from the didactic design of a mobile learning worksheet. The didactic design is developed based on analysing learning obstacles and involves three prominent Sundanese games prepared: *Endog-Endogan, Engklek*, and *Congklak*.

Ethical Consideration

This study has no potential psychological or social sources of harm. All subjects of this study voluntarily participated without pressure or coercion. The researchers guarantee anonymity by not collecting any personally identifiable information without the consent of the participants and by explaining the study's benefits, risks, objectives, and institutional approval.

Findings and Discussion

Creative Thinking Learning Obstacles in Ethnomathematics

Table 2 presents the students' results on learning obstacles and teaching ideas in ethnomathematics.

The data in Table 2 shows that the minimum score in all groups is the lowest score of 0 compared to the total maximum score of 40. This indicates that some students face many difficulties in mathematical creative thinking. Overall, the highest student score is 22 out of a total maximum of 40, indicating that the highest level of student mathematical creative thinking is only up to a moderate level. Students' mathematical creative thinking skills are generally low, with an average score of 9.55 out of a maximum total score of 40.

More specifically, when broken down into each aspect of creative thinking, all students experienced difficulties. From a maximum score of 10.0, the average scores of fluency, flexibility, elaboration, and originality were 2.03, 3.08, 2.69, and 1.76, respectively. All indicators showed a low level, so students still experience obstacles in all indicators of mathematical creative thinking. The forms of constraints are classified and described in the next section.

The separation between cultural groups and majors showed no difference, as all scores were still low. However, it was found that the Sundanese and science groups were higher than their comparison groups. The *learning obstacle* data revealed that students struggle to associate mathematical concepts with traditional games like *Endog-Endogan, Engklek*, and *Congklak* and only understand a few traditional games related to integers and fractions. The local culture is not fully integrated into the mathematics curriculum, making learning less meaningful (Hadar & Tirosh, 2019).

The researcher identified various types of difficulties based on the results. Type 1: Students have difficulty making model images to represent mathematical ideas (required learning media consisting of mathematical and game ideas being taught). Type 2: Students face epistemological learning obstacles (LO) when searching for traditional games, with only two games dominating knowledge among respondents, indicating low student creativity.

Table 2

Student Response to Learning Obstacles Test

Group		Min	Max	Mean	Creative Thinking Indicators			
					Fluency	Flexibility	Elaboration	Originality
Cultural	Sundanese	0	19	7.36	1.36	2.38	2.20	1.42
	Non-Sundanese	0	22	12.55	2.94	4.03	3.36	2.21
Majors	Science	0	22	12.44	2.54	4.05	3.62	2.23
	Non-Science	0	18	6.67	1.51	2.10	1.77	1.28
All		0	22	9.55	2.03	3.08	2.69	1.76

Table 3

Statistical Analysis of Learning Obstacles in Mathematical Creative Thinking

	Total Score	Count	Measure	Model Error	Infit		Outfit	
					MNSQ	ZSTD	MNSQ	ZSTD
Mean	5.9	4.0	**-1.56**	.65	.99	-.1	1.00	-.1
SD	2.3	.0	.99	.11	.77	1.1	.78	1.2
Max	12.0	4.0	.49	1.07	2.89	2.1	3.04	2.3
Min	1.0	4.0	-4.16	.47	.06	-2.1	.06	-2.1

Real RMSE = .76 True SD = .64 Separation = .83 Person Reliability = .41
model RMSE = .66 True SD = .74 Separation = 1.12 Person Reliability = .56
S.E.of Person Mean = .12

	Total Score	Count	Measure	Model Error	Infit		Outfit	
					MNSQ	ZSTD	MNSQ	ZSTD
Mean	5.6	4.0	-1.71	.70				
SD	2.6	.0	1.23	.25				
Max	12.0	4.0	.49	1.86				
Min	.0	4.0	-5.47	.47				

Real RMSE = .83 True SD = .91 Separation = 1.09 Person Reliability = .54
model RMSE = .74 True SD = .98 Separation = 1.32 Person Reliability = .63
S.E.of Person Mean = .14

Person Raw Score-To-Measure Correlation = .97
Cronbach Alpha (KR-20) Person Raw Score "Test" Reliability = .51

	Total Score	Count	Measure	Model Error	Infit		Outfit	
					MNSQ	ZSTD	MNSQ	ZSTD
Mean	110.0	78.0	.00	.15	.94	-.4	1.00	.0
SD	25.9	.0	.55	.01	.13	.8	.12	.8
Max	149.0	78.0	.66	.16	1.10	.6	1.14	.8
Min	80.0	78.0	-.81	.14	.77	-1.5	.81	-1.2

Real RMSE = .15 True SD = .53 Separation = 3.55 Person Reliability = .93
model RMSE = .15 True SD = .53 Separation = 3.60 Person Reliability = .93
S.E.of Person Mean = .32

The data shows that in in-game activities, the weakest aspects of creativity are fluency and originality. It was in line with the theory that students' lower creative abilities are influenced mainly by fluency and originality (Hocevar, 1979). The two aspects are interrelated and affect each other. The lack of originality arises because modifying cultural ideas and combining them with mathematics requires high-order thinking, necessitating cognitive habituation in lectures (Benedek & Zöhrer, 2020). Students need to be familiar with and experience a variety of forms of cultural elements so that creative alternatives can emerge and find solutions that are different or original from those that have been experienced. Subsequently, the data underwent analysis using the Rasch Model Analysis, generating the following output data in Table 3.

The mean value of students completing the learning obstacles test instrument in mathematical creative thinking ability was -1.56, indicating that their abilities were less influenced by the difficulty level of the questions, as indicated by

Figure 4

Variable Map of Respondents' Ability

```
TABLE 1.3 DATA INPUT DIF.xlsx                   ZOU044WS.TXT  Oct 26 2021 11: 6
INPUT: 78 PERSON  4 ITEM  REPORTED: 78 PERSON  4 ITEM  7 CATS     WINSTEPS 4.4.5
--------------------------------------------------------------------------------

MEASURE ITEM - MAP - PERSON
        <rare>|<more>
   1         T+
              |
              |
           X S|
              |T P37 A
           X  |  P67 A
              |
   0         M+  P21 A  P36 A
           X  |
              |  L3  A  L7  S  P16 A  P35 A  P45 A
              |
             S|S
           X  |  P32 A  P33 A  P44 A  P51 A  P64 A  P7  A
              |
  -1         T+  L4  A  L6  S  P10 S  P26 A  P27 S  P28 S  P29 S  P30 S  P31 A
                 P34 S  P38 A  P41 S  P42 S  P43 A  P56 A  P70 A  P8  A
              |
              |
              |  L2  S  L8  A  P12 S  P13 A  P14 S  P19 S  P2  S  P40 A  P49 S
                 P54 A  P60 A  P9  A
              |M
              |  L5  S  P15 S  P18 A  P22 A  P23 A  P39 S  P4  S  P5  S  P53 S
                 P55 A  P69 A
              |
  -2          +
              |  P20 A  P3  A  P46 A  P47 A  P61 A  P62 A  P63 A
              |
              |
              |S
              |  P17 A  P50 S  P57 S  P58 S  P59 A  P65 S
              |
  -3          +
              |
              |  P11 A  P52 A  P66 S
              |
              |T
              |
              |
  -4          +  L1  S  P24 S  P48 S  P68 S
              |
              |
              |
              |
              |
              |
  -5          +  P1  S  P25 S  P6  A
        <freq>|<less>
```

the logit value below 0.00. The person reliability was .41, while the item reliability was .93. The consistency of student answers was weak, but the quality of questions in the learning obstacles test instrument was good.

The instrument's reliability is estimated at .92, indicating excellent reliability. The range of student abilities is +0.48 to -5.36, with the minimum extreme number being three people. More visual details are provided in the Wright variable map in Figure 4.

Figure 4 displays the research data analysis results, revealing the data person working on the test (78 people) and the number of items (up to 4). Three key points are analyzed based on the Wright map, including:

First, the analysis reveals that P37 and P67 can answer the most questions, with P37 having the highest ability (+0.48 logit). However, the ability only works on 3 out of 4 items tested and cannot work on Q1 questions with the highest difficulty level. The study found that P67 (+0.25 logit) had a lower ability than P37 but could

Table 4

Analysis of the Difficulty of Items

Person: REAL SEP.= 1.07 REL.= 0.53 ... Item: REAL SEP.= 3.73 REL.= 0.93
Item STATISTICS: MEASURE ORDER

Entry No.	Total Score	Total Count	Measure	Model S.E	Infit		Outfit		PT-Measure		Exact Match		Item
					MNSQ	ZSTD	MNSQ	ZSTD	Corr.	Exp.	Obs%	Exp%	
1	80	78	.68	.16	.84	-1.0	.96	-.2	.50	.56	60.0	49.3	N1
4	95	78	.32	.15	.76	-1.6	.81	-1.2	.62	.59	49.3	47.6	N4
2	116	78	-.13	.15	1.03	.3	1.08	.5	.52	.63	54.7	47.6	N2
3	153	78	-.87	.13	1.12	.7	1.17	1.0	.79	.67	36.0	46.5	N3
Mean	110.0	78.0	.00	.15	.94	-.4	1.00	.0			50.0	47.7	
SD	27.4	.0	.58	.01	.15	.9	.13	.8			8.9	1.0	

perform the same problem with P37. Out of 78 participants, only 15 were able to perform the questions well, including P37, P67, P21, P36, L3, L7, P16, P35, P45, P32, P33, P44, P51, P64, and P7. The analysis reveals that three individuals, P1, P25, and P6, have the lowest abilities in counting integers and fractions related to local culture. This indicates a need for additional attention from lecturers to improve the students' understanding.

Second, the item's left side reveals varying difficulty levels, starting with the most challenging Q1 item, followed by the easiest Q4, Q2, and Q3 sequences, indicating the item's complexity. The package's varied questions provide valuable information about students' abilities, but the difficulty in arranging questions on the top left makes it difficult for many students to work optimally. Out of 78 students, only 15 excelled in answering three out of four items, while the others struggled with the easiest questions (Q3).

Third, the distribution of abilities on the right is wider than the distribution of difficulty on the left, as shown by M-S-T (mean, 1SD, and 2SD) and other distribution methods. The study reveals that 78 students have varying abilities, and while the questions provided provide clear information about the learning process, students with low abilities still require assistance from lecturers to comprehend the material.

Table 4 indicated that the question with the highest difficulty level was number 1 in the fluency aspect, with the lowest total score of 80. Other challenging questions included number 4 in the originality aspect (score 95), number 3 in the flexibility aspect (score 116), and number 4 in the elaboration aspect (score 153). The study found that 78 students faced learning obstacles in mathematical creative thinking ability, with only two types of traditional games being familiar. The ideal score was 312, indicating difficulty in providing multiple relevant local cultural ideas for solving mathematical problems.

The data in Table 4 shows that students experience difficulties in fluency and originality. The type of obstacle encountered is an epistemological obstacle caused by a lack of exposure to elements of cultural knowledge and related basic mathematical concepts. The basic concepts of subtraction and factional numbers are already known, but only through one activity in one traditional game. To handle this, variations of the *Endog-Endogan* activity were created by modifying negative number integer subtraction.

Meanwhile, in the most challenging aspect, originality, students need to be trained to find their numbers and how to solve fraction calculations using a modified *Engklek* in the form of simple fractions with sequential steps (forward or backward). This method aims to make students find their fractions that can be used in math-based *Engklek* games (forward and backward and line order).

Didactic Design of Mobile Ethnomathematics Learning with Sundanese Game

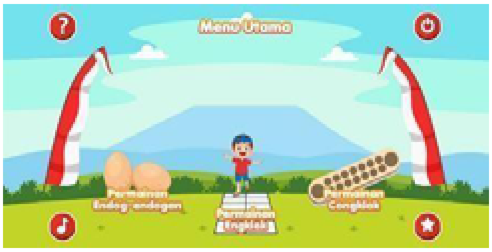
The Sundanese Ethnomathematics game's activity design will incorporate gameplay elements and the fundamental mathematical model (see Figure 5).

Didactic Design for Subtraction Concept

The researcher created activities and worksheets for students to teach basic mathematical concepts like subtraction using the *Endog-Endogan* game, based on learning difficulty results, to enhance creative thinking skills

Figure 5

Design of Game list in Sundanese Ethnomathematics Mobile Apps

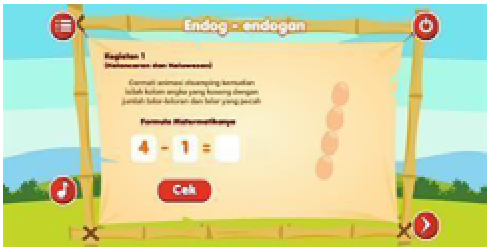


The main menu in Sundanese ethnomathematics displays game lists and functions on the game home page.

The user accesses the *Endog-Endogan* game by clicking on its icon/logo, which displays Read (*Baca*), Play (*Main*), Activity 1 (*Kegiatan 1*), and Activity 2 (*Kegiatan 2*), similar to the structure for *Engklek* and *Congklak* pages.

Figure 6

Students' Worksheet Design for Subtraction Concept using the Endog-Endogan Game



In Activity 1, the pencil icon displays math questions based on the audio and subtraction practice questions that the *Endog-Endogan* game following the song automatically answers. Example 4-1=

If the user's answer is incorrect, a red cross icon/logo notification will appear on the right, accompanied by audio, indicating the user's mistake.

A green checklist icon/logo notification on the right will indicate the correct answer, accompanied by a sound.

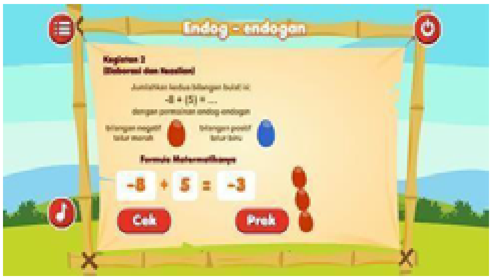
on the Sundanese ethnomathematics mobile platform (See Figure 6).

Didactic Design for Integer Concept

Another *Endog-Endogan* game was designed to teach subtraction in both whole numbers and integers. It was incorporated into an activity and worksheet based on the curriculum for simple integer concepts (See Figure 7).

Figure 7

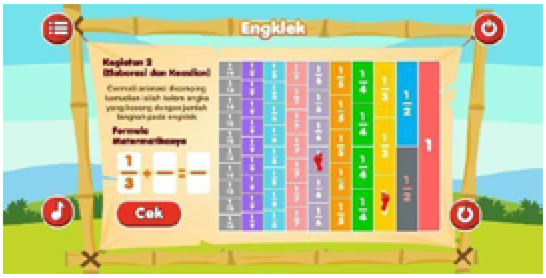
Students' Worksheet Design in Subtraction Concept using the Endog-Endogan game



Activity 2 features subtraction practice questions with negative numbers, with red (negative) and blue (positive) eggs. Students can answer questions using the *Endog-Endogan game*, using the basic buttons "Start", "Prek" (Crack), and "Cek (Check)" to crack and answer questions.

Figure 8

Students' Worksheet Design, in addition to the Concept of Fraction Numbers using the Engklek game



Activity 2 of the *Engklek* game offers practice questions for subtracting or adding fractions numbers where two pieces complement each other, with blue pieces having first fractions and red pieces having second fractions, indicated by footprints. For example, *Engklek* board with two footprints in 2 lines, for example, 1/3+1/6 = 1/2

Didactic Design for Fraction Concept

To target the concept of fractions, which brings out user originality, researchers modified the *Engklek* game from 1 board to several fraction number boards so that users can choose different ways of solving problems. The researcher created activities and worksheets for simple Fraction concepts using the *Engklek* game, as depicted in Figure 8.

Discussion

Learning Obstacles on Mathematical Creative Thinking in Ethnomathematics

The study reveals that even when the mathematics curriculum encourages students to develop new mathematical ideas, the category of finding mathematical ideas is rarely highlighted in textbooks, suggesting that some creative thinking goals may require more attention (Hadar & Tirosh, 2019). The data indicates that students' abilities tend to be less than the difficulty level of questions in the learning obstacles test instrument, as indicated by a logit value below 0.00. It supports Benedek and Zöhrer's (2020) claim that students' obstacles in learning mathematics stem from cognitive factors, including intellectual abilities and mental processing. The study found weak consistency in student answers on the learning obstacles test instrument, while the quality of questions was good.

The study found that 78 students had difficulties working on the learning obstacles test, with two meeting only one criterion. The cultural background did not affect difficulty, but the science background was perceived as better than the non-science background. Students' difficulties were attributed to limitations, such as difficulty creating image models representing mathematical ideas. In addition, this study also found that students faced learning obstacles in epistemology and limited knowledge in searching for traditional games, resulting in low creativity, particularly in fluency and originality in mathematical creative thinking, which is crucial for connecting mathematical and cultural ideas in learning mathematics.

This finding strengthens Lupu's (2013) results that in integrating culture in learning, especially science, epistemological challenges have the most substantial influence. So, designers must integrate cultural elements into learning activities as much as possible to support creativity. This finding is relevant to Hocevar (1979), who emphasized the importance of student creativity in education, and its development has become a teacher's additional accountability (Zemljak & Virtič, 2022). The importance of valuing a child's current perspective and understanding of the world to foster the development and appearance of creativity across various domains (Milić et al., 2018). Involving ethnicity and mathematics has potential and is closely related to developing students' creative thinking (Suherman & Vidákovich, 2024). The more exposure to forms and activities that intersect with culture, the stronger the epistemological foundation of prospective elementary school teachers will be. Therefore, it needs to be supported by an appropriate and acceptable medium to the students' level. Preparing prospective teachers with ethnomathematics competence is crucial to accommodate learning that stimulates creative thinking (Verner et al., 2019).

Didactic Design of Mobile Sundanese Ethnomathematics through Students Worksheet

The research utilized Sundanese traditional games, including *Endog-Endogan, Engklek,* and *Congklak*, which were culturally relevant and emphasized basic mathematics. The game rules were modified to enhance creative thinking skills, based on Meta-Peda-Didactic analysis, enhancing the overall research's strength. The Sundanese ethnomathematics mobile application is designed through re-personalization and re-contextualization, combining mathematical concepts, culture introduction, and mobile learning. This structured procedure and analysis enhance critical thinking skills through a well-designed didactic design (Dzhurylo & Shparyk, 2019).

Different mobile game activities incorporate traditional Sundanese games relevant to mathematics learning on the technology platform. Mobile games are designed with varying activities of practice and quiz materials. In the didactic design, the concept of subtraction is taught through the *Endog-Endogan* game and the concept of subtraction of whole numbers using the *Endog-Endogan* by placing the larger negative number. Meanwhile, the *Engklek* game modified with a fraction board can teach fraction addition simply. This integration element is considered relevant to fill the gap in the analysis results where the choice of modified game activities *Endog-Endogan* and *Engklek* proved successful in improving students' simple mathematical modelling skills (Fitri & Supriadi, 2023; Supriadi et al., 2023a; Supriadi et al., 2023b).

The activities in this mobile platform make the game less physical contact like the original game but still apply appropriate mathematical concepts. Additional technological features make the design of learning activities more flexible and fun. Traditional games also have a stronger relevance to the learning process because the atmosphere is set as a learning activity with an introductory concept rather than just a game and/or interaction with technology in a personalized way. The development of game activities in this mobile environment is also relevant because, apart from being appropriate to students' needs, it also adapts to the success of previous ethnopedagogic digital environment integration (Cahyana et al., 2020; Rochmah et al., 2021; Silitonga et al., 2021; Wijayanti et al., 2024) and is novel with cultural elements that are different from other mobile learning activities.

Implications

The study reveals that students face learning barriers when trying to connect mathematical concepts with local culture, particularly in counting integer operations using ethnomathematical learning, resulting in limitations in their understanding. Elementary teacher education students should not only rely on verbal explanations from lecturers but also interact with activities related to their understanding. Mobile learning-modified traditional game activities can be an alternative solution to simplify students' understanding of abstract integer operations concepts.

It answers the lack of prior ethnomathematics learning research that exploited students' barriers. The study reveals that students face complex obstacles, necessitating a didactic intervention combining ethnomathematics, games, and mobile learning. This intervention and the creation of activity sheets will enhance their mathematical creative thinking abilities.

The product of the didactic design from this research is predicted to suit students' needs, but further research needs to look at the effectiveness and also other forms of feasibility testing of the product that has been developed. Schools should encourage teachers to utilise technology and cultural combinations in classroom practices. Supporting and encouraging culture-specific approaches in the region can begin with integrating cultural values in the curriculum or syllabus.

In practical terms, the didactic design of Sundanese mathematics in mobile platforms can continue to be developed in other forms and types of games and used in other mathematics concept materials. Development from simple concepts can be done through expansion and modification of the game and a good mobile support system.

The contribution of this research theoretically shows the intersection pattern of the combination of mobile technology, traditional games and connected mathematics learning. Complementing the conception of traditional games in ethnomathematics, which tend to be physical and do not require digital technology as a tool. With this intersection and combination, it is hoped that the wider utilisation of Sundanese ethnomathematics through games and other cultural entities will increase.

The limitation of this research is on pre-service teachers, which is predicted to be very likely when the actual application in the classroom will encounter different obstacles, and the development of didactic design in the form of student activities has not been fully tested on elementary school students. This can be a note for further research development.

The implications of the results of this research can be used as a basis for developing other forms of culture-based learning and ethnopedagogy, as well as developing novelty in the use of mobile technology on subjects with cultural diversity and learning needs.

Conclusion

Ethnomathematics learning has been widely used to accommodate dominant cultural forms rather than student needs. The urgency of increasing creative thinking is especially rare, and no one has combined it with the flexibility of the mobile platform. This research aims to analyse the learning constraints of mathematical creative thinking in ethnomathematics-based learning and develop learning activities through didactic design using worksheets on mobile platforms.

The study revealed that students struggled with creating image models representing mathematical ideas, faced learning obstacles in epistemology, and had limited knowledge about traditional games related to mathematical concepts. Students encountered many obstacles in the epistemological mathematical creative thinking process due to a lack of mastery of concepts in formulating some basic mathematical concepts related to culture-based learning.

The Sundanese ethnomathematics mobile learning design aims to enhance students' creative thinking skills through traditional games in the form of mobile apps. Three Sundanese traditional games were selected as interventions, and the game modification process followed a didactic design approach to improve students' mathematical and cultural understanding. Therefore, learning activities and worksheets were designed as traditional Sundanese games of *Endog-Endogan* to teach the concept of subtraction of whole numbers and Engklek to teach the addition of fractions in a mobile game platform. The suitability of mathematical concepts and games framed by mobile technology activities are the proposed alternatives.

Ethnomathematics learning can enhance students' creative thinking skills by combining cultural and mathematical concepts. However, it should be tailored to real learning difficulties to create effective didactic design interventions. The limitation of this research is that the development process only used small-group design testing and simple mathematical concepts, and it did not reach the stage of testing the effectiveness of the product being developed. Future research ideally assesses the product effectiveness and could extend the utilisation of this design to other mathematical concepts.

This research can provide a foundation for investigating additional aspects and modalities of cultural integration relevant to the needs and creativity of teachers within the ASEAN context, given the ASEAN countries' shared yet diverse cultural traits. The challenges and possibilities of ethno-pedagogical exploration in ASEAN could benefit due to their vast cultural heritage.

▪ ▪ ▪

Statements and Declarations

1. **Funding details.**
   For single-agency grants
   This work was supported by the Indonesian Ministry of Research, Technology, and Higher Education under the Grant of 2023.

2. **Disclosure statement.**
   The authors report that there are no competing interests to declare.

3. **Declaration of Generative AI in Scientific Writing**
   -

4. **Acknowledgement.**
   The authors extend their gratitude to the Elementary School Teacher Study Program, Universitas Pendidikan Indonesia, where this research was conducted.

5. **Ethical Approval.**

   The research does not need any ethical approval from any institution.

References

Asriadi, M., & Istiyono, E. (2020). Exploration of creative thinking skills of students in physics learning. *Journal of Educational Science and Technology, 6*(2), 151–158. https://doi.org/10.26858/est.v6i2.12737

Asrial, A., Syahrial, S., Maison, M., Kurniawan, D. A., & Perdana, R. (2020). A study of traditional games "Engklek" in mathematics for elementary school. *Jurnal Ilmu Pendidikan, 26*(1), 15–21. http://dx.doi.org/10.17977/um048v26i1p15-21

Bayu, E.P.S., Fauzan, A., & Armiati, A. (2023). The development of teacher and student's book based on realistic mathematics education in statistics for a package program. *European Journal of Educational Research, 12*(1), 119–131. https://doi.org/10.12973/eu-jer.12.1.119

Benedek, M., & Zöhrer, L. (2020). Creativity on tap 2: Investigating dose effects of alcohol on cognitive control and creative cognition. *Consciousness and Cognition, 83*, 102972. https://doi.org/10.1016/j.concog.2020.102972

Cahyana, U., Rahmawati, Y., Paristiowati, M., Sasmoko, S., Ahman, A., Ferdianto, J., & Dudung, A. (2020). Ethnopedagogy integration with mobile learning to improve students' learning achievement in remote areas. *Universal Journal of Educational Research, 8(*5), 1687–1697. http://dx.doi.org/10.13189/ujer.2020.080505

Chan, S.W., Looi, C.K., Ho, W.K., Huang, W., Seow, P., & Wu. L. (2021). Learning number patterns through computational thinking activities: A Rasch model analysis. *Heliyon, 7*(9), e07922. https://doi.org/10.1016/j.heliyon.2021.e07922

Dzhurylo, A.P., & Shparyk, O.M. (2019). ICT competence for secondary school teachers and students in the context of education informatization: Global experience and challenges for Ukraine. *Information Technologies and Learning Tools, 70*(2), 43–58. https://doi.org/10.33407/itlt.v70i2.2438

Fitri, E.N., & Supriadi, S. (2023). Analisis desain didaktik etnomatematika melalui Endog-Endogan dalam mengembangkan kemampuan berpikir kreatif kelas II SD. *Didaktika, 3*(1), 67–77. https://doi.org/10.17509/didaktika.v3i1.38144

Gandana, G., Sumantri, M.S., Hapidin, H. (2022). Ethnopedagogical digital media of Sunda culture kindergarten as a psychological self-image development effort early child in West Java Province. *Journal of Positive School Psychology, 6*(9), 3049–3052. https://journalppw.com/index.php/jpsp/article/view/12797

Hadar, L.L., & Tirosh, M. (2019). Creative thinking in mathematics curriculum: An analytic framework. *Thinking Skills and Creativity*, *33*, 100585. https://doi.org/10.1016/j.tsc.2019.100585

Hocevar, D. (1979). Ideational fluency as a confounding factor in the measurement of originality. *Journal of Educational*

Psychology, 71(2), 191–196. https://psycnet.apa.org/doi/10.1037/0022-0663.71.2.191

Hu, X., Leung, F.K.S., & Teng, Y. (2018). The influence of culture on students' mathematics achievement across 51 countries. *International Journal of Science and Mathematics Education, 16*(1), 7–24. https://doi.org/10.1007/s10763-018-9899-6

Hwang, W.Y., Chen, N. S., Dung, J.J., & Yang, L.Y. (2007). Multiple representation skills and creativity effects on mathematical problem solving using a multimedia whiteboard system. *Educational Technology and Society*, *10*(2), 191–212. https://www.jstor.org/stable/jeductechsoci.10.2.191

Kamid, K., Sofnidar, S., Septi, S.E., & Citra, Y.D. (2021). The contribution of the traditional game of congklak to mathematics learning: How is the relationship and influence of interest, cooperative character and student responses. *Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran, 11*(2) 280–295. https://doi.org/10.25273/pe.v11i2.9995

Kamidah, N., Zaenuri, Z., Junaedi, I. (2023). Development of teaching materials using problem-based learning (PBL) models with ethnomathematics nuances to improve students' critical thinking ability. *International Journal of Research and Review, 10*(8), 228–235. https://doi.org/10.52403/ijrr.20230829

Leung, F.K.S., Park, K., Shimizu, Y., & Xu, B. (2015). Mathematics education in East Asia. In S. J. Cho (eds), *The Proceedings of the 12th International Congress on Mathematical Education* (pp. 123–143). Springer, Cham. https://doi.org/10.1007/978-3-319-12688-3_11

Lupu, C. (2013). Epistemological and psychological fundamentals of the didactics of science. *Procedia-Social and Behavioral Sciences*, *92*, 490–94. http://doi.org/10.1016/j.sbspro.2013.08.706

Majid, N., & Warman, W. (2021). The effectiveness of ethnopedagogy-based digital book processing in improving civics learning outcomes in distance learning. *Educational Studies: Conference Series, 1*(1), 15–25. https://doi.org/10.30872/escs.v1i1.923

Milić N.S., Nedimović, P., & Sturza S. (2018). The frequency with which creativity development strategies are used in various fields. *Journal of Elementary Education*, *11*(3), 202–214. https://doi.org/10.18690/rei.11.3.201%20-214.2018

Modestou, M., & Gagatsis, A. (2013). A didactical situation for the enhancement of meta-analogical awareness. *The Journal of Mathematical Behavior, 32*(2), 160–172. http://doi.org/10.1016/j.jmathb.2013.02.004

Nugraha, T., Maulana, M., & Mutiasih, P. (2020). Sundanese ethnomathematics context in primary school learning.

Mimbar Sekolah Dasar, 7(1), 93–105. https://doi.org/10.53400/mimbar-sd.v7i1.22452

Nurhairani, N., Sugito, S., Suyanta, S & Haryanto, H. (2024). Integrating local culture into STEM-based learning in ASEAN elementary schools: A literature review. *Proceedings International Conference on Education Innovation and Social Science, 3*(1)*,* 82–93. https://proceedings.ums.ac.id/iceiss/article/view/4970

Nurzulifa, S., & Dwijanto, D. (2021). Creative thinking mathematical ability of students in Treffinger learning based on cognitive style. *Unnes Journal of Mathematics Education, 10*(1), 52–61. https://doi.org/10.15294/ujme.v10i1.32402

Ogunkunle, R.A., & George, N.R. (2015). Integrating ethnomathematics into secondary school mathematics curriculum for effective artisan creative skill development. *European Scientific Journal, 11*(3), 386–397. https://eujournal.org/index.php/esj/article/view/5013

Putra, C.S., & Mahmudah, F.N. (2021). The implementation of ethnomathematics based-learning for students. *SJME (Supremum Journal of Mathematics Education), 5*(2), 162–169. https://doi.org/10.35706/sjme.v5i2.4827

Rochmah, N., Cahyana, U., & Purwanto, A. (2021). Development of mobile learning: Basis of ethnopedagogy of Baduy Community, Banten Province. *IOP Conference Series: Materials Science and Engineering, 1098,* 022092. http://doi.org/10.1088/1757-899X/1098/2/022092

Rohaeti, E.E., Fitriani, N., & Akbar, F. (2020). Developing an interactive learning model using visual basic applications with ethnomathematical contents to improve primary school students' mathematical reasoning. *Infinity, 9*(2), 275–286. https://doi.org/10.22460/infinity.v9i2.p275-286

Rudi, R., Suryadi, D., & Rosjanuardi, R. (2020). Teachers' Perception as a crucial component in the design of didactical design research-based teacher professional learning community in Indonesia. *European Online Journal of Natural and Social Sciences, 9*(3), 642–654. https://european-science.com/eojnss/article/view/6089

Salim, H., Waterworth, P.G., Daud, A., Dahnilsyah, & Hanif, M. (2023). The integration of digital technologies into practicum classrooms by smartphone-savvy pre-service teachers in Indonesia. European Journal of Educational Research, 12(2), 593–603. https://doi.org/10.12973/eu-jer.12.2.593

Salinas, P., González-Mendívil, E., Quintero, E., Ríos, H., Ramírez, H., & Morales, S. (2013). The development of a didactic prototype for the learning of mathematics through augmented reality. *Procedia Computer Science, 25,* 62–70. http://doi.org/10.1016/j.procs.2013.11.008

Shahidayanti, T., Prahmana, R.C.I., & Fran, F.A. (2024). Integrating ethno-realistic mathematics education in developing three-dimensional instructional module. *Journal of Honai Math, 7*(3), 379–400. https:/doi.org/10.30862/jhm.v7i3.698

Setiawan, R., Mardapi, D., Aman, A., & Karyanto, U. B. (2020). Multiple intelligences-based creative curriculum: The best practice. *European Journal of Educational Research, 9*(2), 611–627. https://doi.org/10.12973/eu-jer.9.2.611

Sharples, M., Adams, A., Alozie, N., Ferguson, R., FitzGerald, E., Gaved, M., McAndrew, P., Means, B., Remold, J., Rienties, B., Roschelle, J., Vogt, K., Whitelock, D. & Yarnall, L. (2015). *Innovating Pedagogy 2015: Open University Innovation Report 4.* The Open University. http://doi.org/10.13140/RG.2.1.4727.6885

Silitonga, R.W., Cahyana, U., Purwanto, A., & Rahmawati, Y. (2021). The effectiveness and learning outcomes of mobile learning integrated with ethnopedagogy on metacognitive ability of students in North Tapanuli. *AIP Conference Proceedings, 2331*, 040011. https://doi.org/10.1063/5.0041848

Silvia, P.J., & Beaty, R.E. (2012). Making creative metaphors: The importance of fluid intelligence for creative thought. *Intelligence, 40*(4), 343–351. https://psycnet.apa.org/doi/10.1016/j.intell.2012.02.005

Simamora, R.E., Saragih, S., & Hasratuddin, H. (2018). Improving students' mathematical problem solving ability and self-efficacy through guided discovery learning in local culture context. *International Electronic Journal of Mathematics Education, 14*(1), 61–72. https://doi.org/10.12973/iejme/3966

Sitokdana, M.N.N., Tanone, R., & Tanaem, P.F. (2019). Android-based digitalization of number system of traditional Ngalum, Ketengban, Lepki and Arimtap tribes. *Procedia Computer Science, 161*, 41–48. https://doi.org/10.1016/j.procs.2019.11.097

Skovsmose, O. (2020). Critical mathematics education. In S. Lerman (Eds.), *Encyclopedia of Mathematics Education* (pp. 154–159). Springer, Cham. https://doi.org/10.1007/978-3-030-15789-0_34

Srikoon, S., Bunterm, T., Nethanomsak, T., & Tang, K. N. (2018). Effect of 5P model on academic achievement, creative thinking, and research characteristics. *Kasetsart Journal of Social Sciences, 39*(3), 488–495. https://doi.org/10.1016/j.kjss.2018.06.011

Suherman, S., & Vidákovich, T. (2024). Relationship between ethnic identity, attitude, and mathematical creative thinking among secondary school students. *Thinking Skills and Creativity, 51,* 101448. https://doi.org/10.1016/j.tsc.2023.101448

Supriadi, S., Chudari, I.N., Sundari, N., Tiurlina, T., Ridwan, I.R., Wuryastuti, S., Alfarisa, F., & Robiansyah, F. (2019). Creative intelligence analysis in ethnomathematics learning. *International Journal of Innovation, Creativity and Change*, *5*(1), 169–188. https://www.ijicc.net/images/Vol_5_iss_1_2019/r-Supriadi_et_al_2019_Nov.pdf

Supriadi, S. (2020). Pre-Service elementary teachers: Analysis of the disposition of mathematical modeling in ethno mathematics learning. *Elementary Education Online, 19*(3), 1407–1421. http://doi.org/10.17051/ilkonline.2020.730747

Supriadi, S., Alfarisa, F., Hanif, M., Litundzira, R.S. (2023a). Endog-Endogan games of fractional number ideas in ethnomathematics learning. *AIP Conference Proceedings, 2698,* 060030. https://doi.org/10.1063/5.0122422

Supriadi, S., Alfarisa, F., Hanif, M., Rosita, R., Nurfitri, E., & Nurazizah, E. (2023b). The ethnomathematics learning with Endog-Endogan games to enhance mathematical modeling ability in integer operation and fractional number calculation of primary school students. *AIP Conference Proceedings, 2614,* 040044. https://doi.org/10.1063/5.0125834

Supriadi, S., & Arisetyawan, A. (2020). Didactical design of Sundanese ethnomathematics learning with Endog-endogan and Engklek games in primary school. *Journal of Physics: Conference Series, 1567,* 022087. https://doi.org/10.1088/1742-6596/1567/2/022087

Supriyadi, E., Dahlan, J.A., Juandi, D., Turmudi, T., & Sugiarni, R. (2022). Ethnomathematics in Sundanese culture from Scopus database: Systematic literature review. *Triple S: Journal of Mathematics Education, 5*(2), 77–86. https://doi.org/10.35194/ts.v5i2.2824.g1996

Suryawan, I.P.P., Lasmawan, I.W., & Suharta, I.G.P. (2023a). Innovation of multimodal digital modules based on ethnomathematical problems for meaningful mathematics learning in Merdeka Curriculum. *Journal of Education Research and Evaluation, 7*(4), 587–595. https://doi.org/10.23887/jere.v7i4.59931

Suryawan, I.P.P, Jana, P., Pujawan, I.G.N., Hartawan, I.G.N.Y., & Putri, P.E.W. (2023b). Improving students' critical thinking skills through an ethnomathematically controversial problem-based multimodal approach. *Pegem Journal of Education and Instruction, 13*(3), 323–336. https://doi.org/10.47750/pegegog.13.03.33

Verner, I., Massarwe, K., & Bshouty, D. (2019). Development of competencies for teaching geometry through an ethnomathematical approach. *The Journal of Mathematical Behavior, 56*, 100708. https://doi.org/10.1016/j.jmathb.2019.05.002

Wawan, W., Retnawati, H., & Setyaningrum, W. (2023). An integrative learning model to improve problem-solving and creative thinking abilities, collaboration, and motivation. *Islamic Guidance and Counseling Journal, 6*(2), 1–21. https://doi.org/10.25217/0020236402400

Wijayanti, R., & Trisiana, A. (2018). Pengaruh permainan Engklek berbasis etnomatematika terhadap kemampuan berpikir kritis peserta didik kelas III. *Jurnal Sinektik, 1*(2), 178–190. https://doi.org/10.33061/js.v1i2.2802

Wijayanti, S.W., Sausan, I., & Aditya Prasetyo, M. (2024). An ethnopedagogical approach: The design of AR-based mobile learning of molecular geometry in chemistry. *Jurnal Pendidikan Terbuka dan Jarak Jauh, 25*(1), 59–73. https://doi.org/10.33830/ptjj.v25i1.7731.2024

Yunianta, A., Yusof, N. Othman, M.S., & Octaviani, D. (2012). Analysis and categorization of e-learning activities based on meaningful learning characteristics. *World Academy of Science, Engineering and Technology, 69*, 811–816. https://doi.org/10.5281/zenodo.1078209

Zemljak D., & Virtič M. P. (2022). Are pedagogical students more creative than students of non-pedagogical programs? *Journal of Elementary Education*, *15*(2), 199–210. http://doi.org/10.18690/rei.15.2.199-210.2022