Cypriot Journal of Educational Sciences

Volume 19, Issue 2, (2024) 142-149

www.cjes.eu

The effectiveness of outdoor learning-based teaching materials for middle school students

Ridho Wardana [a*], Universitas Negeri Semarang, Sekaran, Gunung Pati, Semarang City, Central Java 50229, Indonesia, ridhoajiwardana5@students.unnes.ac.id
Amidi Amidi [b], Semarang State University, Faculty of Mathematics, Mathematics and Science Education, Semarang, Indonesia, amidi@mail.unnes.ac.id

Suggested Citation:
Wardana, R. & Amidi, A. (2024). The effectiveness of outdoor learning-based teaching materials for middle school students. *Cypriot Journal of Educational Science*, *19*(2), 142-149. https://doi.org/10.18844/cjes.v19i2.6986

Received from November 20, 2023; revised from December 09, 2023; accepted from March 21, 2024.
Selection and peer review under the responsibility of Prof. Dr. Hafize Keser, Ankara University, Turkey (retired)

iThenticate Similarity Rate: 0%

Abstract

One of the innovations that can be developed based on the problem of the learning angle created is a learning resource based on outdoor learning as an alternative learning media for students. This study aimed to determine the effectiveness of the use of PjBL Teaching Materials with Ethnomathematics Based Outdoor Learning. The sample consisted of 34 students from class VIII D with one group pre-test-post-test design. The results showed that the designed teaching materials were feasible to use. First, the data shows an N-gain coefficient, which indicates the effectiveness of teaching materials on students' mathematical communication. Other data collection shows that students understand the content of teaching materials. In conclusion, this teaching material makes students not only aware of the Pythagorean theorem material but also gives them a different learning atmosphere so that the material is imprinted more deeply in their memory.

Keywords: Ethnomathematics; mathematical communication; outdoor learning; teaching materials.

* ADDRESS FOR CORRESPONDENCE: Ridho Wardana, Universitas Negeri Semarang, Sekaran, Gunung Pati, Semarang City, Central Java 50229, Indonesia. *E-mail address*: ridhoajiwardana5@students.unnes.ac.id

1. INTRODUCTION

The new challenges of the COVID-19 pandemic have changed the order of life very quickly, including the implementation of the learning process which was originally face-to-face learning in schools into online learning at home (Mateo-Canedo et al., 2023). These challenges certainly go hand in hand with various opportunities, such as scientific and technological advances and demographic bonuses in 2045 (Sagala & Widyastuti, 2021). Therefore, education must be able to produce quality output in the form of Human Resources who have skills and competencies so that they can respond positively to challenges by utilizing various opportunities (Lase, 2019; Schwab, 2017; Frances et al., 2024).

The problem that is often encountered in school is that students easily forget the subject matter. Books/modules play an important role in restoring students' memories because modules can help students recover their memories through illustrations and explanations (Rachmawati et. Al., 2019). This problem is also found in the Pythagorean theorem material in class VIII students, where the results of preliminary studies show that students do not have good mathematical communication skills. Students have difficulty capturing the question commands given by the teacher. Some cannot represent problems in mathematical models. This is in line with the literature study from Arifani et al., (2021) which says that outdoor mathematics is an outdoor educational process; learning is about nature and aims for a better environmental future. It supports the student's experience in exploring wider and more enjoyable knowledge (Jucker & von Au 2022).

Outdoor learning is one alternative to getting closer to nature directly (Neville et al., 2023; Van Kraalingen & Beames 2024). Oktaviani et al., (2018) and Schroth (2023) explained that outdoor learning is learning that invites students to find all answers or problems outside the classroom by observing and researching directly. When math is taught in this way, students' arithmetic lessons become more significant and memorable. Additionally, one way to help pupils understand Pythagorean theorem content better is to help them communicate their mathematical ideas more effectively. This is especially true for junior high school students.

The application of *Project Based Learning* (PjBL) with the character of collaboration to mathematical communication skills is effectively shown by achieving classical and individual completeness and improvement. Every student is required to study mathematics for various reasons, one of which is that mathematics is a systematic and appropriate communication tool because mathematics is closely related to everyday life. Students' vocabulary will increase by communicating, they can also develop the ability to speak, write various ideas systematically, and have better learning ability. Communication is an important part of mathematics and mathematics education. Communication is a way of sharing ideas and clarifying understanding. Through communication, ideas become objects that can be reflected, improved, discussed, and developed. The communication process also helps to build meaning and make ideas easier and can generalize or explain ideas (Maulyda, 2020).

1.1. Purpose of study

The ability that plays a very important role in mathematics learning is the ability to communicate mathematically because mathematics communication is the ability to write, integrate, and evaluate ideas, symbols, mathematical information, and mathematical terms. However, some factors affect the level of student ability, and students also have difficulty in sketching and revealing everyday questions or events to mathematical symbols. One of the materials that make students difficult is the Pythagorean Theorem in the mathematics material of junior high school students / MTs class VIII. The Pythagorean theorem is a subject whose concept is frequently applied in other mathematical learning, especially in

the subject of geometry, which is why the Pythagorean theorem was chosen as the subject matter for this research proposal. This means that a teacher must package learning through the PjBL model of Outdoor learning for students to comprehend not only the formula but also to research, discover, and articulate their Pythagorean concepts as well as apply Pythagorean concepts to real-world mathematical difficulties. Based on the explanation of the aforementioned idea, research was done in this work to demonstrate the efficacy of learning about the Pythagorean theorem using the PjBL model of outdoor learning (Puloo et al., 2020) .

2. METHOD AND MATERIALS

This research is a pseudo-experimental study. This study was used to calculate the effect of certain treatments on a particular sample of the population. The data obtained is processed and described using words (quantitative descriptive).

2.1. Research design

This research uses a one-group *pre-test-post-test* design; the research design with the initial stage provides a *pre-test* sheet for students to work on before obtaining teaching materials and provides a post-test sheet to find out the results after being given teaching materials. The design of this research is described in the following design (figure 1):

Figure 1

One-Group Pretest-Posttest Design

$O_1 \quad X \quad O_2$

Information:

X : *treatment*

O_1 : *pretest* value

O_2 : *posttest* value

2.2. Participants

The population of this study is a class VIII D student of SMP Negeri 4 Ungaran in 2021/2022 consisting of 34 students. A sample is a portion of a population or several individuals (objects) that represent a study. A good sample can describe the population. The sampling technique used is random sampling. This technique provides the same possibility for each individual in the population to be sampled for research. Sample members are selected by lottery because the school gives the discretion to select the research subject, and all sample members are homogeneous. In this study, researchers sampled 34 students consisting of VIII D classes.

2.3. Data collection techniques

2.3.1. Observation

This study population is a class VIII junior high school student in 2021/2022 consisting of class VIII D as many as 34 students. The study observed students' mathematical communication skills in ethnomathematically assisted *outdoor learning* ethnomathematical. In this study, data collection refers

to the rubric of assessment of each capacity. This rubric is used to observe the ability of students in learning and following learning from the initial stage to the final stage.

2.3.2. Test

Tests are a form of measurement and a way to obtain information in the form of knowledge.

2.4. Data analysis

The N-gain test aims to find out how much difference a student's mathematical communication skills are before and after a given action using the *student's pretest* and *posttest* scores. The formula for finding N-gain values is as follows (table 1).

$$N - gain\ \langle g \rangle = \frac{skor\ posttest - skor\ pretest}{skor\ maksimum - skor\ pretest}$$

The N-gain value criteria are indicated in the Table as follows.

Table 1
N-gain value criteria table

Value $\langle g \rangle$	Criterion
$\langle g \rangle > 0{,}70$	Tall
$0{,}30 < \langle g \rangle \leq 0{,}70$	Keep
$\langle g \rangle \leq 0{,}30$	Low

3. **RESULTS**

At the time of the trial, the first step was a question-and-answer session about Pythagorean theorem material for class VIII students to find out the initial knowledge of the material. In the second step, students are divided into six groups of five children. The third step is the distribution of *the pre-test* sheet first to the student. The fourth step of teaching materials is distributed to each group to read, understand, and carry out each instruction in the teaching material with the guidance of the researcher. The results begin by discussing the results of observations in the field. The first data found by researchers who conducted an assessment was in the form of simple questions on students about their knowledge. As many as 20 students can describe the problems they understand and what they have.

3.1. Readability of outdoor *learning-based* ethnomathematics-assisted PjBL teaching materials

This teaching material readability test was conducted on 34 students of class VIIID. The results have shown that students can fill out the reading test questionnaire of teaching materials with an average number of Yes answers of about 629 questions. Based on the readability criteria of teaching materials, these results show that PJBL teaching materials nuanced ethnomathematics based on *outdoor learning* in Pythagorean theorem material practical or easy to understand by students with a percentage of 93%.

3.2. Pre-test dan post-test

Students 'mathematical communication skills can be seen from the *pre-test* and *post-test* scores and the results of the pretest data, the average score of the experimental class is 55. So the Actual Complete Limit (BTA) of mathematical communication ability is 58. While the results of the post-test data, the

average score of the experimental class was 82.65. Here is a comparison of the pretest and post-test data (table 2).

Table 2

Comparison of Values in Experimental Classes (VIIID)

Value	*Pretest*	*Posttest*
Average	55	82,65
Highest	81	95
Lowest	27	70

Based on the analysis of validity, practicality, and effectiveness, PJBL teaching materials nuanced ethnomathematics based on outdoor learning that has been developed meet the criteria of validity with an average achievement rate of percentage by validators of 87.79% which means that it is very valid to be used to support students to learn mathematical communication in outdoor learning and meet the criteria of practicality or students understand with an average achievement rate of percentage by students of 93%. This means that it is practically used to support students to learn mathematical communication in outdoor learning after a slight revision as recommended. Three factors indicate how effective PjBL teaching materials nuanced ethnomathematics based on outdoor learning are for students learning mathematical communication: (1) students' mathematical communication skills reaching individual completion ≥58, which obtained an average score of 82.65 on student tests; (2) classical completion ≥75%, which obtained the proportion of students who complete mathematical communication tests by 100%; and (3) there is an increase in ability to complete the ability High student mathematical communication after the application of PjBL teaching materials nuanced ethnomathematics based on outdoor learning, which based on the N-gain test obtained a value of g⟩ = 0.614.

3.2.1. Classically

The results of calculations according to the specified formula are obtained as follows.

$$\langle g \rangle = \frac{82{,}65 - 55}{100 - 55} = 0{,}614$$

Based on the results of calculations, obtained. Because then the value is included in $\langle g \rangle = 0{,}614$ $0{,}30 < \langle g \rangle \leq 0{,}70 \langle g \rangle$The medium criteria. So, it can be concluded that the improvement or difference in mathematical communication skills before and after learning with PJBL teaching materials and nuanced ethnomathematics based *on outdoor learning* is moderate.

3.1.2. *Individually*

The recapitulation of each student's N-gain Test results using *pretest* and *post-test* scores is shown in Table 3 here.

Table 3

Individual N-gain test recapitulations

Criterion	**Many Students**	**Percentage**
Tall	10	29,41%
Keep	22	64,70%
Low	2	5,88%

There were 10 students with improved mathematical communication test results included in the high criteria, 22 students with improved mathematical communication test results included in the medium criteria, and 2 students with improved mathematical communication test results included in the low criteria. This shows that learning using ethnomathematics pjbl teaching materials based on *outdoor learning* can improve students' mathematical communication skills up to high and medium criteria.

4. DISCUSSION

Based on the N-gain test, a value is obtained. So according to Hake (1999), if then the value is included in the medium criteria. It can be concluded that differences in mathematical communication skills classically before and after learning by applying $\langle g \rangle = 0{,}6140{,}30 < \langle g \rangle \leq 0{,}70 \langle g \rangle$ PJBL teaching materials and nuanced ethnomathematics based on *outdoor learning* are included in the medium criteria. This is because students have learned menuli (written text), drawing (drawing), and mathematical expressions (mathematical expression). Individually, there were 10 students with improved mathematical communication test results included in the high criteria, 22 students with increased mathematical communication test results included in the medium criteria, and 2 students with improved mathematical communication test results included in the low criteria. This is because the two students with low shouts have previously demonstrated mathematical communication skills, and their completion results are similar to those of the pretest and post-test. In contrast, the 22 students with criteria are not finishing the project that has been mutually agreed upon. This results in students not being able to do mathematical communication posttests to the maximum.

Thus, PJBL teaching materials' nuanced ethnomathematics based *on outdoor learning* meet the effective criteria for students to use in learning mathematical communication *in outdoor learning*. Mathematical communication skills are measured by mathematical communication indicating test questions through summative evaluation. The problem has been tested first in the trial class before being used in the experimental class. After analyzing the test questions, 7 questions can be used from 8 questions tested. As a result of the *pretest* data, the average score of the experimental class is 55. So the Actual Complete Limit (BTA) of mathematical communication ability is 58. While the results of *the post-test* data, the average score of the experimental class was 82.65.

5. CONCLUSION

This research illustrates that media originating from the environment have a high probability of improving student learning outcomes. In addition, outdoor learning-based ethnomathematics teaching materials on Pythagorean theorem materials for class VIII students can be categorized into one application: mathematical transformations in a book. This is due to the presence of out-of-class activities with mathematics in the form of traditional games. This teaching material is also said to be effective because the learning results show a positive response and an increase in the student's mathematical communication ability in studying Pythagorean theorem materials. Finally, teaching materials have two advantages, namely outdoor learning ethnomathematics-based pjbl teaching materials on Pythagorean Theorem materials for class VIII students that not only help students understand cognitively, but can also provide new insights to students, and preserve culture.

Based on this conclusion, the study provides some recommendations. First, teachers should use this teaching as an alternative medium. Second, schools can make teaching materials as reference books to teach ethnomatematically assisted *outdoor learning*-based materials to students. Finally, other researchers can research the development of PjBL teaching materials nuanced with ethnomathematics based on *outdoor learning* is also still limited to Pythagorean theorem materials so it is necessary to

conduct development research on other materials both first and upper intermediate level. relevant. It would be better if more innovation in applying this material in mathematics with learning to help understand the application of various mathematical instructions in life.

Conflict of Interest: The authors declare no conflict of interest.

Ethical Approval: The study adheres to the ethical guidelines for conducting research.

Funding: This research received no external funding.

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