Improving creative thinking skills and learning motivation through ethnomathematics-based interactive multimedia: An experimental study in primary school

Istabiqul Ilma | Riyadi | Budi Usodo

Abstract This research aimed to determine the effect of ethnomathematics-based interactive multimedia to creative thinking skills and learning motivation of elementary school students. This research used quasi experiment of quantitive approach. This research was conducted at Gentan 01 Public Elementary School, Purbayan 01 Public Elementary School, and Kudu 01 Public Elementary School. The data collection method used test, questionnaires, and documentation. The stages of data analysis include conducting multivariate normality tests, homogeneity tests of variance and covariance matrices, pretest data balance tests, and hypothesis testing with multivariate analysis of variance. The research showed that Multivariate Tests output obtained a sig. value of 0.0001<0.05 or hypothesis is rejected. This means that there was a difference in the average of creative thinking skills and learning motivation between the experimental class and control class. Therefore, it can be concluded that ethnomathematics-based interactive multimedia impacted creative thinking skills and learning motivation simultaneously (together).

Keywords: creative thinking skills, ethnomathematics, interactive multimedia, learning motivation

1. Introduction

The Sustainable Development Goal (SDG) program in Indonesia has become one of the ways to improve and empower public welfare. The focus of SDG programs includes improving education quality because education quality has a major influence on achieving sustainable development (Heleta & Bagus, 2021). An education goal is set as a foundation for pushing the target of an SDG program. This goal is also in line with education in the era of the Industrial Revolution 4.0, which has created many challenges for several countries world wide, including Indonesia. The Industrial Revolution 4.0 in the education field is a response to producing a creative, innovative, and motivated individual (Oke & Fernandes, 2020; Tyas & Naibaho, 2021). With the existence of SDG, there are many hopes for each country to address education obstacles and produce creative, critical, and innovative generations.

In addition to the SDG program, education in the 21st century also forces students to implicate 4C skills (critical thinking, communication, collaboration, and creativity) (Naqvi et al., 2023; Robberts & Van Ryneveld, 2022). 4C Skills must be mastered and owned by students to face the challenges of the 21st century. According to the Career Center Maine Department of Labor, USA, one of the 4C skills, creative thinking skills, are the skills that are desired in the work field. Creative thinking skills become very important in global competition since the level of problem complexity in every life aspect is increasing (Mutohhari et al., 2021). Creative thinking skills are habits that result from sharp thinking through intuition, moving one’s imagination, expressing new ideas, discovering outstanding ideas, and inspiring unwanted ideas (Fauziah et al., 2020a; Galés & Gallon, 2020). The indicators of creative thinking skills include fluency, originality, flexibility, and elaboration (Fauziah et al., 2020b; Kartikasari et al., 2022). The importance of students’ creative thinking skills should be acknowledged beginning in the elementary years. These skills should be a focus since creative students will be able to solve problems easily (by solving problems).

Students with creative thinking skills typically can act originally with strong motivation (Balakrishnan, 2022; Goulet-Pelletier et al., 2023). They are pushed to explore new things and achieve their dreams. The motivation comes from within oneself to achieve the maximum results in learning (Esra & Sevilen, 2021). In other words, motivation is based on the student’s learning motivation. The creative thinking process becomes more effective since it is supported by learning motivation, either through quality or quantity. Creative thinking skills and learning motivation are important potentials that
should be owned, built, and developed for each student (Srikongchan et al., 2021). This is because both things are related to productivity, which is anything that can be considered a real form of learning achievement. Previous studies revealed that creativity can increase learning motivation to improve academic achievement (Lian, 2020). Furthermore, a study showed that creativity affects students’ learning motivation (Huang et al., 2020).

Creative thinking skills and motivation become a challenge for producing a generation that is ready to improve education and social life. Creative thinking and motivation are educational challenges that are in line with Minister of Education and Culture Regulation Number 20 of 2016 concerning competency standards for primary and secondary education graduates. The government wants students to master three dimensions at once (knowledge, attitudes and skills). One of these dimensions is the skills dimension. Creative thinking skills are what is needed to welcome Indonesia’s Golden Generation in 2024. Creative thinking is the graduation standard for students according to 21st century competencies. Therefore, it is ideal to accommodate students to maximize their creative thinking skills and learning motivation.

The challenge that is usually faced by students is the lack of creativity in thinking. This affects their learning results. According to the results of research by Richard Florida et al. on the Global Creativity Index in 2015, of 139 countries in the world, Indonesia was ranked 67th (Rahardjonia & Mashuri, 2022). This ranking is quite low compared to that of other countries. The problem of students’ low mathematical creative thinking skills was also discovered at one of the elementary schools in Baki District. This is consistent with the results of the presurvey regarding the ability to provide new idea, which showed that 71.43% (20 students) were unable to provide ideas regarding spatial forms in local culture. Moreover, only 28.57% (8 students) were able to provide ideas about spatial forms in local culture.

In addition to the problem of creative thinking skills, there is also a problem with students’ learning motivation. The interview results showed the lack of enthusiasm, interest, and motivation of the students during the mathematics class. This was marked by the students not concentrating during class, lacking property, and inappropriate learning media selection. The use of appropriate learning media has become a solution to the existing problem. Teachers need active and fun learning media to engage students in learning (Puspitarini & Hanif, 2019). Another study showed the significant positive influence of learning media and parental attention on students’ learning motivation (Wong & Hughes, 2022).

One of the media outlets that aligns with the SDG and with 21st century education is the use of technology-based learning media (Khahro & Javed, 2022). With all of the facilities attached to the technology, the learning process is considered more effective and efficient. Some of the technology-based media have been disseminated, either online or offline. Technology-based learning media can be used for computer usage via telecommunication and multimedia facilities as the main media for material delivery and interaction between educators and students (Pratama et al., 2023). Interactive multimedia the has become a technology-based media that can be utilized. Interactive multimedia is a tool equipped with control tools that can be operated by the user according to their needs (Alobaid, 2020). Interactive multimedia includes the combination of several media, such as texts, images, graphics, sounds, animations, videos, and interactions (Praheto et al., 2020); these media are packed into a digital file (computerization) and used to convey messages to the public. Several previous studies revealed that interactive multimedia can improve students’ learning motivation, learning results, concept mastery, activity, and thinking skills (Liliana et al., 2020; Sartono et al., 2022; Sarwinda et al., 2020; Syahputra & Maksum, 2020).

In addition to the use of media, utilizing the environment around students is a way to preserve local culture in the area where students live. The combination of culture and mathematics is called ethnomathematics or ethnomath. Ethnomathematics is a form of mathematics that is influenced by or based on culture (Hartinah et al., 2019; Sudrajat et al., 2023). This is supported by Sowanto (2019), who stated that ethnomaths acknowledge that there are different ways to solve mathematical problems in society. The concepts used are how to group, count, measure, and design shapes. The application of ethnomathematics-based interactive multimedia during the learning process will deepen students’ knowledge in different ways. Ethnomathematics is also considered a program that aims to study how students comprehend, articulate, process, and use mathematical ideas, concepts, and practices to solve problems related to daily life (Fendrik & Wangid, 2020; Payadnya et al., 2021). The utilization of ethnomath-based interactive multimedia can solve mathematical problems that arise from the surrounding environment, improving the learning process to be more interesting, interactive, and concise without essential or material reduction.

Previous findings highlight modifications to ethnomathematics-based mathematics learning. The results of the research show that the development of this model has a positive influence on students’ learning achievement (Putri et al., 2023). Additionally, there is research comparing the effectiveness of ethnomathematics with traditional approaches to learning (Sunzuma et al., 2021). The findings showed that the use of an ethnomathematics approach can improve students' understanding of the subject. Other researchers state that ethnomathematics based on project-based learning influences students’ creative thinking (Suryonegoro & Hidayah, 2023) and critical thinking skills (Suryawan et al., 2023). This model can increase students’ cultural and state literacy skills, and the development of ethnomathematics can improve junior high students’ mathematical literacy (Ristanti & Murdiyani, 2021).

According to several previous studies, this research differs in its ability to determine the independent variable (ethnomathematics-based interactive multimedia), the dependent variable (creative thinking skills and learning motivation),
the research approach (quantitative approach), and the research sample (elementary school students). Previous research has extensively reviewed ethnomathematics in relation to learning models and used samples at the junior high school level. Many studies have focused on critical thinking skills, learning outcomes, and literacy skills, while this research has focused on creative thinking skills and learning motivation. The research approach used is also different. This research used a quantitative approach, while previous studies used a developmental approach. It is believed that findings regarding traditional media have not been able to differentiate students’ motivation and creative thinking abilities; thus, these abilities are still low, and students are not active in the learning process. Therefore, there is a need for renewal through the use of interactive multimedia based on ethnomathematics to improve creative thinking skills and learning motivation.

In addition, many previous researchers have recommended testing interactive multimedia that is linked to ethnomathematics in learning. This test was recommended again by previous researchers to determine its effect on creative thinking skills. Other researchers suggest knowing its effect on learning motivation. Therefore, this research examines the use of ethnomathematics-based interactive multimedia to improve creative thinking abilities and learning motivation.

Based on previous research recommendations, this research was conducted to determine the effect of ethnomathematics-based interactive multimedia on students’ creative thinking skills and learning motivation in mathematics learning at elementary schools. The research question of this study is whether ethnomathematics-based interactive multimedia affects students’ creative thinking skills and learning motivation.

2. Materials and Methods

2.1. Research methodology

This research is a quantitative study with a quasi experimental design. This method was chosen because extraneous variables that affect students’ creative thinking skills and mathematical learning motivation could not be controlled by the researcher. This quasiexperimental study included an experimental group and a control group, but the control group in this study could not control all of the extraneous variables that affected the research (Creswell, 2013). The research design used a Nonequivalent Control Group because there are 3 variables in this study, namely, ethnomathematics-based interactive multimedia as the independent variable or treatment (X). On the other hand, the dependent or outcome variables are affected by the treatment of the independent variable (X) on creative thinking skills (Y1) and learning motivation (Y2).

2.2. Research sample

This research was conducted in Baki District, Sukoharjo Regency, Indonesia. There were three elementary schools in Baki District, namely, Gentan Public Elementary School 01, Purbayan Public Elementary School 01, and Kudu Public Elementary School 01. These three schools were assigned to the instrument trial group, control group, or experimental group.

The sampling technique used was cluster random sampling. This technique is a two-step process in which the entire population is divided into groups (Acharya et al., 2013). Cluster sampling is useful for obtaining samples and selecting sample representatives from all elements when the population has a wide distribution. Cluster sampling is used when samples are divided into several groups and each item is taken from a subgroup (Baltes & Ralph, 2022). Each school in the research has the same opportunity to constitute the sample. The sampling is based on a predetermined population area. The following are the steps for cluster random sampling.

First, the researchers evaluated 28 public elementary schools in Baki District, Sukoharjo Regency. Second, researchers carried out drawings three times from 28 elementary schools to determine the three schools that would be used as research sites. Third, the researchers conducted the experiments again three times from the three schools to determine which of the schools would be used as the instrument trial group, control group, or experimental group. After several rounds of drawing, the researchers were ultimately able to determine which school would be used as the research site for the instrument trial group, control group, or experimental group. The drawing resulted in the instrument trial group being 27 fifth-grade students at Kudu Public Elementary School 01, the control group being 24 fifth-grade students of Purbayan Public Elementary School 01, and the experimental group being 25 fifth-grade students of Gentan Public Elementary School 01.

2.3. Data collection technique

The data collection methods used in this research included tests, questionnaires, and documentation. The test is used to review students’ creative thinking skills. Tests are intended to measure knowledge (Brown, 2019). In this research, a test was carried out to determine the level of students’ motivation toward mathematics. The multiple choice test was used. The test was carried out twice—pretest and posttest. The pretest was administered to the control group and experimental group. The post test was administered after the students had studied the material presented. The post test was administered to the control and experimental groups, and the results were subsequently analyzed to answer the research questions.

Before creative thinking skills in mathematics subjects were tested, validity and reliability tests were first carried out to determine whether the research instruments used in the research were valid and reliable so that they could be used in
research and could truly measure the level of creative thinking skills in mathematics learning. The reliability test used in the skill test for calculating integer operations was the Cronbach’s alpha, which is considered reliable if $r > 0.7$.

The questionnaire was used to assess students’ learning motivation. A questionnaire is a method of collecting data that is carried out by asking respondents a set of questions or written statements (Heslina & Syahruni, 2021; Stantcheva, 2023). The scores on the student learning motivation questionnaires ranged from 1 to 4 points for items that led to positive answers. The scoring criteria were as follows: always, 4; often, 3; rarely, 2; and never, 1.

Documentation is a method used to search for data concerning things or variables that can be in the form of notes, transcripts, books, newspapers, magazines, inscriptions, meeting minutes, and so on (Hikmawati et al., 2021; Putra et al., 2021). The data collected in this documentation were lesson plans, fifth-grade mathematics syllabuses, and photos and videos during learning activities.

### 2.4. Data validity and reliability techniques

An instrument is feasible if its validity and reliability have been tested. The validity of the instrument in this research was tested using the point biserial correlation formula. The instrument is valid if $r$ is greater than the $r$-table. If $r > r$-table, the instrument is valid; otherwise, if $r < r$-table, the instrument is invalid.

From the instrument data calculations, five instrument items are known to be invalid, namely, instrument numbers 2, 5, 8, 9, and 17. Apart from these numbers, all of them have been declared valid because the $r$ value is greater than the $r$ table (0.381). It can be concluded that 15 of the 20 questions met the validity criteria and were used for the next stage, namely, data collection. The learning motivation questionnaire yielded six invalid questionnaire items (numbers 3, 14, 16, 26, 27, and 28). Apart from these data, all of them reached the specified $r$ table value. Of the 30 statement items, 24 met the validity criteria and were used for the next stage, namely, data collection.

When given to the same subject by different individuals, at different times, or in different locations, an instrument will produce the same or almost identical results (not significantly different) (Pal & Vanijja, 2020; Viglia & Dolnicar, 2020). The correlation coefficient, symbolized by $r$, between items or statement items and questions in an instrument is what determines the level of reliability. The benchmark for interpreting the degree of instrument reliability is determined by the following criteria according to Guilford.

#### Table 1 Benchmark for interpreting the degree of instrument reliability.

<table>
<thead>
<tr>
<th>Correlation Coefficient</th>
<th>Correlation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.90 &lt; r \geq 1.00$</td>
<td>Very high</td>
<td>Very constant/very good</td>
</tr>
<tr>
<td>$0.70 &lt; r \geq 0.90$</td>
<td>High</td>
<td>Constant/good</td>
</tr>
<tr>
<td>$0.40 &lt; r \geq 0.70$</td>
<td>Medium</td>
<td>Quite constant/quite good</td>
</tr>
<tr>
<td>$0.20 &lt; r \geq 0.40$</td>
<td>Low</td>
<td>Inconstant/poor</td>
</tr>
<tr>
<td>$r &lt; 0.20$</td>
<td>Very low</td>
<td>Very inconstant/very poor</td>
</tr>
</tbody>
</table>

The results of the valid instrument reliability test are as follows:

#### Table 2 Reliability test results.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Sum PG</th>
<th>Variants</th>
<th>Reliable</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creative Thinking Skills</td>
<td>3.86</td>
<td>15.06</td>
<td>0.78</td>
<td>Constant/good</td>
</tr>
<tr>
<td>Learning Motivation</td>
<td>32.27</td>
<td>251.23</td>
<td>0.90</td>
<td>Very constant/very good</td>
</tr>
</tbody>
</table>

Based on reliability testing using Ms. Excel, the correlation coefficients ($r$) of the instrument for creative thinking skills and learning motivation are 0.78 and 0.90, so the level of reliability of the instrument used in the research is constant/good and very constant/very good.

### 2.5. Data analysis technique

Data analysis is an activity after data from all respondents or other data sources have been collected (Mujahidin et al., 2020). Activities in data analysis involve grouping data based on variables and types of respondents, tabulating data based on variables from all respondents, presenting data for each variable studied, carrying out calculations to answer the problem formulation, and carrying out calculations to test the hypotheses proposed (Damanik et al., 2020; Tabroni et al., 2022). The testing stage included a prerequisite test and hypotheses test (partial test and simultaneous significance test).

The first prerequisite test was to calculate the normality test. The normality test was performed to determine the multivariate normality of the mean difference. The multiple comparison statistical method required the fulfillment of the normality distribution assumption with the following testing steps: 1) determining the hypothesis, (2) determining the significance level ($\alpha = 0.05$), (3) determining the test statistics, and (4) determining the test decision. These testing stages are the same as the correlation between the Mahalanobis index and chi-square test in SPSS version 25. If the distance and
correlation plot between the Mahalanobis index and hi-square tend to form a straight line or approach 1, then the data are considered to be multivariate normally distributed.

The second prerequisite test was the homogeneity test. The homogeneity test is a statistical test procedure designed to show that two or more sets of sample data come from a population with the same variance. The Levene test was used to test the homogeneity of the pretest and posttest data, and the Levene test was used with the help of SPSS version 25. Normally distributed data were considered to be normally distributed if the sig. value > 0.05. The obtained sig. values were 0.340 and 0.840. This means that both sets of data were higher than 0.05. Therefore, it can be concluded that Ha was rejected and Ho was accepted, so that the pretest data between the experimental and control groups were declared homogeneous.

The second prerequisite test is the homogeneity test. The homogeneity of covariance matrices test is a test used to determine the homogeneity of covariance matrices and variance matrices of variables. The homogeneity test was performed using the Levene test in SPSS version 22, with a significance level of 0.05. Normally distributed data were considered to be normally distributed if the sig. value > 0.05.

The third prerequisite test is the data balance test. A pretest data balance test was conducted to determine whether there was a difference in the mean pretest score between the experimental group and the control group before the treatment with ethnomathematics-based interactive multimedia in the experimental class. In the data balance test, researchers use multivariate and univariate mean difference tests. This research multivariate mean difference test uses Hotelling’s T² statistics. A univariate mean difference test was performed using the independent sample t test with Statistical Package for the Social Sciences (SPSS) version 22.

In the next step, this research hypothesis test used multivariate analysis with the help of SPSS program version 25. Based on the variables being studied, the hypothesis test in this research used the Mann–Meier test. The Mann-square test is a parametric analysis used to calculate the difference in means that is significant simultaneously or together between groups and dependent variables totaling two or more. This research used Wilk test statistics. These statistics are used since the Wilcoxon test can be formulated differently for the p value (the number of dependent variables) and k value (the number of groups). This research used p or dependent variables totaling two, critical thinking skills and learning motivation; moreover, k or the number of groups in this research used the experimental group or control group, respectively.

The Multivariate Analysis of Variance (MANOVA) test result criterion was as follows: if the significance level (sig.) was < 0.05, then Ho, which declared that there was no difference between groups, was rejected. There were two outputs produced by SPSS in this research, namely, the test result of Hotelling’s T² and the multivariate test result. (Multivariate test). When testing the effect of variables or between individuals using Hotelling’s T² test, the criterion was that if the significance value (sig.) > 0.05, then Ho was accepted; if the significance value (sig.) < 0.05, then Ho was rejected. After a univariate test is performed, a multivariate test is subsequently performed to test the effect between subjects or variables simultaneously. The decision criterion uses the significance value. If the significance value (sig.) > 0.05, then Ho is accepted. If the significance value (sig.) < 0.05, then Ho is rejected.

3. Results

This research used fifth year students aged > 2022/2023 years from three elementary schools in Baki District, Sukoharjo Regency. The participants were assigned to the instrument trial group, the control group, or the experimental group. The instrument trial group included 27 Kudu Public Elementary School 01 students and the control group included 24 Purbayan Public Elementary School 01 students. The experimental group included 25 students from Gentan Public Elementary School 01. The data obtained from this research included learning motivation questionnaire scores and students’ creative thinking skill test scores. These data were obtained from the control class and experimental class. There were 49 students involved in this research; 24 were from the control class, and 24 were from the experimental class.

The research data on creative thinking skills before and after treatment were used as dependent variables for the research hypothesis test; A comparison of the pretest and posttest scores for creative thinking skills is shown in Table 3.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Central Tendency Measures</th>
<th>Dispersion Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Mode</td>
</tr>
<tr>
<td>Pretest</td>
<td>60.6</td>
<td>60</td>
</tr>
<tr>
<td>Posttest</td>
<td>86.7</td>
<td>80</td>
</tr>
<tr>
<td>Control</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Posttest</td>
<td>76.7</td>
<td>73.7</td>
</tr>
</tbody>
</table>

Table 3 shows that, on the basis of the posttest results for group control creative thinking skills, the average score in the control group was 76.7, which was previously 60 on the pretest. The highest post test score of the control group was 93, while the pre test score was 73. The lowest score during the pretest was 47 and it rose to 60 during the posttest. The mode score during the control group pretest was 60, and the mode score during the posttest was 73.3. The pretest median of the
control class was 60, while the posttest median was 77. Moreover, the pretest and posttest deviation standards were 8.57 and 8.61, respectively.

Unlike the average score of the control class, the experimental class had an average posttest creative thinking ability score of 86.7. The mode score of the experimental class on the pretest was 60, and the mode score on the posttest was 80. The median score of the experimental class on the pretest creative thinking skills was 60, and that on the posttest was 87. The standard deviation of the pretest value for the experimental class was 8.57, and that of the posttest was 8.34.

Learning motivation was also used as a dependent variable for testing the research hypothesis. A comparison of the pre-test and post-test results for overall motivation to learn in both classes is shown in Table 4.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Central Tendency Measures</th>
<th>Dispersion Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Mode</td>
</tr>
<tr>
<td>Experiment</td>
<td>Posttest</td>
<td>86.1</td>
</tr>
<tr>
<td>Control</td>
<td>Posttest</td>
<td>80.6</td>
</tr>
</tbody>
</table>

As shown in Table 4, the results of the learning motivation posttest in the control class showed that the average score in the control class was 80.6, and the pretest average score was 54.3. The highest posttest score in the control class was 92, while the pretest score was 66. The lowest score during the pretest was 41, and it rose to 71 during the posttest. The mean score on the pretest for the control class was 61.46, and the average score on the posttest was 87.5. The median score on the pretest for the control class was 57, and that on the posttest was 79. Moreover, the pretest and posttest deviation standards were 8.17 and 6.22, respectively.

Unlike the average score of the control class, the experimental class had an average posttest score for learning motivation of 86.1. The mode score for the experimental class on the pretest was 54.17, and the mode score on the posttest was 90.63. The median score for the experimental class on the pretest of learning motivation was 53, and that on the posttest was 87. The standard deviation of the pretest score for the experimental class was 4.27 and that of the posttest was 6.53.

Next, a normality test was conducted. Data were tested for normality using parametric statistics. The analysis used is correlation analysis. The use of correlation analysis is because researchers want to measure the relationship between two variables. The multiple comparison statistical method requires the fulfillment of the normality distribution assumption with the following hypothesis:

H₀: The data are multivariate normally distributed
H₁: The data are not multivariate normally distributed

If the plot of the distance and correlation between the Mahalanobis index and chi-square tends to form a straight line or approaches 1, it can be concluded that it is a multivariate normal distribution. The results of the data normality test using SPSS can be found in the following table. The results of the data normality test using SPSS version 25 can be seen in Table 5.

<table>
<thead>
<tr>
<th>Mahalanobis Distance</th>
<th>Q ChiSquare</th>
<th>Pearson Correlation</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.941**</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Based on the results of the multivariate normality test that correlated the Mahalanobis and chi-square values, a correlation value of 0.941 was obtained (close to 1), so the data were declared to be normally distributed. Normality data means that the distribution data is normally distributed so that it can be generalized to the research population. Normality data is also used so that the conclusions made are not wrong. Therefore, a normality test was carried out to determine further statistical analysis.

Next, a homogeneity test was carried out to show that two or more groups of sample data come from a population that has the same variance. The data was tested using Levene test analysis to test homogeneity. The levene test was carried out because researchers needed to know the ability to distribute the data. If the data distribution has the same abilities, then the population has equal creative thinking abilities and learning motivation. The homogeneity test results become a reference for carrying out further tests. The results of the homogeneity test using the Levene test with the help of SPSS 25 are shown in Table 6.
The results of the homogeneity test using the Levene test with the help of SPSS produced a sig. value of 0.340 or greater than 0.05; therefore, it was concluded that Ha was rejected and that Ho was accepted so that the two sets of pretest data relating to creative thinking skills and learning motivation were homogeneous. The output of the multivariate mean difference test with SPSS version 25 is shown in Table 8.

The covariance matrix homogeneity test was used to determine that the significance value (Sig.) was 0.504 > 0.05. Therefore, the variance matrix of the Creative Thinking Skills and Learning Motivation variable in both classes (experimental and control) was homogeneous. After performing the homogeneity test, the balance test was performed using the multivariate mean difference test and the univariate mean difference test with SPSS version 25.

Based on the test results obtained using Hotelling’s T\(^2\) statistics, the significance value of F\(_{obs}\) was 0.610, and that of F\(_0\), \(0.05,2,45\) was 3.20. This result indicated that F\(_{obs}\) is not a member of the critical area. Therefore, Ho was accepted, and the two populations were concluded to be balanced. Then, the pretest balance of creative thinking skills was tested. The results can be found in Table 10.

The output of the T test showed a significant difference. (2-tailed) was 0.840 or < 0.05, which showed that there was no difference in the average score on the creative thinking skills pretest between the experimental class and the control class. Therefore, both populations were balanced. The balance of learning motivation was tested pretest. The results can be found in Table 11.

The output of the T test showed that the Sig. value (2-tailed) was 0.348 or < 0.05, which showed that there was no difference in the average score on the learning motivation pretest between the experimental class and the control class. Therefore, both populations were balanced. The following test was the hypothesis test. The output of the hypothesis test
was obtained through multivariate analysis of variance using SPSS version 25. The results of the SPSS test can be found in Table 12.

**Table 12 Creative thinking skills hypothesis test results using Hotelling’s T2 test.**

<table>
<thead>
<tr>
<th>Paired Differences</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTS_Experiment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the results of Hotelling’s $T^2$ test, a significance value of 0.000 was obtained. According to the criteria for hypothesis testing, if the significance value is less than 0.05, then the hypothesis is rejected. It can be concluded that there was an average difference in creative thinking skills between the experimental class and the control class. It has also been declared that ethnomathematics-based interactive multimedia affects creative thinking skills. The results of the learning motivation test are shown in Table 13.

**Table 13 Learning motivation hypothesis test results using Hotelling’s T2 score.**

<table>
<thead>
<tr>
<th>Paired Differences</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM_Control</td>
<td>-5.583</td>
<td>9.203</td>
<td>1.878</td>
<td>-9.469 -1.697</td>
<td>-2.972</td>
<td>23</td>
<td>.000</td>
</tr>
<tr>
<td>LM_Experiment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the results of Hotelling’s $T^2$ test, a significance value of 0.007 was obtained. According to the criteria for hypothesis testing, if the significance value is less than 0.05, then the hypothesis is rejected. There was an average difference in learning motivation between the experimental class and the control class. It has also been declared that ethnomathematics-based interactive multimedia affects learning motivation. After obtaining the hypothesis test results for each variant, a hypothesis test was performed to determine the effect of ethnomathematics-based interactive multimedia formats on creative thinking skills and learning motivation simultaneously. The results can be found in Table 14.

**Table 14 Multivariate Hypothesis Test Results.**

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>Pillai’s Trace</td>
<td>.994</td>
<td>3882.103$^a$</td>
<td>2.000</td>
<td>45.000</td>
</tr>
<tr>
<td></td>
<td>Wilks’ Lambda</td>
<td>.006</td>
<td>3882.103$^b$</td>
<td>2.000</td>
<td>45.000</td>
</tr>
<tr>
<td></td>
<td>Hotelling’s Trace</td>
<td>172.538</td>
<td>3882.103$^a$</td>
<td>2.000</td>
<td>45.000</td>
</tr>
<tr>
<td></td>
<td>Roy’s Largest Root</td>
<td>172.538</td>
<td>3882.103$^a$</td>
<td>2.000</td>
<td>45.000</td>
</tr>
<tr>
<td>Test</td>
<td>Pillai’s Trace</td>
<td>.264</td>
<td>8.085$^b$</td>
<td>2.000</td>
<td>45.000</td>
</tr>
<tr>
<td></td>
<td>Wilks’ Lambda</td>
<td>.736</td>
<td>8.085$^b$</td>
<td>2.000</td>
<td>45.000</td>
</tr>
<tr>
<td></td>
<td>Hotelling’s Trace</td>
<td>.359</td>
<td>8.085$^b$</td>
<td>2.000</td>
<td>45.000</td>
</tr>
<tr>
<td></td>
<td>Roy’s Largest Root</td>
<td>.359</td>
<td>8.085$^b$</td>
<td>2.000</td>
<td>45.000</td>
</tr>
</tbody>
</table>

- a. Design: Intercept + Tes
- b. Exact Statistics

Based on the multivariate test output, the “Class” “Wilks Lambda” column had a sig. value of 0.0001<0.05. According to the hypothesis test criteria, if the sig. value <0.05, the hypothesis is rejected. There was an average difference in creative thinking skills and learning motivation between the experimental class and the control class. The multivariate test results showed that ethnomathematics-based interactive multimedia practices affect creative thinking skills and learning motivation simultaneously (together).

4. Discussion

The data analysis results are related to the hypothesis submission of this research. In accordance with the calculation of the hypothesis test through multivariate analysis of variance, an average difference in creative thinking skills was found between the experimental class and the control class. This means that students’ creative thinking skills value whose learning process uses ethnomathematics-based interactive multimedia were better than those of students who learn with conventional media. The results were due to the advantages of ethnomathematics-based interactive multimedia.

In this study, interactive multimedia was presented in the form of computer use. Moreover, the ethnomathematics associated with these methods involve media in the form of origami paper with cubes and blocks. The cubes and block media were presented as food or ketan cakes, palm sugar, or coconut milk. The food was illustrated to be the same as cubes and
blocks. In addition, images of Senik (traditional kitchen utensils made of woven bamboo) were also presented. The kitchen utensils or seniks were illustrated as rectangular and large circular shapes. The use of culture-based multimedia helped to increase the activity of the students. They were interested in learning because of the images that students often see. According to the theory, ethnomathematics becomes a bridge or link between culture and education (Albanese et al., 2017). The integration of mathematics, culture, and interactive media has a contextual and realistic meaning that shows that mathematics is part of culture (Simamora & Saragih, 2019).

From the side of interactive multimedia, this type of media is considered more attractive because multimedia can present material in the form of images and videos. In addition, interactive multimedia programs also have good visual design and are equipped with interactive evaluation questions to measure student understanding. The attractive display and local culture presentations provided students with a broad perspective and an open space for ideas. This opportunity opened up a deeper space or student creativity. Temuan sebelumnya menyatakan bahwa pemanfaatan multimedia efektif meningkatkan kualitas, efektivitas belajar, kemampuan berpikir aktif dan logis, mental, dan penalaran siswa di sekolah dasar (Muxtarova, 2021).

These findings are in line with previous research. There was a relationship between the ethnomathematics-based PBL model and students' creative thinking skills (Suryonegoro & Hidayah, 2023). Multimedia development has proven effective in improving students' creative thinking skills (Richardo et al., 2018). Additionally, the development of augmented reality-based ethnomathematics media has had an effect on creative thinking skills (Damayanti et al., 2023). Ethnomathematics-based learning could improve students' creative thinking skills through the problem-solving process (Turmuzi & Suparta, 2023).

Compared to those of conventional media, the results obtained were quite different. Media conventions, such as whiteboard and uncoloured images, were less interesting for students. Learning material could be delivered but was not attractive. If the students were not interested, creative thinking skills also did not improve. Previous studies have shown that traditional application media are not very effective at preventing the development of technology or students' creative thinking skills (Yilmaz, 2021).

The next finding showed that there was an average difference in learning motivation between the experimental class and the control class. The experimental class involved ethnomathematics-based interactive multimedia, while the control class involved traditional media.Judging from the treatment carried out, the difference between the two was very striking. When students learned in the experimental class, they gained much experience in terms of interactive multimedia or ethnomathematics. The use of these media sources influenced the student learning process. Student scores increased, especially during the posttest. This increase was due to the learning process involving ethnomathematics-based interactive multimedia. The experiences gained by students were more abundant. For example, students could learn directly using computers, students learned directly by observing and mastering media in the form of objects in their surroundings/food and traditional tools, and students obtained interesting teaching materials containing subject matter with color images. This approach made the students more motivated to learn than those who only with learned in the old way (lectures) or through blackboard media/nondigital media.

The results of this research were in accordance with previous findings that stated that there were significant differences in learning motivation between the experimental and control classes after receiving the ethnomathematics-based visual thinking approach (Suksesdyarno et al., 2023). Likewise, learning mathematics through ethnomathematics has also been proven to have a positive effect on students' learning motivation and discovery motivation (Shahbari, 2020). Media such as ethnomathematics-based AR multimedia can increase students' motivation, curiosity, and thinking skills (Functions et al., 2023). Additionally, another study concluded that the ethnomathematics learning approach was proven to increase students' motivation and positive behavior (Suksesdyarno et al., 2023). Students demonstrate an active, enjoyable, and enthusiastic attitude in learning mathematics.

The results of the multivariate test revealed that ethnomathematics-based interactive multimedia had simultaneous effects on creative thinking skills and learning motivation. This was in line with the researcher's hypothesis that ethnomathematics-based interactive multimedia would impact students' creative thinking skills and learning motivation.

The combination of interactive multimedia programs based on ethnomathematics represents a breakthrough in mathematics learning. Ethnomathematics is defined as mathematics in culture. Other experts define ethnomathematics as mathematical thinking and practice related to culture to help students translate mathematical ideas and practices from cultural elements (Lidinillah et al., 2022). Integrating ethnomathematics in interactive multimedia is part of maximizing learning so that the processes obtained by students are influenced by technological and cultural elements simultaneously. The combination of these two elements represents a breakthrough in learning so that students can gain mature knowledge and can prioritize cultural elements that are appropriate for the content of their lessons. Therefore, the combination of ethnomathematics and multimedia becomes more interesting when applied in the classroom.

Ethnomathematics-based interactive media aprovided more real visualizations to the students about many forms of geometry. With more real visualization, the students were encouraged to act to achieve their goals. Furthermore, previous research has shown that multimedia learning increases learning motivation (Leow & Neo, 2014), clarifies the understanding
of material concepts (Gunawardhana & Palaniappan, 2016; Wu & Tai, 2016), and improves the quality of student learning (Nusir et al., 2013).

However, interactive multimedia based on ethnomathematics also has limitations. This limitation is in the form of internet availability for teachers. Schools must provide adequate internet access. On the other hand, there are several schools that are far from internet access. Therefore, the use of multimedia is not optimal. Because of this, teachers try to modify learning by linking relevant material to everyday life. What is done is that students open multimedia via computer. The teacher provides several menu options containing materials, evaluations and learning videos. The material explanation contains the volume of blocks, cubes and non-standard units. When choosing non-standard units, students will see the form of the unit illustrated in the form of a picture. Meanwhile, the explanation about cubes is illustrated in the form of diamond Jenang. The illustrated images displayed become part of culture using multimedia.

Based on the above discussion, it can be concluded that ethnomathematics-based interactive multimedia has been proven to improve students’ creative thinking skills and learning motivation simultaneously. This increase was influenced by the advantages of ethnomathematics-based interactive multimedia. The provision of mathematics learning with cultural and technology-based nuance could spark students’ interest in learning. This was because the culture that is raised in mathematics learning is in line with students’ daily lives and experiences. Therefore, students became more able to sharpen their skills creatively, and students were encouraged to learn mathematics, which is related to the culture of the students' environment.

5. Conclusions

This research concluded that ethnomathematics-based interactive multimedia simultaneously impacts students’ creative thinking skills and learning motivation. This was in line with the results of the multivariate tests, for which the significance level was 0.05; a significance value of 0.001 was obtained in the test column. This showed that the significance value was 0.001 < 0.05. The findings of this study have implications for theory and practice. Theoretically, ethnomathematics-based interactive multimedia has an effect on students’ creative thinking skills and learning motivation. This means that computer-based interactive multimedia can provide a new experience for students that can improve their creative thinking skills. As a result, students’ learning motivation also improves.

Practically, appropriate learning media can be one solution to overcoming problems in learning, especially mathematics. New learning media will provide valuable experiences for students. One of the learning media applied in this research is interactive multimedia based on ethnomathematics. Media provides new and meaningful experiences for students so that they can influence their creative thinking skills and learning motivation. It is hoped that ethnomathematics-based interactive multimedia can be used by students and teachers as an alternative for increasing students’ creative thinking skills and learning motivation.

Based on these findings, researchers have suggested certain points for students, teachers, and future researchers. For students, they should be more active and come up with new ideas during learning using ethnomathematics-based interactive media to optimally sharpen creative thinking skills and learning motivation. For teachers, teachers should develop mathematics learning innovatively and creatively so that students can be more active and develop new ideas. This can be accomplished by implicating ethnomathematics-based interactive media so that the learning process will be more meaningful. For future researchers, these research results can be used as a foundation or insight for future research redesigning the development of ethnomathematics-based interactive media, namely, the addition of variables or the addition of the number of respondents and strengthened theories. Future researchers are also advised to develop this research by using more innovative research, such as development research, bibliometrics, or systematic literature reviews.

Acknowledgments

The authors would like to thank the teachers and students who participated in this research. This research was not funded by any grant.

Ethical considerations

Not applicable.

Conflict of interest

The authors declare no conflicts of interest.

Funding

This research did not receive any financial support.

References

https://www.malque.pub/ojs/index.php/msj


https://www.malque.pub/ojs/index.php/msj
