



## Learning Innovation Through E-Worksheet Ethnomathematics: Improving Creative Thinking Skills

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### Info Article

Received: 17 Nov 2024

Revised: 02 Jan 2025

Accepted: 27 Feb 2025

Online Version: 05 Mar 2025

### Abstract

This study aims to develop ethnomathematics-based e-worksheets and analyze their effects on students' creative thinking skills in learning quadrilaterals and triangles. Ethnomathematics was chosen as an innovative approach that connects mathematical concepts with local wisdom, thus creating a more contextual and meaningful learning experience. E-worksheets are made with the stages of development, implementation, and evaluation adopted from branches using 90 samples from purposive sampling techniques. The data collection instrument was an essay test to measure students' creative thinking skills. Data analysis used an independent sample t-test statistical test with the help of SPSS 25 software. The study showed that the t-count value (14.216) was more significant than the t table (1.990) at a significance level of 0.05, indicating an essential difference between the experimental and control groups. The experimental group showed an average increase in creative thinking skills of 67.5%, much higher than the control group of 46.5%. This improvement is especially seen in originality and elaboration, which shows that ethnomathematics can stimulate students' creative ideas through relevant cultural contexts. This study offers a new approach to learning mathematics in the digital era through integrating local culture in e-worksheets, creating interactive learning media, and strengthening students' cultural identity. Using ethnomathematics-based e-worksheets is recommended as an alternative innovative and effective learning media to improve the quality of education, especially in building students' creative thinking skills in the digital era.

Keywords: Creative Thinking Skills; Education; E-Worksheet; Ethnomathematics

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## INTRODUCTION

Creative thinking is generally considered a mental process emphasizing reasoning and thinking to gain new understanding. Creative thinking refers to the ability to believe, which begins with awareness of the situation at hand, where the situation is considered a problem that needs to be solved (Akpur, 2020; Chen et al., 2022; Saeed, & Ramdane, 2022; Suherman, & Vidakovich, 2022; Sirait & Ratti, 2024; Qiu,

Ikeda, & Yamashita, 2025). According to Khalil et al., (2023), creativity is the ability to find new relationships, see new perspectives on a subject, and combine existing concepts in the mind into new combinations. Creative thinking also involves the ability to be sensitive to problems, consider new and unusual ideas with an open mind, and have the skills to connect concepts to solve problems (Dou, Li, & Jia, 2021; Forte-Celaya, Ibarra, & Glasserman-Morales, 2021; Avci & Durak, 2023; Abrianto, Amaefuna, & Onyemowo, 2024; Suryonegoro et al., 2025). This creative thinking process includes essential aspects such as fluency, flexibility, originality, and elaboration, all of which play a necessary role in shaping students' abilities to face complex challenges innovatively.

One effective way to develop students' creative thinking skills is through using information technology in learning. Information technology provides convenience in accessing various learning resources and creates a more interactive and practical learning environment. Through various digital applications and platforms, students can easily explore new ideas, search for multiple references, and visualize abstract concepts interactively. The use of mind-mapping software or brainstorming applications, for example, allows students to express many ideas quickly, supporting the aspect of thinking fluency as expressed (Dong, Zhu, & Li, 2021; Guven et al., 2022; Lende et al., 2023; Dwi Cahyani, Sulastrri, & Bouakel, 2024; Furqon et al., 2024). In addition, technology also provides various simulations, learning videos, and game-based challenges that encourage students to see problems from multiple perspectives and seek alternative solutions, in line with the concept of thinking flexibility. According to Shalgimbekova et al., (2024), integrating technology in learning can increase student motivation and outcomes by providing a more varied and enjoyable learning experience. Teachers also benefit from the ease of delivering material, providing evaluations, and monitoring student progress in real time (Aljawarneh, 2020; Calderon, Merono, & MacPhail, 2020; Sharma & Srivastava, 2020; Citrawan et al., 2024; Muhamad, AB, & Supriyadi, 2025). Thus, the use of technology in education is an aid and a catalyst to create 21st-century learning that is adaptive, sustainable, and supports the development of students' creative thinking.

One innovative approach to utilizing technology in learning is integrating the concept of ethnomathematics through e-worksheets. Ethnomathematics is an approach that connects mathematical concepts with local culture to improve students' creative thinking skills. This concept involves exploring mathematics in everyday cultural practices, such as batik patterns, traditional house architecture, and traditional games (Prahmana, & D'Ambrosio, 2020; David et al., 2024; Muchlis et al., 2025). E-worksheets based on ethnomathematics utilize digital technology to present learning materials that are not only informative but also interesting and easily accessible. With interactive features such as videos, animations, and adaptive quizzes, students can more easily understand mathematical concepts while staying connected to their cultural values (Huang et al, 2021; Dede, Akcakın, & Kaya, 2022; Schotte et al., 2022; Nguyen, & Tran, 2023; Purnomo, Retnowati, & Zumaeroh, 2024; Yuliyannah, Gumala, & Yohamintin, 2025). Through this approach, students are invited to analyze, find patterns, and create creative solutions based on their cultural context to develop critical thinking skills and strengthen divergent thinking skills (Groyecka et al., 2020; Liu et al., 2021; Okolie et al., 2022; Octavia, Heriberta, & Sriayudha, 2024; Harmaini et al., 2025).

Although various studies have shown the effectiveness of technology and ethnomathematics in improving creative thinking skills, several research gaps still need to be addressed. First, most studies focus more on the general application of technology in learning. However, few specifically examine the effectiveness of ethnomathematics-based e-worksheets in developing students' creative thinking, especially in mathematics learning. Second, previous studies discuss creativity in general without delving into specific aspects such as fluency, flexibility, originality, and detail in the ethnomathematics-based learning process. Third, many e-worksheets currently available are still limited to delivering information without allowing students to apply knowledge in real situations related to the local cultural context. Fourth, minimal research still quantitatively or qualitatively measures the impact of using ethnomathematics-based e-worksheets on improving students' creative thinking skills in mathematics learning.

Based on these gaps, this study aims to develop ethnomathematics-based e-worksheets that can

improve students' creative thinking skills, especially fluency, flexibility, originality, and detail. This study will also measure the effectiveness of e-worksheets in the mathematics learning process and identify factors that support and hinder their implementation in the classroom. Thus, the results of this study are expected to not only provide significant contributions to the development of innovative teaching materials based on local wisdom but also provide empirical evidence regarding the effectiveness of ethnomathematics-based e-worksheets in improving students' creative thinking skills. In addition, this study supports creating 21st-century learning that is interactive, adaptive, and relevant to students' cultural context, as well as being a bridge between science and culture in forming a creative and competitive generation.

## RESEARCH METHODS

There are 3 stages of Branch (2009) in this research model, namely (1) Development, (2) Implementation, (3) Evaluation, which will be explained in more detail as follows: At the development stage, the available ethnomathematics-based student activity sheets are then made into software design rules. Experts validate the development of e-worksheets to test the validity of the product, and the final result of the e-worksheet development process is the e-worksheet design that will be implemented using the following method. At the implementation stage, e-worksheets using the prepared application are implemented simultaneously with their role and function as e-learning that can facilitate ethnomathematics-based learning with the hope that system users can use it well and can improve students' understanding of the material on rectangular and triangular plane shapes that will be delivered. In addition, e-worksheets can make it easier for students to use on mobile devices and can be carried anywhere without having to bring printed student worksheets. The final result of the implementation process is the ability to think creatively in ethnomathematics-based learning in the material on rectangular and triangular plane shapes using student worksheets with applications that can help the learning process for students. At the evaluation stage, the process is to see students' creative thinking skills using ethnomathematics-based e-worksheets using tests.

This study conducted content validity through consultation with experts (Expert Assessment Validation Criteria) according to their fields. The validity test in this study involved media experts. Content validity can be seen from the product's suitability to the curriculum's demands (Ivers & Barron, 2002) with assessment criteria such as those in Table 1 below.

Table 1. Validation criteria

Interval	Category
0.0 – 25.0	Very Inadequate
25.1 – 50.0	Not Feasible
50.1 – 75.0	Worthy
75.1 – 100.0	Very Decent

Construct validity, regarding the construct or structure and psychological characteristics of the aspects to be measured by the instrument. Does the construct explain the differences in individual activities or behaviors in relation to the aspects being measured. The sample used in this study was 80 students obtained by sampling using purposive sampling techniques. Purposive sampling is selecting samples based on certain criteria (Kerlinger, 2014).

The first activity that must be carried out in the data collection process is to create an e-worksheet framework and resources, then enter all resources and e-worksheet frameworks into the application, after being entered into the application, a validation test is carried out by experts to see the feasibility of the ethnomathematics-based e-worksheet, after the expert validity test is complete and the results are obtained, it is applied in learning to see students' creative thinking abilities in learning using an essay test that has been made totaling 10 questions with a weight of 4 for the maximum score and 0 for the minimum score. And the categories can be seen in table 2.

Table 2. Category Students' creative thinking abilities

Interval	Category
0.0 – 10.0	Very Not Good
10.1 – 20.0	Not Good
20.1 – 30.0	Good
30.1 – 40.0	Very Good

Data obtained through essay test were analyzed using inferential statistics with t test (Independent sample t-test) with the help of SPSS 25 computer program. While perception questionnaire data were analyzed using descriptive statistics assisted by SPSS 25 computer program.

## RESULTS AND DISCUSSION

The results of the research conducted by this researcher are modifications to ethnomathematics-based activity sheets to improve students' creative thinking skills on the material of quadrilaterals and triangles using applications. In Indonesia, printed activity sheets are usually used for learning activities. Therefore, researchers innovate by creating electronic activity sheets based on applications for students studying quadrilaterals and triangles. Therefore, the novelty in this study is the change from printed teaching materials to electronic ones based on this application containing lesson materials, work procedures, and assessment formats that are all based on ethnomathematics to improve students' creative thinking skills on the material of quadrilaterals and triangles using applications.

Along with advancing information technology, teaching materials used in the learning process are developed and innovated to improve education. One of the beneficiaries of information technology is the world of education. Electronic-based learning media (e-learning) has various advantages in supporting a more effective, efficient, and adaptive learning process to technological developments. One of the main advantages is ease of accessibility, where students and teachers can access learning materials anytime and anywhere through digital devices. In addition, electronic learning media offers interactive and varied content, such as videos, animations, simulations, and interactive quizzes that can increase students' interest and motivation to learn. Electronic-based learning media can provide a more interesting and interactive learning experience, thereby helping students understand the material more deeply (Mehall., 2022; Yu et al., 2022; Barman, & Jena, 2023; Wang, & Zhu, 2024; Faturrahman et al., 2025). Another advantage lies in the flexibility in independent learning, where students can learn according to their own pace and learning style. On the teacher's side, this media allows for more creative delivery of material and facilitates evaluating and monitoring student development through analytical features (Christopoulos, & Sprangers, 2021; Fan, & Zhong, 2021; Dimitriadou, & Lanitis, 2023; Sulaiman et al., 2024). Thus, electronic-based learning media not only enriches learning methods but also becomes an innovative solution in facing the challenges of education in the digital era.

Information technology is an important factor that enables students to speed up their knowledge transformation. Research utilizing information and communication technology, one of which is the development of printed teaching materials into electronic-based worksheets, better known as e-worksheets. E-worksheets based on ethnomathematics to improve students creative thinking skills on the material of quadrilaterals and triangles using the application were first validated by experts. The results can be seen in Table 3.

Table 3. Results from expert validation of e-worksheet

No	Aspect	Feasibility Level	Category
1	Theory	86.2	Very Decent
2	Display	84.5	
3	Language	87.3	

From the validation results carried out by experts, it was found that the very feasible category for the material aspect had a feasibility level of 86.2, the display aspect was 84.5 with a very feasible category, and the language aspect had a feasibility level of 87.3, which means very feasible. Therefore, based on the validation results by experts, it can be concluded that ethnomathematics-based e-worksheets to improve students' creative thinking skills on the material of rectangular and triangular plane shapes using the application are very feasible and good to use.

After the ethnomathematics-based e-worksheet to improve students' creative thinking skills on the material of rectangular and triangular plane shapes using the application was modified, the e-worksheet was implemented in a small group of students in learning the material of rectangular and triangular plane shapes to see students' creative thinking skills. Practical activities are more effective in encouraging students from the acquisition of the abilities they will have (Haryanto et al., 2020; Cai et al., 2021; Goulart, Liboni, & Cezarino, 2022; Wekerle, Daumiller, & Kollar et al., 2022; Darmaji et al., 2024). The following presents the results of students' creative thinking abilities analyzed using descriptive statistics in Table 4.

Table 4. The gap in scores for implementing ethnomathematics-based e-worksheets and students' creative thinking abilities in the pre-test and post-test between the Experimental and Control classes.

	Variable	Groups	Category	Mean	Min	Max	N	%
Pre-test	Respons students about e-worksheet	Experiment	Enough	15.5	12	36	40	46.0
		Control	Enough	13.5	13	35	40	43.7
	Creative thinking ability	Experiment	Enough	16.4	14	36	40	47.2
		Control	Enough	14.6	12	34	40	44.5
Post-test	Respons students about e-worksheet	Experiment	Good	24.5	12	36	40	65.0
		Control	Enough	19.5	13	35	40	45.7
	Creative thinking ability	Experiment	Good	26.4	14	36	40	67.5
		Control	Enough	17.6	12	34	40	46.5

The results of the study shown in Table 4 indicate a significant increase in creative thinking skills and students' responses to using ethnomathematics-based e-worksheets in the experimental group compared to the control group. Before the treatment, the average pre-test score for creative thinking skills in the experimental group was 47.2% ( $M = 16.4$ ) and students' responses to the e-worksheet were 46.0% ( $M = 15.5$ ), while the control group showed an average creative thinking ability score of 44.5% ( $M = 14.6$ ) and students' responses of 43.7% ( $M = 13.5$ ). These results indicate that before implementing ethnomathematics-based e-worksheets, both groups had relatively equal abilities and responses. After treatment, there was a significant increase in the experimental group, with an average post-test score for creative thinking skills reaching 67.5% ( $M = 26.4$ ) and students' responses to the e-worksheet being 65.0% ( $M = 24.5$ ). Meanwhile, the control group only experienced a slight increase with an average creative thinking ability score of 46.5% ( $M = 17.6$ ) and student responses to e-worksheets of 45.7% ( $M = 19.5$ ). The more significant increase in the experimental group indicates the effectiveness of ethnomathematics-based e-worksheets in improving students' creative thinking skills.

According to previous research, using culture-based learning media, such as ethnomathematics, can improve creative thinking skills because it allows students to associate mathematical concepts with local cultural contexts (Umbara, Wahyudin, & Prabawanto, 2021; Jaudinez, & Joaquin, 2023; Payadnya et al., 2024; Pratama, & Yelken, 2024; Susana, & Nwanya, 2024; Sunzuma & Umbara, 2025). This aligns

with the findings of Astuti, Wijaya, & Hanum (2024), who state that “ethnomathematics-based learning provides a more contextual and relevant learning experience, thus encouraging students to think critically and creatively.” This increase in creative thinking skills reflects that students are better able to generate new ideas, see problems from various perspectives, and find alternative solutions, which are indicators of creative thinking.

The increasing student response to ethnomathematics-based e-worksheets also shows that this learning media is effective in improving cognitive skills and provides a more interesting and interactive learning experience. This is reinforced by research by Yu, Gao, & Wang (2021), which shows that creatively designed electronic learning media can increase students' learning motivation and positively impact their learning outcomes. Overall, these findings indicate that the integration of ethnomathematics in e-worksheets not only has a positive influence on students' creative thinking skills and creates a learning environment that is more adaptive and in accordance with technological developments and local culture. Thus, using ethnomathematics-based e-worksheets can be an effective alternative learning strategy in improving the quality of education in the digital era.

Table 5. Independent sample t-test

	T	df	Mean	Std.Deviation	95% confidence interval	
					Lower	Upper
Creative Thinking Ability	14.216	80	3.0504	.23221	17.234	.6120
	14.216	98.067	2.3021	.30024	16.985	.8615

The statistical test results in Table 5 show a significant difference in students' creative thinking skills between the group using ethnomathematics-based e-worksheets and the group not using them. The t-count value of 14.216 is much higher than the t-table value of 1.990 at a significance level of 0.05 with degrees of freedom ( $df = 80$ ). According to Cramer (2003), when the t-count is greater than the t-table, the null hypothesis ( $H_0$ ) is rejected, which means there is a significant difference between the two groups. The average value (mean) of students' creative thinking skills is 3.0504 with a standard deviation (Std. Deviation) of 0.23221, indicating that the use of ethnomathematics-based e-worksheets has a positive effect on the development of students' creative thinking skills. The 95% confidence interval, with a lower limit of 17.234 and an upper limit of 0.6120, shows a fairly narrow range of values, providing confidence that the results are relatively consistent and significant.

Previous research supports this finding, where innovative learning media based on local culture can improve students' creative thinking skills. Ethnomathematics helps students understand mathematical concepts in real-life contexts, encouraging creative and critical thinking (Prahmana, 2022; Kabuye Batiibwe, 2024). In addition, a study by Sunzuma, G., & Maharaj (2021) stated that technology-based learning, such as e-worksheets, provides an interactive and interesting learning experience, ultimately increasing students' motivation and creative thinking skills. Creative thinking skills include several important aspects such as fluency, flexibility, originality, and elaboration in thinking (Sunzuma, G., & Maharaj, 2021; Meeran et al., 2024; Mokoginta, Suparli, & Mokwena, 2024). E-worksheets based on ethnomathematics support the development of these aspects through activities that require students to observe patterns, find relationships between concepts, and create new solutions based on local cultural contexts. For example, questions inviting students to analyze batik patterns or calculate symmetry in traditional architecture hone math skills and train students to think creatively in various situations.

Overall, these findings indicate that using ethnomathematics-based e-worksheets is a learning aid and an effective means of improving students' creative thinking skills. These results are relevant to efforts to create adaptive, contextual learning under the demands of 21st-century learning, where creativity is one of the main competencies students must have to face future challenges. This study offers novelty in the use of application-based e-worksheets integrated with the concept of ethnomathematics to improve students' creative thinking skills. Unlike conventional printed teaching materials, this e-worksheet utilizes digital

technology to create a more interactive and contextual learning experience under local culture. The results of this study provide positive implications in the world of education, especially in the development of technology-based learning media. Ethnomathematics-based e-worksheets can be adopted as a creative learning model that can improve students' creative thinking skills at various levels of education, especially in materials related to mathematics and local culture. Teachers and educators are advised to utilize ethnomathematics-based e-worksheets as a learning aid to improve students' creativity. Further researchers can develop this e-worksheet in other subjects or cultural contexts to expand its benefits. Schools and educational institutions need to support the development of technological infrastructure to ensure the implementation of electronic-based learning media runs optimally. This study has limitations in the sample scope, which only involved 80 students from one school. In addition, the implementation of the e-worksheet only focused on the material of quadrilaterals and triangles. Further research is expected to expand the research subjects and cover broader learning materials to obtain more generalizable results.

## CONCLUSION

The results of this study indicate that the use of ethnomathematics-based e-worksheets has a significant impact on improving students' creative thinking skills. This is indicated by the t-value of 14.216, greater than the t-table of 1.990, indicating a significant difference between the experimental and control groups. The increase in creative thinking skills in the experimental group reached 67.5%, while the control group only reached 46.5%. More than just improving cognitive skills, this e-worksheet offers a more interactive and relevant learning experience to the local cultural context, making it a contextual and meaningful learning tool. By integrating local cultural values into mathematics learning, students understand academic concepts and develop an appreciation for their own culture, thus supporting a holistic learning approach. These findings provide an important contribution to creating innovative learning media under the needs of 21st-century education, where creativity and adaptability are key competencies. E-worksheets based on ethnomathematics can be an effective learning alternative in the school curriculum, especially in the context of mathematics learning. In addition, this study opens up opportunities to integrate ethnomathematics approaches into various other subjects, thus further enriching the cross-disciplinary learning process. Further development can be done by increasing the interactivity of e-worksheets, for example, through multimedia content or game-based learning, to further attract students' interest and involvement. In the context of education policy, these results support the implementation of a local wisdom-based curriculum, where each region can develop contextual teaching materials according to the culture and characteristics of students. Thus, using ethnomathematics-based e-worksheets supports creative and adaptive learning and becomes a strategic step in preserving local culture through education.

## ACKNOWLEDGMENTS

Thank you to all colleagues who have helped, so that this research can be carried out and completed.

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