JAMES

Journal of Advanced Multidisciplinary Education Studies

PISSN XXX-XXX (Print)
ISSN XXX-XXXX (Electronic)
https doi xxxxx

Development of an Ethno-RME-Based Electronic Student Worksheet (E-LKPD) on Geometric Transformation Using Yogyakarta Batik Motifs to Improve Mathematical Problem Solving Ability

Nahwa Fathia [1], Ahmad Anis Abdullah [2]

[1,2] Mathematics Education, Alma Ata University, Indonesia

ABSTRACT

A low level of mathematical problem solving ability is partly due to teaching materials that aren't geared towards problem solving. Teaching materials used in learning generally still use conventional teaching materials so that they are less interesting and interactive. Furthermore, lecture-based learning approaches are frequently used, which makes students less engaged and active during the learning processTo boost mathematical problem-solving abilities, this project focuses on developing E-LKPD that are rooted in ethno-RME and utilize Yogyakarta batik as a theme. The main objective of this research and development effort is to produce E-LKPD that are both reliable and effective. While practicality is evaluated through teacher and student practicality assessments, validity is evaluated through validation by knowledgeable material and media validators. This study utilizes Research and Development (R&D) with the ADDIE model as its methodology, though only the development stage was implemented due to time limitations. The study's findings show that the created E-LKPD products meet reliable and useful standards. The high validation percentages from both material experts (75%, 'Valid') and media experts (92.4%, 'Very Valid') serve as evidence for this. In addition, the practicality test by teachers reached 90% (category "Very Practical"), and the overall percentage of practicality tests by students was 87.25% (category "Very Practical").

Keywords:

E-LKPD,
Geometric Transformation,
Ethno-RME,
Yogyakarta Batik Motifs, Problem Solving

Corresponding Author:

Nahwa Fathia
Affiliation Mathematics Education, Alma Ata University, Indonesia
Email: 211400135@almaata.ac.id

Introduction

Mathematics is a universal science that serves as the foundation for the advancement of modern technology. This discipline also plays a crucial role in various educational fields and can enhance human abilities and skills. There is a prevailing perception that mathematics is a difficult and tedious subject, often seen as irrelevant to real life due to its focus on symbols and numbers. As the level of education increases, mathematics tends to become more abstract and disconnected from daily contexts.

Therefore, the main task of mathematics teachers is to bridge this gap by presenting mathematical concepts rooted in everyday life (Bakhrodin, Istiqomah, & Abdullah, 2019).

Mathematics is considered the foundation of all sciences, consisting of abstract concepts; therefore, mathematical material is generally linked to real-life contexts so that students can develop understanding and improve their mathematical thinking abilities (Setyaningrum & Kusno, 2024). Mathematical thinking skills are indicated through the accumulation of several competencies: (1) understanding mathematics; (2) problem-solving; (3) mathematical reasoning; (4) mathematical connections; and (5) mathematical communication (Fajri, 2017). The ability to understand mathematical concepts can be seen from students' competence in interpreting and re-explaining a mathematical concept, developing algorithms to solve problems accurately, precisely, and efficiently in their own words, so that this knowledge can be applied to daily life situations (Sengkey, Sampoerno, & Aziz, 2023).

Problem-solving is a directed reasoning ability to find effective solutions when facing various difficulties and challenges (Mustami'ah, 2023). Solving mathematical problems involves methods, processes, and plans that emphasize central and primary procedures within the mathematics curriculum (Kusmayanti & Murtiyasa, 2024). Polya explained that there are four steps related to solving mathematical problems: (1) understanding the problem; (2) devising a plan; (3) carrying out the plan; and (4) looking back to review the process and results (Nasution, Oktaviani, & Utara, 2020).

Based on the results of the international *Programme for International Student Assessment (PISA)*, Indonesia experienced a decline in its score. The mathematics score decreased from 379 in 2018 to 366 in 2022. Meanwhile, the *Trends in International Mathematics and Science Study (TIMSS)* in 2015 showed that Indonesia obtained a score of 379, ranking 44th out of 49 participating countries. This finding indicates that Indonesian students' mathematical and problem-solving abilities remain below international standards (Hanggara, Aisyah, & Amelia, 2022). The factors contributing to the decline in students' problem-solving abilities include the tendency for learners to receive material information rather than engage in reasoning activities to solve mathematical problems. Mathematics learning should not only focus on memorizing formulas but also emphasize conceptual understanding through real-life applications (Richardo, 2020). A study conducted by (Sa'diyah & Istiandaru, 2021) showed that students at one of the junior high schools in Yogyakarta still struggled to solve mathematical problems. Students' difficulties are not only caused by a lack of conceptual understanding but also by inappropriate problem-solving strategies, which lead to calculation errors.

In addition, several other factors contribute to students' difficulties in solving mathematical problems, such as ineffective teaching methods and instructional materials. Learning materials consist of a combination of various tools and learning resources containing systematically and structurally designed content and information to achieve learning objectives (Magdalena et al., 2020). Currently, the learning materials used are less engaging and difficult for students to understand, making them feel bored because the materials are monotonous (Wibowo & Pratiwi, 2018).

Based on these factors, it is necessary to develop learning materials that can improve students' mathematical problem-solving abilities. One of the materials needed to support mathematics learning is the Student Worksheet. Student Worksheet is a learning tool containing instructions, guidelines, assignments, and information that guides students to analyze or solve problems through structured activities or experiments, aiming to develop all learning aspects and help achieve learning indicators (Effendi, Herpratiwi, & Sutiarso, 2021). The use of LKPD provides opportunities for students to be active and creative during the learning process.Along with technological advancements, the presentation of Student Worksheet has been combined with digital technology, now known as *Electronic Student*

Worksheet (E-LKPD). E-LKPD is a digital learning material presented in an organized format containing instructions, materials, and learning activities provided by teachers to students (Septiani & Amir, 2023). E-LKPD serves as a tool for teachers to encourage students toward more interactive learning. It helps facilitate and simplify learning activities, captures students' attention to prevent boredom, and keeps them focused during the learning process (Triyani, Pamungkas, & Santosa, 2024).

This E-LKPD material is designed with realistic contexts drawn from students' daily lives. The learning approach that focuses on realistic problem-solving is *Realistic Mathematics Education (RME)*. RME is a mathematics learning approach emphasizing the process of mathematical problem-solving, discussion, collaboration, and peer interaction, enabling students to find solutions individually or in groups (Siregar, Lubis, & Ardiana, 2023). This RME approach is strengthened by incorporating elements of students' real-life contexts. The context most relevant to students' real-life experiences is local culture, which can be used as a basis for learning materials in applying mathematical concepts and principles. The integration of mathematics with local culture helps students better understand mathematical concepts (Kholisa, 2021). The systematic integration of ethnomathematics and cultural values is referred to as *Ethno-RME*. Learning that combines culture and RME can serve as an effective innovation in which culture is interpreted through a mathematical perspective.

In this research, the author integrates cultural elements in the form of Yogyakarta batik motifs into the topic of geometric transformations. Geometric transformation is defined as a change in the shape, size, or position of an object. The principles of transformation are often found in various batik motifs, such as translation, reflection, rotation, and dilation (Abdullah & Yoga, 2021). Geometric transformation is highly beneficial for students in developing spatial ability, geometric reasoning, and strengthening mathematical proof skills (Ardinata, Sudiarta, & Suharta, 2020). The topic of geometric transformation is closely related to Yogyakarta batik patterns. Yogyakarta batik is one of the traditional arts that remains deeply rooted in the local community, combining traditional values with modern development. The dominant colors of Yogyakarta batik are brown, black, and white, with various distinctive motifs such as *kawung*, *ceplok*, and *parang* (Prayoga et al., 2023). The existence of Yogyakarta batik can thus serve as a contextual reference for developing learning materials that enhance students' ability to solve problems related to geometric transformations. Based on the discussion above, the researcher conducted a study entitled "Development of Ethno-RME-Based Electronic Student Worksheet (E-LKPD) on Geometric Transformation Using Yogyakarta Batik Motifs to Improve Mathematical Problem-Solving Ability."

Methods

This research and development employed the Research and Development (R&D) method using the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. However, due to time constraints, this study was conducted only up to the Development phase, and therefore, it did not proceed to the Evaluation stage. The data collection techniques used in this study included literature review and questionnaires. The questionnaires utilized a Likert scale with four criteria: *Strongly Agree (SA)*, *Agree (A)*, *Disagree (D)*, and *Strongly Disagree (SD)*.

The data obtained from the questionnaires were analyzed using the following formula:

$$P = \frac{R}{SM} \times 100\%$$

Explanation: *P* = Percentage sought, *R* = Score obtained, *SM* = Maximum score

After calculating the percentage, the data were classified according to product validity and practicality criteria. A validity percentage within the range of 75.01%–100% indicates that the developed product meets the "Very Valid" category, while a practicality percentage within the same range (75.01%–100%) signifies that the product is categorized as "Very Practical" (Parasmita, 2023).

Results and Discussion

The result of this Research and Development (R&D) study is an Ethno-RME-based E-LKPD on geometric transformation using Yogyakarta batik motifs designed to improve students' mathematical problem-solving abilities. The product can be accessed via a link or URL through electronic media such as smartphones, laptops, and tablets. The following presents the development results of the E-LKPD in this research Analyze. The analysis stage represents the initial activity conducted to ensure that the product being developed aligns with user needs.The purpose of the user needs analysis is to identify fundamental problems encountered during mathematics learning. These issues include the availability of teaching materials or media, the application of teaching methods and learning models, and the conditions of both teachers and students during the learning process. Data for this analysis were obtained through interviews. From the interviews, it was found that the school has implemented the *Merdeka Curriculum*. One of the challenges faced by teachers during instruction is that students respond well and remain engaged during the early stages of learning; however, toward the end of the lesson, they begin to lose interest, leading to a less conducive learning atmosphere. This phenomenon occurs because students tend to feel bored as learning progresses. One of the contributing factors is the use of lecture-based and discussion-based teaching methods, which result in limited student participation. In addition, the instructional materials used are still conventional in nature, such as worksheets (LKS), textbooks, and PowerPoint presentations.

Based on this analysis, the researcher took the initiative to develop a learning material in the form of an Electronic Student Worksheet (E-LKPD) to improve the quality of mathematics learning and to foster student engagement. Therefore, the researcher decided to design the E-LKPD in the form of an interactive flipbook. Material Needs Analysis The material needs analysis was conducted to obtain comprehensive information regarding the learning outcomes, specific learning objectives, and relevant teaching materials to be used. In this analysis, the researcher employed a literature study as the primary method. Through the literature review, an in-depth analysis was carried out on the learning outcomes set forth in the *Merdeka Curriculum*.

The developed E-LKPD contains material on geometric transformations, which are taught in Grade IX. The scope of the material includes four subtopics: translation, reflection, rotation, and dilation (enlargement/reduction). Geometric transformation is part of geometric elements in mathematics, as stipulated in the Decree of the Head of the Agency for Standards, Curriculum, and Educational Assessment of the Ministry of Education, Culture, Research, and Technology No. 008/H/KR/2022,

concerning *Learning Outcomes in Early Childhood Education, Basic Education, and Secondary Education* under the Merdeka Curriculum. The Learning Outcome (Capaian Pembelajaran / CP) for the geometric transformation topic is as follows

Table 1. Learning Outcomes based on Ministry of Education, Culture, Research, and Technology No. 008/H/KR/2022

Elemen	Learning Outcomes
Geometri	Students can use points, lines, and plane shapes to solve problems or perform single transformations (reflection, translation, rotation, and dilation) in Cartesian coordinates at the end of phase D.

Based on the established learning outcomes, researchers then formulate learning objectives that must be achieved. These learning objectives are presented in the following table:

Table 2. Learning Objectives

Sub Material	Learning objectives
Translation	1. Explain the meaning of translation. 2. Describe translation using Cartesian coordinates. 3. Implement translation in real-world problems.
Reflection	1. Explain the meaning of reflection. 2. Describe reflection using Cartesian coordinates. 3. Implement reflection in real-world problems.
Rotation	1. Explain the meaning of rotation. 2. Describe rotation using Cartesian coordinates. 3. Implement rotation in real-world problems.
Dilation	1. Explain the meaning of dilation. 2. Describe dilation using Cartesian coordinates. 3. Implement dilation in real-world problems..

Product specification analysis was conducted through a literature review to identify various types of software that could be utilized in product development for this study. In this study, flowcharts were created using Microsoft Word, while the e-LKPD (learning task assignment) design was done using Canva, which generates PDF files. To generate the e-LKPD, the researchers used the Heyzine website to enable access to the e-LKPD via digital devices such as laptops, smartphones, tablets, computers, and other digital devices. Through Heyzine, the researchers included links to interactive questions and exercises for the LKPD, previously created using LiveWorksheet, so students could access and complete the assessments and LKPD interactively.

*Design.*The next stage is design development, which is the process of selecting a design that is precise and appropriate for the product being developed. The steps followed by researchers in this stage are:

a. Creating an initial product design in the form of a flowchart. This flowchart plays a crucial role as a schematic for the overall E-LKPD development process. This flowchart provides researchers with a systematic overview of how the E-LKPD will be designed, including the sequence of elements and the final appearance.
b. Creating a storyboard as a structured visual representation of the flowchart created in the previous stage.
c. Collecting reference materials, sample questions, and content relevant to the geometric transformation material included in the E-LKPD to be developed.

The material and discussion of the problems contained in the E-LKPD are presented in the following table:

Table 3. List of Materials in E-LKPD

List	Material Title	Problem Discussion
LKPD 1	Translation, reflection, rotation, dilation	Determine the coordinates of translation, reflection, rotation, dilation, and define dilation.
LKPD 2	Translation, reflection, rotation, dilation	Attach each element according to the picture given
LKPD 3	Translation, reflection, rotation, dilation	Put a tick on the correct statement
LKPD 4	Translation, reflection, rotation, dilation	Answer questions using the voice recording method and answer listening questions.
LKPD 5	Reflection	Determining reflection coordinates and the amount of ink (ml) in making batik
LKPD 6	Translation, reflection, rotation, dilation	Determining coordinates by solving Polya's problem

Development

Product Creation

The e-LKPD (E-LKPD) creation process begins with gathering materials, videos, and supporting elements, then designing them in Canva as a PDF. Learning videos are uploaded to YouTube and embedded within the e-LKPD. For interactivity, Liveworksheets is used as a platform to create questions that can be filled in directly, complete with scoring and timing settings, generating links that are embedded within the e-LKPD. Interactive assessment quizzes are also created in Wordwall, generating links to multiple-choice questions with automatic scoring, which are also embedded. After all elements are integrated in Canva, the PDF output is converted into a flipbook using Heyzine, resulting in an E-LKPD product.

Figure 2. Flipbook view on Heyzine

Product validation involved two subject matter experts and two media experts to ensure the validity and feasibility of the E-LKPD. The following product validation was conducted:

1) Subject Matter Validation

The subject matter expert validation in this study was conducted on two lecturers from the Mathematics Education Study Program at Alma Ata University. The following material validation findings were obtained:

Table 4. Results of Material Expert Validation

No	Assessment Aspect	Total Score	
		Validator 1	Validator 2
1.	Content quality	18	18
2.	Language quality	18	18
Total Score		36	36

Persentase	75%	75%
Persentase	Valid	Valid
Overall percentage	75%	
Overall category	Valid	

Based on the recapitulation of the material expert validation, the overall percentage was 75%, categorized as "Valid," so the E-LKPD can be used with minimal revisions.

1) Media Validation

Media expert validation in this study was conducted by two lecturers from the Informatics Engineering Study Program at Alma Ata University. The following are the media validation results:

Table 5. Media Expert Validation Results

No	Assessment Aspects	Total Score	
		Validator 1	Validator 2
1.	E-LKPD display quality	32	35
2.	Content quality	14	15
3.	Quality of use of E-LKPD	7	8
Total Score		53	58
Percentage		88,3%	96,6%
Category		Very Valid	Very Valid
Overall percentage		92,4%	
Overall category		So Valid	

Source: Data processed

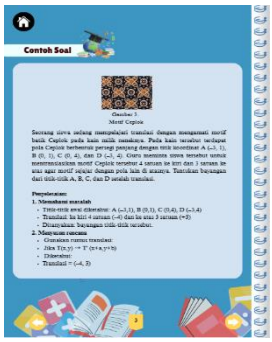
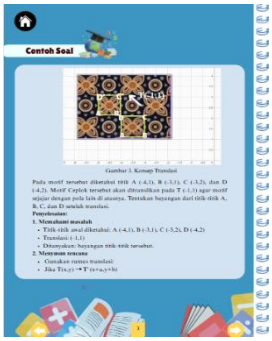
Based on the recapitulation of media expert validation, the overall percentage was 92.4%, categorized as "Very Valid," so the E-LKPD can be used with minimal revision.

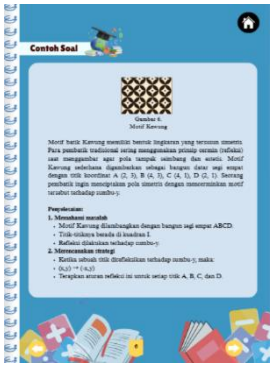
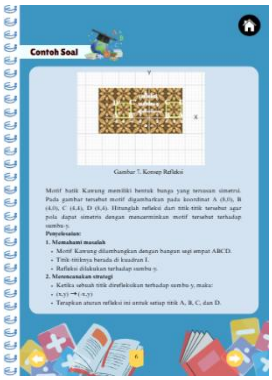
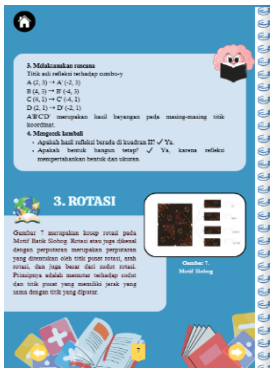
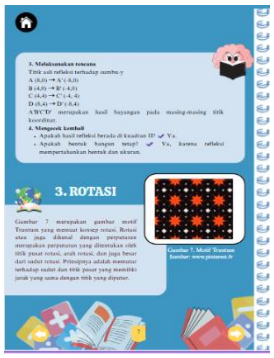
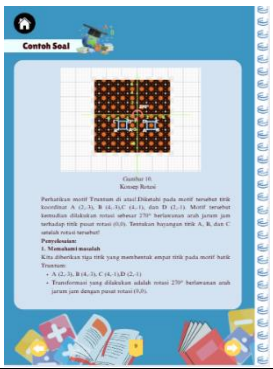
Product Revision

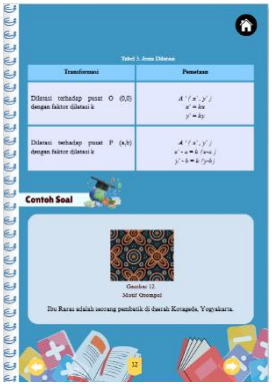
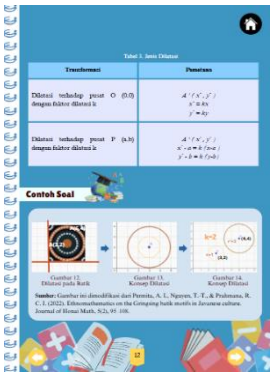
Validation by material and media experts included criticism and suggestions for the E-LKPD for further revision for improvement.

The following is a revision of the E-LKPD based on criticism from material experts and media experts:

Table 6. Product Revisions

Criticism and suggestions	Before Revision	After Revision
In the independent curriculum there is no term KD		
The image of the parang motif does not match the translation concept.	 	 

Example of reflection questions corrected	   
Image on rotation fixed	   

Corrected dilation example questions		
There are small letters that can be read		

The product practicality test in this study was conducted on a small scale, with three mathematics teachers at SMP N 16 Purworejo and eight ninth-grade students. The following are the results of the practicality test:

Results of the Teacher Practicality Test

The teacher practicality test was conducted on three junior high school mathematics teachers: Ms. Sriwati, S.Pd., M.Pd., Ms. Sugiyani, S.Pd., and Mr. Rizky Saputra, S.Pd. The results of the teacher practicality test were as follows:

Table 7. Results of Teacher Practicality Test

No	Assessment Aspects	Total Score		
		Teacher 1	Teacher 2	Teacher 3
1.	Presentation aspects of E-LKPD	42	43	43
2.	Aspects of material presentation	40	47	45
3.	Aspects of language presentation	3	4	3
Total Score		85	94	91
Percentage		85%	94%	91%
Category		Very Practical	Very Practical	Very Practical
Overall Percentage			90%	
Overall Category			Very Practical	

Based on the recapitulation of teacher practicality, an overall percentage of 90% was categorized as "Very Practical," so the E-LKPD can be used with minor revisions.

Student Practicality Test Results

The teacher practicality test was conducted on eight ninth-grade junior high school students. The following are the results of the student practicality test:

Table 8. Results of Student Practicality Test

Assessment Aspects	Assessment Score							
	1	2	3	4	5	6	7	8
E-LKPD display quality	15	14	14	11	15	15	13	13
Quality of E-LKPD content	15	14	14	14	14	15	14	14
Quality of use	18	17	17	16	18	18	18	17
Total score	48	45	45	41	47	48	45	44
Persentase	92,3	86,5	86,5	78,8	90,3	92,3	86,5	84,6
Total overall score	363							
Overall percentage	87,25%							
Overall category	Sangat Praktis							

Based on the recapitulation of students' practicality, the overall percentage was 87.25% in the "Very Practical" category so that E-LKPD can be used with slight revisions.

Conclusion

Based on the validation percentage results obtained from the material and media experts, as well as the practical evaluation results from teachers and students, it can be concluded that the E-LKPD on geometric transformations based on ethno-RME with the context of Yogyakarta batik motifs, aimed at enhancing mathematical problem-solving skills, is valid and suitable for use in teaching. Therefore, the E-LKPD developed in this study falls into the categories of both valid and highly practical.

References

Bakhrodin, Istiqomah, U., & Abdullah, A. A. (2019). *Identifikasi etnomatematika pada Masjid Mataram Kotagede Yogyakarta*.

Setyaningrum, A., & Kusno, K. (2024). Etomatematika: Eksplorasi konsep transformasi geometri di Batik Banyumasan. *Jurnal Derivat: Jurnal Matematika dan Pendidikan Matematika*, 11(2), 63–71.

Fajri, M. (2017). Kemahiran bernalar matematis pada konteks belajar abad 21 di SD. *Lemma: Letters of Mathematics Education*, 3(2).

Sengkey, D. J., Sampoerno, P. D., & Aziz, T. A. (2023). Kemahiran pemahaman konsep matematis: Suatu kajian literatur. *Griya Journal of Mathematics Education and Application*, 3(1), 67–75.

Mustami'ah, D. (2023). *Perlunya Kemahiran Problem Solving ketika Menghadapi Kehidupan*.

Kusmayanti, H., & Murtiyasa, B. (2024). E-LKPD matematika berbasis React: Menaikan kemahiran memecahkan permasalahan matematis. *Teorema: Teori dan Riset Matematika*, 9(1), 27–38.

Nasution, M. D., Oktaviani, W., & Utara, S. (2020). Mengembangkan perangkat belajar matematika berbasis permasalahan guna menaikan kemahiran memecahkan permasalahan pelajar SMP PAB 9 Klambir V TP 2019/2020. *Jurnal Pendidikan Matematika Sigma*, 1(1), 46–54.

Hanggara, Y., Aisyah, S. H., & Amelia, F. (2022). Analisa kemahiran memecahkan persoalan matematis pelajar dilihat dari perbedaan gender. *Pythagoras: Jurnal Program Studi Pendidikan Matematika*, 11(2), 189–201.

Richardo, R. (2020). Belajar matematika lewat konteks Islam Nusantara: Suatu kajian etnomatematika pada Indonesia. *Jurnal Pendidikan Matematika (Kudus)*, 3(1), 73–82.

Sa'diyah, L. K., & Istiandaru, A. (2021). Profil kemahiran memecahkan persoalan matematika pelajar SMP berlandasan framework Polya. *Jurnal Ilmiah Pendidikan Matematika Al Qalasadi*, 5(1), 19–28.

Magdalena, I., Sundari, T., Nurkamilah, S., Ayu Amalia, D., & Muhammadiyah Tangerang, U. (2020). Analisa bahan ajar. *Jurnal Pendidikan dan Ilmu Sosial*, 2(2), 311–326.

Wibowo, E., & Pratiwi, D. D. (2018). Mengembangkan bahan ajar memakai aplikasi Kvisoft Flipbook Maker materi himpunan. *Desimal: Jurnal Matematika*, 1(2), 147–156.

Effendi, R., Herpratiwi, H., & Sutiarso, S. (2021). Mengembangkan LKPD matematika berbasis PBL di SD. *Jurnal Basicedu*, 5(2), 920–929.

Septiani, W., & Amir, A. (2023). Mengembangkan E-LKPD di materi teks negosiasi pelajar kelas X SMAN 1 Sarolangun. *Ta'rim: Jurnal Pendidikan dan Anak Usia Dini*, 4(1), 43–55.

Triyani, R., Pamungkas, A. S., & Santosa, C. A. H. F. (2024). Mengembangkan E-LKPD matematika berbasis liveworksheet ketika menunjang belajar berdiferensiasi pelajar SMP. *Delta-Pi: Jurnal Matematika dan Pendidikan Matematika*, 13(1), 34–52.

Siregar, A. M., Lubis, R., & Ardiana, N. (2023). Analisa faktor rendahnya kemahiran memecahkan persoalan matematis pelajar dilihat dari motivasi belajar pelajar di kelas VII SMP Negeri 5 Padang Sidimpuan. *Mathematic Education Journal (MathEdu)*, 6(2), 41–47.

Kholisa, F. N. (2021). Eksplorasi etnomatematika pada konsep geometri di Rumah Joglo Pati. *CIRCLE: Jurnal Pendidikan Matematika*, 1(2), 89–108. https://doi.org/10.28918/circle.v1i02.4225

Abdullah, A. A., & Yoga, A. (2021). Eksplorasi etnomatematika di Batik Kayu Krebet Bantul. *Jurnal Pendidikan Matematika*, 9(2), 163–172.

Ardinata, I. D. G. P., Sudiarta, I. G. P., & Suharta, I. G. P. (2020). Mengembangkan GeoGebra guna materi transformasi geometri berorientasi strategi IKRAR dengan usaha menaikan kemahiran menyelesaikan persoalan matematika. *Wahana Matematika dan Sains: Jurnal Matematika, Sains, dan Pembelajarannya*, 14(1), 87–96.

Prayoga, A., Maimunah, Sukmasetya, P., Yudianto, M. R. A., & Hasani, R. A. (2023). Arsitektur Convolutional Neural Network guna model klasifikasi citra Batik Yogyakarta. *Journal of Applied Computer Science and Technology*, 4(2), 82–89.

Parasmita, R. M. (2023). *Mengembangkan E-LKPD berbasis PBL di SMP IT Insan Batanghari* (Skripsi, IAIN Metro).