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Implementation and Effectiveness of the "Transformatiks" LMS Based on Indonesian Batik Culture for Geometry Transformations

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Abstract

Abstract

The integration of technology and local culture in mathematics learning is essential to create meaningful and engaging learning experiences. This study aimed to implement and evaluate the effectiveness of the Transformatiks Learning Management System (LMS), which integrates Indonesian batik culture into geometry transformation learning. The LMS was developed using Google Sites and includes learning materials, instructional videos, interactive worksheets, and online quizzes designed to support students understanding of translation, reflection, and rotation concepts through ethnomathematical contexts. The study employed the ADDIE development model and involved validation by one mathematics education lecturer and two mathematics teachers. The implementation was conducted with grade XI senior high school students due to scheduling constraints in the intended target school. Data were collected through validation sheets, pre-tests, and post-tests. The validation results indicated that the LMS was valid and suitable for learning implementation. The effectiveness of the LMS was measured using the N-Gain score obtained from students' learning outcomes. The analysis showed an N-Gain score of 82.15%, indicating a high level of effectiveness. These findings suggest that the Transformatiks LMS can serve as an effective learning medium for enhancing students' understanding of geometry transformations while introducing Indonesian batik culture.

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INTRODUCTION

The rapid development of digital technology has significantly influenced various aspects of human life, including education. Technology is no longer merely a supporting tool but has become an essential component in creating effective, flexible, and interactive learning environments (Ulfa et al., 2025). One of the technological innovations widely implemented in education is the Learning Management System (LMS), a digital platform that facilitates the delivery of learning materials, assignment management, communication, and assessment within an integrated system (Mahabu et al., 2025). The utilization of LMS enables students to access learning resources anytime and anywhere, thereby supporting independent and student-centered learning (Kerimbayev et al., 2023). The flexibility provided by LMS also facilitates personalized learning experiences that accommodate students' individual needs and learning preferences.

In mathematics learning, the implementation of LMS is particularly relevant because many mathematical concepts are abstract and require visualization to facilitate conceptual understanding (Rafi et al., 2020). One topic that frequently presents learning difficulties is geometry transformation, which includes translation, reflection, rotation, and dilation. Students often struggle to understand these concepts because they involve spatial reasoning and visualization skills (Hafizh & Kusno, 2025). As a result, conventional teaching methods that rely primarily on verbal explanations may not adequately support students' understanding of geometry transformation concepts. Therefore, innovative learning media are needed to provide interactive and meaningful learning experiences.

Problem Based Learning (PBL) is one of the instructional approaches that can address this issue. PBL emphasizes student-centered learning through the exploration of contextual problems that encourage critical thinking, collaboration, and problem-solving skills (Muhartini et al., 2023). Through this approach, students actively construct knowledge rather than passively receiving information. The effectiveness of PBL can be enhanced through its integration with digital learning environments, such as Learning Management System (LMS), which provide structured learning resources, collaborative activities, and assessment opportunities (Syaikhu, 2024). Furthermore, LMS supports the implementation of PBL by facilitating the organization of learning activities and providing a digital space for students to investigate problems, collaborate, and construct knowledge throughout the learning process (Nisa & Navlia, 2025).

In addition to technological integration, mathematics learning can be enriched through ethnomathematics, an approach that connects mathematical concepts with cultural practices and local wisdom (Rahmawati Z, 2020). Ethnomathematics enables students to recognize the existence of mathematics in their daily cultural experiences, making learning more contextual and meaningful. One cultural artifact that contains various mathematical concepts is Indonesian batik. Batik motifs often exhibit patterns, symmetry, and geometric transformations that can be utilized as meaningful contexts for learning geometry transformation (Asfyra et al., 2026). Integrating batik culture into mathematics instruction not only supports conceptual understanding but also promotes cultural awareness and appreciation among students.

Previous studies have reported the positive impact of LMS on learning effectiveness, the benefits of PBL in enhancing problem-solving skills, and the contribution of ethnomathematics to contextual mathematics learning. However, most studies have examined these aspects separately. Research integrating digital learning technology, problem-based learning, and ethnomathematics within a single learning system for geometry transformation learning remains limited. Furthermore, few studies have specifically utilized Indonesian batik culture as a contextual basis for learning geometry transformation through a learning management system.

To address this gap, this study developed the Transformatiks Learning Management System (LMS), a digital learning platform that integrates problem-based learning and ethnomathematics based on Indonesian batik culture in geometry transformation learning. The LMS incorporates learning materials, instructional videos, digital worksheets, and interactive quizzes designed to support students' understanding of translation, reflection, rotation, and dilation concepts. This integration represents the novelty of the study by combining educational technology, student-centered pedagogy, and local cultural contexts within a single learning environment.

Therefore, this study aims to implement the Transformatiks Learning Management System (LMS) based on Indonesian batik culture in geometry transformation learning and to evaluate its validity and effectiveness in improving students' learning outcomes. The findings are expected to contribute to the development of innovative mathematics learning media that integrate technology, pedagogy, and local culture.

METHOD

This study employed a Research and Development (R&D) approach using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Rachma et al., 2023). The ADDIE model was selected because it provides a systematic framework for developing educational products and has been widely used in technology based learning media development (Safitri & Aziz, 2022). Through this model, the Transformatiks Learning Management System (LMS) was developed to support geometry transformation learning by integrating digital technology, problem-based learning, and ethnomathematics based on Indonesian batik culture.

The development process began with the analysis stage, which involved identifying students learning needs, characteristics, and difficulties in understanding geometry transformation concepts. The design stage focused on developing the LMS structure, learning materials, instructional videos, digital worksheets, assessment instruments, and user interface. The LMS was designed to cover four geometry transformation topics: translation, reflection, rotation, and dilation. During the development stage, all learning resources were integrated into a Google Sites platform. The implementation stage involved classroom testing of the LMS, while the evaluation stage was conducted to assess the validity and effectiveness of the developed product.

The implementation was conducted with 33 students from class XI F1 at SMA Negeri 13 Semarang. Although the LMS was originally designed for grade IX junior high school students, grade XI students were selected because grade IX students were unavailable during the observation period due to the implementation of the Academic Competency Test (TKA). Furthermore, grade XI students had previously studied geometry transformation concepts, enabling them to provide meaningful feedback regarding the use of the LMS. Due to time limitations before the final semester examination, the implementation was conducted in two learning sessions covering translation, reflection, and rotation, while the dilation topic was not implemented.

Data was collected through expert validation and learning achievement tests. Expert validation was conducted to assess the feasibility of the Transformatiks LMS before its implementation. The validation process involved one mathematics education lecturer and two mathematics teachers who evaluated the LMS using a validation sheet covering aspects of learning objectives, content, instructional design, language, visual appearance, and learning activities. The validation results were used to revise and improve the LMS before classroom implementation. Learning achievement data was obtained through pre-tests and post-tests administered before and after the implementation of the LMS to measure students' understanding of geometry transformation concepts and determine improvements in learning outcomes.

The collected data were analyzed using validity analysis and N-Gain analysis. Validation data obtained from the expert assessment sheets, which employed a four point likert scale, were converted into percentages to determine the validity level of the LMS (Fikriyah & Sukmawati, 2022). The effectiveness of the LMS was evaluated using the N-Gain Score calculated from students' pre-test and post-test results. The N-Gain analysis was used to measure the improvement in students' learning outcomes after using the Transformatiks LMS. The N-Gain value was calculated using the following formula:

$$N - GAIN = \frac{Posttest\ Score - Pretest\ Score}{Ideal\ Score - Pretest\ Score}$$

N-Gain Effectiveness Criteria	
Percentage	*Effectiveness Category*
< 40	*Ineffective*
$40 - 55$	*Less Effective*
$56 - 75$	*Moderately Effective*
> 76	*Effective*

Figure 1. N-Gain Effectiveness Criteria

RESULTS AND DISCUSSIONS

The Transformatiks LMS is a web based learning platform developed for geometry transformation learning by integrating Indonesian batik culture as a contextual learning resource. The LMS was designed to facilitate students' understanding of geometry transformation concepts through visual and interactive learning materials. Batik motifs were incorporated into the learning content to illustrate the concepts of translation, reflection, rotation, and dilation, allowing students to connect mathematical concepts with cultural artifacts. The LMS consists of learning materials, instructional videos, digital worksheets (LKPD), and interactive quizzes. Learning materials and videos support independent learning, while the worksheets facilitate collaborative problem solving activities. Student learning outcomes were assessed using quizzes administered through Quizizz after each learning session.

The learning content was organized into three instructional sessions. The first session focused on translation and reflection, the second session focused on rotation, and the third session focused on dilation. Each session included learning materials, instructional videos, worksheets, and evaluation activities designed to support students' conceptual understanding of geometry transformations. However, due to time constraints during the implementation stage, only the first and second sessions were conducted, while the third session on dilation was not implemented.

Prior to the implementation stage, the validity of the Transformatiks LMS was evaluated to determine its feasibility as a learning medium. The validation process involved three experts consisting of one mathematics education lecturer and two senior high school mathematics teachers. The evaluation was conducted using a validation instrument based on a four point likert scale covering several aspects, including LMS content, learning materials, interface design, and language. The validation results are presented in Table 1.

Table 1. Validation Results of the Transformatiks

Validator	Percentage	Category	Remarks
1	91%	Highly Valid	Usable after revision
2	73%	Valid	Usable after revision
3	98%	Highly Valid	Usable after revision
Mean	87.33%	Highly Valid	Suitable for use

As shown in Table 1, the average validity score was 87.33%, which falls into the highly valid category. These results indicate that the LMS is suitable for use in geometry transformation learning. In addition to providing quantitative assessments, the validators also suggested several improvements related to content presentation, visual appearance, and language clarity. These recommendations were incorporated into the LMS before the implementation stage. After the revision process, the Transformatiks LMS was considered appropriate for classroom use.

Following the validation stage, the Transformatiks LMS was implemented in a senior high school classroom. The

implementation consisted of two learning sessions. The first session focused on translation and reflection, while the second session focused on rotation. Before the learning activities began, students completed a pre-test to assess their prior knowledge of geometry transformation concepts. Subsequently, students accessed the LMS to study the learning materials and instructional videos, complete collaborative digital worksheet activities, and participate in quizzes administered through Quizizz.

During the first session, students demonstrated positive engagement with the learning activities. The visual presentation of the materials and videos helped students understand the concepts of translation and reflection more effectively. Furthermore, the integration of Indonesian batik motifs provided meaningful contextual examples, enabling students to observe geometry transformation concepts directly through cultural patterns. Group discussions facilitated through digital worksheets also encouraged active participation and collaborative problem solving among students.

In the second session, the learning activities focused on the concept of rotation. Like the first session, students utilized the LMS as the primary learning medium. Based on classroom observations, students experienced no significant difficulties in accessing or navigating the LMS features. The visual illustrations included in the learning materials helped students understand how objects change position through rotational transformations. Additionally, the quizzes administered at the end of the lesson encouraged students to review and reinforce their understanding of the concepts learned.

Although the Transformatiks LMS was originally designed for three instructional sessions covering translation and reflection, rotation, and dilation, only the first two sessions could be implemented due to time constraints associated with the end-of-semester examination schedule. Consequently, the dilation topic was not tested during the implementation stage. Nevertheless, the results obtained from the two completed sessions demonstrated that the LMS functioned effectively as a learning medium for geometry transformation learning.

The effectiveness of the Transformatiks LMS was evaluated using the N-Gain score calculated from students' pre-test and post-test results. The pre-test was administered before the implementation of the LMS to assess students' initial understanding, while the post-test was conducted after the completion of the learning activities to measure students' learning outcomes.

N-Gain Score Calculation							
No.	NAME	PRE-TEST	POST TEST	POST-PRE	Ideal Score (100-pre)	N-Gain Score	N-Gain Score (%)
1	Adelwis Niken P.	58.3	93.3	35	41.7	0.84	83.93
2	Albani Baraka	36.1	94.4	58.3	63.9	0.91	91.24
3	Alifia Arfa A.	50	91.6	41.6	50	0.83	83.20
4	Aqilla Dhafi M.	50	91.6	41.6	50	0.83	83.20
5	Arya Bagas A.	30.5	77.7	47.2	69.5	0.68	67.91
6	Ayu Jannah F.	27.7	91.6	63.9	72.3	0.88	88.38
7	Azahra Afifatunisa S.	38.8	93.3	54.5	61.2	0.89	89.05
8	Azzura Syahidah S.	27.7	84.7	57	72.3	0.79	78.84
9	Bintang Hambyah	30.5	87.5	57	69.5	0.82	82.01
10	Birgitta Aurellia Z.A.	55.5	69.4	13.9	44.5	0.31	31.24
11	Deo Brata S.	41.6	93.3	51.7	58.4	0.89	88.53
12	Desvita Yuliasari	38.8	95	56.2	61.2	0.92	91.83
13	Dzakiya Rafifah A.	25	95	70	75	0.93	93.33
14	Farrel Triwiguna M.	33.3	83.3	50	66.7	0.75	74.96
15	Favian Aditya Felix P.	36.1	97.2	61.1	63.9	0.96	95.62
16	Hashifah Tsabita Zada	55.5	95	39.5	44.5	0.89	88.76
17	Inka Nafila Ilmi	52.7	100	47.3	47.3	1.00	100.00
18	Isya Dafiata K.	36.1	83.3	47.2	63.9	0.74	73.87
19	Kezia Nauli	44.4	93.3	48.9	55.6	0.88	87.95
20	Kharisna Surya	58.3	91.6	33.3	41.7	0.80	79.86
21	Maria Helena	30.5	87.5	57	69.5	0.82	82.01
22	Marvely Aliceandra	33.3	91.6	58.3	66.7	0.87	87.41
23	Maulida Nuril M.	55.5	84.7	29.2	44.5	0.66	65.62
24	Meidina Fathi K.	52.7	95	42.3	47.3	0.89	89.43
25	M. Fathi Farhat	44.4	91.6	47.2	55.6	0.85	84.89
26	M. Umar Zulfikar	55.5	93.3	37.8	44.5	0.85	84.94
27	Naira Bilqis Amiko	55.5	95	39.5	44.5	0.89	88.76
28	Naja Satria Gama	41.6	88.8	47.2	58.4	0.81	80.82
29	Naufal Azmi D	58.3	95	36.7	41.7	0.88	88.01
30	Radhitia Nur A.	63.8	95	31.2	36.2	0.86	86.19
31	Sabrina Aulia A.	55.5	83.3	27.8	44.5	0.62	62.47
32	Tania	44.4	91.6	47.2	55.6	0.85	84.89
33	Theresa Rosaria Widyaputri	30.5	80.5	50	69.5	0.72	71.94
	Mean	43.89	90.15	46.26	56.11	0.82	82.15

Figure 2. N-Gain Score of Students Learning Outcomes

As presented in Figure 1, the obtained N-Gain score was 82.15%. Based on the N-Gain effectiveness criteria, this result falls into the effective category. The high N-Gain score indicates that the Transformatiks LMS significantly contributed to improving students' understanding of geometry transformation concepts. The improvement in learning outcomes can be attributed to several factors. First, the LMS integrates learning materials, instructional videos, digital worksheets, and evaluation activities within a single platform, allowing students to learn in a structured and systematic manner. Second, the visual representation of geometry transformation concepts helps students better understand abstract mathematical ideas. Third, the integration of Indonesian batik culture provides meaningful learning experiences by connecting mathematical concepts with cultural contexts familiar to students. As a result, students become more engaged and motivated throughout the learning process.

These findings suggest that the Transformatiks LMS is not only highly valid but also effective in supporting geometry transformation learning. The integration of technology and local cultural contexts can therefore serve as an alternative approach to creating meaningful, engaging, and effective mathematics learning experiences.

CONCLUSION

The implementation of the Transformatiks LMS based on Indonesian Batik culture demonstrated that the LMS is valid and effective for geometry transformation learning. The validation results indicated that the LMS met the criteria of a highly valid learning medium in terms of content, learning materials, interface design, and language. Furthermore, the implementation process showed that students were able to actively engage in learning activities through the integrated features provided within the LMS, including learning materials, instructional videos, digital worksheets, and interactive quizzes. The effectiveness analysis yielded an N-Gain score of 82.15%, indicating that the LMS effectively improved students' understanding of geometry transformation concepts. These findings suggest that the integration of local cultural contexts and digital technology can enhance mathematics learning

experiences and support students conceptual understanding. Therefore, the Transformatiks LMS contributes to the development of culturally responsive digital learning media as an alternative approach for teaching geometry transformation concepts.

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