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The Effectiveness of JERAMAT Learning Management System Integrated with PBL-STEAM to Improve Students' Learning Outcomes on Two-Variable Linear Inequality Systems

Nisa Mutiara Dewi[1]✉, Citra Mutiara Pertiwi, Rizky Candra Wijaya, Nada Nailal Husni, Fahmi Husaini

Universitas Negeri Semarang, Indonesia

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Abstract

The integration of digital technology into mathematics learning is expected to enhance students' conceptual understanding and engagement. This study aimed to investigate the effectiveness of the JERAMAT Learning Management System (LMS), which integrates Problem-Based Learning (PBL), the STEAM approach, and ethnomathematics in learning Two-Variable Linear Inequality Systems (TVLIS). The study employed a Research and Development (R&D) approach using the ADDIE model involving 36 eleventh-grade students at SMA Negeri 6 Semarang. Data were collected through pre-test, post-test, classroom observations, and documentation, then analyzed using descriptive statistics and the Wilcoxon Signed-Rank Test. The results showed that the average score increased from 39.0 in the pre-test to 67.1 in the post-test. Statistical analysis also revealed a significant improvement in students' learning outcomes ($p < 0.001$). These findings indicate that JERAMAT is an effective digital learning platform for improving students' understanding of TVLIS through contextual, interactive, and technology-supported learning.

✉Correspondence Address:
UNNES, Semarang, Indonesia
E-mail: nisamutiara@student.unnes.ac.id

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INTRODUCTION

The rapid development of digital technology has significantly transformed educational practices, encouraging teachers to integrate technology into classroom instruction to create more interactive, flexible, and meaningful learning experiences. In mathematics education, technology-supported learning environments are expected to facilitate students in understanding abstract mathematical concepts through visualization, exploration, and collaborative learning activities. Learning Management Systems (LMS) have emerged as one of the most widely adopted digital platforms because they provide integrated facilities for delivering learning materials, managing assignments, monitoring student progress, and conducting online assessments.

Despite these technological advances, students continue to encounter difficulties in learning mathematics, particularly in the topic of Two-Variable Linear Inequality Systems (TVLIS). Many students struggle to transform contextual situations into mathematical models, determine feasible solution regions, and interpret optimization results correctly. Conventional teacher-centered instruction often emphasizes procedural calculations rather than conceptual understanding, resulting in low student engagement and limited opportunities to develop higher-order thinking skills.

Recent studies have demonstrated that integrating digital learning media with innovative instructional models can improve students' conceptual understanding and motivation in mathematics learning. Likewise, contextual learning that incorporates local culture enables students to relate mathematical concepts to real-life situations, making learning more meaningful and relevant. Therefore, mathematics learning should not merely emphasize computational skills but also encourage students to construct knowledge through authentic problem-solving activities supported by appropriate technology.

To address these challenges, this study developed JERAMAT (Jejak Rasa Matematika), a web-based Learning Management System designed for learning TVLIS through contextual and technology-enhanced instruction. JERAMAT integrates the Problem-Based Learning (PBL) model with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach while incorporating ethnomathematics through the cultural context of the Indonesian Soto Festival. The platform provides learning videos, digital worksheets, GeoGebra simulations, interactive quizzes, assignment submission features, and discussion forums to support both independent and collaborative learning.

Compared with conventional LMS platforms that primarily function as repositories for learning materials, JERAMAT emphasizes contextual problem solving, visualization, cultural integration, and interactive learning activities within a single platform. The incorporation of GeoGebra facilitates students in visualizing solution regions, while contextual problems related to Indonesian culinary culture promote meaningful mathematical understanding and increase student engagement.

The implementation of JERAMAT was conducted in Grade XI at SMA Negeri 6 Semarang involving 36 students. The platform was designed not only to improve students' achievement in TVLIS but also to foster critical thinking, creativity, collaboration, and technological literacy through authentic mathematical experiences. Therefore, this study aims to investigate the effectiveness of the JERAMAT Learning Management System in improving students' learning outcomes in Two-Variable Linear Inequality Systems.

METHOD

This study employed a Research and Development (R&D) approach using the ADDIE development model, consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. The model was selected because it provides a systematic framework for developing and evaluating digital learning media.

The development procedure followed the five stages of the ADDIE model, beginning with the identification of students' learning needs and ending with the evaluation of the developed learning management system. The overall research procedure is illustrated in Figure 1.

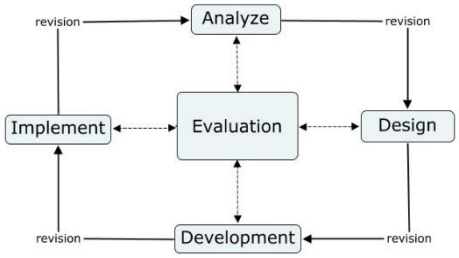

Figure 1. Research Procedure Based on the ADDIE Model

The research was conducted at SMA Negeri 6 Semarang during the second semester of the 2025/2026 academic year. The implementation of the developed Learning Management System (LMS) was carried out on 7 May 2026 involving 36 students of Grade XI-C as the research participants. The participants were selected because they had studied the prerequisite concepts required for learning the topic of Two-Variable Linear Inequality Systems (TVLIS).

During the analysis stage, the researchers identified students' learning characteristics, curriculum requirements, and common learning difficulties related to TVLIS. The findings indicated that students experienced difficulties in translating contextual problems into mathematical models and determining feasible solution regions. These findings served as the basis for designing the learning platform.

The design stage involved preparing the instructional flow, user interface, digital worksheets, learning videos, assessment instruments, and learning activities based on the Problem-Based Learning (PBL) model integrated with the STEAM approach. Furthermore, ethnomathematics was incorporated through contextual problems related to the Indonesian Soto Festival to increase students' engagement with local culture.

In the development stage, all learning materials and multimedia resources were integrated into the JERAMAT platform. Interactive features such as instructional videos, digital worksheets, assignment submission, discussion forums, GeoGebra simulations, and online quizzes were developed to support students' independent and collaborative learning.

The implementation stage consisted of classroom learning activities using the JERAMAT LMS. Students accessed learning materials, completed digital worksheets, explored graphical representations using GeoGebra, discussed contextual mathematical problems, and completed formative as well as summative assessments through the platform.

The final stage was evaluation, which focused on assessing the effectiveness of the developed LMS. Evaluation was conducted continuously throughout the development process as formative evaluation and at the end of implementation as summative evaluation.

Data were collected using achievement tests, classroom observations, and documentation. The achievement test consisted of pre-test and post-test instruments designed to measure students' understanding of TVLIS before and after using JERAMAT. Classroom observations were conducted to evaluate the implementation of the PBL syntax, students' participation, and the integration of STEAM during learning activities. Documentation included photographs, students' assignments, and records of learning activities within the LMS.

The collected data were analyzed using both descriptive and inferential statistics. Descriptive analysis was used to determine the mean, minimum, and maximum scores of the pre-test and post-test results. Prior to hypothesis testing, the normality of the data was examined using the Shapiro–Wilk test because the sample size consisted of fewer than fifty participants. Since the data were not normally distributed, differences between pre-test and post-test scores were analyzed using the Wilcoxon Signed-Rank Test with a significance level of 0.05. Statistical analyses were performed using IBM SPSS Statistics version 27.

RESULTS AND DISCUSSIONS

The effectiveness of the JERAMAT Learning Management System was evaluated by comparing students' learning outcomes before and after the implementation of the platform. In addition to learning outcomes, the developed LMS provided an interactive learning environment that integrated instructional videos, digital worksheets, GeoGebra, online quizzes, and discussion forums. The homepage of the developed learning management system is presented in Figure 2.

Figure 2. Home Page of the JERAMAT Learning Management System

The learning process within the platform consisted of contextual learning activities designed according to the Problem-Based Learning model and the STEAM approach. Students accessed learning materials, completed digital worksheets, participated in discussions, and submitted assignments through the LMS. An example of the learning activities is presented in Figure 3.

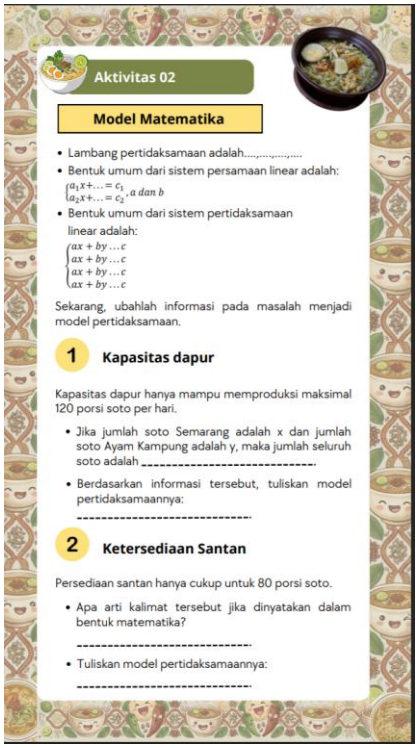

Figure 3. Learning Activities in the JERAMAT LMS

To support students' understanding of graphical solutions in TVLIS, GeoGebra was integrated into the learning activities. This feature enabled students to visualize feasible regions and verify their manual solutions. The implementation of GeoGebra within the LMS is shown in Figure 4.

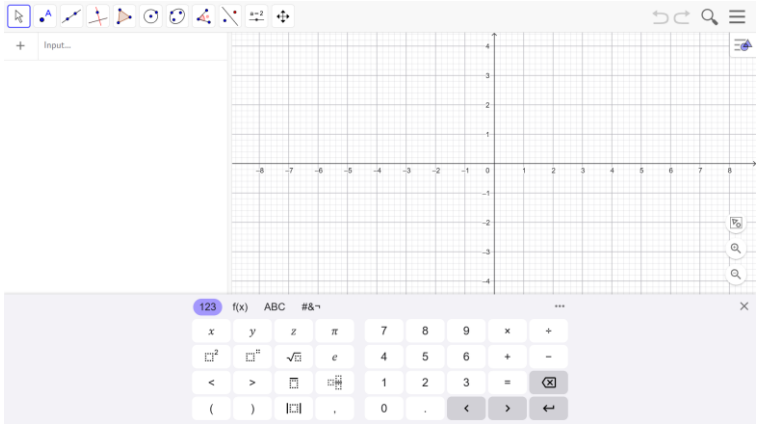

Figure 4. GeoGebra Integration in the JERAMAT LMS

Students' learning outcomes before and after using the LMS are summarized in Table 1.

Table 1. Descriptive Statistics of Students' Learning Outcomes

Variable	N	Minimum	Maximum	Mean
Pre-Test	36	20	80	39.00
Post-Test	36	40	90	67.10

As presented in Table 1, the average score increased from 39.00 on the pre-test to 67.10 on the post-test. The minimum score also increased from 20 to 40, while the maximum score improved from 80 to 90, indicating that students achieved better learning outcomes after using the JERAMAT LMS.

Before hypothesis testing, the normality assumption was examined using the Shapiro–Wilk test. Since the data were not normally distributed ($p < 0.05$), a non-parametric statistical test was employed. The results of the Wilcoxon Signed-Rank Test are presented in Table 2.

Table 2. Wilcoxon Signed-Rank Test Results

Comparison	Asymp. Sig (2-Tailed)	Decision
Pre-Test and Post-Test	< 0.001	Significant Difference

As shown in Table 2, the Wilcoxon Signed-Rank Test yielded a significance value of $p < 0.001$, indicating a statistically significant improvement in students' learning outcomes after the implementation of the JERAMAT LMS.

The findings indicate that the JERAMAT Learning Management System effectively improved students' understanding of Two-Variable Linear Inequality Systems. The significant increase in learning outcomes suggests that the integration of digital technology with contextual learning activities successfully enhanced students' conceptual understanding.

The improvement can be attributed to the implementation of the Problem-Based Learning (PBL) model, which encouraged students to investigate contextual problems, construct mathematical models, and evaluate possible solutions collaboratively. Such learning activities promoted active participation and higher-order thinking skills.

The integration of the STEAM approach further enriched the learning experience by combining science, technology, engineering, arts, and mathematics within authentic learning contexts. GeoGebra supported students in visualizing feasible regions, while the ethnomathematics context of the Indonesian Soto Festival enabled students to relate mathematical concepts to familiar cultural experiences.

Furthermore, the LMS integrated instructional videos, digital worksheets, discussion forums, online quizzes, and assignment submission features within a single platform. These facilities promoted independent learning and provided students with greater flexibility to access learning resources both inside and outside the classroom.

Overall, the effectiveness of JERAMAT resulted from the integration of digital learning technology, Problem-Based Learning, the STEAM approach, ethnomathematics, and interactive visualization tools. The combination of these instructional components created a meaningful learning environment that enhanced students' engagement, conceptual understanding, and mathematical problem-solving abilities.

CONCLUSION

The findings of this study demonstrate that the JERAMAT Learning Management System is effective in improving students' learning outcomes on the topic of Two-Variable Linear Inequality Systems (TVLIS). The implementation of the platform resulted in a substantial increase in students' achievement, as indicated by the improvement in the average score from 39.0 on the pre-test to 67.1 on the post-test. Statistical analysis using the Wilcoxon Signed-Rank Test confirmed that the improvement was significant ($p < 0.001$). The effectiveness of JERAMAT can be attributed to the integration of the Problem-Based Learning model, the STEAM approach, ethnomathematics, and digital learning

technologies such as GeoGebra within a single learning environment. These components collectively encouraged active learning, enhanced conceptual understanding, promoted mathematical problem-solving skills, and increased students' engagement in mathematics learning. Therefore, JERAMAT has considerable potential to serve as an innovative digital learning platform for mathematics instruction at the secondary school level.

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