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Development of Google Classroom Learning Management System-Based Mathematics Learning on Relations and Functions in Junior High School

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Abstract

This study develops a Google Classroom–based learning management system (LMS) for Relations and Functions in junior high school and examines its feasibility. The study used an R&D approach with the ADDIE model involving eighth-grade students and a mathematics teacher at SMP Muhammadiyah 5 Surakarta. Data were collected through observation, interviews, expert validation, and user-response questionnaires, and analyzed quantitatively and qualitatively. The results show high validity (material expert 93%; media expert 87%) and high feasibility (students 91%; teacher 97%). The novelty lies in a complete and structured LMS learning flow for Relations and Functions, integrating mapped topics, tiered activities, quizzes, discussions, and assignments supported by tools such as Quizizz, YouTube, GeoGebra, and Google Forms. Pedagogically, the LMS supports systematic concept learning, student engagement, and formative feedback in one coherent environment.

Keywords: Learning Management System, Google Classroom, Relations and Functions, Mathematics Learning, ADDIE

1. Introduction

Mathematics learning in junior high schools needs to adapt to changes in the increasingly digital learning ecosystem so that the learning process remains structured, documented, and easy to monitor. ICT literacy is key to the sustainability of distance learning because it acts as the main link between teachers and students (Latip et al., 2020). Online learning is a system that requires design, learning service support, and resource management to keep learning interactions running

(Martin et al., 2021). In Indonesia, blended learning is associated with better student learning outcomes across various educational stages, especially regarding content mastery and thinking skills development (Lusa et al., 2021). The definition and design of blended learning determine whether technology truly strengthens the learning process or merely shifts activities to a digital format (Mccarthy & Palmer, 2023). Thus, this requirement demands the selection of an LMS that is feasible for use and capable of managing materials, activities, and assessments in an integrated manner in mathematics learning.

Google Classroom is relevantly positioned as an LMS that supports practical digital classroom management and is integrated with mathematics learning activities. The use of Google Classroom is associated with an increase in interest in online learning (Safaruddin et al., 2023). The integration of Google Classroom with attractive learning media can have an impact on improving mathematics learning outcomes (Jamil et al., 2022). Student engagement patterns on LMS are influenced by how learning activities are designed and mediated through LMS features (Larasati, 2023). The use of LMS is positively correlated with student motivation and learning satisfaction (Murcahyanto, 2024). Therefore, Google Classroom needs to be positioned as a learning environment that directs conceptual activities, provides feedback, and maintains student engagement.

LMS-based mathematics learning innovations need to be directed at strengthening student learning engagement and self-regulation in problem solving and concept building. Learners who have self-regulated learning actively set learning goals, make plans, choose strategies, monitor the learning process, and evaluate their learning outcomes (Lestari & Duryati, 2021). Educational technology effectively increases engagement when features are used to design meaningful activities, not just access to materials (Godsk & Møller, 2025). Learning analytics-based interventions on LMS provide insights for designing learning support that is more adaptive to student needs (Pan et al., 2024). The flipped classroom model within blended learning, supported by Google Classroom, is suitable for use in junior high school mathematics learning (Kurniawati et al., 2019). A Google Classroom–assisted flipped classroom can enhance students' mathematical problem-solving skills more effectively than conventional instruction (Marita et al., 2022). The application of blended learning can improve students' conceptual understanding and learning outcomes (Jumaini et al., 2021). The integration of collaborative strategies assisted by technology can strengthen the effectiveness of team-based learning (Khasanah et al., 2025). Thus, the LMS design needs to place tiered activities, feedback, and scaffolding at its core, especially in mathematics topics that require conceptual and representational accuracy.

The Relations and Functions material in grade VIII is the foundation for advanced topics, so conceptual errors at this stage have the potential to impact subsequent learning. Variations in students' problem-solving abilities in relations and functions material still leave weaknesses in several indicators (Purba & Warmi, 2022). Eighth-grade students' errors in solving relation and function problems indicate gaps in their understanding of concepts and procedures (Rahmat &

Bernard, 2023). Epistemological obstacles in mathematics learning are often related to how students construct the meaning of concepts, including in the topic of relations and functions (Firda et al., 2024). Learning obstacles in relations and functions are also evident in the difficulty of distinguishing between functions and non-functions and notating functions from the information provided (Puspitasari & Fuadiah, 2024). Therefore, the development of LMS in this material needs to emphasize representation, examples and non-examples, and contextual exercises that are guided gradually so that conceptual understanding is formed more stably.

Research related to the utilization and development of LMS-based mathematics learning shows opportunities and gaps that still need to be addressed in the Relationships and Functions material in junior high schools. Findings show that students' mathematical problem-solving abilities on the topic of relationships and functions are heterogeneous, and weaknesses can be identified in several problem-solving indicators. Rahmi & Yulianti (2022) state that learning obstacles in the topic of relations and functions arise in conceptual understanding and representation, which hinder students from solving problems. Fitrianna et al. (2021) state that students show types of errors in understanding the concepts of relations and functions, which indicate the need for more targeted learning support. Astiwi & Siswanto (2024) state that e-LKPD relations and functions can be developed to meet validity and feasibility criteria, but their integration as a complete learning flow in the Google Classroom LMS still needs to be clarified in the context of learning implementation in junior high schools.

Research on Relations and Functions in junior high school shows that students still make substantial conceptual, principle, and procedural errors, indicating persistent misconceptions and representational difficulties (Kadi et al., 2023). Studies using Google Classroom in mathematics report practical benefits and perceived effectiveness, but most still emphasize implementation outcomes rather than offering a replicable, topic-specific design blueprint (Dewi & Afriansyah, 2022). Likewise, development studies often produce partial media (e.g., e-worksheets) and focus on validity/practicality/effectiveness, instead of explaining how an LMS integrates materials, activities, assessment, assignment management, and feedback into one coherent learning flow (Sitorus et al., 2023; Sugandi et al., 2025). A recent systematic review confirms that Google Classroom research remains dominated by effectiveness studies, while motivation—closely linked to mathematics achievement—needs to be supported through engaging tasks and timely feedback (Arini & Sari, 2023; Nugroho & Warmi, 2022; Waritsman et al., 2024). In conclusion, what remains insufficiently addressed is a complete and structured ADDIE-based Google Classroom LMS learning flow for Grade 8 Relations and Functions; therefore, this study uniquely contributes a developed and validated LMS blueprint that integrates mapped topics, tiered activities, formative assessment, structured assignments, and feedback within one coherent Google Classroom environment.

Based on the above description, this study aims to develop an innovation in mathematics learning based on the Google Classroom Learning Management System for the material on Relations and Functions in junior high school; describe the feasibility of the developed product through validity and feasibility assessments; and to produce an LMS design that contains a

structured learning flow (material, tiered activities, exercises/quizzes, assignment collection, and feedback) that is easy for teachers to implement and easy for students to follow.

2. Methods

This study followed an R&D approach guided by the ADDIE stages to produce a Google Classroom–supported LMS design for the Grade 8 topic of Relations and Functions. This model was chosen because the ADDIE stages provide a systematic flow—from needs analysis to evaluation—so that digital learning products can be developed, tested, and refined in stages (Arnisya et al., 2025).

The Analysis stage identified students' needs and defined the scope of Relations and Functions. The Design stage mapped the learning flow and prepared materials, activities, quizzes, discussions, and assignments in Google Classroom. The Development stage produced the LMS, conducted expert validation, and revised the product based on validators' feedback. The Implementation stage conducted a limited trial and collected feasibility responses from students and the teacher. The Evaluation stage synthesized validation and trial feedback to finalize and refine the LMS.

Figure 1.
ADDIE Model Steps

The research subjects were mathematics teachers and eighth-grade students at SMP Muhammadiyah 5 Surakarta. Data were collected through observation, interviews, expert validation, and response questionnaires. Quantitative analysis was used to calculate validity and feasibility percentages from validation sheets and response questionnaires. Qualitative analysis was used to describe observational findings and synthesize interview results as a basis for revision. The research was conducted at SMP Muhammadiyah 5 Surakarta. The study was carried out from October to December 2025. Validation was carried out by two experts, including a media expert and a material expert, to assess the feasibility of the LMS before testing it on users (Rahmawati et al., 2021).

The data processing techniques in this study used qualitative and quantitative analysis. Qualitative analysis was used to interpret descriptive data from observations and interviews, while quantitative analysis was applied to process data from expert validation and student responses by calculating the average score and percentage of learning module feasibility. The validity score was calculated using equation (1), with$P$ as the percentage obtained from the comparison between the total score of the respondents' answers $(\sum x)$ and the maximum possible score $(\sum xi)$.

$$P = \frac{(\sum x)}{(\sum xi)} x100\%$$

Table 1.
Validity Percentage

Score (%)	Validity Criteria
81-100	Highly Valid
61-80	Valid
41-60	Fairly Valid
0-40	Not Valid

The feasibility score is calculated using equation (2), with P as the percentage obtained from the comparison between the total score of the respondent's answers $(\sum x)$ and the maximum possible score $(\sum xi)$.

$$P = \frac{(\sum x)}{(\sum xi)} x100\%$$

Table 2.
Feasibility Percentage

Score (%)	Feasibility Criteria
81-100	Highly Feasible
61-80	Feasible
41-60	Fairly Feasible
0-40	Not Feasible

3. Result and Discussion

3.1. Analyze

The results of the needs analysis at SMP Muhammadiyah 5 Surakarta show that learning the material on Relations and Functions still requires media that can: (1) organize material and exercises in a logical sequence, (2) facilitate the neat collection of assignments, (3) provide faster feedback, and (4) provide a space for discussion when students encounter difficulties. The material analysis determined the scope of concepts: understanding relations, representation of relations (arrow diagrams, ordered pairs, tables, graphs), understanding functions, determining domain–codomain–range, and testing functions/non-functions through examples and non-examples. Analysis of the characteristics of eighth-grade students shows the need for concise instructions, contextual examples, and gradual exercises from easy to intermediate so that the transition from relations to functions does not cause misconceptions. The development of an LMS based on needs analysis has proven to be capable of organizing material and exercises systematically and providing effective feedback for students (Wibowo et al., 2025)

. In addition, the assignment collection and discussion forum features in the LMS support learning interactions and help students overcome difficulties during the learning process (Muntafi'ah et al., 2024).

3.2. Design

The design stage involved preparing the Google Classroom LMS for Grade VIII Relations and Functions in an ordered workflow, from establishing objectives and content boundaries to selecting instructional methods and learning media. This was done so that the product could be immediately used in technology-integrated learning. The principles of instructional design for ICT integration emphasize the systematic setting of learning objectives, selection of material scope, and selection of methods and media so that the product is ready to be applied in technology-integrated learning (Hwang & Lim, 2024). The design of Google Classroom is effective if it starts with planning objectives, compiling material, selecting methods and media, and evaluation so that the material and platform can be immediately used for distance learning (Hastutiningsih & Ariyono, 2023).

The design of learning tools integrated into Google Classroom includes teaching materials, supporting learning media, and student worksheets. In its implementation, these components are mapped into topics in Google Classroom so that the learning flow is clearer, (1) Syllabus, (2) concepts of relations and examples–non-examples, (3) concepts of functions and examples–non-examples, (3) Function Representation, (4) Function Application in Daily Life, (5) quizzes, (6) discussions, (7) structured assignments.

To strengthen student engagement and improve the quality of the LMS, various digital platforms are used. Quizizz is used for quiz-based evaluation that encourages participation. YouTube is used as audio-visual enrichment so that students can more easily grasp concepts and procedures. Geogebra is used to present function representations. Google Forms is used for formative quizzes that automatically record scores and make it easier for teachers to provide feedback.

Figure 2.
Google Classroom front page

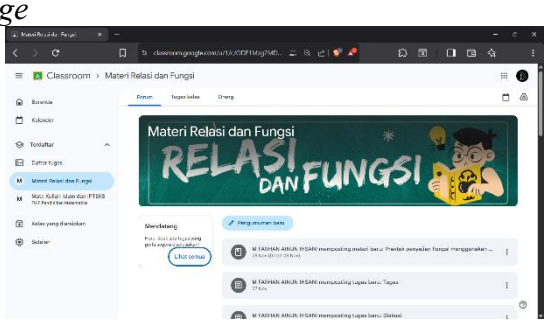
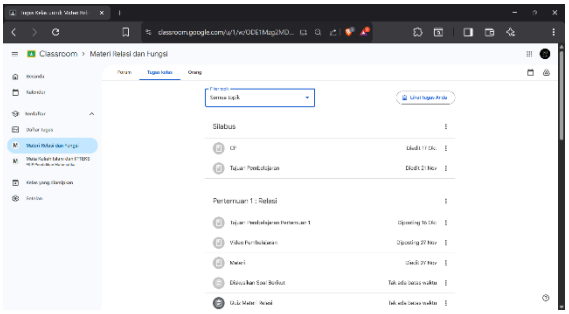


Figure 3.
Google Classroom tools display



3.3 Development

Table 3.
Expert Validator Assessment Results

Validator	Percentage	Description
Material	93%	Highly Valid
Media	87%	Highly Valid

Based on the validation results from two validators, namely material (93%) and media (87%), it is declared highly valid according to the validity criteria used in LMS development research, where a percentage >80% is classified as highly valid and therefore feasible for use in digital learning (Fristianingroem, 2025). These results indicate that both in terms of content and appearance, the Learning Management System (LMS)-based learning product has met the eligibility standards to support teaching and learning activities. This is in line with research findings reporting that LMS that is valid in terms of content is also capable of improving the quality of the learning experience of students (Septiari & Bayu, 2025).

3.4. Implementation

After conducting the validation process, the development of teaching modules can be continued with a limited field trial.

Table 4.
Feasibility Test Results

Instrument	Percentage	Description
Questionnaire response students	91%	Highly Feasible
Response survey Teachers	97%	Highly Feasible

The LMS feasibility test results show that the student response survey obtained a percentage of 91%, while the teacher response survey obtained a percentage of 97%. Both results are in the Highly feasible category because they are within the 81%-100% range. These findings indicate that the developed LMS is easy to use by both students and teachers in the learning process and has optimally met the feasibility aspects.

Students showed high enthusiasm when using the Learning Management System (LMS) developed in learning the material on relations and functions. This can be seen from their active involvement during the learning process, both in exploring the LMS features and in completing the tasks and exercises provided. This engagement indicates that the LMS can enhance students' learning interest, support their understanding of relations and functions, and foster a more interactive and enjoyable learning environment.

Systematically, each stage of ADDIE (Analysis, Design, Development, Implementation, and Evaluation) was carried out with reference to the needs of digital generation students and the characteristics of 21st-century learning. The LMS developed was tailored to the learning outcomes of eighth-grade junior high school students in the subject of relations and functions, utilizing Google Classroom to support technology-based learning processes. This aligns with the opinions of Adeoye et al. (2024) and Tasmiyah et al. (2023) that the ADDIE model is highly relevant for the development of digital learning products.

The developed module has undergone a validation process by two experts, namely a media expert with an assessment result of 87% and a subject matter expert with a result of 93%. Based on these results, the designed Learning Management System (LMS) can be considered to meet good-quality criteria in terms of content, visual design, and the use of clear, communicative language. These results are consistent with Andari (2022) , who reported that LMS use can function effectively as a learning tool supporting the implementation of the Merdeka Curriculum. The difference is that this study not only examines the effectiveness of LMS through a literature review, as conducted by Andari(2022), but also conducts a direct development process and empirical product testing in a classroom environment.

The Feasibility level obtained shows that the developed LMS has met the standards for use in learning without requiring significant revisions. These findings are in line with the opinions of Subekhi & Nindiasari (2021), which emphasize that good learning modules must have essential characteristics, be interesting, relevant, and contextual to the needs and learning environment of students. The feasibility test results also show a very high level of usability, with a percentage of 91% of learners and 97% of teachers. These figures indicate that the developed LMS is easy to use in terms of both technical aspects and learning content. These feasibility aspects include ease of access to the LMS platform, an attractive interface, and ease for teachers in managing learning activities within the system. These results are consistent with evidence that an LMS incorporating

interactive feedback features significantly enhances learning motivation and participation (Ardiansyah & Diella, 2019).

The results indicate that the developed LMS positively supports students' understanding, particularly in relations and functions. This finding is consistent with Sitanggang et al. (2025) state that the implementation of LMS not only expands learning access but has also been proven to enhance students' learning independence. The results of the study Tony et al. (2025) also support these findings, showing that web-based e-modules through Google Sites are highly valid and effective in their application. In line with this, this study proves that the integration of Google Classroom-based LMS can increase efficiency of use and motivate students to be more active in the learning process.

Furthermore, the development of digital media in learning does not only focus on improving cognitive aspects, but also on shaping the attitudes and character of students. Septarianti et al. (2021) emphasizes that character values can be instilled effectively through the use of digital platforms that support active and contextual learning. This is in line with this study, where LMS-based teaching modules on relations and functions not only help students understand mathematical concepts such as ordered pairs, domains, and ranges, but also encourage them to develop carefulness, responsibility, and cooperation in completing tasks and group projects. Thus, the application of LMS in relation and function material contributes not only to improving conceptual understanding but also to shaping positive character through collaborative activities in the learning process.

3.5. Evaluation

The evaluation stage was conducted after expert validation and the limited trial to finalize the Google Classroom LMS. Revisions focused on improving the clarity of instructions, strengthening the sequence of Relations and Functions materials (including examples–non-examples and representations), and streamlining assignment submission and feedback procedures. In addition, discussion prompts and activity directions were refined to better guide students and support timely feedback. Overall, this stage ensured the final LMS is classroom-ready as a complete and structured learning flow for Grade 8 Relations and Functions.

4. Conclusion

This study developed an ADDIE-based Google Classroom LMS for Grade 8 Relations and Functions that provides a complete and structured learning flow—from mapped topics and tiered activities to formative assessment, structured assignments, and feedback within one coherent environment. The product quality was supported by high expert validity (93% for material and 87% for media) and strong user feasibility (91% student responses and 97% teacher responses), indicating that the LMS is easy to use, visually clear, and aligned with classroom learning needs. Therefore, the main contribution of this study is a classroom-ready and replicable LMS design

blueprint that teachers can implement to organize learning activities systematically while maintaining student engagement in Relations and Functions learning.

This study has limitations because the trial involved a limited setting and sample, and the evaluation focused on validity and feasibility rather than measuring learning outcomes through experimental comparison. In addition, although the LMS supports feedback through existing tools, automatic and accurate diagnostic feedback for students' misconceptions has not been fully optimized and still relies on teacher-driven feedback. Future research is recommended to conduct quasi-experimental or experimental studies to examine the impact of the developed LMS on students' conceptual understanding, problem-solving performance, and learning motivation. Further development can also integrate learning analytics or intelligent feedback features to provide more automatic, timely, and accurate feedback and to strengthen scalability across different schools.

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