Jurnal Teknologi Pendidikan, Desember 2025, 27 (3), 896-908
DOI: http://dx.doi.org/10.21009/JTP2001.6
p-ISSN: 1411-2744 e-ISSN: 2620-3081
Accredited by Directorate General of Strengthening for Research and Development
Available online at http://journal.unj.ac.id/unj/index.php/jtp

Development of Gamification-based Microlearning Media for Learning Integers

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Received : September 28, 2025
Revised : October 10, 2025
Accepted : December 22, 2025

Abstract

Learning integers at the junior high school level often faces obstacles in the form of low student understanding and engagement, mainly due to the abstract nature of the material and the learning approaches that are still dominated by conventional methods. Therefore, it is necessary to develop learning media that can present material concisely, interestingly, and relevant to the characteristics of students. This study aims to develop gamification-based microlearning media on a Learning Management System (LMS) platform specifically designed for integer material at the junior high school level, and to examine its feasibility for classroom use. The novelty of this study lies in the integration of microlearning and gamification in a media development design for the context of integer learning, which is still rarely studied in previous studies. This study uses the Research and Development method with the Web-Based Instructional Design (WBID) model as the development framework. The research subjects consisted of 32 students at a junior high school selected using a purposive sampling technique. Data were collected through expert validation, student response questionnaires, LMS analytics, and were analyzed using descriptive quantitative and qualitative techniques. The results of the validation by material and media experts obtained an average score of 87.5% and 90%, respectively, with the category of very valid. The limited trial and full implementation showed excellent results with percentages of 86.05% and 87%, respectively. Summative evaluations showed that 27 of 32 students completed the learning on time, 30 of 32 students earned engagement badges, and the majority accessed the LMS consistently every week. These findings provide empirical evidence that the developed gamification-based microlearning media is effective in increasing engagement and supporting integer learning. However, this study is limited by the sample size and has not yet measured the direct impact on academic learning outcomes.

Keywords: Gamification-based Microlearning, Integers, Learning Management System, Media Development

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How to Cite: Rani, S., Soepriyanto, Y., Wedi, A., & Degeng, M. D. K. (2025). Development of Gamification-based Microlearning Media for Learning Integers. *JTP - Jurnal Teknologi Pendidikan*, *27*(3), 896–908. https://doi.org/10.21009/jtp.v27i3.60542

INTRODUCTION

Mathematics learning plays a fundamental role in developing logical, analytical, and systematic thinking patterns in students (Muhammad Arvi et al., 2025; Yu et al., 2024). Mathematics learning not only serves as academic knowledge but also serves as a foundation for solving problems in everyday life (Santos-Trigo, 2024). Within Indonesia's Independent Curriculum, integers are introduced at the junior high school level as a foundation for understanding number

operations, algebraic reasoning, and other advanced mathematical concepts. Understanding integers will facilitate students' learning of more complex, advanced material (Acosta & Soliba, 2024).

Various studies show that students often struggle to understand integers due to their abstract nature, such as the lack of resources that connect number lines and negative numbers to real-world contexts (Sercenia et al., 2023). Learning that predominantly uses conventional and monotonous methods makes students passive and tends to memorize (Setiawan et al., 2024). This will have an impact on the learning process such as low student involvement, material retention, learning motivation, which will have implications for learning outcomes because it does not develop critical thinking skills (McDonald et al., 2020). The level of student involvement in learning tends to be in line with the increase in learning completion and will subsequently reflect on learning outcomes (You, 2022).

Therefore, learning innovations that can encourage active student engagement are needed. The use of learning media is a strategic alternative because it functions not only as a tool but also as a means of creating interactive learning experiences (Febrina & Setiawan, 2024; Lestari & Ningrum, 2022). The use of digital learning media is also increasingly relevant because it adapts to the characteristics of today's digital generation, who tend to have short attention spans and prefer practicality (Wajdi et al., 2024). However, in practice, mathematics learning media in schools is still dominated by textbooks and conventional teacher explanations due to limited digital competence of educators and limited technological infrastructure readiness (Hidayat & Chao, 2025).

One relevant learning approach in this regard is microlearning (Silva et al., 2025). Microlearning is the presentation of material in short, focused chunks without losing sight of the learning objective itself (Allela, 2021). Microlearning is designed to accommodate the limited attention spans of the digital generation and the need for flexible and accessible learning (Alias & Razak, 2025). With these characteristics, microlearning can be a strategy that supports active student engagement in digital learning environments.

The effectiveness of microlearning has also been demonstrated in improving student learning outcomes (Sathiyaseelan et al., 2024). However, this effectiveness is greatly influenced by the selection of appropriate media and content delivery strategies, a key principle of microlearning (Monib et al., 2025). Microlearning still has the disadvantage of compromising the understanding of complex material due to content fragmentation (Monib et al., 2024). Several other studies have also integrated microlearning with other strategies such as collaborative learning (Garshasbi et al., 2021) and flipped classroom (Fidan, 2023).

This research proposes the integration of gamification in the development of microlearning on a learning platform to build a more meaningful student learning experience. Gamification is a current learning trend by presenting game elements such as points, badges, challenges, missions, leaderboards in a non-game context (Jun & Lucas, 2024). Gamification has been proven to increase students' intrinsic motivation, create a healthy competitive learning environment, and strengthen student engagement (Hellín et al., 2023; Li et al., 2024). Thus, the development of gamification-based microlearning media is expected to provide an interesting

learning experience and at the same time maintain students' attention span through the presentation of short content.

Various studies have demonstrated the effectiveness of microlearning in improving knowledge retention and content delivery efficiency (Al-Zahrani, 2024; Jubran, 2024). However, most studies have not optimally addressed how microlearning is designed to build meaningful learning experiences, particularly for abstract mathematics material. On the other hand, gamification has been widely used to increase motivation, engagement, and learning outcomes through game elements that encourage active student participation (Hellín et al., 2023; Purba et al., 2024). However, studies that specifically develop and test the integration of microlearning and gamification in a single learning media design are still limited. This limitation is increasingly apparent in the context of learning integers for junior high school students, which is basic and fundamental material for the development of mathematical understanding of the digital generation. Therefore, this study aims to develop gamification-based microlearning media on a Learning Management System platform specifically designed for integers at the junior high school level. This research is expected to increase learning engagement and strengthen student understanding.

METHODS

This research uses a Research and Development (R&D) approach with reference to the Web-Based Instructional Design (WBID) model developed by Davidson-Shivers, Rasmussen, and Lowenthal (2018). This model was chosen because it emphasizes web-based instruction through parallel stages so that it is in line with the output produced in this study, namely web-based learning using a Learning Management System (LMS) with a gamification-based microlearning design.

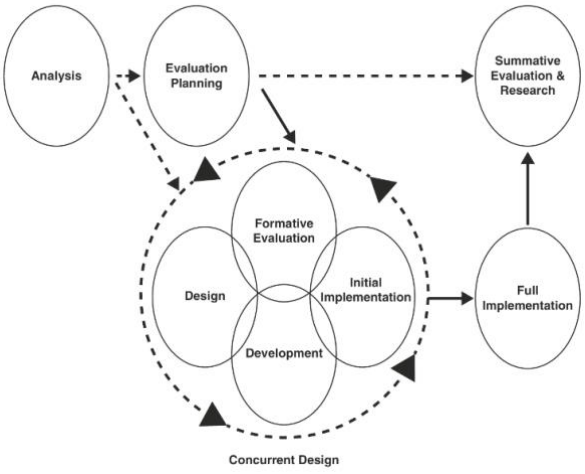

Figure 1. The Web-Based Instructional Design (WBID) Model

Based on Figure 1, the WBID stages include 1) analysis, which in this study identifies problems in learning integers, student needs, and characteristics of the

school context in its implementation; 2) evaluation planning, which is designing evaluation instruments, both formative ones carried out during development, and summative ones after full implementation so that development can be directly accompanied by testing and improvement; 3) concurrent design which includes design, development, formative evaluation, and initial implementation so that a gamification-based microlearning LMS is produced that is suitable for full implementation; 4) full implementation, which is conducting trials on 32 junior high school students in the city of Palangka Raya, Indonesia; and 5) summative evaluation, which is assessing the effectiveness of learning through badge acquisition data and LMS analytics.

The data obtained were analyzed descriptively using quantitative and qualitative methods. Quantitative analysis was conducted by calculating the percentage of eligibility and student responses through questionnaires, score distribution, and badge acquisition in the LMS. Qualitative analysis was conducted to interpret the results of observations, interviews, and open responses regarding the media's strengths and weaknesses as a basis for improvements before widespread implementation.

RESULTS & DISCUSSION

The results of a literature review and needs analysis conducted at junior high schools in Palangka Raya city indicate that several challenges remain in learning integers. This is indicated by the average student math score on the subject remaining below the completion standard. Teachers' ability and motivation to develop innovative learning strategies often lead to the teacher-centered approach being applied. As a result, students tend to be passive, and 58.6% of students agree that they lack motivation in participating in math lessons. 67.3% of students also agree that they have difficulty focusing for long periods of time during math lessons. In this regard, the development of gamification-based microlearning media packaged in a Learning Management System (LMS) is a solution offered to address the existing challenges. Positive responses were shown by teachers, and the majority of students (82.7%) agreed with the implementation of short lessons integrated with game elements.

In the evaluation planning stage, instruments were developed to assess media quality, both formatively and summatively. Formative instruments included an expert validation checklist questionnaire focused on content and media design, as well as a student response questionnaire used to assess display clarity, ease of navigation, and media appeal. Summative evaluation was based on LMS analytics in the form of scores, badges, and processing time, and a large-scale pilot questionnaire was used to measure perceptions of media usability. Through early evaluation planning, each development stage could be based on the initial objectives and its effectiveness monitored systematically and continuously.

Gamification-based Microlearning Media Design

The LMS design is based on seven dimensions of microlearning, including time, content, curriculum, form, process, mediality, and type (Hug et al., 2005) and

integrated with eight gamification elements, namely avatar, badge, challenge, leaderboard, level, point, quest, and trophy (Kapp, 2012; Werbach & Hunter, 2020; Zichermann & Cunningham, 2011). The LMS is packaged in an adventure narrative called "Angkavora" with five learning levels aligned with the learning objectives of the Independent Curriculum for integers in grade VII. Each level contains a narrative mission, objectives, microlearning modules, challenges, and formative evaluations. Gamification elements such as points, badges, leaderboards, and trophies are used to obtain student feedback on learning in the LMS. Badges are divided into three criteria: 1) progress badges (completing all activities at each level), 2) competency badges (the 10 fastest and highest performing students in each formative evaluation), and 3) engagement badges (consistently opening content on the LMS). The design of a gamification-based microlearning LMS is explained through the flowchart below.

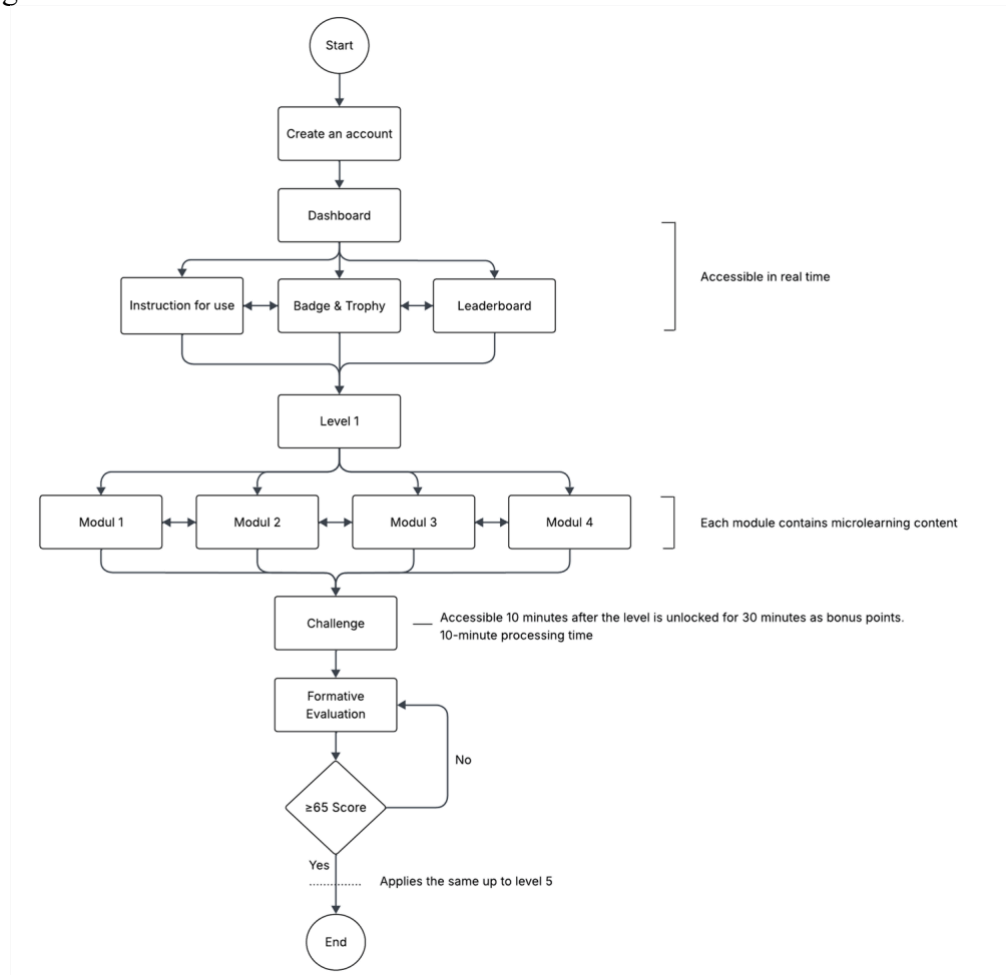

Figure 2. Flowchart LMS

The process begins with creating an account as an identity (avatar) and accessing a dashboard that provides real-time access to three main features: instructions for use, badges & trophies, and a leaderboard to motivate and compete among students. The LMS consists of five levels, accessed sequentially and in stages.

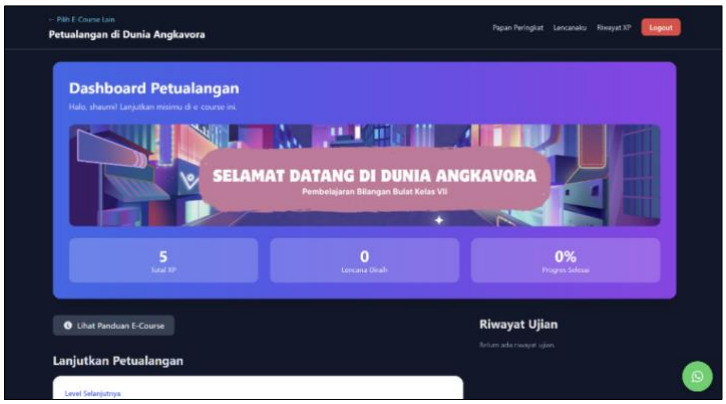

Figure 3. Dashboard Interface

Each level contains learning modules that address the microlearning dimension. Additionally, challenges are available as bonus points, accessible 10 minutes after the level is unlocked, with a 10-minute completion time. Challenges are only available for 30 minutes. Once all content has been accessed, a formative assessment will open, and students must achieve a completion score (65) to access the next level.

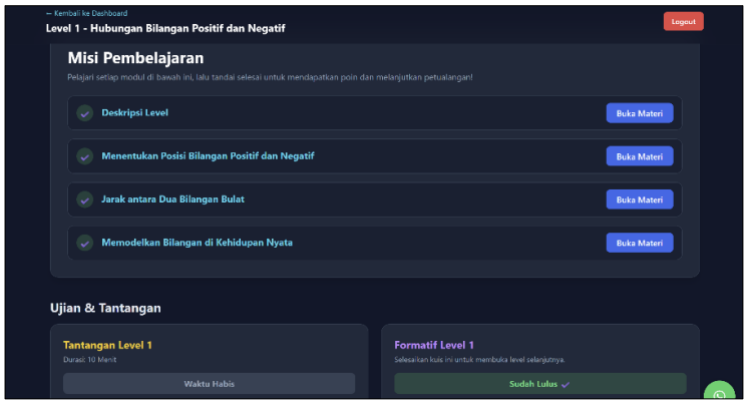

Figure 4. Feature Display of Each Level

Feedback in the form of point, badge, leaderboard, and trophy will be automatically obtained by students according to the established criteria.

Figure 5. Leaderboard View

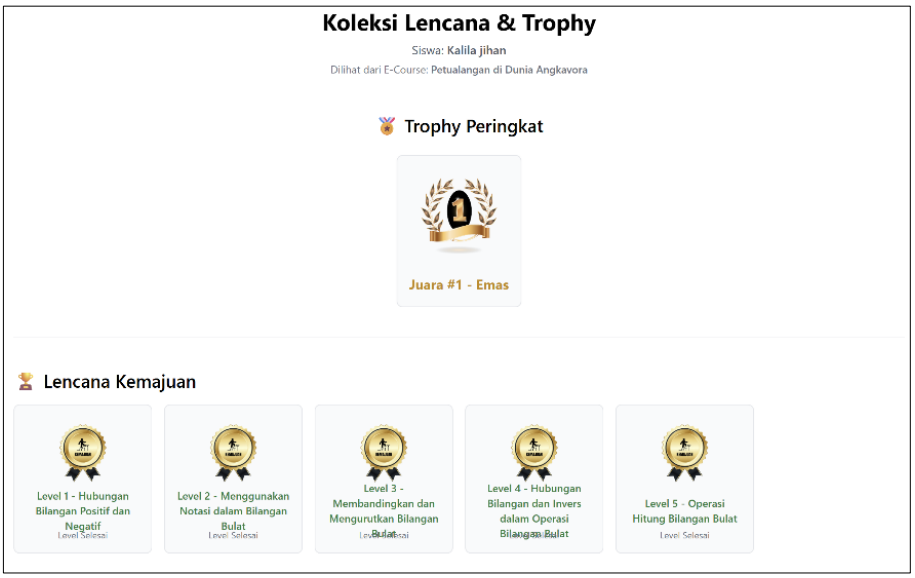

Figure 6. Badge and Trophy Earning

Validation Results

The initial LMS prototype was tested through expert validation (materials and media) and limited trials. Material validation was conducted by educators in the field of mathematics education, resulting in the following results.

Table 1. Material Expert Validation Results

Dimension	Mean	Category
Content Suitability	3,6	Very Valid
Suitability for Learners	3,3	Very Valid
Quality of Presentation and Learning Activities	3,08	Valid
Relevance to the Learning Context	3,6	Very Valid
Technical Aspects	3,9	Very Valid
Mean	**3,5**	**Very Valid**
Persentage	**87,5%**	

Based on Table 1, the highest score is in the technical aspect with an average of 3.9, indicating that text readability, visual display, and media integration strongly support the student learning process. Meanwhile, the appropriateness of the content and the relevance of the learning context show the same average, namely 3.6. This indicates that the material is considered accurate, relevant to the curriculum, and appropriate to the real conditions of students. However, for the two dimensions that obtained a lower average, namely student suitability and the quality of presentation and learning activities, there are still needs to be improved to be more relevant and easier to understand by students. Overall, the material in the developed gamification-based microlearning media obtained an average of 3.5 with a feasibility percentage of 87.5%, so it is included in the very valid category.

Furthermore, media expert validation was carried out by learning media lecturers who were experienced in the field of technology for learning, resulting in the following results.

Table 2. Media Expert Validation Results

Dimension	Mean	Category
Visual Appearance and Design	3,6	
Gamification Elements	4	
LMS Navigation and Structure	3,25	Very Valid
Interactive Features and Evaluation	3,67	
Microlearning and Retention	3,5	
Mean	**3,6**	**Very Valid**
Percentage	**90%**	

Based on Table 2, the gamification element aspect is a strength in the developed media with an average score of 4, thus it is considered capable of increasing student motivation and engagement. This is followed by the interactive features and evaluation dimension (3.67) and the visual appearance and design (3.6), indicating that the media is considered aesthetically appealing, easy to use, and supports the interactive learning process. Although still in the very valid category, the two dimensions that obtained the lowest scores, namely the microlearning and retention dimension (3.5) and the navigation and structure of the LMS (3.25), indicate that the LMS still needs to be improved in terms of material variety and several navigation aspects still need to be clarified to make it easier for students to follow the learning path. Overall, the results of the media expert validation show that the gamification-based microlearning LMS obtained an average score of 3.6 with a feasibility percentage of 90%, so it falls into the very valid category. This indicates that the gamification-based microlearning media developed meets the feasibility standards for materials and media and is therefore very suitable for use in learning integers for junior high school level.

Initial and Full Implementation

In the initial implementation stage, the LMS was tested on a limited basis with 10 seventh grade students to determine the level of student understanding of instructions, navigation fluency, attractiveness, and student engagement during the learning process using the LMS. The instrument contained 20 statement items with a Likert scale of 1-4 covering aspects of clarity of objectives and material structure, presentation quality, learning activities and evaluation, student motivation and engagement, and LMS technical and navigation, resulting in the following below.

Table 3. Initial Implementation Results

Dimension	Mean	Category
Clarity of Objectives and Material Structure	3,65	
Presentation Quality	3,5	
Learning Activities and Evaluation	3,46	Very Good
Student Motivation and Engagement	3,275	
LMS Techniques and Navigation	3,325	
Mean	**3,442**	**Very Good**
Persentage	**86,05%**	

Based on Table 3, the average score was 3.442 with a percentage of 86.05%, thus included in the very good category. The dimension with the highest score was clarity of objectives and material structure with an average of 3.65. This indicates

that the presentation of the material is easy for students to understand. The results shown in the dimensions of presentation quality and examples (average 3.5) and learning activities and evaluation (average 3.46) also indicate that the content presented is in accordance with students' learning needs. Meanwhile, the dimensions of student motivation and engagement as well as the technical and navigation of the LMS still need to be improved to be more optimal. Increasing the variety of challenges and making instructions simpler can be ways to optimize the LMS in the future. The results of the validation and trials indicate that this gamification-based microlearning media is very feasible to use and can be continued to the full implementation stage with a larger number of students.

Unlike the initial implementation, which only assesses whether the product functions well on a small scale, the full implementation stage assesses how the product works on a full scale and whether learning is proceeding according to objectives. This stage was conducted in a junior high school class in Palangka Raya City with 35 students over five meetings. The instrument contained 22 statements with a Likert scale of 1-4 covering aspects of clarity of learning objectives and structure, learning techniques and support, material presentation and relevance, learning activities and evaluation, and student motivation and engagement, resulting in the following below.

Table 4. Full Implementation Results

Dimension	Mean	Category
Clarity of Learning Objectives and Structure	3,42	
Learning Techniques and Support	3,42	
Material Presentation and Relevance	3,5	Very Good
Learning Activities and Evaluation	3,57	
Motivation and Engagement	3,49	
Mean	**3,8**	**Very Good**
Percentage	**87%**	

Based on Table 4, the full implementation results show that the gamification-based microlearning media achieved an average score of 3.8, with 87% achieving a very good score. Therefore, the developed media is highly suitable for implementation in real classrooms. The highest dimension is shown by learning activities and evaluation (average 3.57). This indicates that students found the learning activities engaging, relevant to the objectives, and supported by appropriate evaluation. This reinforces the characteristics of microlearning, which emphasizes short exercises and rapid feedback (Monib et al., 2025) and gamification that supports active engagement (Rivera & Garden, 2021). Other dimensions also showed very good ratings, indicating that concise presentation of the material, relevance of the content to everyday life, student engagement through gamification elements, and adequate technical support all contributed to the successful implementation of the media. In other words, learning effectiveness is supported not only by learning activities and evaluation, but also by a complementary combination of content quality, motivation, and technical fluency.

Summative Evaluation Results

The summative evaluation stage was conducted after full implementation by 32 seventh grade students to assess learning effectiveness through badge acquisition data and LMS analytics such as access frequency, module completion, and study time.

PERINGKAT	NAMA SISWA	TOTAL XP	PROGRES
1	Kalila jihan -> cek detail	1,322	100%
2	AQEELA FEBY VIRAL CAKRWAWANGSA -> cek detail	1,306	100%
3	Nabilla Puspita Rini -> cek detail	1,303	100%
4	Ahmad Umar Abdillah Yusuf -> cek detail	1,300	100%
5	MUHAMMAD AL KHALIFI ZIKRI -> cek detail	1,293	100%
6	salwa maisya -> cek detail	1,281	100%
7	Fuad fudhail -> cek detail	1,273	100%
8	Jihan syahla hanifa -> cek detail	1,265	100%
9	M.arezki putra -> cek detail	1,263	100%
10	aryani -> cek detail	1,257	100%
11	malikah lailatus syarifah -> cek detail	1,256	100%
12	Citra Angelica Putri -> cek detail	1,253	100%
13	M.khaidir iskandar al mahfud -> cek detail	1,248	100%
14	Wildan fattah ibrahim -> cek detail	1,245	100%
15	Zahra Nofin Rizqi Ramadhani -> cek detail	1,236	100%

Figure 7. Student Progress

The analysis results in Figure 7 show that 27 of 32 students (84.375%) completed the entire learning series on time during class. This indicates that the majority of students were able to follow the learning flow in the LMS according to the target.

PERINGKAT XP	NAMA SISWA	TANTANGAN LEVEL 1	TANTANGAN LEVEL 2	TANTANGAN LEVEL 3	TANTANGAN LEVEL 4	TANTANGAN LEVEL 5	FORMATIF LEVEL 1	FORMATIF LEVEL 2	FORMATIF LEVEL 3	FORMATIF LEVEL 4	FORMATIF LEVEL 5
1	Kalila jihan	80	100	100	60	60	93	88	94	80	100
2	AQEELA FEBY VIRAL CAKRWAWANGSA	70	100	100	80	70	74	86	94	70	86
3	Nabilla Puspita Rini	80	100	90	80	80	79	86	87	90	80
4	Ahmad Umar Abdillah Yusuf	80	70	90	80	60	65	100	93	90	87
5	MUHAMMAD AL KHALIFI ZIKRI	-	100	60	90	90	80	88	73	90	87
6	salwa maisya	80	100	80	70	50	73	74	87	80	100
7	Fuad fudhail	70	100	90	80	50	72	74	74	80	75
8	Jihan syahla hanifa	100	100	100	60	40	86	74	88	100	73
9	M.arezki putra	80	90	60	90	50	86	75	87	90	81
10	aryani	80	80	90	90	20	93	81	86	90	80
11	malikah lailatus syarifah	-	90	70	80	70	73	80	87	80	74
12	Citra Angelica Putri	90	90	80	80	60	73	80	67	80	86
13	M.khaidir iskandar al mahfud	60	100	70	80	50	86	88	79	70	81

Figure 8. Distribution of Student Scores Across Challenges and Formative Tests

However, not all students completed the challenges that earned bonus points. This is evident from the distribution of student scores, where some students

received zero points on the challenges section. This could be due to limited time to complete the tasks, while students have varying learning rates. Therefore, these bonus points are only an optional activity to provide opportunities for students with faster learning abilities without disrupting the achievement of other students' goals.

Another finding showed that 30 out of 32 students (93.75%) successfully earned engagement badges. This indicates that almost all students routinely access the material repeatedly every week. The results, from the implementation stage to the summative evaluation, indicate that gamification-based microlearning is effective in encouraging student engagement and task completion. This is in line with research by Monib et al (2025) which states that the effectiveness of microlearning does not only depend on content but also the integration of other strategies such as the use of interactive elements and gamification that are able to attract students' attention.

CONCLUSION

Learning integers in mathematics is often a challenge for seventh-grade junior high school students due to its abstract nature. This is especially true with the teacher-centered learning approach and the lack of instructional media that foster student motivation and engagement. This study presents a solution in the form of a gamification-based microlearning LMS as a learning medium developed using the Web-Based Instructional Design (WBID) model. The validation results from material experts show a very valid category with an average value of 3.5 and a percentage of 87.5%. The validation results from media experts also show a very valid category with an average value of 3.6 and a percentage of 90%. This is followed by limited implementation and full implementation, which obtained a very valid category. The summative evaluation stage, seen from LMS analytics, shows that 84.375% of students have completed all learning activities on time and 93.75% of students have successfully earned engagement badges, indicating that almost all students routinely access the material repeatedly every week.

However, this study is still limited by the number of respondents and does not directly measure academic learning outcomes. Therefore, future research is expected to involve a larger number of respondents to produce more representative findings. Furthermore, it could integrate experimental designs to measure the influence of media on academic learning outcomes. The research scope could also be expanded to examine the consistent effectiveness of gamification-based microlearning approaches.

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