



ADVANCING JAPANESE *KAIWA* PROFICIENCY THROUGH WEB-BASED GAMIFICATION

Hardy Padmayudha Nugraha*, Agus Wedi, Citra Kurniawan

Department of Educational Technology, State University of Malang, Malang, East Java, Indonesia

*email: hardy.padmayudha1.2401218@students.um.ac.id

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Abstract

Japanese language learning at the senior high school level remains challenged by students' limited mastery of *kana* writing and *kaiwa* (speaking) skills, both of which require coordinated psychomotor performance in handwriting and pronunciation. Existing web-based learning media rarely integrate gamification with learning analytics to support these skills. This study aimed to develop and evaluate a web-based gamified learning platform integrated with learning analytics to improve students' *kana* mastery and *kaiwa* skills. The study adopted the Lee and Owens instructional development model, consisting of analysis, design, development, implementation, and evaluation phases. A purposive sample of 34 Grade XI students participated in a one-group pre-test–post-test implementation. Data were collected through expert validation, learning achievement tests, and the System Usability Scale (SUS). Expert validation indicated that the developed media achieved very high validity across instructional strategy, content, media, and assessment instruments (Aiken's $V = 0.878\text{--}0.925$). Wilcoxon signed-rank tests revealed significant improvements across all learning dimensions ($p < .01$), with a high overall normalized gain (0.76) and a large overall effect size (0.87). The greatest improvements were observed in psychomotor-oriented outcomes, particularly *kana* writing and *kaiwa* performance, supported by automated feedback and repetitive guided practice. The usability evaluation produced a SUS score of 69.03, indicating marginally acceptable usability while highlighting opportunities to improve interface organization, navigation, and multimedia interaction. These findings suggest that integrating gamification with learning analytics can effectively support psychomotor-oriented Japanese language learning, although further studies employing controlled experimental designs are needed to strengthen causal inference and generalizability.

Keywords: *kaiwa*, *kana*, learning analytics, learning media, psychomotoric, web-based gamification.

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INTRODUCTION

Twenty-first century learning increasingly demands instructional designs that not only convey content but also cultivate productive language skills among learners. In senior high school, especially in Japanese language learning, learners are expected to achieve a balanced mastery of listening, speaking, reading, and writing, including fluid production of basic *kaiwa* and accurate construction of *kana* characters. However, learning a non-alphabetic writing system and producing spontaneous oral utterances present complex cognitive and procedural challenges for high school learners. These



difficulties arise because foreign language production requires continuous motor coordination, accurate phonetic pronunciation, and rapid structural retrieval simultaneously. Conventional, one-way, paper-based instruction fails to provide the interactive scaffolding, adaptive feedback, and real-time correction required to effectively overcome these learning bottlenecks.

Web-based gamification has become a common strategy to improve learner engagement and behavior in digital platforms. This framework incorporates standard game components, such as points, badges, progression bars, and leaderboards into academic environment to reinforce positive study habits (Hamari, 2019; Sailer & Homner, 2020). Using open web architectures ensures cross-platform accessibility across multiple user devices. When combined with learning analytics, web-based gamification can also provide adaptive feedback, sustain motivation through immediate reinforcement, and scaffold repetitive practice that is essential for skill acquisition. These characteristics make web-based gamification particularly suitable for language learning that demand both repeated exposure and active production.

From a learning domain perspective, mastering *kana* writing and *kaiwa* production is fundamentally a psychomotor activity because both involve coordinated muscular movements, stroke order in handwriting, and articulator coordination in speech production (Schwery et al., 2026). This study therefore adopts the psychomotor domain of Bloom's taxonomy, focusing on the level of guided manipulation in which learners imitate, practice, and reproduce target behaviors under structured digital scaffolding. This orientation serves as a rigorous standard baseline for defining clear instructional objectives, mapping sequential lesson planning, and structuring empirical assessment instruments related to *kana* writing and *kaiwa* performance.

Empirically, Mulyana (2020) reported that high school learners experienced recurring difficulties in Japanese, specifically regarding incorrect stroke order, character recognition, character recall, and character shape discrimination. Furthermore, Rahayu et al. (2023) identified that a substantial percentage of learners failed to write *kana* accurately and struggled with oral pronunciation, indicating that the primary instructional bottleneck is located in the psychomotor rather than the purely cognitive domain. Modern empirical evaluations by Mardhatillah & Setiana (2023) and Amril et al. (2024) further confirmed that limited opportunities for active oral practice and unsupportive self-paced language environment remain the dominant factors hindering fluent *kaiwa* mastery.

A growing body of research has explored digital media to support Japanese learning, including augmented-reality flashcards (Putri & Gustalika, 2025), QR-game integration (Safitri & Dewandono, 2023), virtual reality (Pramesti et al., 2025), web-based applications (Sisephaputra et al., 2023), and gamified *kanji* platforms (Sonjaya et al., 2024). These studies generally reported positive outcomes in improving learner motivation, vocabulary acquisition, and character recognition through interactive digital environments. However, most previous studies primarily focused on the cognitive domain, particularly recognition and recall activities, while psychomotor-oriented skill related to *kana* stroke production and *kaiwa* articulation remain underexplored. In addition, although several studies implemented gamification features, existing media rarely integrated learning analytics capable of monitoring stroke-order accuracy, pronunciation quality, and longitudinal learner progress to support adaptive repetitive practice. Furthermore, previous studies still provide limited evidence regarding the sustainability of learner engagement during continuous language practice (Fuchs, 2023; Irvani et al., 2025). These unresolved gaps motivate the present study to develop a web-based gamification platform integrated with learning analytics to support *kana* mastery and *kaiwa* skills simultaneously.

METHOD

This research used the Lee & Owens (2004) model in developing learning media, which consists of five stages which displayed on Figure 1 as Analysis, Design, Development,

Implementation, and Evaluation. This model was chosen because it is appropriate for developing web-based learning media and interactive multimedia. The analysis phase comprised a needs assessment and a front-end analysis. The needs assessment was conducted through classroom observations and semi-structured interviews with the Japanese teacher and a sample of grade XI students to identify learning problems related to limited *kaiwa* practice opportunities, insufficient corrective feedback, and difficulties in mastering kana and oral communication skills. In the front-end analysis stage, four aspects were examined, namely audience analysis, situation analysis, technology analysis, and media analysis. The audience analysis identified recurring learner difficulties in kana writing and *kaiwa* practice, particularly related to stroke-order accuracy, pronunciation, and repetitive skill performance. The situation analysis revealed that classroom instruction still relied on conventional learning activities with limited opportunities for interactive and self-paced practice. Furthermore, the technology and media analyses indicated that although digital infrastructure was available, there was still an absence of web-based learning media that systematically support psychomotor-oriented Japanese language learning. These findings became the basis for determining the instructional specifications, feature design, and technological direction of the developed media.

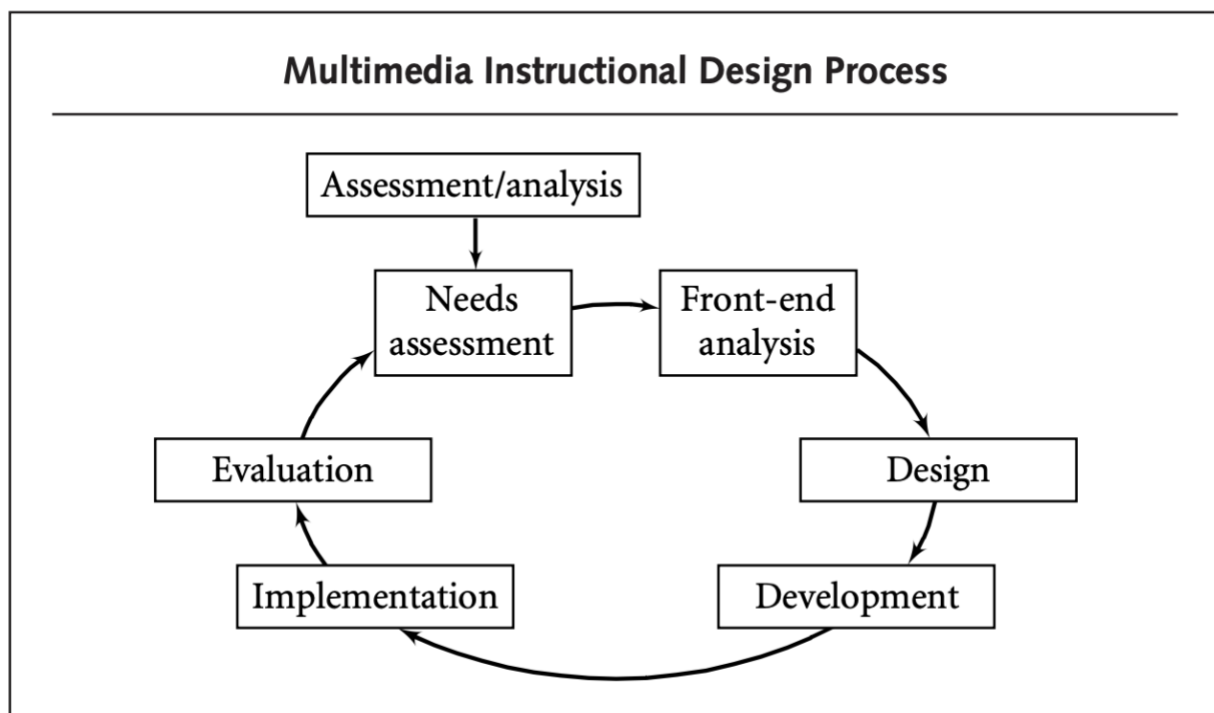


Figure 1. Lee & Owens (2004) Model

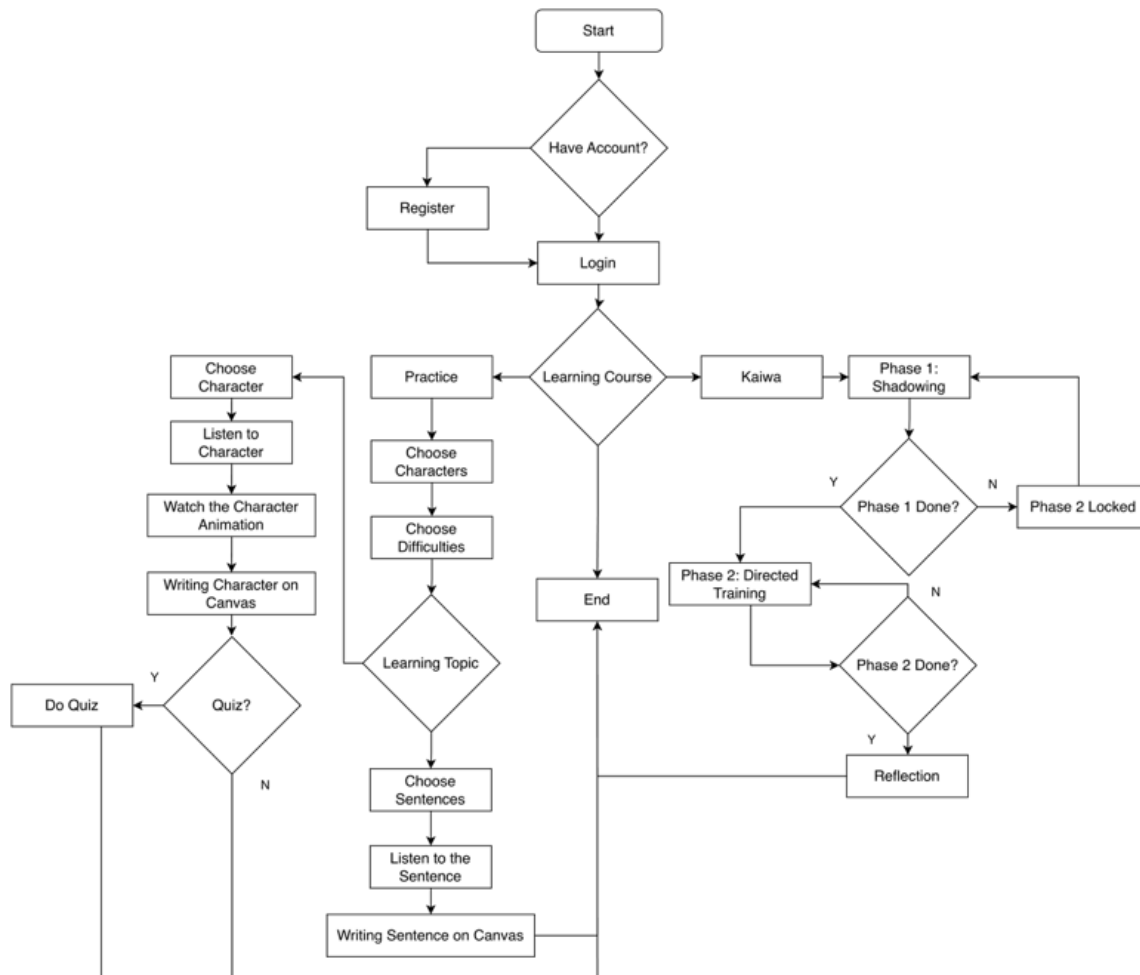


Figure 2. Application Main Flowchart

In the design phase, the results of the analysis were translated into a preliminary blueprint of the web-based learning media. The system workflow and interaction process were first visualized through the development of a flowchart, as presented in Figure 2. The flowchart illustrates the operational sequence of the application, including user navigation, kana writing activities using the digital canvas, and *kaiwa* practice with pronunciation recording features. This design was intended to ensure that each learning activity follows a structured process aligned with the instructional objectives and psychomotor learning outcomes.

Furthermore, wireframes were developed to represent the initial interface layout of main feature of the application before the implementation stage, as shown in Figure 3. The wireframe design focused on the arranged layout, navigation structure, interactive buttons, and learning content. Several features were visualized in the wireframe, as: (1) Figure 3.a presents set of learning characters based on the category from A~O to Wa~N; (2) Figure 3.b presents the interactive digital canvas where learners can draw the character from the scratch based on the stroke-order; (3) Figure 3.c presents the list of vocabularies for each kana characters; (4) Figure 3.d presents the pronunciation target to be pronounce by the learner to perform the *kaiwa*; and (5) Figure 3.e presents the button to start recording and analyze learner input for *kaiwa* performance. These wireframes functioned as the initial visual reference for organizing psychomotor-oriented learning activities within the web-based learning environment.

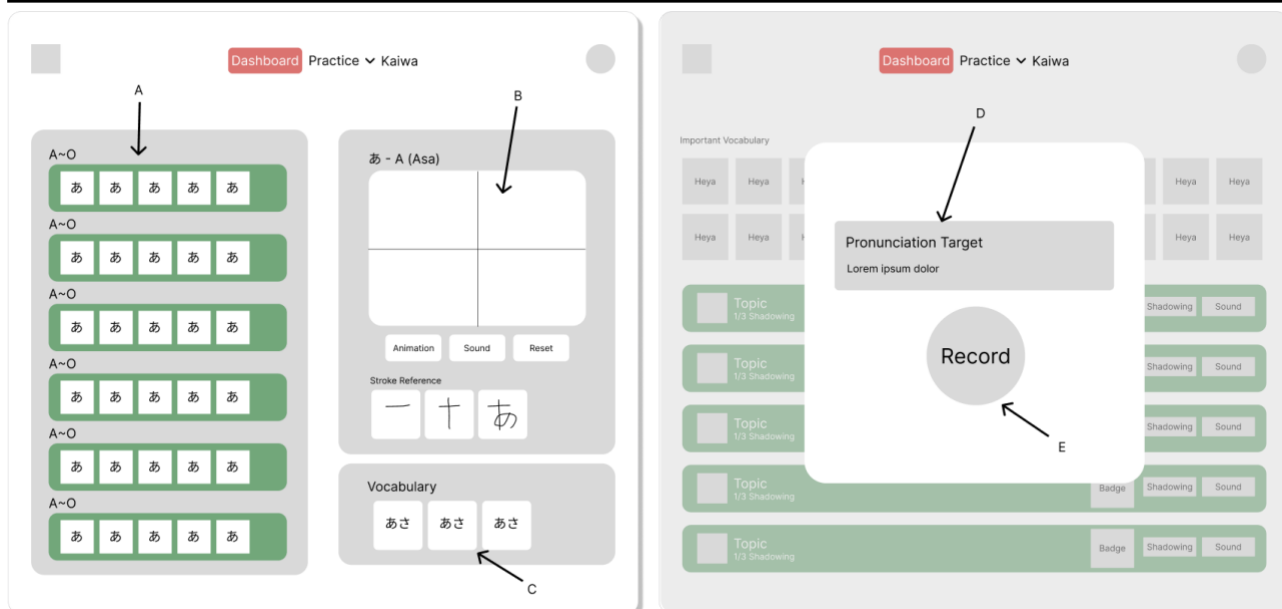


Figure 3. Kana and Kaiwa Feature Wireframe

Development phase realized the design into a functional product. The web-based learning medium was developed using modern front-end and back-end technologies, integrating gamification mechanics as: (1) points; (2) badge; and (3) leaderboard, learning analytic modules that records learner progress on each task also the comparison between the character coordinate with the user drawing in the canvas, and some plugins or libraries that used in speech-to-text for *kaiwa* recognition and text-to-speech for learning or scaffolding. The prototype was then validated by content, media, and language experts using a four points Likert-scale questionnaire which results were analyzed with Aiken's V (Aiken, 1985) to ensure content validity before the medium was used in the field.

The implementation phase involved a field trial using purposive sampling with 34 grade XI students at a public senior high school. The participants were selected based on the Japanese teacher's recommendation of low to medium graded group. This trial employed a one-group pre-test and post-test design in which students first completed a pre-test, then participated in learning activities using the developed web-based gamification media, and finally completed a post-test using parallel instruments. The design enabled the researchers to examine student's learning improvement after using the developed media, particularly in kana recognition, kana writing, and *kaiwa* performance.

The final phase was evaluation, which examined the effectiveness and usability of the developed media. The System Usability Scale (SUS) adopted from Brooke (1996) was used to measure usability through ten measurement items rated on a five-point scale, in which even numbered items represented negative statements. Pre-test and post-test measurement covered four dimensions: character recognition, kana writing, vocabulary and sentence comprehension, and *kaiwa* performance. These dimensions were selected because they represent the core competencies required in Japanese language production, encompassing both cognitive understanding and psychomotor performance involved in recognizing, writing, comprehending, and orally producing Japanese language elements. The pre-test and post-test from these dimensions were analyzed using Shapiro-Wilk test, Wilcoxon Signed-Rank Test, and effect size calculation with the formula $= \frac{|Z|}{\sqrt{N}}$ (Field, 2013) interpreted using Cohen (1988), and learning gains with the Normalized Gain Score (Hake, 1998). The findings of this phase were used to confirm the feasibility of the media and to guide refinements for broader use.

RESULTS AND DISCUSSION

Based on the design specifications developed during the previous phase, the web-based learning media was implemented into a functional system integrating gamification and learning analytics features. This development resulted in an interactive learning environment that facilitates continuous kana writing and *kaiwa* practice through structured digital activities. The media incorporates several gamification elements, including points, levels, leaderboards, and automated feedback to support learner motivation and engagement during repetitive practice. In addition, the learning activities were organized into sequential stages consisting of orientation, material exploration, interaction, challenge-based practice, evaluation, and reflection to support both cognitive understanding and psychomotor skill performance.

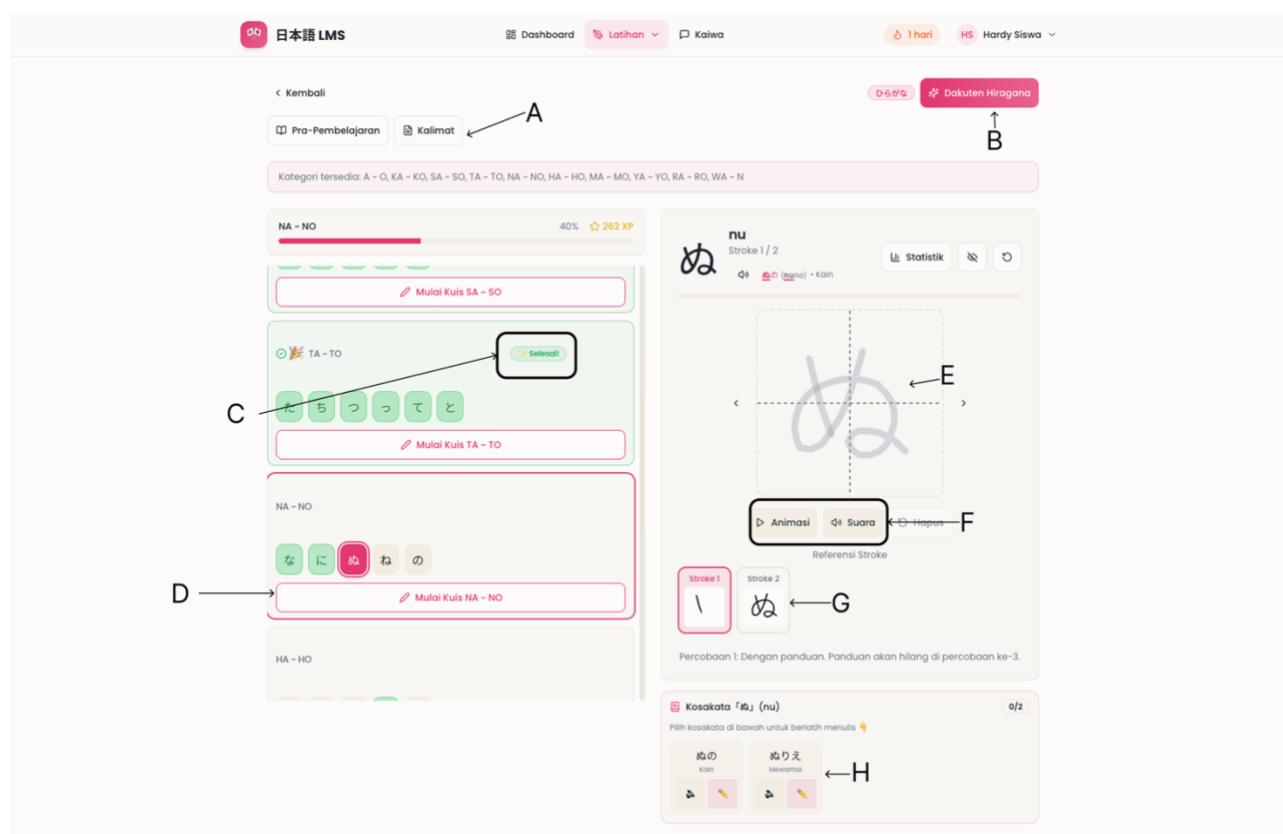


Figure 4. Kana Practices

The implementation of kana practice is presented in Figure 4. The interface displays a structured learning environment that integrates kana writing exercises with gamification elements and learning analytics. As shown at the top of the panel, Figure 4.a provides feature for learning sentences and Figure 4.b provides button to access the advanced characters. Students are allowed to explore and practice all available content. However, basic characters remain the primary learning focus. On the left panel, the learning modules are organized into categories ranging from A~Ko to Wa~N, following the standard order of kana characters as presented by Figure 4.c. Each category also includes a completion indicator marked by a symbol, allowing students to monitor their learning progress. In addition, every category provides a quiz feature that can be accessed either independently by students to challenge themselves and improve their scores or through teacher instruction which displayed by Figure 4.d.

Furthermore, on the right panel, Figure 4.e presented the interactive digital canvas for writing practice. Figure 4.f represent the feature to play the stroke animation and pronunciation audio of the character as part of the learning. Moving to Figure 4.g, this panel displayed the stroke order as

guidance to learner in writing practice on digital canvas, which also strengthen the stroke order animation feature from previous figures. These features support active and repetitive practice, which is essential for improving kana writing skills. Furthermore, Figure 4.h provides a vocabulary list that demonstrates the usage of each character in words and sentences, helping learners connect character recognition with practical language use.

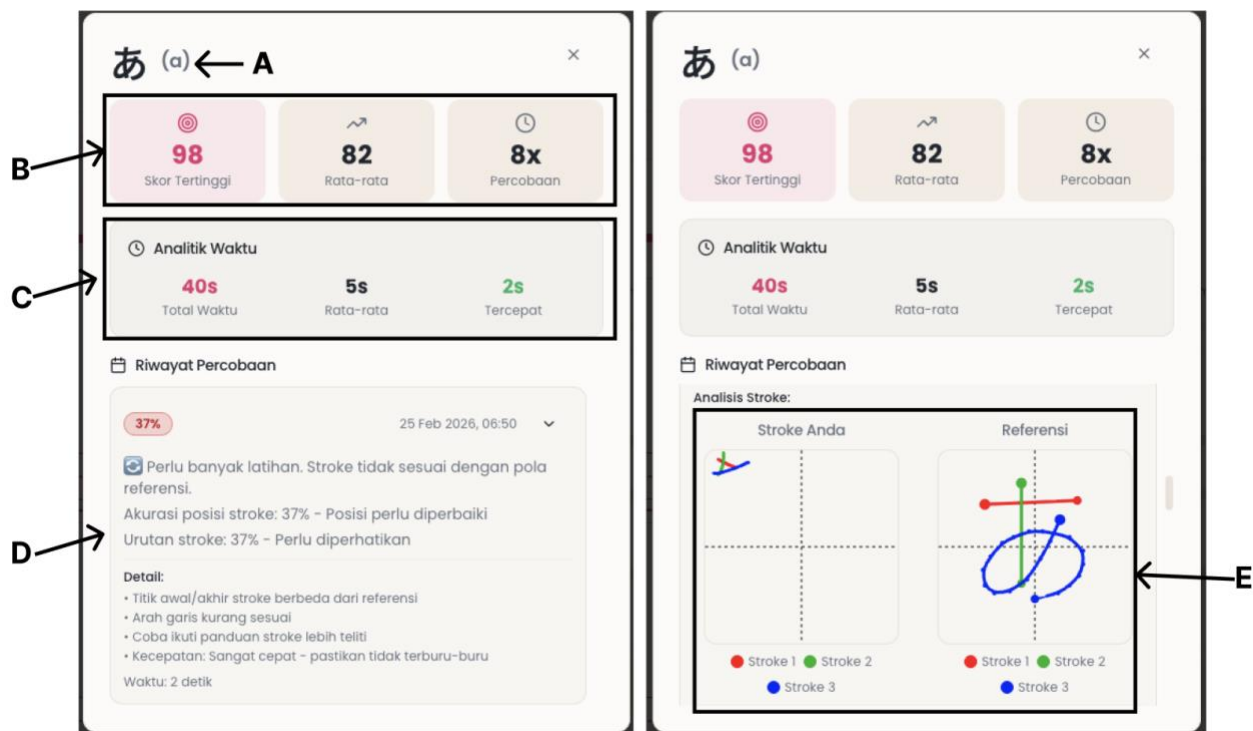


Figure 5. Canvas Statistic Features

Figure 5 presents the detailed representation of the statistics and feedback features integrated into the digital canvas interface. Figure 5.a displays information about the currently selected kana character along with its corresponding romaji representation. Figure 5.b presents learner performance statistics, including the highest score, average score, and the total number of writing attempts completed for each character. Furthermore, Figure 5.c shows the time analytics feature, which records the accumulated duration of writing practice, the average completion time for each attempt, and the fastest writing performance achieved by the learner.

Feedback generated from learner practice results is presented in Figure 5.d. This feedback provides information regarding handwriting precision, stroke accuracy, and aspects that still require improvement during kana writing practice. In addition, the system also provides suggestions for subsequent practice sessions to support continuous skill improvement. Lastly, Figure 5.e presents a visual comparison between the learner's handwriting result, including the stroke order performed, and the expected kana writing pattern generated by the system.

Figure 6 illustrates the interface layout of the *kaiwa* topic dashboard. The dashboard provides a collection of vocabulary items accompanied by romaji and translated meanings to support learners in understanding kana expressions commonly used in daily conversations, as shown in Figure 6.a. Furthermore, Figure 6.b displays dialogue cards containing conversation examples presented in three forms: kana characters, romaji transliteration, and translated text. These dialogue cards function as learning references to help learners understand conversational patterns and speaking flow between speakers.

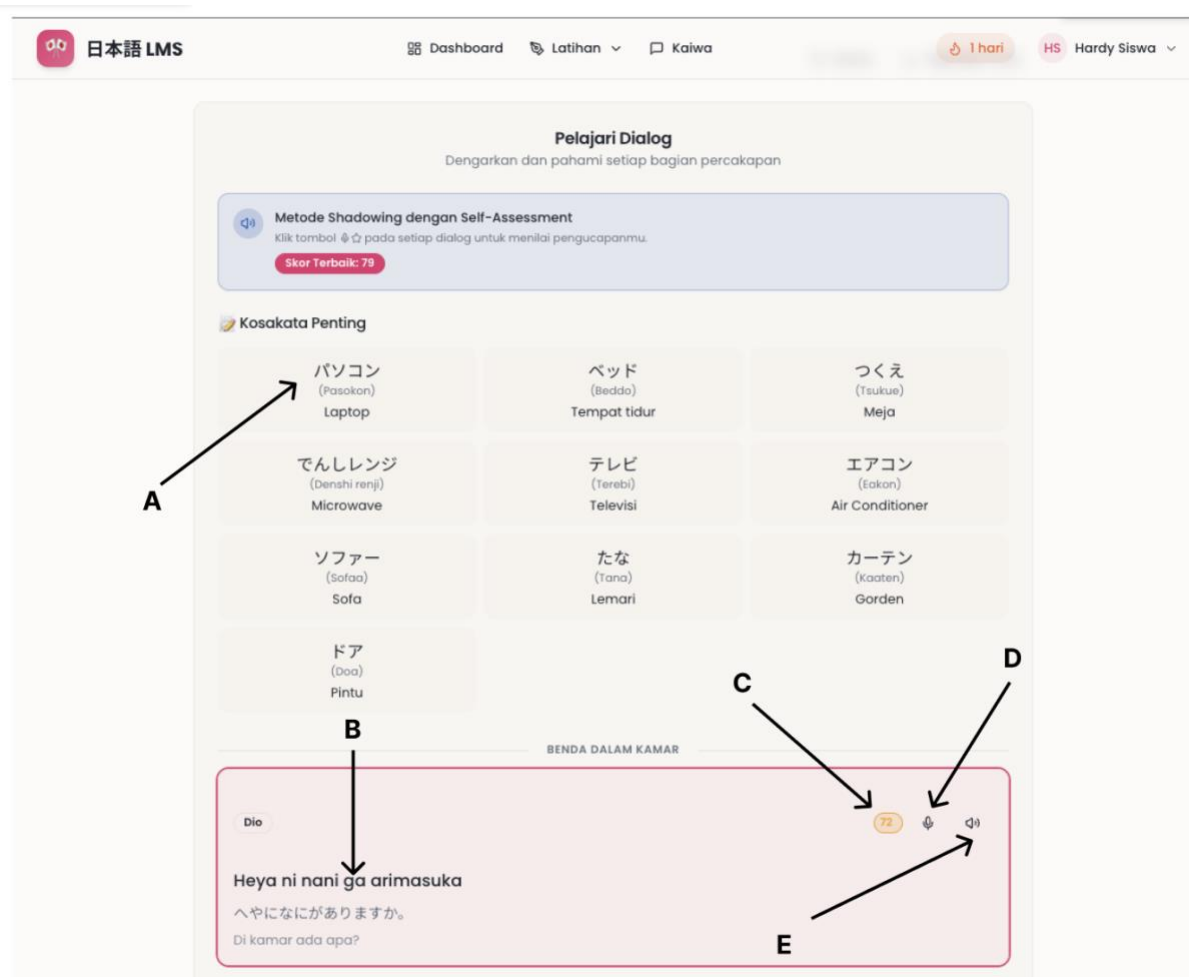


Figure 6. Kaiwa Dialogue

Figure 6.c presents the completion indicator connected to the shadowing and recording activities available in Figure 6.d. The recording feature allows learners to practice pronouncing the dialogue directly through a speaking activity integrated into the system. Meanwhile, Figure 6.e functions as an audio playback feature that enables learners to listen to the pronunciation model of the selected dialogue card before performing their own *kaiwa* practice.

Figure 7 presents the pronunciation practice interface integrated into the selected *kaiwa* dialogue card. This interface consists of several components representing the input, processing, and output stages of the pronunciation assessment activity. Figure 7.a displays the recording button used by learners to capture their pronunciation based on the target dialogue sentence. The recorded learner input is then processed by the system to generate a pronunciation score, as presented in Figure 7.b.

In addition to numerical scoring, Figure 7.c displays the original target sentence used as the pronunciation reference for learners. After the pronunciation analysis process is completed, the learner's spoken input is displayed in Figure 7.d and compared with the target sentence to identify pronunciation differences and inaccuracies. This comparison process enables the system to provide direct feedback and improvement suggestions, which support learners in improving pronunciation accuracy and *kaiwa* performance through repetitive speaking practice.



Figure 7. Kaiwa Practice

Before the implementation stage, the developed learning media was evaluated through expert validation to determine its feasibility in terms of instrument quality, learning strategy, media design, and material suitability. The validation process involved three expert validators selected based on their expertise in Japanese language education, instructional media development.

The first validator specialized in educational assessment and evaluated the research instruments used in the study. The second validator, who had expertise in Japanese language teaching and instructional strategies, assessed the learning strategy and material suitability with the curriculum objectives. The third validator, who specialized in educational media and system design, evaluated the usability, interface, and functionality of the developed web-based learning media. The validation results were analyzed using Aiken (1985) with the following criteria: $V \geq 0.67$ is categorized as Valid and $V \geq .800$ is categorized as Very Valid. The validation results are presented in Table 1. Based on Table 1, all validation aspects obtained Aiken's V values above 0.80, indicating that the developed learning media falls into the Very Valid category. The highest score was achieved in the material aspect with a value of 0.925, indicating that the learning content was highly appropriate for the curriculum objectives and students' learning needs. In addition, the media and instrument aspects also obtained high validity scores, demonstrating that the developed system, learning strategy, and evaluation instruments were suitable for implementation in Japanese language learning activities.

Table 1. Expert Validation Results

Validation Aspect	Aiken's V Score	Category
Instrument	0.897	Very Valid
Learning Strategy	0.878	Very Valid
Material	0.925	Very Valid
Media	0.920	Very Valid

After validation, the developed media was implemented through small group and large group trials involving grade XI senior high school students. The small-group trial involved 10 students and was conducted to identify technical issues, usability problems, and initial student responses towards the developed media. Several students reported that the layout was still less organized and that some navigation features, including unavailable sound playback and undetected voice recordings. Based on this feedback, improvements were made to the interface layout, navigation structure, and audio functionalities before proceeding to the larger implementation.

The large-group implementation involved 34 students using a one-group pre-test and post-test design. The implementation covered four learning dimensions: character recognition, *kana* writing skills, vocabulary understanding, and *kaiwa* performance. Among these dimensions, *kana* writing and *kaiwa* particularly targeted students' psychomotor skills through writing and pronunciation practice activities.

In the implementation stage, the teacher first introduced the *kana* materials and *kaiwa* conversation topics that would be practiced during the learning session. After the initial explanation, students independently accessed the developed web-based learning media using their personal devices, as shown in Figure 8. Figure 8.a illustrates students practicing *kana* writing activities by following the character categories and stroke order guidance provided within the application. Meanwhile, Figure 8.b shows students conducting *kaiwa* pronunciation practice by recording their voices according to the target dialogue presented in the selected conversation topic. During the implementation process, students demonstrated active participation and engagement throughout the learning activities. The integration of gamification elements, such as points, progress tracking, and achievement indicators, encouraged learners to repeatedly practice *kana* writing and *kaiwa* pronunciation. In addition, the immediate feedback provided by the system supported learners in identifying pronunciation inaccuracies and improving writing precision during the learning process.

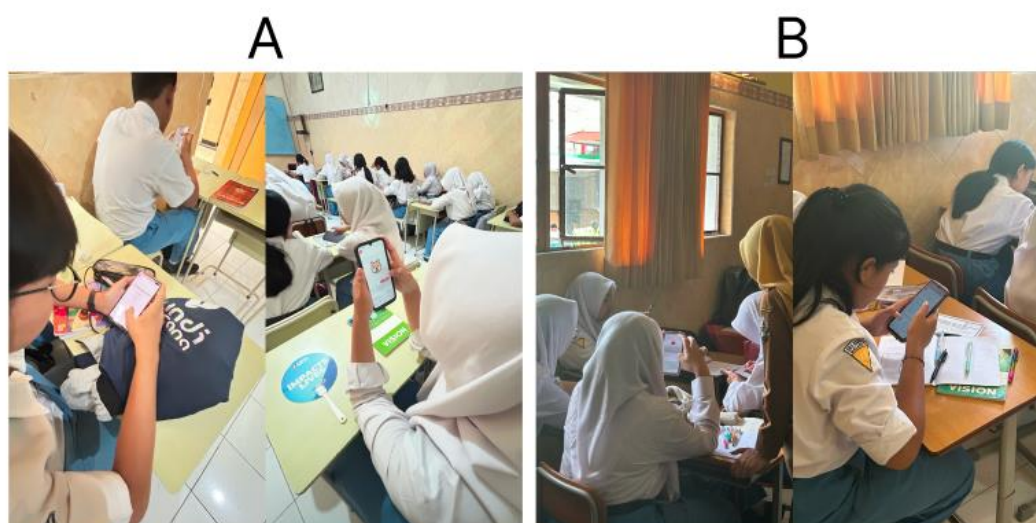


Figure 8. Media Implementation

Evaluation was conducted to determine the effectiveness of the developed learning media in improving students' Japanese language skills and usability experience. The evaluation focused on four learning dimensions: character recognition, *kana* writing skills, vocabulary understanding, and *kaiwa* performance. Among these dimensions, *kana* writing and *kaiwa* particularly represented psychomotor skills because students were required to actively perform writing movements and pronunciation practices during the learning process. The effectiveness of the learning media was measured using pre-test and post-test assessments. The collected data were analyzed using the Wilcoxon-Signed Rank Test, N-Gain analysis, and effect size analysis to determine statistical significance, improvement level, and practical impact of the implemented media.

The results of the Wilcoxon Signed-Rank Test are presented in Table 2. All dimensions obtained significance values below 0.05, indicating statistically significant differences between pre-test and post-test scores after the implementation of the learning media. These findings indicate that the developed media contributed positively to students' Japanese language learning outcomes. The interactive exercises, gamification elements, and adaptive learning features encouraged students to engage more actively in *kana* writing and *kaiwa* practice activities. These findings consistent to the results by Safitri & Dewandono (2023) who stated the gamification has positive effect in increasing student understanding and interest in Japanese language learning.

Table 2. Wilcoxon Signed Rank Test Results

	Characters Recognition	Writing Skill	Characters Vocabulary	<i>Kaiwa</i>	Total Score
<i>Z</i>	-2.732	-4.858	-3.677	-4.766	-5.087
<i>Asymp. Sig. (2-tailed)</i>	.006	<.001	<.001	<.001	<.001

Furthermore, the comparison between pre-test and post-test scores presented in Table 3 shows a considerable increase in student performance after receiving learning treatment using the developed media. The improvement indicates that repeated practice activities, pronunciation exercises, and writing-based interactions helped students better understand and apply Japanese language skills during the learning process.

Table 3. Pre-test and Post-Test Results

Test	Average Score
Pre-test	69.47
Post-test	93.38

To measure the level of improvement, N-Gain analysis was conducted, and the results are presented in Table 4. The overall N-Gain score was categorized as high, indicating that the developed media effectively supported Japanese language learning. However, the improvement level varied across the four measured dimensions. Writing skill and *kaiwa* obtained medium improvement categories, indicating that the media was particularly effective in improving practical and psychomotor-based skills through writing and pronunciation activities. This approach aligns with Skill Acquisition Theory (Anderson, 1982), which explains that procedural skills develop progressively through repeated practice and feedback processes. The integration of interactive guidance and automated feedback within the system enabled learners to improve writing accuracy and oral production performance progressively during the learning process.

Meanwhile, character recognition and vocabulary dimensions showed lower gain scores. Within the framework of Skill Acquisition Theory, these dimensions primarily represent the initial declarative stage, where students encode foundational linguistic facts. The lower gain scores may indicate that students already possessed a solid baseline of declarative understanding in these areas before the implementation stage, resulting in smaller score increments compared to the practical,

procedural dimensions. Nevertheless, the overall findings demonstrate that the developed media successfully facilitated the progression from cognitive representation to autonomous language performance.

Table 4. N-Gain Results

Dimension	Score	Category
Characters Recognition	0.05	Low
Writing Skill	0.35	Medium
Character Vocabulary	0.09	Low
<i>Kaiwa</i>	0.39	Medium
Total Dimensions	0.76	High

In addition, the effect size analysis results presented in Table 5 indicate that the developed media had a strong practical impact on students' learning outcomes. Large effect size values in writing skill and *kaiwa* dimensions show that the media was effective in supporting students' practical Japanese language performance, particularly in writing accuracy and pronunciation practice.

Table 5. Effect Size Results

Dimension	Score	Category
Characters Recognition	0.47	Medium
Writing Skill	0.83	Large
Character Vocabulary	0.63	Large
<i>Kaiwa</i>	0.82	Large
Total Dimensions	0.87	Large

Overall, the results from statistical testing, N-Gain, and effect size analysis consistently show that the developed web-based gamification learning media is effective in improving student's Japanese language learning outcomes. The gamification elements implementation proofed that it affects the learning outcomes (Sonjaya et al., 2024). This also aligns where gamification elements conduct the continuous engagement theory where well planned and designed gamification able to fulfill student's basic need for autonomy, competence, and social connectedness (Ryan & Deci, 2000).

Usability evaluation using the System Usability Scale (SUS) obtained an average score of 69,03 as displayed in Figure 8, which is included in Grade Scale D, OK in Adjective Ratings category, and High Marginal in Acceptability Ranges (Bangor et al., 2009). These results indicate that the developed learning media is acceptable and usable for students, although improvements are still needed in interface organization and navigation aspects.

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SUS Score
1	3	2	3	3	3	2	4	2	4	3	62,5
2	4	3	3	3	3	3	4	3	3	3	55
3	5	3	4	4	5	4	4	2	4	5	60
4	4	1	5	1	4	1	4	1	4	1	90
5	2	1	5	1	3	4	5	3	5	1	75
6	3	4	2	5	3	4	3	4	3	3	35
7	4	2	4	3	4	2	4	2	3	2	70
8	4	2	4	2	3	3	4	2	3	3	65
9	4	1	5	1	4	3	5	1	4	2	85
10	4	2	3	2	4	1	3	2	3	3	67,5
11	4	2	4	2	3	2	4	2	3	2	70
12	5	2	4	2	4	2	4	2	5	2	80
13	4	1	5	2	4	1	5	4	2	3	72,5
14	4	3	5	4	5	3	5	2	3	5	62,5
15	4	2	4	2	5	2	4	1	4	2	80
16	4	3	4	2	5	4	5	2	4	4	67,5
17	3	2	4	3	3	2	3	2	3	3	60
18	5	2	4	1	5	2	5	1	4	3	85
19	4	2	4	2	4	2	4	2	4	2	75
20	3	2	4	3	4	2	3	2	3	4	60
21	4	2	3	3	4	4	3	2	4	3	60
22	4	2	3	3	4	2	4	2	4	3	67,5
23	3	2	4	2	4	2	4	2	3	2	70
24	4	2	4	2	3	3	3	2	4	3	65
25	4	3	4	2	4	2	4	2	4	3	70
26	3	2	5	2	3	3	4	2	3	3	65
27	4	3	4	1	5	3	4	2	4	3	72,5
28	4	2	5	3	4	1	4	1	4	3	77,5
29	4	2	3	3	4	2	4	2	3	2	67,5
30	4	2	4	3	5	2	5	2	5	4	75
31	3	2	3	4	3	3	3	3	3	3	50
32	5	2	4	1	3	3	4	2	5	1	80
33	5	2	5	2	4	2	4	2	4	2	80
34	3	2	4	3	4	3	5	2	4	3	67,5
35	4	2	5	3	4	3	5	3	4	3	70
36	4	2	4	2	4	3	4	2	3	2	70
Average SUS Score											69,027778

Figure 8. Participant Score in SUS

Discussion

The expert validation results indicated that the developed web-based gamification learning media satisfied all validity criteria across media, instructional strategy, content, and instrument aspects. These findings demonstrate that the developed system is structurally and pedagogically appropriate for classroom implementation and capable of supporting active learning activities.

Following the implementation stage, the developed media produced statistically significant improvements across all measured dimensions, supported by high N-Gan and large effect size values. These findings are consistent with Safitri & Dewandono (2023), who reported that gamification elements increased learner engagement and comprehension in Japanese language learning. Similarly, Sonjaya et al. (2024), found that gamified Japanese language learning activities contributed positively to student learning outcomes. In the present study, interactive exercises, progress visualization, quizzes, and reward mechanisms encouraged learners to participate more actively and maintain continuous practice throughout the learning sessions.

However, the present findings also reveal a different pattern compared to several previous studies. Earlier studies such as Putri & Gustalika (2025) and Sonjaya et al. (2024) primarily emphasized cognitive-oriented outcomes, including vocabulary recognition and character memorization. In contrast, this study found that the developed media generated the strongest improvements in psychomotor-oriented skills, particularly *kana* writing and *kaiwa* pronunciation performance. This difference may be influenced by the integration of guided writing practice, stroke-order correction, pronunciation assessment, and repetitive shadowing activities that directly targeted productive language behaviors rather than recognition activities alone.

This finding is consistent with Skill Acquisition Theory proposed by Anderson (1982), which explains that procedural skills gradually develop through repetitive practice, immediate feedback and continuous correction. In the present study, learners repeatedly practiced *kana* writing and *kaiwa* production through structured activities supported by automated feedback mechanisms. As a result, declarative knowledge regarding *kana* forms and pronunciation could progressively transform into procedural and more autonomous performance. The largest gains observed in *kana* writing and *kaiwa* dimensions therefore indicate that repetitive guided manipulation contributed substantially to psychomotor skill development.

Meanwhile, the relatively lower gains in character recognition and vocabulary comprehension do not necessarily indicate weak instructional performance. Instead, these findings suggest that students already possessed prior declarative knowledge before the implementation stage, as reflected by the relatively high pre-test scores in these dimensions. Nevertheless, these cognitive components remained essential because they functioned as foundational knowledge supporting higher-level writing synthesis and oral production during psychomotor activities.

The present study also extends previous web-based Japanese language learning research by integrating learning analytics into the instructional process. Previous studies, including Sisephaputra et al. (2023), mainly focused on digital accessibility and content delivery functions. In contrast the developed system in this study recorded behavioral learning data such as stroke accuracy, pronunciation scores, practice frequency, and learning duration. These analytics enabled both learners and instructors to monitor learning progress more systematically and identify specific areas requiring further practice.

The findings additionally support Christopoulos & Mystakidis (2023), who argued that gamification can enhance learner motivation, engagement, and immediate feedback when implemented strategically within instructional systems. Nevertheless, the usability findings in this study also align with Fuchs (2023) and Irvani et al. (2025), who emphasized that gamification may become ineffective when technical usability and instructional alignment are insufficient. Several learners in the present study reported limitations related to layout organization, navigation flow, and audio synchronization during multimedia interaction. These findings indicate that successful gamified learning environments require not only motivational elements but also efficient interface design to prevent cognitive overload during intensive psychomotor practice.

Overall, this study contributes to Japanese language learning research by providing a web-based gamification platform that integrates psychomotor practice, automated feedback, and learning analytics within a single instruction environment. The findings demonstrate that gamification combined with repetitive guided practice can effectively bridge declarative understanding and productive language performance, particularly in *kana* writing and *kaiwa* activities at the senior high school. Nevertheless, several limitations should be acknowledged. First, the study employed a one-group pre-test–post-test design without a control group, limiting the ability to attribute the observed learning improvements exclusively to the developed intervention, as other instructional or contextual factors may also have contributed to the outcomes. In addition, the participants were purposively selected from students with low-to-moderate initial performance. Although this sampling strategy was appropriate for evaluating the media with learners requiring greater instructional support, these students naturally had greater room for improvement, which may have contributed to the relatively high N-Gain scores. Consequently, the findings should be interpreted with caution and may not be fully generalizable to students with different proficiency levels or educational contexts. Future studies should employ randomized or quasi-experimental designs with appropriate control groups and more diverse participant samples to strengthen causal inference and improve the generalizability of the findings.

CONCLUSION

Based on the results of the study, it can be concluded that the web-based gamification Japanese language learning media with learning analytics support was successfully developed using the Lee and Owens development model. The developed media fulfilled the validity requirements in terms of learning strategy, material, instrument, and media aspects, indicating its feasibility for Japanese language learning activities in senior high schools. The implementation results showed that the developed media effectively supported students' Japanese language learning, particularly in kana writing and *kaiwa* skills through interactive practice, gamification elements, and adaptive learning activities. In addition, the integration of learning analytics assisted teachers in monitoring student progress and identifying learning difficulties during the learning process. Overall, the developed media can be used as an alternative learning tool to support active, interactive, and psychomotor-oriented Japanese language learning. Future research is recommended to involve larger participant groups and experimental designs with control classes to obtain broader findings regarding the effectiveness of the developed media.

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