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Development of a Gamified Moodle Learning Management System for computer science education in Vocational High Schools

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Abstract: Digital transformation in education requires media that sustain student engagement in blended settings. This research seeks to design and develop a Moodle-based Learning Management System for Informatics at Vocational High School 1 Koto Baru and to verify its quality and usability for routine classroom use. The study uses a phased development approach (Analyse, Design, Develop, Implement, Evaluate). Participants were 44 tenth-grade learners and 2 instructors; quality was reviewed by 2 subject-matter experts and 3 media experts. Data came from structured questionnaires and were analysed descriptively in %. Findings show content quality is highly valid at 90% overall (89% content indicators, 92% instructional). Media quality is likewise highly valid at 91% (90% ease of use, 93% visual appeal). Classroom applicability is strong, with practicality of 92% for instructors and 92% for learners. Gamification mechanisms (points, levelling up, badges, and leaderboards) provide quick feedback, structured progress tracking, and support for learning orchestration. Overall, the product meets highly valid and practical criteria and is ready for adoption as a modular, trackable Moodle-based course for Informatics at the vocational high school level. Future work includes quasi-experimental tests of learning outcomes, replication across schools and subjects, performance evaluation under high access loads, and development of adaptive learning analytics.

Keywords: learning management system; Moodle, gamification; vocational high school; leaderboard

1. Introduction

Digital transformation in education requires learning platforms that maintain student engagement in blended learning scenarios (Sangsuwon et al., 2024). Vocational high schools need to master practical competencies accompanied by adequate digital literacy in order to achieve learning objectives in a sustainable manner (Pickersgill et al., 2024). Various studies report a decline in motivation in learning scenarios with minimal interaction (Kronhardt et al., 2024). Motivation and engagement decline when feedback is not available quickly and consistently (Tharot et al., 2024). Learning dominated by one-way assignments tends not to encourage learners' persistence in practicing and reflecting (Gkintoni et al., 2024). Gamification strategies are considered effective for strengthening persistence through elements such as level-up points, badges, and leaderboards (Clapson et al., 2024). Many institutions use the Moodle Learning Management System based on because of its open and flexible nature and extensive ecosystem support (Donekal Chandrashekar et al., 2024). The integration of the Moodle Learning Management System and gamification enables structured learning experiences to be tracked and encourages active participation (Addas et al., 2024).

Although the use of gamification in Learning Management Systems is increasing, publications that present structured development accompanied by quality testing in secondary vocational education are still limited (Yang et al., 2025). Many articles stop at feature descriptions without systematic development procedures or without replicable quality evaluations (Forcael et al., 2024). In vocational high schools, short face-to-face sessions and one-way communication patterns contribute to low student motivation to practice and

reflect on the learning process (Vorlíček et al., 2024). The gap that emerges is the need for a standards-based development model that produces products ready for adoption in the Moodle Learning Management System, accompanied by evidence base of validity and practicality from instructors and learners as the main stakeholders (Cinar et al., 2024). This research responds to these needs through a rigorous development procedure and transparent empirical evaluation so that the findings can be reviewed and replicated (Alshiha & Al-Abdullatif, 2024).

This research produced a Moodle Learning Management System enriched with gamification elements for computer science subjects at vocational high schools (Nacimiento-García et al., 2024). The specific objectives include design and development through the stages of Analyze, Design, Develop, Implement, and Evaluate, as well as quality testing through material validity and media validity by experts and practicality assessment by instructors and learners (Belinskiy et al., 2024). The expected outcome is a product that is deemed valid and practical, making it suitable for use in strengthening student engagement and learning independence (Charkova, 2024).

The novelty of this research lies in the presentation of a structured development sequence on the Moodle Learning Management System, documented from needs analysis to evaluation and accompanied by evidence base of quality that can be replicated in similar settings (Hernández-Martínez et al., 2024). Gamification elements are deployed as measurable pedagogical mechanisms rather than mere interface decorations (Atilla et al., 2024). The practical benefit for schools is the availability of ready-to-adopt course designs and clear assessment instruments so that instructors can manage learning activities, monitor progress, and deliver timely feedback (Fedorcsák, 2024). The scientific benefit is the contribution to the literature on Learning Management System-based development in vocational education, which can serve as a basis for studies on the effectiveness of learning outcomes and strategies to strengthen student motivation (Ghaffarifar et al., 2024).

2. Methods

2.1 Research design

This research uses a Research and Development (R&D) approach with the Analyse Design Develop Implement Evaluate (ADDIE) model to produce a digital learning product in the form of a Moodle-based Learning Management System (Yee et al., 2024). The product focuses on computer science subjects in vocational high schools and is designed to be deployed by instructors and learners with complete work documentation at each stage of ADDIE (Zidi et al., 2024). Gamification integration is structured as a measurable pedagogical mechanism through four elements, namely points, level ups, badges, and leaderboards (Dorin et al., 2024). Points are awarded for completing activities. Level ups mark progress based on accumulated points. Badges record achievements in key activities. Leaderboards deliver feedback on rankings based on total valid points.

The quality evaluation framework produces evidence base of validity from expert assessments of materials and media, as well as evidence base of practicality from teacher and student assessments using indicators of ease of use, learning time effectiveness, and benefits for learning engagement (Satriadi et al., 2024). Scoring is carried out on a 4-point scale, which is then added up to a total score and converted into a percentage. The research design established one user group representing a real learning setting situation without comparing treatments, so the focus was on verifying product quality through validity and practicality.

2.2 Participants

The research population includes all 10th grade learners at Vocational High School 1 Koto Baru in the 2025/2026 academic year. Student samples were selected using simple random sampling with a margin

of error of 14%, resulting in 44 participants representing 11 classes. The distribution of the population per class and the number of samples drawn are shown in Table 1.

Table 1. Number of grade x learners and samples drawn

No	Respondents	Number	Sample
1	Student X Agritan 1	33	4
2	Student X Agritan 2	32	4
3	Student X Agriter 1	23	4
4	Student X Agriter 2	20	4
5	Student X APHP 1	21	4
6	Student X APHP 2	19	4
7	Student X DKV 1	33	4
8	Student X DKV 2	28	4
9	Automotive Student X 1	33	4
10	Automotive Student X 2	33	4
11	Automotive Student X 3	31	4
Total		**306**	**44**

The evaluation involved expert assessors and instructors to complement the learners' perspectives so that the content, media, and ease of application in the learning setting were covered. The composition of participants according to their assessment roles is presented in Table 2.

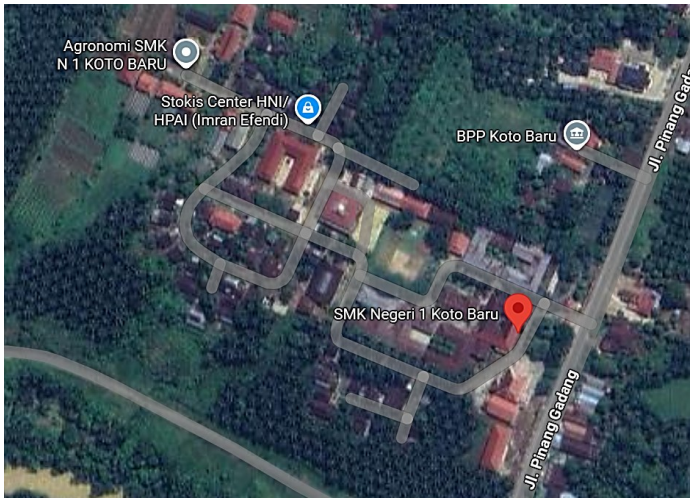
Table 2. Summary of participants according to assessment role

Respondent group	Number
Media validator	3
Content validator	3
Practicality assessor	2
Student practicality assessor	44
Total	**52**

2.3 Study site

The research was carried out during regular classes for 10th grade learners at Vocational High School 1 Koto Baru, located at Jalan Pinang Gadang Koto Padang, Koto Baru District, Dharmasraya Regency, West Sumatra Province. The learning process used school equipment and learners' personal devices that could access the Moodle-based Learning Management System. The IT teacher acted as the course administrator and supervisor of activities. To clarify the operational context and infrastructure access, the geographical location of the educational unit is shown in Figure 1.

Figure 1. School location map



2.4 Instruments and measures

The instruments were designed to obtain auditable evidence base of validity and practicality. Validity was assessed using two assessment sheets by experts, namely the material validity sheet with content and instructional indicators, and the media validity sheet with ease of use and visual appeal indicators. Practicality is assessed using two assessment sheets by instructors and learners, namely the teacher practicality sheet and the student practicality sheet with indicators of attractiveness of use, learning time effectiveness, and benefits. The assessment scale uses four levels of agreement mapped to numerical scores as shown in Table 3.

Table 3. Four-point rating scale for each item of the instrument

Level of agreement	Description	Score
Strongly Disagree	statement not met	1
Disagree	statement partially met	2
Agree	statement is fulfilled	3
Strongly agree	statement strongly met	4

The item distribution for content validity is shown in Table 4 and the item distribution for media validity is shown in Table 5.

Table 4. Material validity instrument grid

Indicator	Item number	Total
Content	1 2 3 4 5 6 7	7
Instructional	8 9 10 11 12 13	6
Total		**13**

Table 5. Media validity instrument grid

Indicator	Item number	Number
Ease of use	1 2 3 4	4
Visual appeal	5 6 7 8 9 10	6
Total		**10**

Practical instruments for instructors and learners capture experiences of use and benefits in terms of learning engagement. The distribution of items for teacher practicality is shown in Table 6 and the distribution of items for student practicality is shown in Table 7.

Table 6. Grid of the teacher practicality instrument

Indicator	Item number	Number
Attractiveness of use	1 2 3 4 5 6 7 8	8
Effectiveness of learning time	9 10	2
Benefits	11 12 13 14	4
Total		**14**

Table 7. Student practicality instrument grid

Indicator	Item number	Number
Attractiveness of use	1 2 3 4 5 6 7 8	8
Effectiveness of learning time	9 10 11 12	4
Benefits	13 14 15 16 17	5
Total		**17**

2.5 Data analysis

Data collection was carried out using questionnaires. The questionnaires were distributed to experts to assess the validity of the material and media, to instructors to assess the practicality of use, and to learners to assess the practicality of the learning experience on the Moodle-based Learning Management System. The analysis was descriptive. Item scores were converted into percentages.

Table 8. Criteria and weights for validity analysis responses

Criteria	Weight
Strongly Agree (SA)	4
Agree (A)	3
Disagree (DS)	2
Strongly Disagree (SD)	1

The formula for validity percentage as written in the thesis is Validity value = Total score obtained ÷ Highest score × 100 Symbolically equivalent.

$$P_{\text{validity}} = \frac{S}{S_{\text{maks}}} \times 100 \quad (1)$$

Table 9. Validity assessment categories

Percentage score	Category
90% - 100%	Highly Valid
80% - 89	Valid
60% - 79	Fairly Valid
0% - 59	Not Valid

The formula for practicality percentage as written in the thesis is Practicality score = Total score obtained ÷ Maximum possible score × 100 Symbolically equivalent.

$$P_{\text{practicality}} = \frac{S}{S_{\text{maks}}} \times 100 \quad (2)$$

Table 10. Practical assessment categories

Percentage score (%)	Category
90% - 100%	Very Practical
80% - 89%	Practical
60% - 79%	Fairly Practical
0% - 59	Not Practical

3. Results

3.1 System overview

This section explicitly interprets the output of each stage analyse, design, develop, implement, evaluate so that the connection between development decisions and final quality can be verified. The explanation focuses on the learning function at Learning Management System based on Moodle with four gamification elements, namely points, level ups, badges, and leaderboards. Each subsection presents the meaning of the findings shown in the thesis without adding features beyond those that have been designed and developed.

3.1.1 Analyse

The analysis stage examines learning needs, media issues, student characteristics, and the effectiveness of the approaches that have been used. The findings of observations and interviews at Vocational High School 1 Koto Baru show that assignments are still distributed through unorganized WhatsApp groups, making it difficult to track assignments and materials. Student participation tends to be passive and learning motivation is low. This condition calls for more interactive and engaging technology-based learning media. The solution is to design and develop a Learning Management System with gamification elements in the form of quests and leaderboards to increase student participation and engagement in the learning process.

Concept analysis formulates the content and scope of Informatics material on the topics of Data Source Validity and Computer Computation Processes. The main conceptual framework is structured so that the

material flows progressively from introduction to application. Supporting concepts relevant to data processing and computer computation are identified so that the material can be linked to learning and assessment activities.

The analysis of learners identifies the characteristics and background of the learning environment as the basis for designing a gamification-based Learning Management System that is in line with Learning Outcomes. User requirements are determined to design the initial Learning Management System for Informatics subjects for 10th grade learners at Vocational High School 1 Koto Baru. The research subjects are 10th grade learners who take Informatics classes at the school.

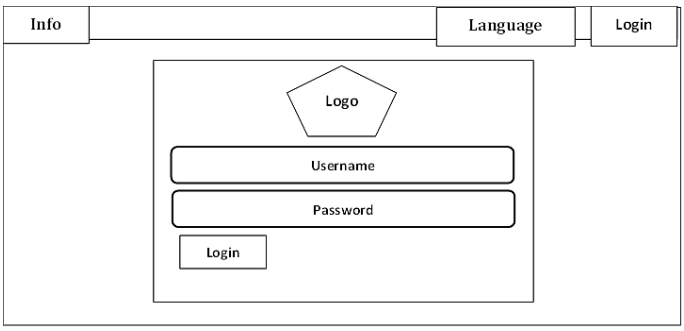
3.1.2 Design

The design stage is the process of formulating a Moodle-based Learning Management System with gamification integration. At this stage, a preliminary design is designed and developed that includes content structure, learning flow, and integration of gamification elements, namely quest level up badges and leaderboards. The design is based on student needs and learning objectives. Storyboards and flowcharts are designed and developed to visualize user interactions as a preliminary design for learning media. In addition, evaluation instruments are designed and developed and learning media elements are compiled in the form of digital teaching materials and interactive objects that will be used to assess the feasibility and effectiveness of the system as an attractive independent learning medium for learners. The storyboard depicts the system workflow from the initial display to each stage of user interaction in a sequential and detailed manner. The details of the storyboard are as follows.

3.1.2.1 Login Page

This image shows the design of the login page on a gamification-based Learning Management System. There is an authentication form consisting of username and password fields that must be filled in to gain access to the system. In the navigation section, there is a language setting that allows users to select the interface language according to their needs.

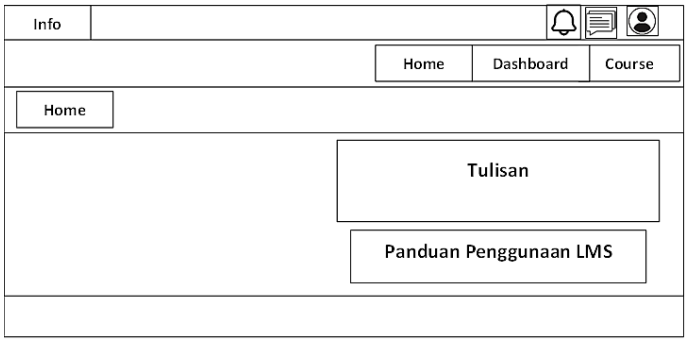
Figure 2.
Login Page



3.1.2.2 Home page

This page serves as the initial display after successful authentication. Users can view general information related to the system, notifications, messages, and profile icons in the upper right corner for quick navigation. The main menu contains the dashboard home button and the course or class to facilitate navigation to the core features of the learning management system.

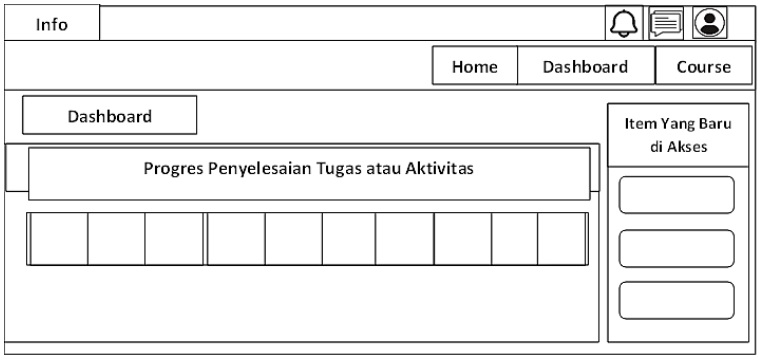
Figure 3.
Home page



3.1.2.3 Dashboard page

The dashboard serves as a control center for users to access learning features. In the main area, there is a timeline that displays a series of learning activities that must be followed in sequence. On the right side, there is a panel of recently accessed items to make it easier for users to review materials, assignments, or the latest information.

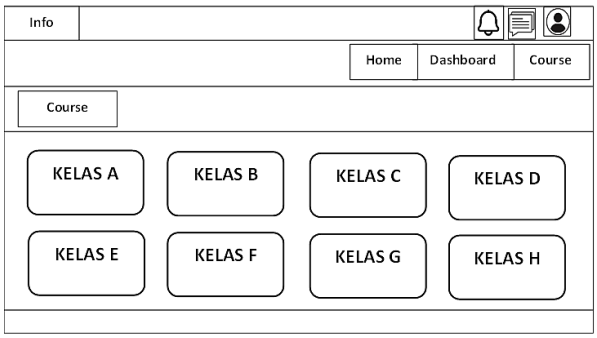
Figure 4.
Dashboard page



3.1.2.4 Course teacher/admin page

This page can be accessed by users with teacher or administrator roles. Users can view and access all classes that are available and registered in the system. The course list is presented in a grid format with labels for each class, for example, classes A to H. The main function of this page is to facilitate course management, monitoring of student activities, and the arrangement of digital learning components. The management features available include uploading materials, creating assignments, managing discussion forums, and arranging assessments.

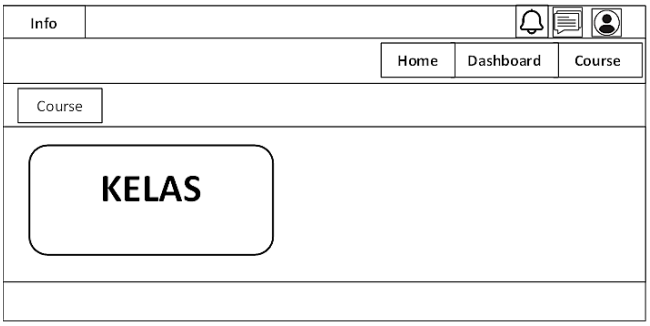
Figure 5.
Course teacher/admin page



3.1.2.5 Student course page

This page is accessed by users with the role of student. The information displayed focuses on the classes or subjects that the student is currently taking. Unlike the teacher or admin view, which displays many classes, the student page only displays classes that are relevant to the account in question.

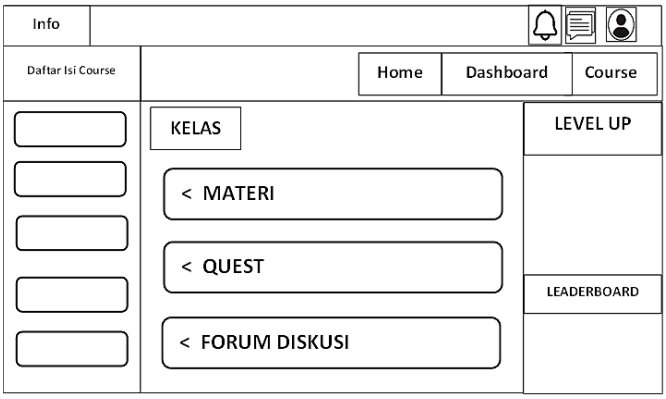
Figure 6.
Student course page



The class page displays the contents of a course selected by the user, whether a student or teacher. This page is the center of online learning activities. Students can access learning resources and participate in activities organized by the instructor. The core components of the class page are as follows.

a. The material contains teaching materials such as documents, videos, slides, or other learning files.
b. A quest is an assignment or challenge that must be completed as part of gamified learning.
c. Discussion Forums enable interaction between learners and instructors regarding materials or assignments.

Figure 7.
Classes taken page



The menu on the left displays the class table of contents or learning components that can be accessed as quick links to specific topics or modules. The menu on the right displays the following supporting features.

a. Level up features a points and level system based on student activity as part of the implementation of gamification elements.
b. The leaderboard displays student rankings based on accumulated points, fostering motivation and healthy competition.

This storyboard is designed to visualize the steps for using a gamification-based learning management system, which is designed so that the process of implementing and developing the system becomes more focused and easier to follow up on.

3.1.3 Develop

3.1.3.1 Home page

When opening the Learning Management System using Moodle, the home page will immediately appear before entering the login page. The home page delivers guidelines for using the Learning Management System, and the next slide shows a list of badges that learners can earn. This can be seen in the following image.

Figure 8.
Initial display of the LMS home page

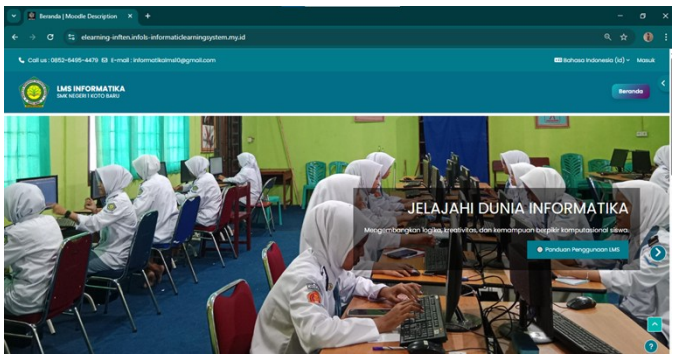
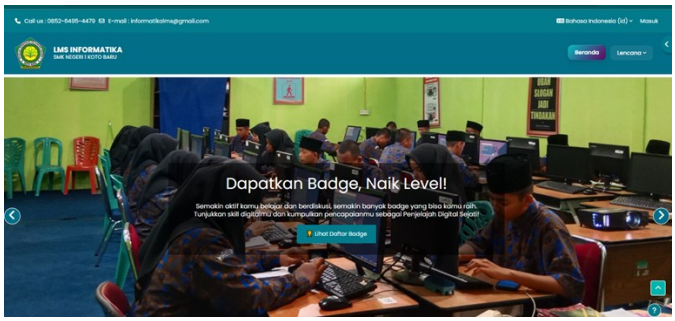


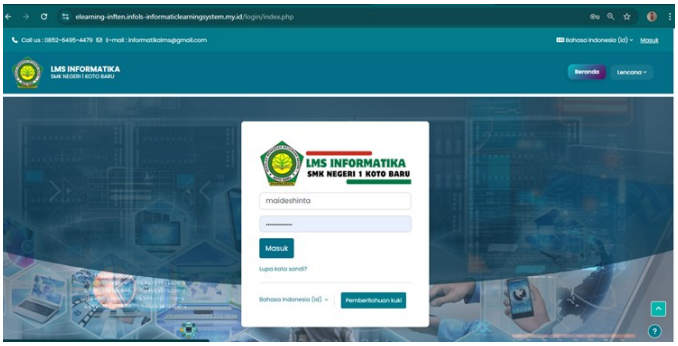
Figure 9.
Homepage slide display



3.1.3.2 Login page

When the user clicks on "Login," the login page will appear before entering the class or course page. This can be seen in the following image.

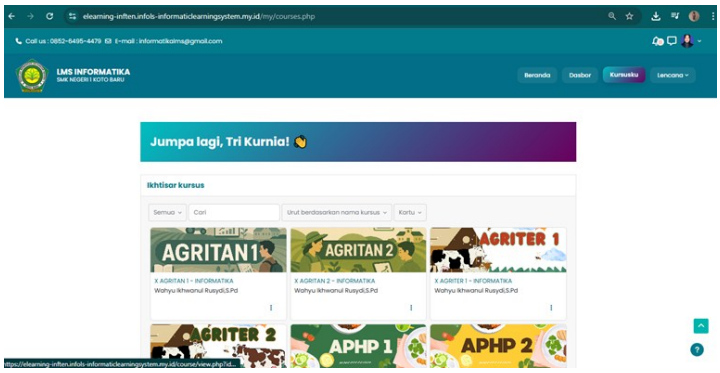
Figure 10.
Login display



3.1.3.3 Course page

The Courses page on the Learning Management System is the first page users see when they log into the platform. This page contains a list of courses taken by users.

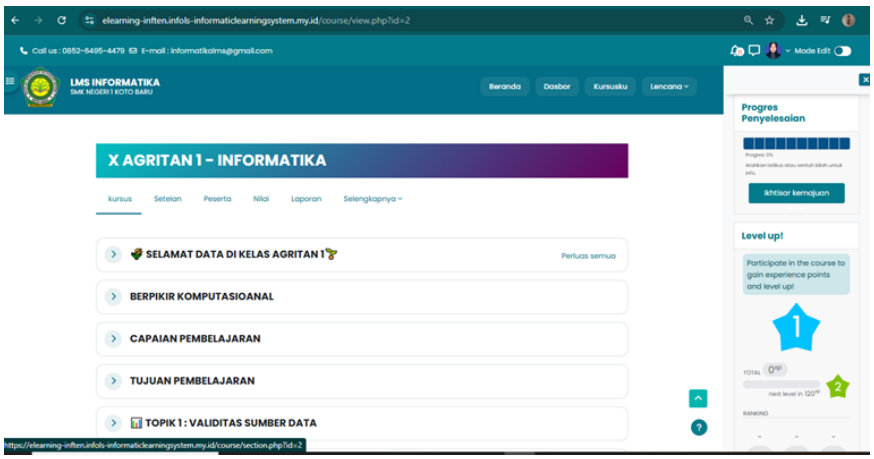
Figure 11.
Courses display



3.1.3.4 Enrolled courses page

The course page that learners follow on the Learning Management System is an online learning space that contains all activities and materials. Course content is organized into learning units that contain interactive video text materials and assignments that must be completed according to the requirements. Each activity has a progress indicator that allows learners to independently monitor their learning achievements. On, this page also features a Completion Progress panel that displays the percentage of activity completion, along with a Progress Overview feature to review detailed learning progress. A Level Up feature is delivered, where each completed activity awards learners with experience points. The accumulation of these points determines level progression, so the more activities completed, the faster learners reach the next level. This can be seen in the following image.

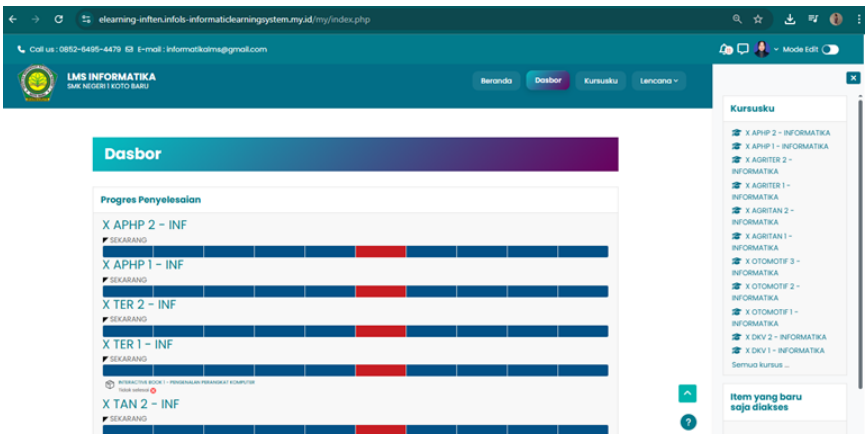
Figure 12.
Classes taken display



3.1.3.5 Dashboard page

This Dashboard page displays Progress Completion information for each activity or task completed by learners, presented in the form of a progress bar that illustrates the level of material achievement. In addition, the dashboard page also features a timeline that displays the sequence of the latest activities or tasks that need to be completed, thereby helping learners prioritize their learning. A calendar feature is also available to display the schedule of deadlines and other academic agendas, serving as a visual reminder for learners to stay organized in their learning process. The dashboard page facilitates learners in monitoring their learning progress in real time, managing their academic schedules, and prioritizing learning activities in a more structured manner, as shown in the image.

Figure 13.
Dashboard display

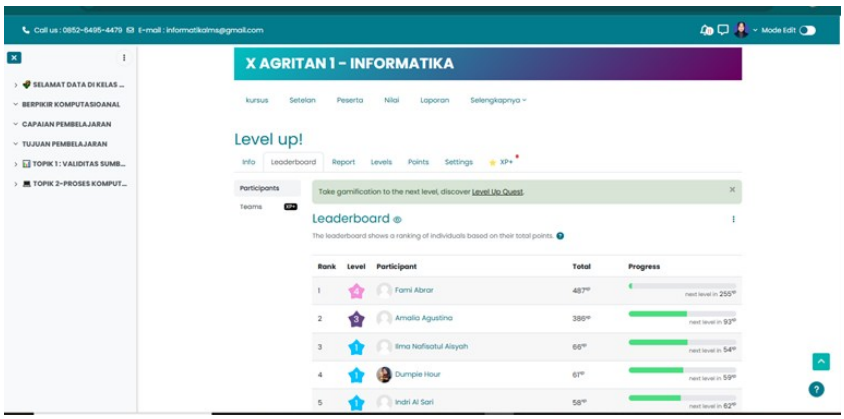


3.1.3.6 Leaderboard page

As part of the gamification strategy, the course page also features a Leaderboard that displays student rankings based on the number of points earned, thereby fostering motivation and positive competitive

spirit in the learning process. The Leaderboard is in the Level Up section. It can be seen in the following image.

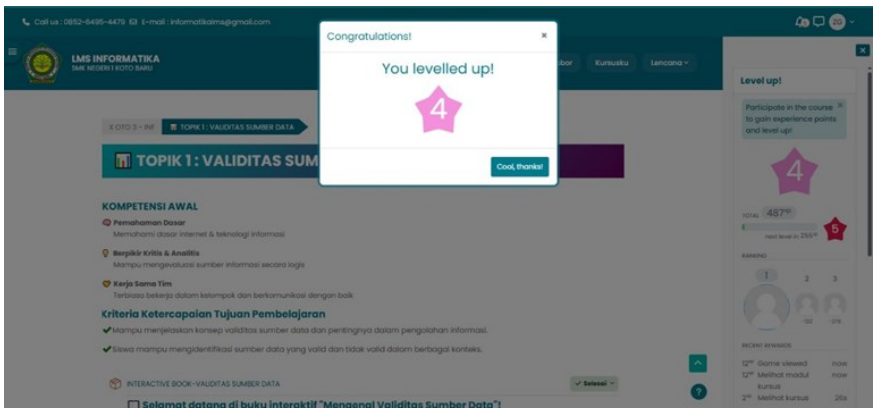
Figure 14.
Leaderboard display



3.1.3.7 Level up

When implementing the Level Up plugin in Moodle, when learners reach a certain number of experience points, the system will display a visual notification in the form of a pop-up window on the screen. This notification contains congratulations and information about the new level achieved, accompanied by a colored star icon as a marker of achievement. Additionally, on the user interface or sidebar, there is a panel that displays the total points earned, the number of points needed to reach the next level, and the participant's ranking compared to other participants. This display delivers real-time feedback that encourages learning motivation and enhances a sense of achievement. This can be seen in the following image.

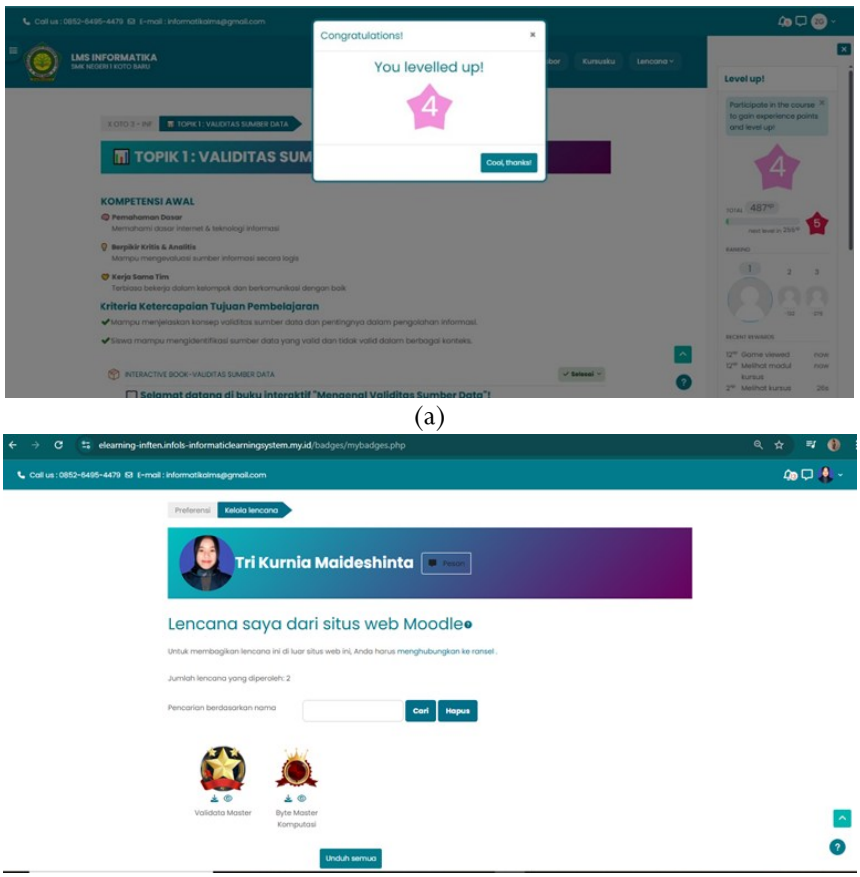
Figure 15.
Level up



3.1.3.8 Badge page

The Badge Page in the Learning Management System is a digital reward feature given to learners based on specific achievements according to predetermined criteria. Each badge has a visual description in the form of an icon and award criteria that are usually set by the instructor or system manager. This badge feature serves as a form of appreciation and motivation because each award received will be stored in the student's profile as proof of their active involvement and achievements in online learning activities. This can be seen in the following image.

Figure 16.
Badge page display



(a)

(b)

3.1.4 Implement

The implementation stage involved applying the Moodle-based Learning Management System that had been designed and developed and validated in regular Grade X classes at Vocational High School 1 Koto Baru together with the Informatics subject instructors. The trial involved 44 learners and 2 instructors in accordance with the composition of participants in the approach section. All activities were carried out according to the regular learning schedule so that the pattern of using the Learning Management System reflected the real learning setting situation. Teachers acted as course administrators, preparing materials, opening quest activities, monitoring progress, and providing feedback. Students accessed materials and completed quests integrated with gamification elements such as points, level ups, badges, and leaderboards.

The materials uploaded to the Learning Management System are aligned with the learning outcome indicators for Grade 10 Informatics so that each activity has measurable objectives. Progress indicators help learners assess their learning progress, while the leaderboard panel and level up notifications deliver immediate feedback that encourages repeated participation. During the session, researchers and instructors observed the stability of authentication, clarity of navigation, and readability of materials to ensure smooth operation on school devices and learners' personal devices.

After the initial series of uses was completed, instructors and learners filled out practicality questionnaires to assess ease of use, learning time effectiveness, and benefits to learning engagement. On the other hand, media experts and material experts completed validity assessments using media validity sheets and material validity sheets. Each questionnaire delivers a comment section for suggestions for improvement related to content, media presentation, instructions, and display consistency. Quantitative data from scores and qualitative data from comments are then used as the basis for revisions in the next stage so that the product meets the established categories of validity and practicality.

3.1.5 Evaluation

The evaluation stage is the final step in the development of the Learning Management System based on Moodle. The review is conducted to ensure that the materials and media meet the expected quality standards. The evaluation process involves lecturers from the Information Technology Department at, PGRI University of West Sumatra, with expertise in learning media from an expert in instructional design from Edukati.com, as well as instructors of Informatics from Vocational High School 1 Koto Baru as subject matter experts. Feedback is collected through validity sheets and structured comments, then linked to corrective actions that are verified in the next iteration.

3.2 Validity

3.2.1 Material validation

Material validation seeks to obtain expert opinions on the feasibility of implementing a Moodle-based Learning Management System. The validation process was carried out by showing the material on the Learning Management System to subject matter experts and then providing a validation questionnaire for assessment. The questionnaire contained statements on two main indicators, namely material content and instructional aspects. The validation was carried out by two subject matter experts who are computer science instructors. The findings of the material validation are presented in Table 11.

Table 11.
Material validity results

No	Assessment aspect	Validator 1	Validator 2	Average	Category
1	Content	89	89	89	Very Valid
2	Instructional	92	92	92	Highly Valid
Overall average				**90**	**Highly valid**

Based on the findings of the analysis of the Moodle-based Learning Management System in terms of content, a score of 89% was obtained, which is categorized as highly valid. In terms of instruction, which was assessed by subject matter experts, a score of 92% was obtained, which is also categorized as highly valid. With a validity category reference of 80% to 89%, it is declared valid. The data in Table 13 demonstrates that the media is categorized as highly valid with an overall average of 90% and is suitable for use as learning media.

3.2.2 Media validation

Media validation seeks to obtain media experts' opinions on the feasibility of a Moodle-based Learning Management System. The validation process was carried out by presenting the designed and developed Learning Management System and then distributing a validation questionnaire for assessment. The questionnaire contained statements on two main indicators, namely ease of use and visual appeal. Media validation was carried out by three experts in the field of learning media. The findings of media validation are presented in Table 12.

Table 12.
Media validity results

No	Assessment aspect	Validator 1	Validator 2	Validator 3	Average	Category
1	User-friendliness	88	94	88	90	Very Valid
2	Visual appeal	92	92	96	93	Very Valid
Overall average					**91**	**Highly Valid**

Based on the findings of the analysis of the Moodle-based Learning Management System on the indicators of ease of use and attractiveness of appearance assessed by media experts, it was declared valid with a validity category of 80% to 89%. The data in Table 12 shows a media validity value of 91% with a category of highly valid.

3.3 Practicality

3.3.1 Practicality of the Gamified Moodle Learning Management System Based on Teachers' evaluation

The practicality test by instructors seeks to assess its usability in learning management through three indicators: attractiveness of use, learning time effectiveness, and benefits. The assessment was carried out by two Informatics instructors using a percentage scale.

Table 13. Teacher practical results

No	Assessment aspect	Validator 1	Validator 2	Average	Category
1	Attractiveness of use	91	91	91	Very Practical
2	Effectiveness of learning time	100	88	94	Very Practical
3	Benefits	94	88	91	Very Practical
Overall average					**92**

Based on the data in Table 13, the overall average score of 92% falls into the Very Practical category. This finding demonstrates that the Moodle-based Learning Management System supports the efficiency of learning orchestration (material preparation, assignment/quest giving, and progress monitoring) while maintaining an attractive interface and functional usefulness for instructors.

3.3.2 Practicality of the Gamified Moodle Learning Management System Based on students' evaluation

Practicality from the student's perspective was evaluated on 3 similar indicators: attractiveness of use, learning time effectiveness, and benefits. The assessment was carried out after learners completed a series of activities in the course.

Table 14. Student practicality results

No	Practical aspects	Average	Category
1	Attractiveness of use	91	Very practical
2	Effectiveness of learning time	91	Very practical
3	Benefits	92	Very practical
Overall average		**92**	**Very practical**

Based on Table 14, the overall average of 92% confirms that learners can navigate the material, complete quests, and use feedback (level up and leaderboard) effectively. The Very Practical category on all three indicators shows high usability in real classrooms and consistency in user experience between instructors and learners.

4. Discussion

The development of a Moodle-based Learning Management System with gamification elements in Informatics subjects at Vocational High School 1 Koto Baru is intended to produce valid and practical media, and the findings indicate 90% material validity and 91% media validity, accompanied by 92% teacher practicality and 92% student practicality as an indication of initial adoption readiness in real classrooms (Namaziandost et al., 2025). These findings are in line with the research objective of presenting a product that can be operationalized in vocational education with transparent and auditable documentation of the Analyze, Design, Develop, Implement, and Evaluate processes, thereby facilitating replication and further evaluation (Dwijaputra et al., 2025). In general, the gamification configuration (points, level up, badges, and leaderboards) contributes to rapid feedback and standardized progress marking, which in the literature is considered effective in maintaining engagement in platform-based learning (Andrao et al., 2024). The validity of the material reflects the suitability of the content and instructional clarity in relation to Informatics learning outcomes, where the content indicator reached

89% and the instructional indicator reached 92%, so that the conceptual flow from introduction to application can be traced clearly (Durodolu et al., 2025).

The integration of material structure with quest-based activities minimizes task ambiguity and clarifies student performance expectations, which is important in education that demands simultaneous procedures and practices such as Informatics in Vocational high school (Saha et al., 2025). With a strong content foundation, reinforcement with specific vocational examples, authentic datasets, and work scenarios is expected to further enhance knowledge transfer to practice (Noguera-Méndez et al., 2024). Media validity of 91%, supported by user-friendliness of 90% and visual appeal of 93%, suggests that the interface design, navigation, and visual consistency are adequate for cross-device access, including learners' personal devices (Naor & Dubovi, 2025). A stable and consistent user experience is a prerequisite for pedagogical features such as progress indicators, level-up notifications, and automatic feedback to be fully used in the daily learning cycle (Fernández Galeote et al., 2025). Within the instructional design framework, the synergy between interface affordances and learning objectives reduces unnecessary cognitive load and maintains focus on meaningful task completion (Daemei et al., 2025).

In terms of usability, the 92% practicality of instructors confirms the efficiency of learning orchestration, namely the preparation of materials, opening activities, monitoring progress, and providing feedback can be done without adding significant administrative burdens (Palmera & Rincón, 2025). The 92% practicality rating among learners suggests that the gamification mechanism functions as easy-to-understand aggregate feedback, while also triggering repeated participation in tiered tasks (Stavroulakis et al., 2025). The consistency of the "Very Practical" category in terms of attractiveness, time effectiveness, and benefits in both user groups indicates the alignment of the design with the real needs of learning setting operations (Misara et al., 2025).

Compared to previous studies on the use of Moodle and gamification in secondary education, the findings of this research are consistent in terms of engagement and ease of operation, although content validity still leaves room for vocational enrichment (Hurova, 2024). Variations in figures between studies are commonly influenced by differences in subject matter, depth of feature integration, and participant profiles and technological readiness, so interpretations need to consider contextual and implementation factors (Gong & Ye, 2025). Conceptually, initial success measured through strong validity and practicality can serve as a foundation for subsequent studies on learning outcome effectiveness, particularly regarding indicators of persistence and retention (Goodhart et al., 2025). Several critical notes are necessary to ensure findings are appropriately contextualized and guide future development priorities, particularly regarding instructional consistency and vocational reinforcement (Mehrotra & Roy, 2025).

Although the attractiveness of the appearance reached 93% (highly valid), the content validity score of 89% indicates the need to enrich vocational examples based on cases, authentic data, and work scenarios so that knowledge transfer to practice becomes stronger (Masso et al., 2025). In terms of motivation, leaderboards effectively trigger participation but point weights need to be calibrated and forms of appreciation diversified, such as badges for collaboration and perseverance, to keep the competitive climate inclusive (Gianni et al., 2025). From an implementation perspective, high teacher practicality depends on course orchestration efficiency, so that wider utilization must be accompanied by server infrastructure readiness, bandwidth, and device compatibility to maintain a stable experience (Martín Bautista-Cerro et al., 2023). With targeted adjustments to vocational content, gamification mechanics, and technical support, initial adoption readiness has the potential to transform into operational sustainability at the learning setting and school levels (Pienwisetkaew et al., 2025).

The implication of this research is that vocational schools obtain ready-to-adopt course designs with a modular structure that integrates material, quests, formative assessment, and real-time feedback, which can become the minimum standard for implementing a Learning Management System in Informatics subjects (Cammarano et al., 2025). For instructors, practical evidence base demonstrates that the use of

Learning Management Systems can shorten the administrative process without sacrificing the quality of feedback and tracking student progress, so that face-to-face time can be focused on high-level guidance (Hofmann et al., 2024). For learners, measured gamification configurations enhance visibility of progress and clarify next steps, which is crucial for maintaining engagement in tiered learning (Mitra et al., 2024).

The limitations of the study include a single-group design without a comparison group, which does not allow for causal inferences about learning outcomes, a short trial duration, a single location (one school, one subject), and reliance on perception instruments that are prone to social desirability bias (Venturi et al., 2025). Additionally, the evaluation of system performance in dense scenarios, such as simultaneous access loads across multiple classes, has not been systematically tested, so the risk of degraded experience during peak traffic has not been quantified (Cremaschi et al., 2025). Generalization across skill programs and levels requires replication at different locations to ensure the robustness of the findings (Alhazmi et al., 2025).

Future work includes quasi-experimental studies to assess the impact on learning outcomes, retention, and metacognition; enrichment of authentic vocational content along with calibration of point weights so that high-value activities receive clear differentiation; evaluation of long-term motivation sustainability; and audit of system access and performance in dense scenarios along with the development of learning analytics for adaptive feedback (Mitra et al., 2024). By linking findings on validity and practicality to the research agenda on effectiveness and sustainability, the contribution of this research can be expanded from initial adoption readiness to consistent and inclusive program-scale implementation (Xiao et al., 2024).

5. Conclusion

This research seeks to design and design and develop a Moodle-based Learning Management System with gamification elements for Informatics subjects at Vocational High School 1 Koto Baru. The development procedure follows the Analyse, Design, Develop, Implement, evaluate stages so that the product is clearly documented and can be deployed by instructors and learners in regular learning. The findings indicate that content quality is in the highly valid category with an average of 90%, consisting of 89% content indicators and 92% instructional indicators. Media quality is in the highly valid category with an average of 91%, consisting of 90% ease of use and 93% visual appeal. Its strong applicability in real learning setting operations is demonstrated by the practicality of instructors at 92% and practicality from learners at 92%. The gamification mechanisms in the form of points, level ups, badges, and leaderboards work consistently to deliver quick feedback and structured progress tracking. Overall, the product meets the criteria of being highly valid and practical. The product is ready to be adopted as a modular and trackable Moodle-based Learning Management System course for Informatics subjects at the vocational high school level in accordance with the research objectives and the established location context.

Author's Declaration

Author contribution

Tri Kurnia Maideshinta: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing original draft, Visualization, Project administration. **Rini Novita**: Conceptualization, Methodology, Validation, Resources, Writing review & editing, Supervision. **Rahayu Trisetyowati Untari**: Validation, Investigation, Data curation, Writing review & editing.

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Conflict of interest

The authors declare no conflicts of interest regarding this publication.

Ethical clearance

The involvement of teachers and students in this educational study is in accordance with the Declaration of Helsinki. Research permission was granted by SMK Negeri 1 Koto Baru (No. 400.3.8/676/08/SMKN.01-KB/7/2025, July 30, 2025). The school management, teachers, and students agreed to the use and publication of anonymized data obtained at SMK Negeri 1 Koto Baru.

Data availability

The data that support this study's findings are available from the corresponding author upon reasonable request.

AI Statement

This article's grammar was improved with assistance from ChatGPT. The author confirmed that all revisions align with the topic and research data, and an English-language specialist validated both the data and wording. The manuscript contains no AI-generated sentences.

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Nomenclature

P_{validity}	: Validity percentage
S	: Total score obtained
S_{maks}	: Highest score
$P_{\text{practicality}}$	: Practicality percentage