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Development Learning Management System Utilizing Google Workspace Integrated with Wordwall Based on Gamification in Non-Formal Education

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Abstract: This research aims to develop and validate a Google Workspace-based Learning Management System (LMS) integrated with gamification-based Wordwall for science learning in non-formal education at the junior high school level. The method used is R&D research with the ADDIE model, limited to the implementation stage. At the analysis stage, it was found that students need flexible, interactive, and enjoyable learning media. The design stage produced a learning flow and an intuitive LMS interface. The development stage resulted in an LMS validated by three experts with very valid results (media 87.0%, material 90.0%, language 92.0%). The implementation stage was conducted through practical tests by teachers and students, with average scores of 95.48% and 91.67%, categorized as very practical. In conclusion, the developed LMS is declared valid and practical, and has the potential to become an innovative, interactive, and relevant science learning solution in the context of non-formal education.

Keywords: Gamification; Google workspace; Learning Management System (LMS); non-formal learning; Wordwall

Introduction

Non-formal education plays an important role as a complement to formal education because it can provide a more flexible (Ionescu, 2020), adaptive, and enjoyable learning space that aligns with the needs and interests of students (Melnyk, 2023). Non-formal education allows students to learn further without the pressure of assessments and strict curriculum targets (Zhang & Bray, 2021), enabling them to learn at a pace that matches their readiness, level of knowledge, and curiosity. However, in reality, non-formal education in Indonesia often uses a one-way lecture method, making the learning process boring. Not only that, but learning technology has also not been used effectively. Non-formal education should be able to make the learning process for students more interesting, interactive, and enjoyable, so that students will be more enthusiastic and eager to learn things they find difficult in school, especially in Natural Sciences (Pienimäki et al., 2021; Romi & Schmida, 2009).

Based on the initial observations that have been conducted, it was found that many students attend tutoring or non-formal courses to review the science material they do not understand at school. However, the lack of varied teaching methods and interactivity causes students to quickly lose interest in learning. As a result, the goal of non-formal education as a place to study material freely and in depth is not achieved. Moreover, many non-formal educational institutions do not have digital learning media that can encourage active student engagement. The use of digital media can help students learn repeatedly, independently, and according to their preferences.

To improve the quality of science education in non-formal education, a learning management system (LMS)

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can be a strategic solution. LMS is a digital platform used to plan, implement, and evaluate the online learning process by providing materials (Syafei & Mawardi, 2022), assignments, quizzes, and discussion spaces within an integrated system (Nugraha et al., 2025). LMS can also enable learners to study independently and repeatedly with structured materials that can be accessed anytime according to their learning pace (Ertikanto et al., 2023). Therefore, LMS can overcome the limitations of the boring lecture method and provide space for students to study the material more deeply according to their interests, making learning more engaging compared to traditional school learning (Sanjaya et al., 2024; Zamista & Azmi, 2023).

Gamification is the application of game elements, such as points, badges, leaderboards, and challenges (Chans & Portuguez Castro, 2021), into the learning process to enhance motivation, engagement, and enthusiasm among learners (Saleem et al., 2022). Gamification is highly relevant for non-formal education because learners tend to seek more enjoyable and interactive learning experiences compared to the usually monotonous school education (Ariyanti et al., 2025; Nurhayati et al., 2025). LMS that supports gamification can meet this need by providing engaging and challenging learning activities that encourage students to learn independently and sustainably (Artawan, 2025; Rahma, 2024). The implementation of gamification into LMS can motivate learners to actively participate in every learning activity because there is a system of rewards and recognition for their achievements (Jayusman & Shavab, 2019). This helps address the issue of low student engagement in non-formal education, which was previously dominated by one-way lecture methods (Buckley & Doyle, 2016). Additionally, gamification provides learners with the opportunity to explore the material more deeply according to their interests and needs.

The research develops, validates, and tests the practicality of a Google Workspace-based LMS integrated with Wordwall gamification for non-formal middle school science education. Google Workspace was chosen because it has the capability to provide collaboration features, access flexibility, and ease of integration with various learning support applications relevant to the needs of non-formal educational institutions (Kumar & Sharma, 2021). While Wordwall was chosen for its ability to provide interactive learning activities and support the implementation of gamification in education (Oña et al., 2024). In addition to providing learning materials, this LMS is also designed to make learning more engaging, facilitating students' freedom to understand concepts independently through gamification-based interactive activities (Muzaki et al., 2025). This research is important to address the needs of non-formal educational institutions for interactive, enjoyable, and contextual digital learning media, thereby increasing students' motivation and engagement in learning science, making non-formal education an effective complementary space in supporting students' learning success.

Method

This research is part of R&D (Research and Development) aimed at designing and developing an LMS by utilizing Google Workspace integrated with gamification-based Wordwall in non-formal education for the subject of natural sciences at the junior high school level, which is valid and practice. This research uses the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) (Hakiki et al., 2022). The selection of this model because it supports the development of a systematic, structured, and flexible learning system (Spatioti et al., 2022). Evaluation can be conducted at every stage to ensure the developed product aligns with user needs (Sandra & Razi, 2022). This model has also proven effective in creating interactive, contextual, and user-friendly digital learning media for non-formal educational institutions, especially in the development of gamification-based LMS (Hakiki et al., 2022).

This research is limited to the implementation stage, specifically the user practicality test. The evaluation stage, which includes a broader effectiveness test, falls outside the scope of this research. To clarify further, the stages of the research can be seen in Figure 1.

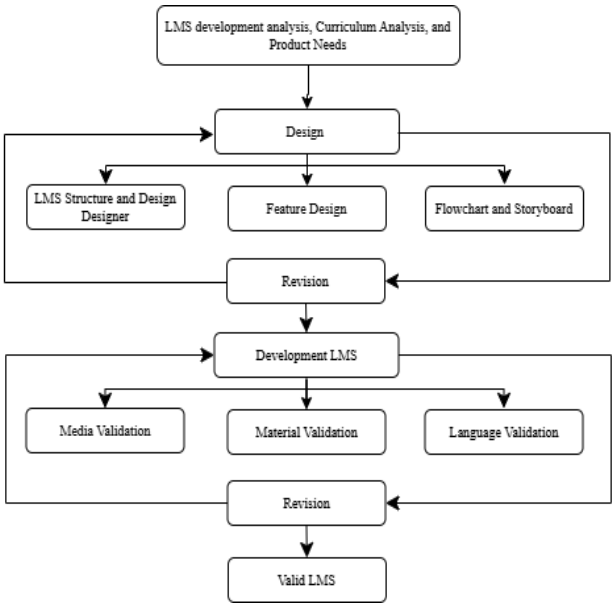

Figure 1. Attached figure in article

This research was conducted from February 2, 2025, to May 12, 2025, in Padang. This research was conducted at *Rumah Belajar Gaera* in Padang City, West Sumatra, which is a non-formal educational institution that operates from kindergarten to high school levels. This institution was chosen because it has not yet implemented an integrated digital learning system.

In the analysis stage, a needs analysis was conducted through interviews with non-formal education tutors and a curriculum analysis to identify science subjects that students find difficult to understand and the need for interactive media that can support their independent learning (Susanti et al., 2020; Tambunan & Siagian, 2022). In the design phase, the LMS structure was developed by integrating Google Workspace and Wordwall, which included features for material delivery, interactive quizzes, and gamification elements to enhance student engagement. The LMS was then developed according to the design results.

At the development stage, the LMS was validated by three experts: a media expert, a content expert, and a language expert, using a validation sheet with a Likert scale to assess aspects of appearance, content feasibility, and language (Apriani et al., 2021). Based on the validators' feedback, improvements were made to the layout, clearer material explanations, appropriate use of scientific terms, and language refinement (Luthfi et al., 2021). As a result, a valid LMS was produced, ready to be tested for practicality.

The practicality test was conducted with three science tutors and twenty junior high school students who participated in learning activities using the LMS (Mulyadi et al., 2019). The practicality test was carried out using a practicality questionnaire with a Likert scale to assess various aspects, including ease of use, learning effectiveness, learning motivation, interactivity, flexibility, benefits, and user satisfaction. Next, feedback from tutors and students is used as a consideration for the revision and adjustment of the LMS. This is done to ensure that the LMS can be practically used for science learning in non-formal education.

Data analysis was conducted descriptively quantitatively using a Likert scale (Sevtia et al., 2022). The assessment results from validators and users are averaged, then categorized based on value interpretation as shown in Table 1.

Table 1. Category score on Likert Scale

Scores	Information
5	Very good
4	Good
3	Moderate
2	Poor
1	Very poor

The average validation result percentage for each component is calculated using the following formula (Sugiyono, 2022).

$$P = \frac{\Sigma X}{N} \times 100\% \quad (1)$$

With the following information:

P = percentage of validator acquisition (rounded to the nearest integer),
ΣX = total score for each selected criterion,
N = ideal score (Asfiya et al., 2024).

The results obtained are then classified with the following eligibility criteria:

Table 2. Level of achievement of LMS development

Partisipation Rate	Qualification
81-100	Very valid
61-80	Valid
41-80	Valid enough
21-40	Less valid
≤20	Less valid

(Sugiyono, 2022)

After the validation process by experts showed that the product falls into the sufficiently valid category with a total score of more than 41, as per Table 2. If it meets the category, the development proceeds to the Implementation stage, which in this study focuses on practicality testing. This test is conducted to assess the ease of use, appearance, and usability of the LMS based on the direct experience of the primary users, namely teachers and students.

Result and Discussion

This study aims to develop a Learning Management System (LMS) that uses Google Workspace and Wordwall based on gamification for non-formal educational institutions. The ADDIE model was used for development. Here is a discussion of each stage that was carried out:

Analyze

The analysis stage was conducted to identify students' needs in science learning in non-formal education through the distribution of questionnaires and interviews with students and tutors at Rumah Belajar Gaera. The focus of the analysis includes academic needs, learning motivation, access flexibility, and preferences for interactive and enjoyable learning. A literature review was also conducted to examine the

effectiveness of gamification in enhancing motivation and learning outcomes.

Analysis of LMS Development

LMS was developed to address various challenges in science learning, such as time and space constraints, one-way teaching methods, and the lack of interactive learning resources. With the integration of Google Workspace and Wordwall, the LMS allows students to learn flexibly at any time, as well as access learning materials, videos, and interactive game-based quizzes. The Wordwall feature enhances student engagement through gamified activities that motivate active participation and deeper understanding (Elsani et al., 2024).

Curriculum Analysis

The curriculum in non-formal education is flexible and tailored to meet the needs of learners. The subject of science becomes the focus, especially the topics of motion and the solar system, which require interactive learning media. LMS is designed not to replace the curriculum, but rather as a tool to deliver material in a more engaging and easily understandable way for students.

Product Needs Analysis

The analysis is conducted through a comparative study of similar LMS to identify strengths and weaknesses, as well as to determine the features that need to be adopted and developed. Google Workspace technology (including Google Classroom, Drive, Sites, Forms, and Sheets) is considered capable of supporting collaboration, administrative efficiency, and open access to information. Meanwhile, Wordwall is deemed superior to creating interactive game-based learning activities and facilitating automatic result tracking.

The analysis results indicate a gap between user needs and the currently available LMS features. Therefore, the development of an LMS that combines Google Workspace, gamification-based Wordwall, and the specific needs of non-formal education is seen as an innovative strategy that is relevant and highly impactful. This product offers an integrated solution that is flexible, interactive, and adaptive to the learning needs of students outside the formal education system.

Design

At this stage, the researchers are designing the LMS by integrating Google Workspace and gamification-based Wordwall. The design focuses on a systematic learning flow and an intuitive user interface (UI) for non-formal education. Gamification elements such as points, challenges, and leaderboards are implemented to enhance students' learning motivation.

Learning Path Design

The learning path begins with an initial orientation through Google Sites as the main portal.

Figure 2. Web Creator Page

The initial page contains the institution's profile and navigation to various menus such as study rooms, registration, assessment, and collaboration.

Figure 3. LMS Home Page

The learning materials are presented in a structured manner by topic and stored on Google Drive. The Science materials consist of two main units: "Forces and Motion" and "Solar System," each consisting of 3 sessions. The special page for the Science subject is organized thematically as we can see at Figure 4 and each session has its material page as shown in Figure 5.

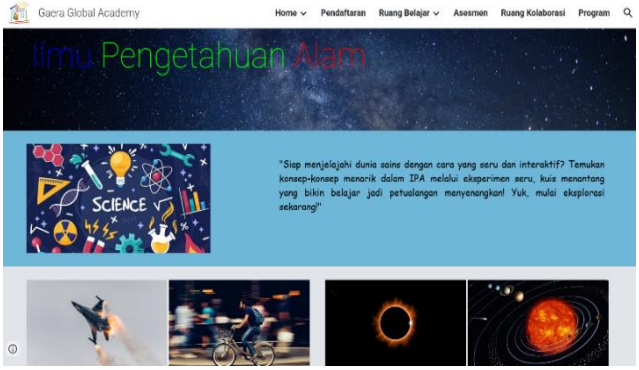

Figure 4. Special Science Page

Figure 5. Forces Material Page

For collaborative interactions, Google Classroom is utilized for assignment submissions and discussions, while Google Docs/Sheets-based tasks enable group work. Interactive quiz activities are embedded through Wordwall directly on the material page and include point elements and a leaderboard to enhance student engagement.

User Interface Design

The UI/UX design is made clean and minimalist with consistent navigation, considering users from diverse technological backgrounds. Colors and icons are tailored to the characteristics of middle school students to enhance visual appeal. The main navigation menu in the top right corner contains links to "Home," "Learning Space," "Assessment," and "Programs," as well as the institution's logo.

Development

The development phase begins after the LMS design is drafted based on the results of the needs analysis. The LMS is developed using Google Workspace as the infrastructure base and Wordwall as the gamification element. The development process consists of platform creation, content preparation, and initial testing of the system's validity and practicality.

This research produced a learning product in the form of a Learning Management System (LMS) that has been validated by three experts, namely a media expert, a content expert, and a language expert. The validation results from each validator can be seen in Table 3-5.

Table 3. Results of media validity testing

Aspects Evaluated	Indicator	Score	Percentage %
LMS Display	1	4	87
	2	4	
	3	5	
	4	4	
Accessebility	5	4	90
	6	5	
	7	5	
Interactivity	8	4	80
	9	4	
	10	4	
Integration of LMS with Wordwall	11	4	
	12	5	
	13	5	
	14	4	
	15	5	
	16	4	
Feasibility	17	4	
	18	4	
Average			
Criteria			Very V

The results of the media validity test, as shown, indicate that the LMS has a very high feasibility, with an average score of 87% and categorized as "Very Valid." For more details, please refer to Table 3. Nevertheless, several improvement suggestions from the validators, such as enhancing the user interface and integrating Wordwall content, have been implemented to refine the LMS.

Tab 4. Results of language validity testing

Aspects Being Evaluated	Indicators	Score	Values %
Freedom	1	4	95
	2	5	
	3	5	
	4	5	
Readability	5	5	90
	6	4	
	7	4	
	8	5	
Use of Technical Terms	9	4	90
	10	4	
	11	5	
	12	5	
Communicative	13	4	93
	14	5	
	15	5	
Language and Instruction Usage	16	5	93
	17	4	
	18	5	
Average			92
Criteria			Very Valid

Based on Table 4, the results of the validity test on the linguistic aspect show an average score of 92% with the category "Very Valid." Validators provided feedback to improve language use, such as paying attention to the use of foreign languages that are not italicized, word order, capitalization, and punctuation. Based on those suggestions, revisions have been made, so the linguistic aspect of the LMS is declared valid and suitable for use in learning.

Table 5. Results of material validity testing

Aspects Being Evaluated	Indikator	Score	Value
Relevance of Material	1	4	87
	2	5	
	3	4	
Presentation of Material	4	5	93
	5	5	
	6	4	
	7	5	
	8	4	
	9	5	
Independent Practice	10	4	90
	11	5	
Average			90
Criteria			Very Valid

The results of the material aspect validity test based on Table 5 show an average score of 90%, which falls into the "Very Valid" category. The validator provided feedback to adjust the images and explanations, use appropriate physics terminology, and add illustrative examples that aid student understanding. Additionally, the validator suggested revising sentences and ensuring alignment between learning objectives, content, and evaluation; all these suggestions have been implemented by the author through comprehensive revisions.

Implementation

After validation, a practicality test was conducted involving teachers and students. Teachers assessed the ease of material management, feature integration, and system flexibility. Students evaluated accessibility, navigation clarity, and enjoyment in use. The results of the practicality test can be seen in the table 6 and table 7.

Table 6. Results of the teacher response questionnaire data

Assessment Aspect	Average Score	Percentage (%)	Category
User-Friendliness	55	91.67	Highly Practical
Learning Effectiveness	44	97.78	Highly Practical
Learning Motivation	43	95.56	Highly Practical
Interactivity	44	97.78	Highly Practical
Flexibility	43	95.56	Highly Practical
Usefulness	58	97.00	Highly Practical
User Satisfaction	42	93.00	Highly Practical
Overall Average Score	47	95.48	Highly Practical

Table 7. Results of the student response questionnaire data

Assessment Aspect	Average Score	Percentage (%)	Category
User-Friendliness	55	91.67	Highly Practical
Learning Effectiveness	41	91.11	Highly Practical
Learning Motivation	41	91.11	Highly Practical
Interactivity	41	91.11	Highly Practical
Flexibility	42	93.33	Highly Practical
Usefulness	54	90	Highly Practical
User Satisfaction	40	89	Highly Practical
Overall Average Score	44.8	91.67	Highly Practical

The practicality results based on the table above show the assessment results of each aspect of practicality from student responses, which are categorized as "very practical." Subsequently, they received an average practicality score of 91.67%, which is also categorized as "very practical." Therefore, student responses to the practicality of the LMS are categorized as very practical to use.

Based on the results of the analysis, design, development, and implementation, it can be concluded that the Google Workspace-based LMS integrated with Wordwall has been successfully developed to meet the needs of science learning in non-formal education. This system is declared valid based on the assessment of media, material, and language experts, as well as practical according to the feedback from teachers and students. The integration of gamification elements through Wordwall provides an engaging and motivating learning experience, while the features of Google Workspace support the smooth management of materials, collaboration, and documentation of learning. The intuitive interface and clear navigation make this LMS easy to use for users from diverse backgrounds. Overall, this LMS can be an innovative solution to improve the quality of learning in non-formal institutions that require a flexible, interactive, and relevant approach to the development of educational technology.

Conclusion

This research aims to develop a Learning Management System (LMS) based on Google Workspace, integrated with gamified Wordwall to improve the quality of science education in non-formal educational institutions. The development process was carried out using the ADDIE model, which includes the stages of analysis, design, development, and implementation.

At the analysis stage, it was found that students in non-formal institutions like Rumah Belajar Gaera need more flexible, interactive, and engaging learning media to understand science material, especially on the topics of force and motion, as well as the solar system. Based on these needs, the LMS was designed by integrating Google Workspace features (Google Sites, Google Drive, Google Classroom) and Wordwall activities that contain gamification elements such as points, challenges, and leaderboards.

After being designed and developed, the LMS was validated by three experts and received a "very valid" category in the media aspect (87.0%), material (90.0%), and language (92.0%). Subsequently, a practicality test was conducted with teachers and students, resulting in the LMS being categorized as "very practical," with an average score of 95.48% from teachers and 91.67% from students.

Thus, the developed LMS has proven to be valid and practical for use in science learning in non-formal education. This LMS provides an innovative solution that can enhance students' motivation, engagement, and learning flexibility through a technology-based and gamification approach that meets the needs of learners outside the formal education system.

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Author Contributions
Conceptualization, E., A.B., A.H., U.R.; methodology, E.; software, E.; validation, A.B., A.H., U.R.; formal analysis, E.; investigation, E.; resources, E.; data curation, E.; writing—original draft preparation, E.; writing—review and editing, A.B., A.H., U.R.; visualization, E.; supervision, A.B.; project administration, E. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

References

Apriani, R., Harun, A. I., Erlina, E., Sahputra, R., & Ulfah, M. (2021). Pengembangan Modul Berbasis Multipel Representasi dengan Bantuan Teknologi Augmented Reality untuk Membantu Siswa Memahami Konsep Ikatan Kimia. *Jurnal IPA & Pembelajaran IPA*, *5*(4), 305–330. https://doi.org/10.24815/jipi.v5i4.23260

Ariyanti, Nazurty, & Sukendro. (2025). The Implementation of a Problem-Based Learning (PBL) Model Assisted by Wordwall Media in the IPAS Subject to Enhance Students ' Learning Outcomes. *Jurnal Penelitian Pendidikan IPA, 11*(2), 602–606. https://doi.org/10.29303/jppipa.v11i2.9373

Artawan, P. (2025). The Influence of the TGT (Team Game Tournament) Type Cooperative Learning Model Assisted by Interactive Wordwall Media on the Interest and Science Learning Outcomes of Junior High School Students. *Jurnal Penelitian Pendidikan IPA, 11*(7), 553–560. https://doi.org/10.29303/jppipa.v11i7.11519

Asfiya, N., Razi, P., Hidayati, & Sari, S. Y. (2024). Development of e-Module for Independent Learning of Physics Material Based on Independent Curriculum. *International Journal of Information and Education Technology*, *14*(5), 761–769. https://doi.org/10.18178/ijiet.2024.14.5.2100

Buckley, P., & Doyle, E. (2016). Gamification and student motivation. *Interactive Learning Environments*, *24*(6), 1162–1175. https://doi.org/10.1080/10494820.2014.964263

Chans, G. M., & Portuguez Castro, M. (2021). Gamification as a strategy to increase motivation and engagement in higher education chemistry students. *Computers*, *10*(10), 1–24. https://doi.org/10.3390/computers10100132

Elsani, B. H. K., Supardi, S., & Lubna, L. (2024). Penggunaan Aplikasi Pembelajaran PAI Berbasis E-Learning: Studi Kasus di Madrasah Tsanawiyah Lombok Timur. *Modeling: Jurnal Program Studi PGMI*, *11*(2), 135–147. Retrieved from https://www.jurnal.stitnualhikmah.ac.id/index.php/modeling/article/view/2391/1328

Ertikanto, C., Viyanti, & Hardini, S. N. (2023). Effectiveness of Guided Inquiry Learning Model on Thermodynamics Content in LMS-Based Blended Learning with Regard to Students' Higher Order Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 11280–11288. https://doi.org/10.29303/jppipa.v9i12.4026

Hakiki, R., Muchson, M., Sulistina, O., & Febriana, A. (2022). The Development of Learning Media Based on Augmented Reality, Hologram, and Ludo Game on The Topic of Molecular Shapes. *International Journal of Interactive Mobile Technologies*, *16*(4), 70–84. https://doi.org/10.3991/ijim.v16i04.28989

Ionescu, F. (2020). Non-formal education approaches in school organization methodological aspects and case study. *Journal of Education, Society & Multiculturalism*, *1*(2), 1–14. Retrieved from https://shorturl.asia/vXeAz

Jayusman, I., & Shavab, O. A. K. (2020). Aktivitas belajar mahasiswa dengan menggunakan media pembelajaran learning management system (LMS) berbasis edmodo dalam pembelajaran sejarah. *Jurnal Artefak*, *7*(1), 13-20. httpss://doi.org/10.25157/ja.v7i1.3180

Kumar, V., & Sharma, D. (2021). E-learning theories, components, and cloud computing-based learning platforms. *International Journal of Web-Based Learning and Teaching Technologies*, *16*(3), 1–16. https://doi.org/10.4018/IJWLTT.20210501.oa1

Luthfi, I., Mufit, F., & Putri, M. R. N. (2021). Design of Physical Teaching Materials Based on Cognitive Conflict Learning in Direct Current Electricity Integrating Virtual Laboratory. *Pillar of Physics Education*, *14*(1), 37. https://doi.org/10.24036/10771171074

Melnyk, A. (2023). Formal, Non-Formal and Informal Content Domain of Blended Learning for Prospective English University Teachers. *Education Innovation Practice*, *11*(7), 71–79. https://doi.org/10.31110/2616-650x-vol11i7-010

Mulyadi, M., Atmazaki, A., & R, S. (2019). The Development of Interactive Multimedia E-Module on Indonesia Language Course. *1st International Conference on Innovation in Education (ICoIE 2018) 178*(ICoIE 2018), 291–295. https://doi.org/10.2991/icoie-18.2019.65

Muzaki, A., Hidayati, A., & Rahmi, U. (2025). Development of Moodle-Based Learning Management System Integrated with Virtual Programming Lab for Basic Vocational Subjects of Software and Game Development. *Jurnal Penelitian Pendidikan IPA*, *11*(2), 898–909. https://doi.org/10.29303/jppipa.v11i2.9914

Nugraha, A. F. E., Adnan, & Daud, F. (2025). Pengaruh Berbagai Tipe Flipped Classroom Berbantuan Learning Management System (LMS) terhadap Kemampuan Berpikir Kreatif pada Siswa SMP. *Jurnal Penelitian Pendidikan IPA*, *11*(4), 821–828. https://doi.org/10.29303/jppipa.v11i4.10991

Nurhayati, B., Palennari, M., Taiyeb, A. M., & Daud, F. (2025). Differences in Students ' Creative Thinking Skills Between Those Taught Using Wordwall and Educaplay in Science Subjects. *Jurnal Penelitian Pendidikan IPA*, *11*(7), 91–99. https://doi.org/10.29303/jppipa.v11i7.11935

Oña, M. E. M., Rodríguez, A. M. M., Mero, J. A. Z., Santos, M. V. L., & Zambrano, D. M. R. (2024). Use of Wordwall as a Tool for the Strengthening of the English Language Vocabulary at Elementary School Level. *Estudios y Perspectivas Revista Científica y Académica*, *4*(4), 1640-1657. https://doi.org/10.61384/r.c.a..v4i4.753

Pienimäki, M., Kinnula, M., & Iivari, N. (2021). International Journal of Child-Computer Interaction Finding fun in non-formal technology education. *International Journal of Child-Computer Interaction*, *29*, 100283. https://doi.org/10.1016/j.ijcci.2021.100283

Rahma, A. L. (2024). Application of Wordwall Gameshow Quiz Media to Increase Interest and Learning Results. *Jurnal Penelitian Pendidikan IPA*, *10*(8), 4504–4509. https://doi.org/10.29303/jppipa.v10i8.8257

Romi, S., & Schmida, M. (2009). Non-formal education: A major educational force in the postmodern era. *Cambridge Journal of Education*, *39*(2), 257-273. https://doi.org/10.1080/03057640902904472

Saleem, A. N., Noori, N. M., & Ozdamli, F. (2022). Gamification Applications in E-learning: A Literature Review. *Technology, Knowledge and Learning*, *27*(1), 139–159. https://doi.org/10.1007/s10758-020-09487-x

Sandra, R., & Razi, P. (2022). Development of Physics Module Using Moodle Integrated Lab Rotation in Senior High School. *Pillar of Physics Education*, *15*(2), 132–138. https://doi.org/10.24036/12848171074

Sanjaya, W., Desyandri, D., Miaz, Y., & Rahmi, U. (2024). Innovation of Interactive Science Teaching Materials Based on Problem Based Learning Model through Learning Management System in Elementary School. *Jurnal Penelitian Pendidikan IPA*, *10*(7), 4442–4452. https://doi.org/10.29303/jppipa.v10i7.7802

Sevtia, A. F., Taufik, M., & Doyan, A. (2022). Pengembangan Media Pembelajaran Fisika Berbasis Google Sites untuk Meningkatkan Kemampuan Penguasaan Konsep dan Berpikir Kritis Peserta Didik SMA. *Jurnal Ilmiah Profesi Pendidikan*, *7*(3), 1167–1173. https://doi.org/10.29303/jipp.v7i3.743

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE Instructional Design Model in Distance Education. *Information*

(Switzerland), *13*(9), 1–20. https://doi.org/10.3390/info13090402

Sugiyono. (2022). *Metode Penelitian Kuantitati, Kualitatif dan R&D*. Bandung: Alfabeta.

Susanti, N., Yennita, Y., & Azhar, A. (2020). Development of Contextual Based Electronic Global Warming Modules Using Flipbook Applications as Physics Learning Media in High Schools. *Journal of Educational Sciences*, *4*(3), 541. https://doi.org/10.31258/jes.4.3.p.541-559

Syafei, S. S., & Mawardi, M. (2022). POGIL Model Integrated Flipped Classroom Assisted Learning Management System (LMS) for Learning Solution in ERI 4.0. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 444–451. https://doi.org/10.29303/jppipa.v8i2.1298

Tambunan, M. A., & Siagian, P. (2022). Pengembangan media pembelajaran interaktif berbasis website (Google Sites) pada materi fungsi di SMA Negeri 15 Medan. *Humantech: Jurnal Ilmiah Multidisiplin Indonesia*, *1*(10), 1520–1533. https://doi.org/10.32670/ht.v1i10.2166

Zamista, A. A., & Azmi, K. (2023). Digital Learning: How the Process Enhances Students' Digital Literacy. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 7189–7195. https://doi.org/10.29303/jppipa.v9i9.5401

Zhang, W., & Bray, M. (2021). A changing environment of urban education: historical and spatial analysis of private supplementary tutoring in China. *Environment and Urbanization*, *33*(1), 43–62. https://doi.org/10.1177/0956247820981820