



Developing Wordwall-Based Formative Assessment for the Periodic Table of Elements

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ABSTRACT

Purpose – This study examines the validity of a Wordwall-based formative assessment on the periodic table of elements and evaluates the perspectives of teachers and students at a public high school in Tebas, Indonesia.

Methodology – This study used a research and development (R&D) approach, focusing exclusively on the ADDIE model's development phase. Data were obtained through Likert-scale questionnaires completed by expert validators, teachers, and students. Pearson's correlation (SPSS) was used to assess item validity, and descriptive statistics (means and percentages) were used to describe questionnaire responses.

Findings – The study found that Wordwall-based formative assessments of the periodic table have high validity, confirmed by expert content validation (98.80%), media validation (98.86%), and practitioner validation (87.50%). Teacher and student feedback categories were both rated as “very interesting” (96.88% and 95.51%, respectively). Of 30 items tested, 15 were valid according to Pearson's correlation in SPSS.

Contribution – This study offers practical implications by equipping teachers with strategies for creating interactive, efficient, digitally based formative assessments that deliver rapid feedback, ultimately enhancing student engagement and learning effectiveness in high school science classes. Theoretically, this study advances understanding of how technology integration in formative assessment contributes to improved learning outcomes and enriches the quality of educational processes, providing a replicable model for similar educational contexts.

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INTRODUCTION

The purpose of education is to develop in students religious and spiritual strength, self-control, personality, intelligence, good character, and skills beneficial to themselves, society, the nation, and the state. According to Law No. 20 of 2003 concerning the National Education System, education is a conscious and planned effort to create a learning environment and learning process that enables students to actively develop their potential (Ermawati et al., 2022). Along with the development of education and teaching methods, it is crucial to improve student learning outcomes. Currently, many teaching methods still leave students bored, affecting their learning outcomes. The curriculum currently being implemented is the independent curriculum (Nafian et al., 2024).

The learning objectives in the independent curriculum cover three aspects, namely knowledge, skills, and attitudes, which students acquire through one or more learning activities. These objectives are formulated by considering evidence that can be monitored and measured in students, thereby enabling students to achieve the desired learning outcomes (Janah et al., 2023). The achievement of learning objectives can be assessed and measured through assessment activities. Assessment is an important component in the learning process. Assessment is an important element in the learning process, used to measure the extent of students' understanding, identify difficulties students experience, and ensure the learning process is effective (Arifeni et al., 2024).

In the new learning paradigm, educators are expected to prioritize formative over summative assessment and to use formative assessment to foster reflection throughout the continuous learning process (Lestari et al., 2023). Assessment can be divided into three types based on purpose: diagnostic, formative, and summative. Formative assessment, conducted during the learning process, aims to identify strengths and weaknesses in educators' teaching methods and pinpoint specific skills or areas that need improvement for each student, thereby motivating them to perform better (Surya et al., 2024).

Assessment has a crucial role, as it is expected to provide feedback on the material that students have learned, the effectiveness of the learning process, and their learning outcomes. Assessment also facilitates the learning process by allowing students to demonstrate their knowledge and skills. Given the importance of assessment tools in evaluation, teachers are expected to develop assessment tools that can comprehensively measure students' abilities, especially in science, particularly chemistry (Oktharia et al., 2017). Assessment in learning helps educators obtain a comprehensive picture of students' learning development, monitor progress, and facilitate continuous improvement of learning outcomes, which can be used to make decisions related to student achievement, curriculum, school programs, and education policy (Hairida et al., 2021).

Discussing education cannot be separated from the rapid technological advancements that continue to evolve today. In the era of digitalization, rapid technological development can provide educators with opportunities to innovate in the use and development of the educational technologies available. The use or development of technology can be applied across various aspects, from planning and implementation to learning evaluation. In general, educational technology is used as a medium for learning and assessment. With technological development, significant changes can be achieved through machines to support students' understanding and develop critical thinking, creativity, cooperation, and communication skills. To achieve learning, the role of creative and innovative educators is essential in creating an engaging and enjoyable learning process (Putri et al., 2024).

In the digital era, the use of technology in education is growing, including in learning assessment. Websites have become a key medium for facilitating online assessment, whether through quizzes, exams, or project-based assignments. The use of technology in assessment can enhance evaluation effectiveness and provide students with faster feedback. Additionally, website-based assessments offer flexibility in time and place, making them better suited to students' diverse needs (Hairida, 2025). One of the digital media tools used is Wordwall, a web-based platform that enables teachers to create a fun learning atmosphere. Using this medium helps students not only avoid boredom but also remain enthusiastic about participating in learning activities (Aziz et al., 2024).

The rapid development of information and communication technology is being leveraged by education practitioners to transition examinations and tests from traditional to computer-based systems, thereby enhancing the quality of education. Therefore, the use of technological media is essential as a supporting tool in assessing student learning outcomes, as teacher assessments have traditionally been conducted using paper-based methods (Fitriani, 2021). One website teacher can use to conduct engaging, interesting learning evaluations or assessments is Wordwall. The development of online practice questions or assessments is essential because it provides students with opportunities to conduct self-evaluations at any time and from anywhere (Sutarto, 2023).

Wordwall is a learning medium that educators can use to design engaging learning experiences for students. This medium can increase the activity of learning groups and actively involve students. A lack of interest and motivation has a significant impact on student learning outcomes. Therefore, teachers need to innovate in developing learning media to avoid problems and difficulties in the learning process (Khotimah et al., 2024). Wordwall is a platform that offers interactive tests and quizzes, accessible via mobile phones and other electronic devices. Wordwall features multimedia elements such as text, images, and audio, making learning more engaging and interactive. Through this medium, teachers can create various types of questions, such as multiple-choice, fill-in-the-blank, matching, and others, tailored to the topic or material being studied (Budiarti et al., 2023). The advantage of this application lies in the large number of templates, easily accessible to many people without educational level restrictions. As a fun website, Wordwall enables students to learn while playing, thanks to its various features, including games and quizzes (Jannah & Masnawati, 2024).

Wordwall offers several advantages, including unrestricted use and five basic game options and five template choices. In addition to the advantages of Wordwall, completed and tailored games can be sent to students through various media, such as WhatsApp, Google Classroom, or other supporting applications (Olisna et al., 2022). There is also a learning evaluation feature in the form of a leaderboard, allowing you to see students' mistakes on each question, as well as a percentage score indicating the most difficult to the easiest questions (Sitinjak et al., 2024).

Interviews with teachers during the needs analysis at SMAN 1 Tebas revealed that the assessments used were not very varied and were carried out manually in a traditional manner. Correcting student assessment results took considerable time, so feedback could not be provided promptly to each student. During the assessment, students appeared unenthusiastic and anxious as they worked on the questions. This also affected their attitude, leading them to lose focus, joke around, and feel sleepy during the assessment. The interviews also revealed that the school already had wireless (Wi-Fi) facilities and allowed students to bring mobile phones for learning.

Based on the theory and facts described above, it is necessary to develop assessments that leverage interactive, creative, and innovative learning media to stimulate students' enthusiasm for learning, increase student engagement, and deepen student understanding. Therefore, a study entitled "Development of Wordwall-Based Formative Assessment in Periodic Table of Elements Material at SMAN 1 Tebas" was conducted.

METHODOLOGY

Research Design

This study employs a research and development (R&D) methodology guided by the ADDIE model, comprising analysis, design, development, implementation, and evaluation stages (Rayanto & Sugianti, 2020). The scope of this study is explicitly limited to the Development phase. Specifically, it focuses on developing and validating a Wordwall-based formative assessment tool for the periodic table of elements, designed for 10th-grade students at a high school in Tebas, Indonesia. The Implementation and Evaluation phases were not fully carried out; these were represented only by expert validation and limited user response testing.

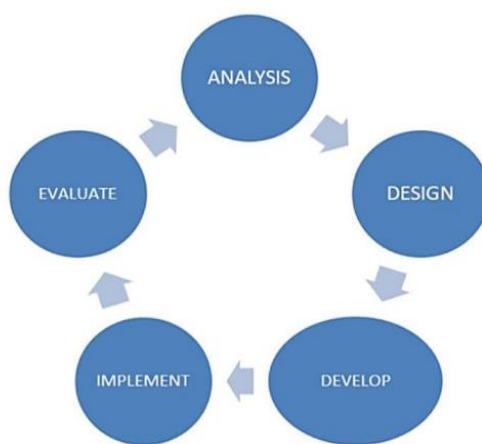


Figure 1. The ADDIE Model (Rayanto & Sugianti, 2020)

Participant

The research subjects consisted of validators and respondents. The validators included two lecturers – one as a subject matter expert and the other as a media expert – and one teacher as a practitioner. Meanwhile, the respondents comprised 1 chemistry teacher and 68 tenth-grade students at a high school in Tebas, Indonesia. The selection of subjects was based on their expertise in the field and their direct involvement in chemistry education.

Data Collection

The collected data consists of both quantitative and qualitative data. Quantitative data were obtained from expert validation, item validity tests using Pearson’s correlation via SPSS, and teacher and student response surveys. Qualitative data consisted of suggestions and comments from validators, which served as the basis for product improvements.

Instrument

The researchers used several data collection tools, namely tests and questionnaires. These questionnaires were used for expert validation and to gather feedback from teachers and students. Meanwhile, observations, interviews, and documentation were used during the needs analysis phase.

Expert Validation Instrument

Validators were asked to evaluate the Wordwall-based formative assessment design using a prepared questionnaire and to provide feedback and suggestions to inform product improvement. This instrument took the form of an expert evaluation questionnaire administered to instrument, content, and media experts. The content validation questionnaire outline covered two aspects, as presented in Table 1.

Table 1. Questionnaire Outline for Material Validation

Aspect	Indicator
Content/Materials	Alignment of questions with learning objectives
	Alignment of test items with answer choices
	Consistency between the image and the question
	Alignment of the questions with the indicators being measured
Language	There is only one correct answer
	Using language that conforms to the rules of the Indonesian language
	Using communicative language
	Language that is easy for students to understand

The framework for the media validation questionnaire covers four aspects, as presented in Table 2.

Table 2. Media Validation Questionnaire Outline

Aspect	Indicator
Presentation	Clarity of the instructions for use
	Clarity of the displayed results
Content Design	Answer Key
	Color composition
	Font compatibility
	The appeal of quizzes
Construction	Eye-catching media display
	Motivating students
Usage	Easy access to Wordwall
	The quiz menu and features (buttons) are very easy to use The practicality of using formative assessment tools

The validation questionnaire framework developed by expert practitioners covers three aspects, as presented in Table 3.

Table 3. Questionnaire Outline for Practitioner Validation

Aspect	Indicator
Materials	Alignment of questions with learning objectives
	Alignment of questions with answer choices
	Alignment of questions with assessment criteria
	Relevance of the questions to the material
	Consistency between the figures/tables and the questions
	Clarity of the instructions for use
Presentation	Clarity of the displayed results
	Answer Key
	Color Composition
	Font compatibility
	The appeal of quizzes
	Eye-catching media display
	Motivating students
Usage	Easy access to Wordwall
	The quiz menu and features (buttons) are very easy to use The practicality of using formative assessment tools

Teacher Response Questionnaire

Teachers' responses were collected via a questionnaire developed for this purpose. This instrument covered aspects such as ease of use, interest, product practicality, and material appropriateness, as presented in Table 4.

Table 4. Teacher Response Questionnaire Outline

Aspect	Indicator
User-friendliness	The instructions for using Wordwall are very simple
	Using Wordwall can make it easier to conduct assessments in the classroom
Interest	The menus and features (buttons) in the Wordwall app are easy to understand
	The Wordwall interface is very appealing
Practicality	The use of features and templates is very appealing
	This Wordwall tool can help motivate students in their learning Using Wordwall can help alleviate students' boredom during formative assessments

Aspect	Indicator
Materials	Using Wordwall makes it a lot of fun for students to work on assessment questions
	Wordwall can provide teachers with a new experience
	Wordwall can provide students with a new learning experience
	Alignment of questions with learning objectives
	Alignment of questions with answer choices
	Alignment of questions with assessment criteria
	Relevance of the questions to the material
Consistency between the visual presentation (table) and the test items	
	Alignment of test items with student ability

Student Response Questionnaire

Student responses were collected via a questionnaire developed for this purpose. This instrument covered aspects of learning motivation, interest in the medium, ease of use, and challenges encountered while using Wordwall, as presented in Table 5.

Table 5. Student Response Questionnaire Outline

Aspect	Indicator
Motivation	I find myself motivated to learn when using WordWall-based formative assessments
	I'm really excited to work on formative assessment questions using Wordwall
	I feel like competing with my friends to get the highest score
	I get even more excited when I make it into the top five
Interest	I don't get bored when working on formative assessment questions
	I'm really interested in Wordwall because it has game features
	I would like Wordwall to be used for the next set of questions
Ease of Use of Media	Wordwall is very easy and fun to use
	The language used is easy for me to understand
	I can easily understand the instructions for using the Wordwall-based formative assessment tool

Data Analysis

A validation assessment was administered to validators to measure the validity of the Wordwall-based formative assessment. Data were collected via a questionnaire. The questionnaire was completed by subject matter experts, media experts, and practitioners (teachers). The validity test in this study used a Likert scale. The Likert scale criteria used are presented in Table 6.

Table 6. Likert Scale Criteria

Score	Criteria
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

The data from the validated questionnaire, evaluated by experts, were then analyzed both quantitatively and qualitatively. Quantitative data was derived from the validators using the following formula:

$$P = \frac{\sum x}{\sum xi} \times 100\% \quad (1)$$

Where P is validation percentage, $\sum x$ is number of answers given by validators, and $\sum xi$ is maximum score. After calculating the total validation score using Equation 1, the results are interpreted according to the criteria in Table 7.

Table 7. Achievement Criteria and Qualification Levels

No	Index (%)	Criteria
1.	$80 \leq P \leq 100$	Very Valid
2.	$60 \leq P \leq 80$	Valid
3.	$40 \leq P \leq 60$	Quite Valid
4.	$20 \leq P \leq 40$	Less Valid
5.	$0 \leq P \leq 20$	Not Valid

Following validation, the next phase involved user-response testing with chemistry teachers and students. The sample for user response testing consisted of 1 chemistry teacher and 64 tenth-grade students from a high school in Tebas, Indonesia. User response testing was conducted using a Likert-scale questionnaire. The Likert scale criteria are presented in Table 6. The data obtained from the questionnaire responses of teachers and students can be converted into percentages using the following formula:

$$P = \frac{f}{N} \times 100 \quad (2)$$

Where P is Percentage of questionnaire responses, f is Number of scores from data collection, and N is maximum score. After converting the response scores to percentages using Equation 2, the analysis yielded conclusions about teachers' and students' responses to the Wordwall-based formative assessment tool, presented in Table.

Table 8. Teacher and Student Response Score Criteria

No	Index (%)	Criteria
1.	$80 \leq P \leq 100$	Very Interesting
2.	$60 \leq P \leq 80$	Interesting
3.	$40 \leq P \leq 60$	Quite Interesting
4.	$20 \leq P \leq 40$	Less Interesting
5.	$0 \leq P \leq 20$	Not Interesting

FINDINGS

Analyze Stage

The initial phase of this research and development project is the analysis phase, which includes needs and content analyses. This phase serves as the foundation for developing a Wordwall-based formative assessment on the periodic table of elements for 10th-grade students at a high school in Tebas, Indonesia.

Based on the results of a needs analysis conducted through interviews with chemistry teachers, conventional formative assessment was deemed ineffective because it requires a time-consuming and inefficient manual correction process. This situation highlights the limitations of practical assessment tools and their inability to provide rapid feedback, a key principle of formative assessment. From the students' perspective, conventional assessment tends to cause boredom and anxiety, resulting in low engagement and concentration during the assessment. This low participation results in suboptimal learning outcomes. These findings indicate that unengaging assessment designs can hinder the role of assessment in the learning process (assessment for learning). This aligns with Khoerunnisa et al. (2023), who state that engaging assessments can enhance students' curiosity and involvement in learning. In addition, the availability of supporting facilities, such as Wi-Fi networks, and students' use of mobile devices indicate opportunities to integrate technology into the assessment process. Therefore, there is a need to develop digital-based formative assessment instruments that are not only practical but also capable of enhancing student engagement and providing

immediate feedback. One relevant alternative is the Wordwall platform. A student needs analysis was conducted through a questionnaire completed by 25 students, with the results presented in Table 9.

Table 9. Results of Student Needs Analysis

No	Question	Response		Percentage (%)
		Yes	No	
1.	Are you excited to participate in the process of learning chemistry?	22	3	88
2.	Are you having trouble understanding chemistry, especially the periodic table of elements?	23	2	92
3.	Are chemistry exams still administered using paper-based tests?	21	4	84
4.	Has assessment in chemistry education ever utilized interactive media or similar tools?	12	13	48
5.	Are you familiar with interactive media like Wordwall?	0	25	0
6.	Have teachers ever given chemistry questions as interactive quizzes?	12	13	48
7.	Do you need any other interactive resources to support your assessment activities?	25	0	100
8.	Do you need more engaging and enjoyable interactive media?	25	0	100
9.	Do you agree that assessments should be conducted using interactive tools like Wordwall?	25	0	100

Based on the needs analysis results, it can be concluded that 10th-grade students at a high school in Tebas, Indonesia, require a more interactive assessment tool to increase their interest and engagement in the assessment process. An interactive quiz game can provide a more enjoyable learning experience and encourage active student participation as they work through the questions. Therefore, this study developed a Wordwall-based formative assessment instrument to increase students' engagement and seriousness in participating in learning assessments.

The curriculum analysis was conducted by reviewing the curriculum in use to ensure alignment between the developed assessments and students' prior competencies and learning objectives. Based on interviews with teachers, the curriculum used is the Merdeka Curriculum. Additionally, the needs analysis revealed that 92% of students struggle to understand the periodic table of elements. These difficulties include understanding the structure and sequence of the periodic table, recognizing element symbols, and understanding concepts such as groups, periods, valence electrons, and the periodic properties of elements. These findings indicate that the periodic table remains abstract to students, necessitating a more interactive, contextual approach to learning and assessment. Thus, the development of Wordwall-based assessments aims not only to serve as an evaluation tool but also to help students understand concepts more concretely and meaningfully.

Design Stage

The design phase was conducted based on the results of the needs analysis to develop a Wordwall-based formative assessment instrument. In this phase, the design focused on developing test items and designing assessment media aligned with the learning objectives. The test items were developed in accordance with the learning objectives and established item criteria. The instrument developed consists of 15 multiple-choice items related to the periodic table of elements. Next, the media design was implemented as an interactive quiz template on the Wordwall platform, with a time limit for each question. Additionally, an expert validation instrument was developed during this stage to assess the product's suitability. The validation sheet covers content, media, and language aspects to ensure the developed assessment meets validity criteria before pilot testing.

Development Stage

This stage involves creating Wordwall-based formative assessment tools, conducting item testing, validating the product, and testing teacher and student responses. In this stage, the developed questions are integrated into the Wordwall platform to create an interactive assessment. The interface of the Wordwall-based formative assessment tool is shown in Figure 2.

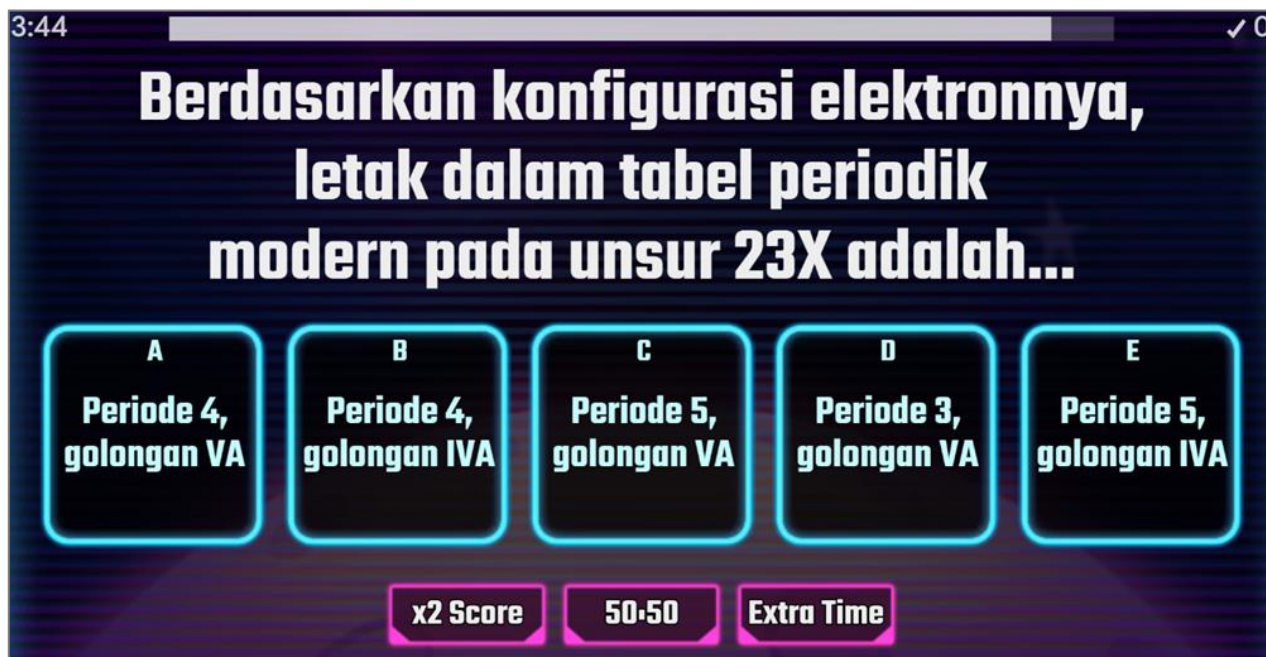


Figure 2. Display of Wordwall Assessment Results

This stage involves creating Wordwall-based formative assessment products, item testing, product validation, and testing of teacher and student responses. In this stage, the developed questions are integrated into the Wordwall platform to create an interactive assessment. Next, the product is validated by subject matter experts, media experts, and practitioners (teachers) to assess the suitability of the developed assessment. The validation results –including evaluations, suggestions, and comments –serve as the basis for refining the product in response to the feedback provided (Riska & Asidiqi, 2025).

The validation process yields evaluations, recommendations, and comments from validators, which serve as the basis for product improvements. After revisions are made based on the validators' feedback, the product is deemed suitable for use. The results of the validity test are presented as follows:

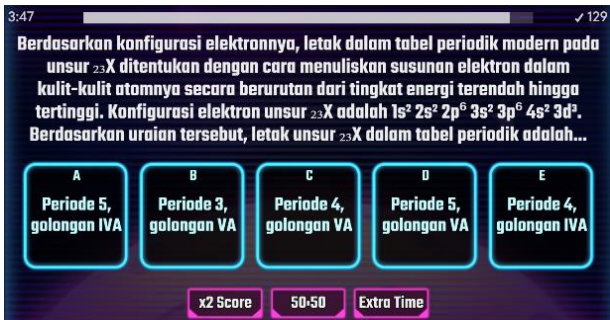
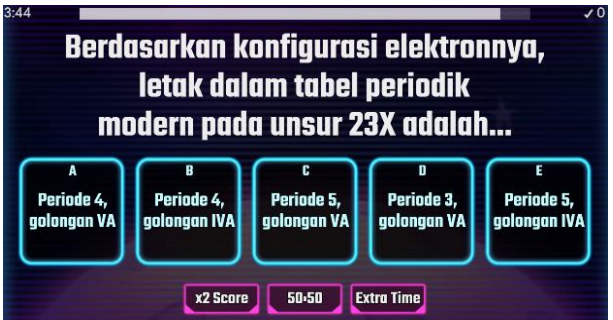
Results of Material Validity Testing

Table 10. Recapitulation Data for Subject Matter Experts I and II

No	Assessment Indicators	Value		Average	Criteria
		Validator I	Validator II		
1.	Content/Materials	100%	95%	97,5%	Very Valid
2.	Language	100%	100%	100%	Very Valid
	Average	100%	97,5%	98,80%	Very Valid

The data in Table 10 show that the average validation rate among subject matter experts was 98.80%, placing it in the "highly valid" category. Nevertheless, the validators provided several suggestions for improvement, which are presented in Table 11.

Table 11. Revised Material Results

Before Revision	After Revision
Some questions are too long.	Because the question is too long, it needs to be simplified.
	

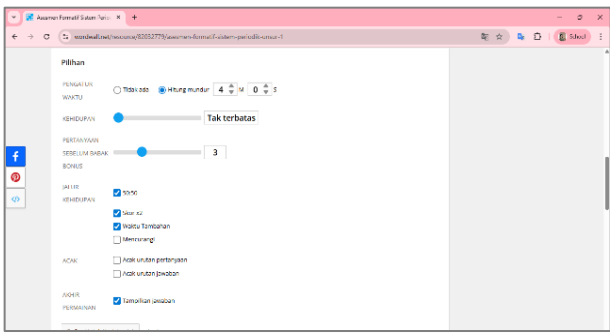
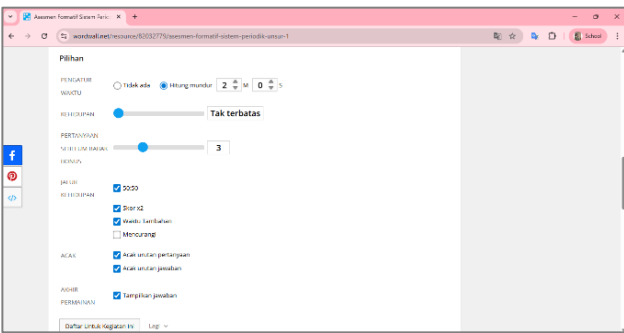
Results of Media Validity Testing

Table 12. Recapitulation Data from Media Experts I and II

No	Assessment Indicators	Value		Average	Criteria
		Validator I	Validator II		
1.	Presentation	100%	91,67%	95.83%	Very Valid
2.	Content Design	100%	100%	100%	Very Valid
3.	Construction	100%	100%	100%	Very Valid
4.	Usage	100%	100%	100%	Very Valid
	Average	100%	97,92%	98,86%	Very Valid

The data in Table 12 show that the average validation rate among media experts was 98.80%, placing it in the “highly valid” category. Nevertheless, the validators still provided several suggestions for improvement, which are presented in Table 13.

Table 13. Revised Media Results

Before Revision	After Revision
The time allowed for each question is too long, namely 4 minutes, and the questions and answer choices are not randomized.	The time limit for each question has been changed to 2 minutes, and the order of questions and answers has been randomized.
	

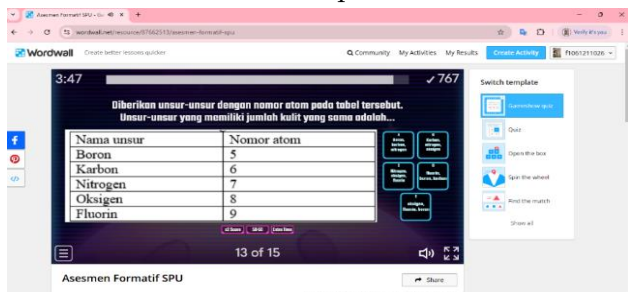

Results of Practitioner Validity Testing

Table 14. Practitioner Recapitulation Data

No	Assessment Indicators	Value	Criteria
1.	Content/Material	75%	Very Valid
2.	Presentation	87,5%	Very Valid
3.	Usage	100%	Very Valid
	Average	87,5%	Very Valid

The data in Table 14 show that the average validation rate among practitioners was 98.80%, placing it in the “highly valid” category. Nevertheless, the validators still provided several suggestions for improvement, which are presented in Table 15.

Table 15. Practitioner Revision Results

Before Revision	After Revision
There is a problem with the table: the compound elements and answer options are incorrect.	The elements in the table have been replaced correctly, in accordance with the answer options.
	

After undergoing expert validation, the product was tested on respondents. Item validity testing was conducted on 20 eleventh-grade students who completed 30 items, using Pearson’s correlation in SPSS. The criteria for determining validity were based on a comparison of the calculated r value and the table r value, where an item was deemed valid if the calculated $r >$ table r , and invalid if the opposite was true. The results of the item validity analysis are presented in Table 16.

Table 16. Validity Test Analysis Results

No	Pearson Correlation (r calculated)	r Table	Conclusion
1	0,031	0,444	Invalid
2	0,545	0,444	Valid
3	0,376	0,444	Invalid
4	0,302	0,444	Invalid
5	0,630	0,444	Valid
6	0,149	0,444	Invalid
7	0,122	0,444	Invalid
8	0,212	0,444	Invalid
9	0,601	0,444	Valid
10	0,621	0,444	Valid
11	0,451	0,444	Valid
12	0,146	0,444	Invalid
13	0,802	0,444	Valid
14	0,451	0,444	Valid
15	0,112	0,444	Invalid
16	0,492	0,444	Valid
17	0,568	0,444	Valid
18	0,338	0,444	Invalid
19	0,772	0,444	Valid
20	0,579	0,444	Valid
21	0,704	0,444	Valid
22	0,090	0,444	Invalid
23	0,595	0,444	Valid
24	0,254	0,444	Invalid
25	0,521	0,444	Valid
26	0,329	0,444	Invalid
27	-0,194	0,444	Invalid
28	0,030	0,444	Invalid
29	0,582	0,444	Valid
30	-0,403	0,444	Invalid

The data in Table 16 show that 15 items have correlation coefficients above the critical r value and are therefore considered valid. Valid items were used in the study, while invalid items were eliminated from the formative assessment. After validation of content, media, and test items, the product was tested with users, namely teachers and students. A teacher response test was conducted to obtain feedback on the developed assessment media. The results of the chemistry teacher response test at a high school in Tebas, Indonesia, are presented in Figure 3.

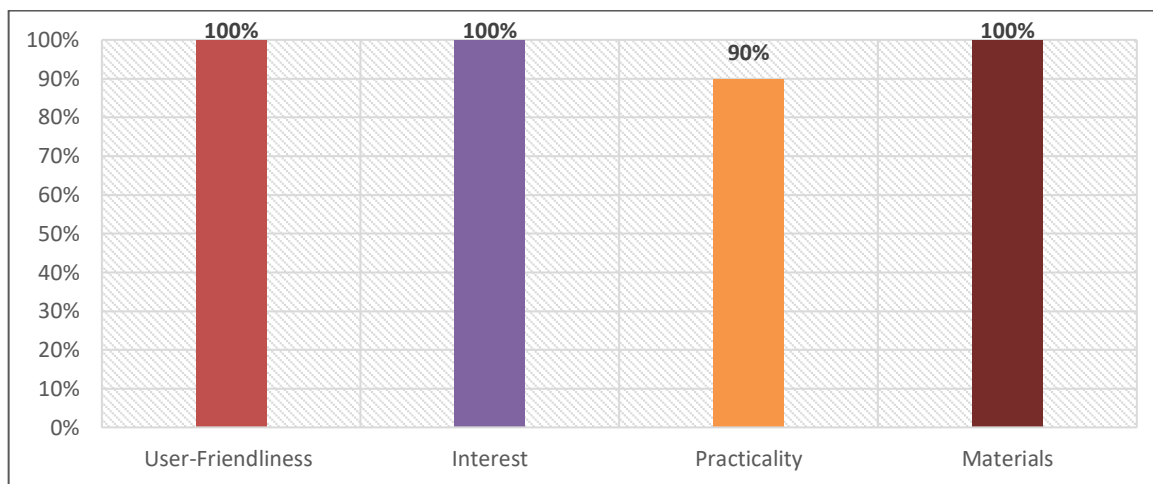


Figure 3. Teacher User Response Test Results

Based on Figure 3, teachers' responses were collected via a questionnaire consisting of 16 statements on a Likert scale (1 = strongly disagree to 4 = strongly agree), covering ease of use, interest, practicality, and content. The analysis results show that ease of use, interest, and content each received a score of 100%, while practicality received 90%. Overall, the average teacher response score was 96.88%, placing it in the "very interesting" category. Next, a user response test was conducted on 64 tenth-grade students at a high school in Tebas, Indonesia, to assess the product's appeal. The results of the student response test are presented in Figure 4.

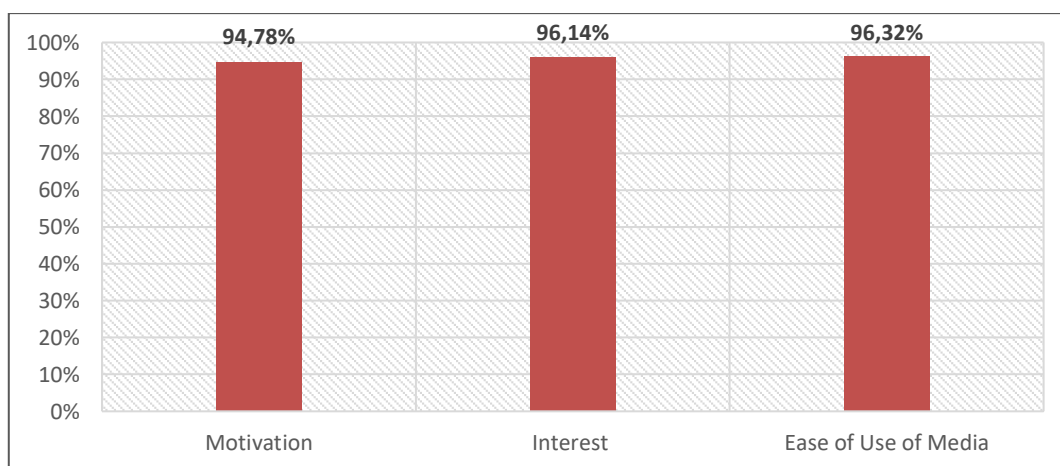


Figure 4. Student User Response Test Results

Based on Figure 4, responses from 64 students were collected via a questionnaire comprising 10 statements on a Likert scale (1 = strongly disagree to 4 = strongly agree), covering motivation, appeal, and ease of use. The analysis results showed that the motivation aspect scored 94.78%, appeal 96.14%, and ease of use 96.32%. Overall, the average student response score was 95.51%, placing it in the "very interesting" category. These findings indicate that Wordwall-based formative assessment is not only appropriate in terms of content and medium but also effective in enhancing students' interest, motivation, and engagement in the assessment process.

DISCUSSION

This study demonstrates that the Wordwall-based formative assessment tool developed in this research exhibits high validity and strong appeal in chemistry instruction on the periodic table of elements. This high validity and positive response indicate that the use of interactive digital media can enhance the effectiveness of formative assessment, particularly by providing immediate feedback and presenting varied questions. From the perspective of formative assessment theory, assessment improves learning effectiveness by providing timely and meaningful feedback. This feedback enables students to identify weaknesses and make continuous improvements before the summative assessment (Andayani & Madani, 2023).

The validation results for the content aspect were 97.5%, and for the language aspect, 100%, yielding an overall average of 98.80%, which falls into the “highly valid” category. These results indicate that the developed instrument meets the criteria for content appropriateness and linguistic clarity, making it suitable for use in learning assessments. The high content validity indicates that the developed test items align with the learning indicators, reflect the key concepts of the periodic table of elements, and demonstrate good conceptual accuracy. This alignment is crucial because, in formative assessment, the quality of the content determines the accuracy of the information obtained to monitor students’ learning progress effectively. Meanwhile, the very high linguistic clarity indicates that the questions are structured with easy-to-understand sentences that do not create ambiguity. However, there is still feedback regarding one item that was deemed too long and potentially difficult for students to understand. Therefore, revisions were made to simplify sentences, making them shorter, clearer, and more communicative, thereby better aligning with students’ characteristics. This aligns with the views of Hidayat & Hidayat (2025) and Hayati et al. (2025) that effective assessments must align indicators, content, and learning objectives to provide accurate information about students’ learning achievements.

From the media perspective, the validation results showed an average percentage of 98.86%, classified as “highly valid.” This validity indicates that the developed media meets the criteria for systematic presentation and features an engaging visual design, thereby effectively supporting student engagement. At the same time, the excellent construction and usability aspects suggest that the media is easy to operate and aligns with learning needs. Theoretically, this aligns with the constructivist approach, which emphasizes that learning occurs most effectively when students actively construct knowledge through meaningful experiences (Syafila & A’yun, 2024). Nevertheless, several suggestions address the effectiveness of media use, particularly regarding time management and question variety. The initial completion time, which was too long, was shortened to align with the characteristics of formative assessment, which emphasizes the speed of feedback. Additionally, randomizing questions and answers was implemented to increase the challenge level and maintain fairness in the assessment process. These improvements demonstrate that media quality is determined not only by its appearance but also by its effectiveness in supporting the assessment process.

From the practitioners’ perspective, the validation results showed an average percentage of 85.93%, classified as “highly valid.” This indicates that the Wordwall-based assessment is suitable for teachers in terms of content, presentation, and ease of use. The high score in the usability aspect indicates that the tool is easy to operate and efficient for conducting assessments. However, inaccuracies were found in one item, necessitating revisions to align with the content. This finding aligns with (Anggraeni & Aeni, 2024), who state that instruments with high validity are suitable for use in learning. Additionally, the use of technology in assessment has been shown to enhance efficiency and enable rapid, continuous feedback (Anwar & Yuliansyah, 2025).

The results of the item validity test indicate that 15 out of 30 items are valid. This means that half of the items meet the criteria for a significant correlation with the learning achievement indicators. However, some items need to be revised to align with the indicators and to ensure their difficulty levels are more evenly distributed. These findings are consistent with Nafs et al. (2023), who emphasize the importance of item selection to ensure the validity of the assessment being developed.

The development of Wordwall-based assessments also aims to support the achievement of Learning Outcomes (LO) in Phase E, particularly understanding the regularities of element properties in the periodic table and their relationship to electron configuration. From an Assessment for Learning (AfL) perspective, assessments are integral to the learning process, providing feedback to continuously improve students' understanding. The results of this study indicate that Wordwall supports this principle by providing immediate, real-time feedback, thereby ensuring that assessments serve not only as evaluation tools but also as a means of learning reflection (Viola et al., 2026; Karepesina & Tinenti, 2025). These findings also demonstrate that interactive digital media such as Wordwall can enhance the effectiveness of formative assessments in the classroom. This aligns with the view of Willianti & Rohayati (2025), who state that Wordwall supports the implementation of formative assessment by providing immediate feedback and allowing teachers to adjust question difficulty according to students' competencies. Furthermore, this platform supports flexible, adaptive learning, making it well-suited to a differentiated learning approach. The use of Wordwall also aligns with the spirit of the Merdeka Curriculum, which emphasizes enjoyable, reflective learning experiences centered on individual student development (Jannah et al., 2025).

The overwhelmingly positive response from teachers and students indicates that the use of Wordwall has transformed perceptions of assessment activities, shifting them from what was previously seen as monotonous to something more engaging and meaningful. This change results from the integration of interactive elements that provide a different learning experience from conventional assessments. Theoretically, this phenomenon can be explained through a gamification approach, in which game elements such as leaderboards, sound effects, and dynamic visual displays enhance students' intrinsic motivation. These elements provide challenges, immediate feedback, and a sense of achievement, encouraging students' active engagement in the assessment process (Emilia et al., 2024). Thus, assessment is no longer perceived as a stressful activity but rather as part of an enjoyable and interactive learning experience.

Furthermore, the high level of user engagement also indicates that Wordwall-based assessments have broader pedagogical significance, namely the ability to support student-centered learning. Students' active involvement during the assessment process allows them not only to answer questions but also to reflect on their understanding in real time. This reinforces the role of formative assessment as an integral part of the learning process, rather than merely a tool for evaluating outcomes. These findings align with previous research indicating that Wordwall can serve as an engaging, effective, and relevant assessment tool for current learning needs (Sari et al., 2025; Qurniawan et al., 2023; Hakim & Rafiq, 2024; Suseno et al., 2025). Thus, the use of Wordwall not only enhances the appeal of assessment but also contributes to creating a more interactive, reflective, and meaningful learning experience.

The uniqueness of this study lies in integrating digital technology with formative assessment, focusing not only on media use but also on developing valid instruments and testing user responses. Additionally, the assessment is linked to the achievement of Learning Outcomes (LO) in the Merdeka Curriculum, thereby serving as a tool for both evaluation and reflection on learning. Thus, this study contributes to the development of more systematic and relevant technology-based assessments. Overall, Wordwall-based formative assessment has the potential to enhance student engagement, motivation, and understanding. However, this study is limited to the development phase, so further research is needed to test its effectiveness on a broader scale.

CONCLUSION

Based on the research findings, the Wordwall-based formative assessment on the periodic table of elements demonstrated very high validity, with validation results of 98.80% from subject matter experts, 98.86% from media experts, and 87.5% from practitioners (teachers). Additionally, user responses fell into the "very engaging" category, with a response rate of 96.88% among teachers and 95.51% among students. Item validity test results indicated that 15 items were deemed valid. These findings suggest that interactive digital media can enhance engagement, motivation, and assessment effectiveness by providing rapid, varied feedback.

The novelty of this study lies in the development of a Wordwall-based formative assessment that is not only interactive but also systematically validated and linked to the achievement of Learning Outcomes (LO). The contribution of this study is to provide an alternative technology-based assessment model that is valid, practical, and relevant to the needs of chemistry learning. In practice, the results of this study can help teachers design more engaging assessments, provide immediate feedback, and enhance student participation and engagement in the learning process. Its implementation in the classroom can be achieved by integrating Wordwall into evaluation activities to continuously monitor students' learning progress. However, this study is still limited to the development stage; therefore, further research is recommended to test the effectiveness of Wordwall-based assessments on a larger scale and across diverse learning contexts to improve student learning outcomes.

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