Jurnal Pendidikan Sains Indonesia
(Indonesian Journal of Science Education)
https://jurnal.usk.ac.id/JPSI/index

13(3), pp.700-720 (2025)
e-ISSN: 2615-840X p-ISSN: 2338-4379
https://dx.doi.org/10.24815/jpsi.v13i3.45213

Development of Formative Assessment Based on Wordwall Games on the Material of Atomic Theory

Jossy Marinda Sari[1], Hairida[1]*, Eny Enawaty[1], Erlina[1], Rachmat Sahputra[1], Fitria Arifiyanti[2]

[1]Chemistry Education Study Program, Faculty of Teacher Training and Education, Tanjungpura University, Pontianak, Indonesia
[2]Faculty of Humanities and Social Sciences, Doctoral School of Education, University of Szeged, Szeged,
Hungary

*Corresponding author email: hairida@fkip.untan.ac.id

Article History:
Received date: March 19 2025
Received in revised from: July 5 2025
Accepted date: July 12 2025
Available online: July 16 2025

Citation:
Sari, J.M., Hairida, Enawaty, E., Erlina, Sahputra, R., & Arifiyanti, F. 2025. Development of formative assessment based on wordwall games on the material of atomic theory. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 13(3):700-720.

Abstract. The implementation of formative assessment in chemistry learning remains suboptimal, as many teachers still rely on conventional methods and rarely utilize innovative digital media such as educational games. This study aims to determine the level of validity and response from chemistry teachers and students to formative assessment media based on wordwall games on the material of the development of atomic theory. The research method used is research and development with the ADDIE model which consists of analysis, design, development, implementation and evaluation stages but this research only reaches the development stage. The data collection techniques used are direct communication techniques with interviews and indirect communication by providing media validation sheets and questions and response questionnaires for chemistry teachers and students. The results of validation by experts on the question aspect obtained a percentage of 91.67% and on the media aspect of 95%, both of these aspects fall into the category of very feasible. The average percentage of chemistry teachers' response to formative assessment media based on wordwall games on the material of the development of atomic theory is 88.3%. While the average response of students to the product obtained a percentage of 82.67% with a very attractive category. Based on the results of validation and response tests, it can be concluded that the wordwall games-based formative assessment product on the material of the development of atomic theory is feasible to use in supporting the implementation of formative assessments in learning.
Keywords: Development, formative assessment, wordwall, atomic theory

Introduction

The Merdeka Curriculum emphasizes the importance of assessment as an integral part of a systematic and continuous learning process to monitor students' progress and learning needs (Efendi et al., 2024) especially in formative assessments which is the most important factor in evaluating student learning performance in the classroom (Hooda et al., 2022). Through formative assessment, teachers are given the opportunity to find out the level of students' understanding of learning and use this information to plan appropriate teaching methods. In contrast to summative assessment, which is final, formative assessment focuses more on the learning process through practice and daily feedback to improve learning outcomes (Dewi et al., 2019). A variety of formative

assessment methods can be applied, as long as they are adapted to the instructional model and learning context (Sortwell et al., 2024)

Creativity in the use of technology allows teachers to design innovative and efficient strategies to improve the effectiveness of learning in the digital era (Sugihartini et al., 2025), especially in learning evaluation. However, the implementation is still not optimal because many teachers still rely on traditional assessment methods and rarely design appropriate innovative media and assessments (Hairida et al., 2023). Other research shows that teachers in high school have a low level of understanding and application of formative assessments, so they have not fully utilized these assessments effectively in learning (Demekash et al., 2024) because many teachers are not aware of the importance of formative assessments, so far they only conduct assessments at the end of learning (Fatmawati et al., 2023).

Teachers need to emphasize formative assessment more than summative assessment and utilize the results to continuously improve the learning process in accordance with the expected goals (Munawar et al., 2024). The lack of information and insight about assessment causes teachers to not optimally apply it in learning. Not all teachers apply formative assessments in learning. Some teachers do it only in the form of oral questions to find out the extent of students' understanding of the material to be taught (Serani & Hairida, 2024). In addition, in carrying out assessments, only a few teachers use digital media as an innovation in conducting assessments in the classroom, especially game-based ones.

Most teachers still use conventional paper-based methods (Rahmawati et al., 2024). Where there are often several problems such as the cost required is quite expensive for logistics, then the quality of questions duplicated with a photocopier is often unclear or opaque so that the readings and images cannot be read properly (Suprihanto, 2016). Conventional assessments require extra time and effort for teachers to check answers (Fatmawati et al., 2023). In addition, at the end of the assessment, a considerable amount of students' question and answer sheets remained unused, resulting in significant paper waste. (Wilyanti & Shidqha, 2023). The implementation of conventional assessments by teachers has so far seemed monotonous and not varied so that students lacked enthusiasm in carrying out assessments (Permatasari et al., 2023). According to Kristanti et al. (2021) the implementation of conventional learning evaluation carried out by providing practice questions or exams in the form of sheets makes the classroom atmosphere tense, students cheat each other and require teachers to continue to supervise.

The use of games-based formative assessment media can actually increase students' motivation and enthusiasm in working on assessment questions, because students will feel challenged to get the highest score among their peers (Agustina et al., 2024). In addition, students can receive the results of the assessment authentically and objectively. The use of this media allows teachers to analyze the results of the assessment in more depth, because the results of students' work can be seen as a whole (Ashari et al., 2023). Formative assessment that utilizes technology, particularly game-based approaches, can help reduce teachers' workload and enhance the overall validity of the evaluation process (Bez et al., 2025). Students can also do this assignment or assessment anywhere and anytime in accordance with the collection limit that has been set as long as they have an electronic device connected to the internet network (Ashari et al., 2023).

One of the materials, especially chemistry, that is widely found still using conventional methods in carrying out formative assessments is the development of atomic theory. The development of atomic theory is a sub-material in the odd semester of class X of high school which studies about the smallest particles of an object that cannot be seen with the naked eye. Atomic theory development material requires students to memorize and use their imagination (Rorita et al., 2018). The breadth of material often makes students feel bored and when students are bored with learning,

the impact is that they also feel lazy to do the learning outcome evaluation test (Rahmawati et al., 2024). In the evaluation of learning material on the development of atomic theory, it contains quite a lot of questions and is also abstract so that it will be easier to make questions and check answers with the help of technology-based applications. This makes students lazy and avoid chemistry. Therefore, a games-based assessment media is needed as an alternative solution to the problems faced by teachers. One of them is to use assessment media in the form of a wordwall application.

Wordwall is one of the media that can be utilized to carry out assessment or assessment in an interesting way. Wordwall is a website-based application that can make it easier for teachers to create learning evaluations or quizzes that are not boring (Pastilah & Putra, 2024). This application provides a variety of fun templates. Based on the results of interviews with chemistry teachers at senior high school number 6 Pontianak, the implementation of learning evaluations in the classroom is generally carried out in an interesting manner.

Although supporting infrastructure such as internet access and technological devices are available, they have not been optimally utilized for learning. As a result, students' motivation to participate in learning evaluation is low. As expressed by several students at senior high school number 6 Pontianak who felt bored and less enthusiastic when participating in the implementation of conventional learning evaluations. In line with research conducted by Duda et al. (2023) which shows that the implementation of assessment in learning at Senior High School Nusantara Indah Sintang is also less than optimal or can be said to be rarely done. Teachers often use test questions, both in the form of essay questions and multiple choice questions that are carried out conventionally (written tests). Innovation is needed in carrying out assessments, especially formative assessments, namely by utilizing technology in the form of games.

Based on the problems and supporting theories, it is realized that there are not many studies that specifically design games-based formative assessments using wordwall on atomic theory material, even though this platform has great potential to support interactive learning evaluation. Therefore, the implementation of wordwall-based formative assessment is important to overcome the limitations of conventional methods and to encourage the creation of more effective and engaging learning evaluations. Based on this, the researcher intends to carry out a study aimed at producing a feasible formative assessment product utilizing wordwall media on the concept of atomic theory to be used in chemistry learning.

Methods

The research method used is research and development (R&D) with the ADDIE model. This model consists of five stages: analysis, design, development, implementation, and evaluation. But, this study was limited to the development phase, as the focus was to determine the validity of the product and gather responses from both teachers and students.

The subject of this study is a formative assessment medium utilizing wordwall games, specifically designed for the topic of atomic theory development. Data collection was conducted through direct communication (interviews) and indirect methods, including validation and response questionnaires for students and chemistry teachers. Prior to its use, the research instrument underwent content validation to ensure its appropriateness. The validation results were analyzed using the Gregory index and presented in a cross-tabulation format, as shown in Table 1.

Table 1. Gregory's cross tabulation

		Expert 1	
		Not relevant	Relevant
Expert 2	Not relevant	A	B
	Relevant	C	D

The results of the instrument content validation obtained from the Gregory cross tabulation table are then calculated using Equation 1, namely the following Gregory equation.

$$\text{Content validity coefficient} = \frac{D}{A+B+C+D} \quad (1)$$

Description:

A : Both experts disagree, scoring in the range of (1-2)

B : Expert 1 agrees (3-4), while expert 2 diasgrees (1-2)

C : expert 1 disagrees (1-2), while expert (3-4)

D : Both experts agree, scoring in the range (3-4)

The calculation obtained from equation 1 is matched with the content validity coefficient category found in Table 2.

Table 2. Content validity categories

Coeficient	Category
0.80-1.00	Very high validity
0.60-0.79	High validity
0.40-0.59	Medium validity
0.20-0.39	Low validity
0.00-0.19	Very low validity

After the instrument was declared feasible, the product was tested for validity by experts from the media and question aspects, namely two media experts and two question experts. The validity test in this study used a Likert scale with four rating scales, namely score 1 (strongly agree), score 2 (agree), score 3 (disagree) and score 4 (strongly disagree). The Likert scale criteria used are in Table 3.

Table 3. Likert scale criteria

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

The data from the validation test were then analyzed both qualitatively and quantitatively. The qualitative analysis included criticisms and suggestions from experts or

experts, while the quantitative analysis was based on the scores provided in the assessment questionnaires. Additional numerical data were also gathered from the response sheets completed by chemistry teachers and students. These scores were then converted into percentages to determine the feasibility of the developed product. The results for each statement are summarized in Table 4.

Table 4. Criterion index of validation results

Index (%)	Criteria
80<x≤100	Very valid
60<x≤80	Valid
40<x≤60	Valid enough
20<x≤40	Invalid
0<x≤20	Very invalid

After being declared valid by experts, the next stage is the response test to chemistry teachers and students. The samples used for the response test were three chemistry teachers and grade 10 students of Senior High School Number 6 Pontianak. The sampling technique for students used one to one evaluation, small group evaluation and field test with a total of 44 students. In taking response data, a Likert scale response questionnaire with four scales was used, namely score 1 (strongly agree), score 2 (agree), score 3 (disagree) and score 4 (strongly disagree). Likert scale and criteria on the response questionnaire of teachers and students can be seen in Table 5.

Table 5. Likert scale and criteria on the response questionnaire

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

The score for each statement was converted into a percentage to determine the level of product feasibility. Based on the results of the data analysis, conclusions were drawn regarding the responses of teachers and students to the formative assessment product, as presented in Table 6.

Table 6. Criteria for the results of teacher and participant responses

Index (%)	Criteria
80<x≤100	Very interesting
60<x≤80	Interesting
40<x≤60	Interesting enough
20<x≤40	Not interesting
0<x≤20	Very uninteresting

Results and Discussion

This study developed a formative assessment based on wordwall games on the material of atomic theory with the ADDIE model. The results obtained in this study are the validity of formative assessments and the responses of students and chemistry teachers. The results of the research and its discussion are explained based on the stages that have been carried out which consist of the stages of analysis, design and development. The research was only carried out up to the third stage, namely the development stage.

Analysis stage

At the analysis stage, the researcher conducted needs and material analysis. The needs analysis was carried out to capture the respondents' wishes. The needs analysis stage was carried out by conducting interviews with chemistry teachers at senior high school number 6 Pontianak. Based on the results of the interview, it was concluded that chemistry teachers at senior high school number 6 Pontianak often carry out formative assessment/evaluation of learning in class but the implementation is generally carried out conventionally. The implementation of assessment in learning is still less than optimal, teachers generally use evaluation tests, both in the form of essays and multiple choices, which are still carried out conventionally through written tests (Duda et al., 2023). Supporting infrastructure such as internet access and technological devices are actually available, but have not been optimally utilized for evaluation because teachers are accustomed to conventional learning evaluation methods, which with this method the motivation of students to take part in learning evaluations is low. In line with research that mentions if many teachers are still stuck in the assessment patterns used in the previous curriculum and are reluctant to improve skills because they face difficulties in using technology, and feel that online training requires too much time (Serani & Hairida, 2024). The use of assessment media is expected to increase students` enthusiasm, make the assessment process more efficient, and help them understand the material more deeply (Nuraeni et al., 2022)

The next step is for researchers to analyze the material. One of the materials, especially chemistry, which is often found still using conventional methods in carrying out formative assessments is the development of atomic theory. At the material analysis stage, researchers analyzed the learning outcomes and objectives prepared by chemistry teachers in class 10 Senior High School Number 6 Pontianak. At the material analysis stage, an evaluation of the learning objectives expected to be achieved by students and an analysis of the indicators used to achieve learning objectives were carried out. In addition, the material is also analyzed to match the demands of the indicators and learning objectives (Muna & Whardana, 2022) . It is from these learning objectives that researchers formulate the lattice of formative assessment questions to be developed.

1. Able to compare the development of atomic theory from Dalton's atom to quantum mechanical atomic theory
2. Critique the development of atomic theory to understand the development of natural science

Design stage

The design stage aims to design the concept of the product to be developed. At the design stage, the selection and preparation of the evaluation tool product design is carried out (Muna & Whardana, 2022). This stage is carried out to make it easier for researchers to carry out development. The design stages are determining the question grids formulated from learning objectives and learning outcomes, determining the template games used, namely using the quiz game show template. The draft model that has been prepared will later enter the development stage (Saputro, 2016). In addition to the assessment instrument, the researcher also compiled an expert validation instrument to obtain product

validity. This instrument is in the form of an expert assessment questionnaire from instrument validation experts, question experts and media experts. The question validation questionnaire grid includes 3 aspects shown in Table 7.

Table 7. Material validation questionnaire grid

Aspects	Indicators	Item	Number of
Material suitability	Compatibility of questions	1	5
	Suitability of questions with	2	
	Suitability of questions to	3, 4 & 5	
Accuracy and difficulty	Difficulty level of the question	6	2
	Alignment of questions and	7	
Clarity and language eligibility	Language clarity	8	3
	Avoidance of ambiguous and biased terms	9 & 10	

The media validation questionnaire grid is shown to include three aspects, namely the physical appearance of the games, ease of access and use, technology shown in Table 8.

Table 8. Media validation questionnaire grid

Aspects	Indicators	Item Number	Number of
Physical Display *Games*	Game Display *Design*	1	5
	Text and Visual Elements	2 & 3	
	Interactive Features and	4 & 5	
Ease of Access & Use	Ease of Access	6	3
	Clarity of Instructions	7	
	Game *Session Duration*	8	
Technology	Stability	9	1

Then, the researchers developed two types of instruments: an teacher response questionnaire and a student version. The structure of the student questionnaire is presented in Table 9.

Table 9. Chemistry teacher response questionnaire grid

Aspects	Aspects	Item	Number of
Display	Text readability	1	2
	Attractiveness of the display	2	
Language	Communicative	3	1
Use	Ease of use	5	8
	Student engagement	4, 7, 8, 9	
	Appeal of the app	6, 10. 11	

While the response test to teachers involved 3 chemistry teachers of Senior high school number 6 Pontianak. The questionnaire grids of teachers' responses are shown in Table 10.

Table 10. Teacher response questionnaire grid

Aspects	Indicator	Item	Number of
Language	Conformity with the level of	1	3
	Communicative	2, 3	
Display	Text readability	4, 5	3
	Image media functions	6,	
Use	Ease of use	8	6
	Effectiveness and innovation	7, 9, 11	
	Student engagement	10	
	Highlights	12	

Development stage

The development stage involves the realization of the planned product design. This phase is carried out based on the design formulated in the previous step. The outcomes include the creation of the product, content validation of instruments, assessment of question quality, media validation, as well as response tests from teachers and students. The following section presents a detailed explanation of each procedure within this phase.

At the product design realization stage, researchers began designing the appearance of wordwall games and adjusting them to the questions that had been compiled. At this stage, the development of the product design using wordwall is carried out. After the media is made, validation is then carried out. After the design and development process is complete, the next step is the expert testing stage. At this stage, validation is carried out by experts, including content, question, and media. This expert validation is very important to ensure that the products produced meet the standards and are in accordance with the needs (Rayanto & Sugianti, 2020). The first validation is instrument validation. Content validation of question instruments is carried out to ensure that each item developed has high relevance and is in accordance with the learning objectives that have been set. Instrument grids and question items are submitted to experts to be assessed for validity. The results of the assessment will later be used as a basis for improving the instrument (Jusuf & Istiyowati, 2023). The results of the instrument validation are explained in Table 11.

Table 11. Cross tabulation of instrument content validation results

		Expert 1	
		Not relevant	Relevant
Expert 2	Not relevant	0	1
	Relevant	0	8

Based on the results of the cross tabulation analysis, most of the items are considered to have a high level of relevance, with a content validity score of 0.89 which is in the very high category. The instrument is declared valid if the price is above 0.50 (Susetyo, 2015). The validation results show that the questions developed have met the quality standards in terms of material suitability, structure, and language clarity. The question instrument demonstrates a very high level of validity, indicating its appropriateness for use in formative assessment.

After the instrument is declared valid, then the question validation is carried out. The question validation was carried out by 2 experts, namely a chemistry education lecturer at Tanjungpura University and a chemistry education lecturer at Muhammadiyah Pontianak University offline. This validation aims to determine the level of validity of the questions on the development product. The results of question validation can be seen in Figure 1.

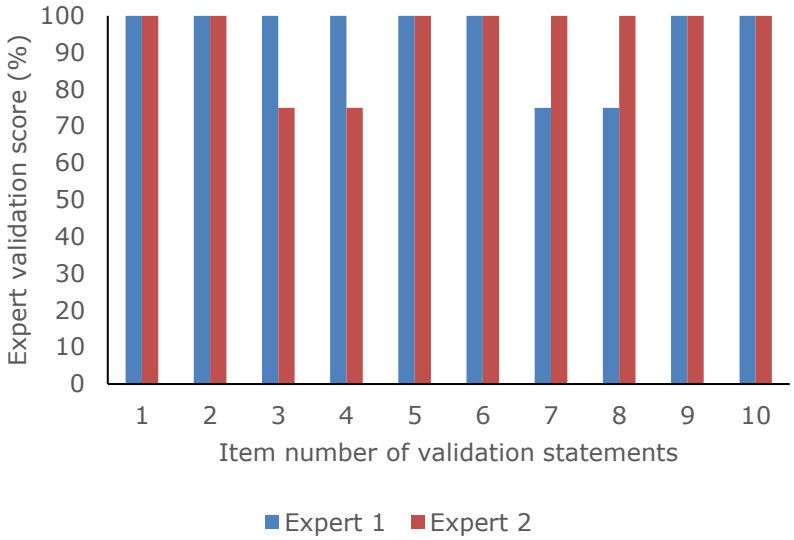


Figure 1. Question validation results

Based on Figure 1, there are ten statements that are tested to assess the quality of the questions. The first statement shows that the questions are in accordance with the indicators of competency achievement on the development of atomic theory, with 100% perfect validation. The second statement also received full validation, indicating that the questions had covered the complete history of atomic theory, from Dalton's model to quantum mechanics. In the third statement, which assesses whether the questions help students understand the core concepts of each atomic model, there is a difference of opinion between expert 1 who gave 100% validation and expert 2 who only 75%, so revisions need to be made to be more effective in exploring core concepts. The same thing happened in the fourth statement, which tested the extent to which the questions encouraged students to think critically about the concept of atomic theory. Expert 1 gave 100% validation, while expert 2 only 75%, indicating that there is still room for improvement to make the questions more challenging in developing students' analytical skills.

Furthermore, in the fifth statement, the question was considered very valid with 100% validation in helping students understand the advantages and disadvantages of each atomic model. Similarly, the sixth statement, which assessed the variation in the level of difficulty of the questions, also obtained perfect validation. However, in the seventh statement, related to the alignment between the question material and answer options, there was a difference of opinion between expert 1 who gave 75% validation and expert 2 who gave 100%, indicating that some questions still needed to be improved. The eighth statement regarding the clarity of the question language also showed differences in views, where expert 1 gave 75% and expert 2 gave 100%, so some parts still need to be simplified to make it easier for students to understand. Meanwhile, the ninth and tenth statements, which assessed the use of terms and the absence of bias or multiple interpretations in the questions, received 100% full validation, indicating that the questions had been clearly structured and did not cause ambiguity.

Overall, the validation shows that the questions have very good quality. This is reflected in the validation results which obtained an average validation score of 95% with a very feasible category, although there are several aspects that can be improved to be more optimal in measuring student understanding. These validation results evaluate the representativeness of the material in achieving learning objectives (Leite et al., 2018). The suggestions given by experts on several questions are shown in Table 12.

Table 12. Revisions based on question validation feedback

Expert advice	Revision
Question number 5 regarding the phenomenon that occurs on the mill is changed to focus on the nature of cathode rays	Question number 5 is changed to a conclusion about the properties of cathode rays
Question number 9 regarding solar power technology was omitted because the scope was too deep	Question number 9 is not used in formative assessment questions
Question number 10 regarding the use of MRI was omitted because the scope was too deep	Question number 10 is not used in formative assessment questions

In addition to question validation, media aspects were also validated. Validation of media aspects was carried out by 2 experts. This validation aims to determine the validity level of the development product from the media aspect. The results of media validation can be seen in Figure 2.

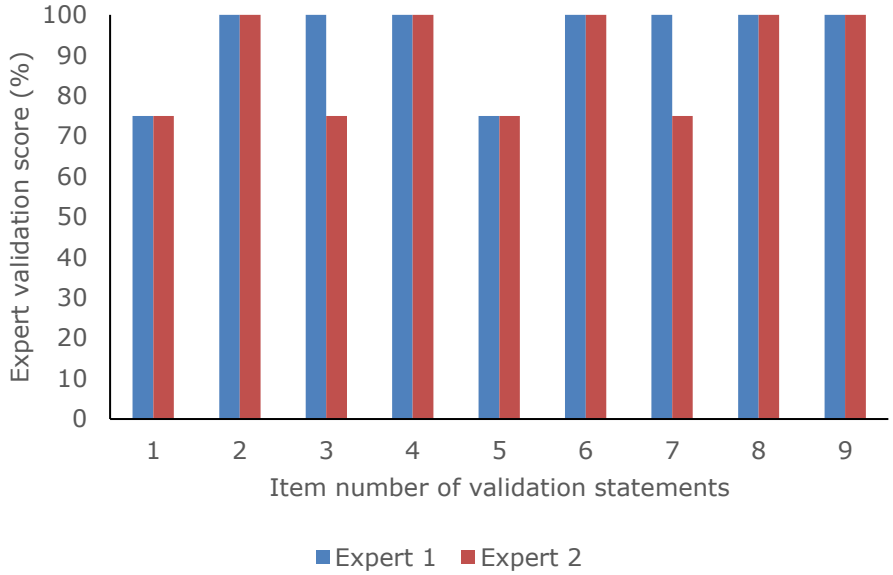
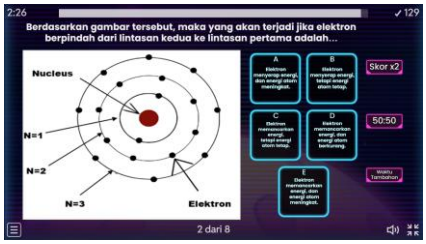


Figure 2. Media validation results

Based on the results of media validation shown in Figure 2, there are nine statements assessed in the wordwall game on the material of the development of atomic theory. In the first statement regarding the design of the game display, both experts gave 75% validation, which shows that the display is quite attractive and in accordance with the material, but still needs improvement. One suggestion for improvement is to change the theme to make it more relevant to the atomic concept. Meanwhile, in the second statement, which assessed the clarity of text and visual elements in supporting student understanding, the validation reached 100%, confirming that the elements in the game had been designed very well. The third statement regarding design elements (colors, fonts, images) received different validations from the two experts, where expert 1 gave 100%, while expert 2 only 75%, indicating the potential for improvement, especially in increasing the contrast of text colors to make it clearer.

Furthermore, the fourth statement assessing the effectiveness of the in-game help features received a perfect validation of 100%, indicating that features such as x2 score, 50:50, and extra time were able to increase students' active participation. The fifth statement regarding in-game feedback received a 75% validation, indicating that the game is good enough in providing feedback, but can still be improved by displaying the correct answer when students answer incorrectly. The sixth statement regarding the ease of access to the game received a full validation of 100%, indicating that the game can be accessed by the students easy through various devices. The seventh statement regarding the clarity of instructions in the game received 100% validation from expert 1 and 75% from expert 2, which indicates that there still needs to be improvements in the presentation of instructions, for example by adding information at the beginning of the game. The eighth statement regarding the duration of the game that matches the learning time, as well as the ninth statement regarding the stability of the technology, both obtained a perfect validation of 100%. Overall, the validation from both experts shows that the game has very good quality with an average validation of 91.67%, indicating that this formative assessment media has very good quality. Nevertheless, there are some things that must be improved from the media that have been made. The suggestions from the experts to make improvements are shown in Table 13.

Table 13. Media revision results

Before revision	After the revision
Changed theme directly related to atoms	Because there is no theme related to atoms in the quiz game show template, the researcher changed the theme to space which is more related to science
	
The color of the writing is less contrasting so it looks blurry	Text fonts are clearly visible when using a space theme
	
Need appreciation for right and wrong	The answer is displayed when the student answers the question incorrectly

Need instructions at the beginning regarding assistance

Instructions regarding the power up feature added at the beginning of the game

After the product is declared valid from the aspects of questions and media, the product is ready to be tested for response, namely to chemistry teachers and students. The test to teachers was carried out to find out the responses, reactions and comments of teachers on the assessment media developed. The results of the response test of chemistry teachers at senior high school number 6 Pontianak are shown in Figure 3.

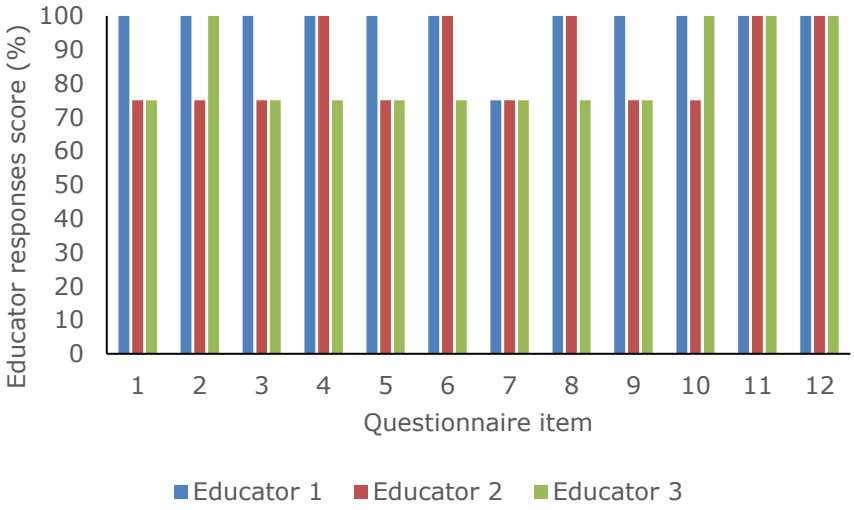


Figure 3. Teacher response test results

Based on Figure 3, the responses of the three chemistry teachers in the first statement regarding the suitability of the language to the level of audience understanding show that teacher 1 gave 100% validation, while teachers 2 and 3 gave 75%. This indicates that the language used in the wordwall is quite suitable for the level of understanding of students. The second statement about the ease of understanding the language showed that teachers 1 and 3 gave 100%, while teacher 2 gave 75%. The majority of teachers rated the language in wordwall as easy to understand. The third statement related to language ambiguity showed that teacher 1 gave 100%, while teachers 2 and 3 gave 75%. This result shows that the language in the wordwall is generally clear, but there are still

some parts that can cause multiple interpretations according to teachers 2 and 3. The fourth statement regarding the clarity and readability of the text in the wordwall shows that teachers 1 and 2 gave 100%, while teacher 3 gave 75%. This shows that the majority of teachers rated the text in the wordwall as clear and easy to read. The fifth statement related to the attractiveness of the theme showed that teacher 1 gave 100%, while teachers 2 and 3 gave 75%. This indicates that the theme used in the wordwall is quite interesting. The sixth statement regarding the function of the picture media showed that teachers 1 and 2 gave 100%, while teacher 3 gave 75%. The majority of teachers agreed that the picture media functioned well and helped students' understanding.

The seventh statement about the effectiveness of wordwall in assessing students' understanding of the material on the development of atomic theory showed that all teachers gave 75% validation. Although this game is quite effective as an evaluation tool, there are still some aspects that need to be improved in order to measure student understanding more comprehensively. The eighth statement regarding the ease of use of wordwall showed that teachers 1 and 2 gave 100%, while teacher 3 gave 75%. Overall, wordwall is considered easy to use, although there are still some aspects that can be improved to increase user comfort. The ninth statement about new experience in designing formative assessments showed that teacher 1 gave 100%, while teachers 2 and 3 gave 75%. This result shows that wordwall provides a new experience in preparing assessments. The tenth statement regarding increasing students' enthusiasm towards the assessment shows that teachers 1 and 3 gave 100%, while teacher 2 gave 75%. This shows that Wordwall is effective in increasing students' motivation through interesting game elements. The eleventh statement about wordwall's efficiency in saving teachers' time and effort in correcting answers showed that all teachers gave 100%. This confirms that wordwall is very helpful in automatically correcting answers, reducing teachers' workload, and increasing efficiency in assessment. The twelfth statement regarding teachers' interest in using wordwall in assessing other materials showed that all teachers gave 100%. This reflects the high enthusiasm of teachers towards wordwall as an effective and interesting assessment tool to be applied in various learning topics.

Overall, based on the analysis of all statements, the average percentage of teachers' responses was 88.8% with a very interesting category. These results indicate that wordwall-based formative assessment products are very well received by chemistry teachers and feasible to use in learning evaluation, especially on the material of atomic theory development. The positive response from chemistry teachers shows that this product is in accordance with modern learning needs. In the digital era, the utilization of technology such as wordwall in chemistry teaching can create a more interactive learning experience and in accordance with the preferences of digital era students. Overall, the high percentage of positive responses (88.8%) indicates that the wordwall game-based formative assessment on the development of atomic theory has great potential to be applied in chemistry learning.

This product is not only considered valid, but also seen as an innovation that can improve the quality of learning and assessment in chemistry education. In line with the findings in the form of teachers giving positive responses to the use of wordwall, assessing it as an interesting assessment and learning media and effective in increasing student learning motivation (Maryanti et al., 2022).

Student response test

The student response test was conducted to evaluate their level of acceptance and interest in the assessment media that had been developed. This stage is a crucial part of the media development process, because it provides insight into its effectiveness and attractiveness from the perspective of the main users, namely students. This test was conducted in three stages, namely one to one, small group, and field tests with the number of respondents increasing at each stage.

At the one to one stage, the media was tested on 3 students. According to Suparman (2012), three students come from students who have high, low and medium abilities so that they can be seen as a representative sample. In the one-to-one stage, researchers tested the design that had been developed to students as testers. The results of this trial were used as a basis for revising the design that had been made (Amini & Ginting, 2024). The results of the response test from the three students can be seen at Figure 4.

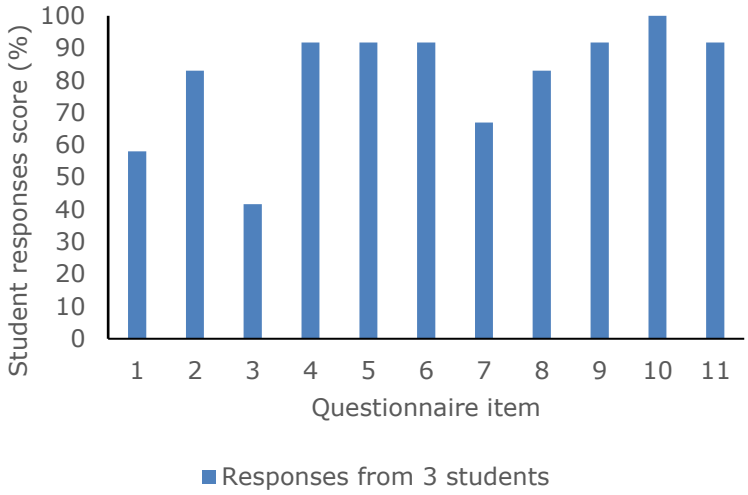


Figure 4. One-to-one evaluation response results

Based on the results of the one to one evaluation response test on three students, the results obtained on several aspects that received high scores, namely in statement 2, the wordwall display is quite interesting, the average percentage obtained is 83%. Statement 4 on the aspect of new experiences in evaluation gets an average percentage of 92%. Statement 5 regarding ease of use obtained an average percentage of 92%. Statement 6 regarding the interest in continuing to use wordwall also received an average percentage of 92%. Statement 7 regarding students' preference for wordwall over the paper method obtained an average percentage of 67%. Statement 8 regarding the increase in motivation to learn chemistry obtained an average percentage of 83%. Statement 9 regarding wordwall's ability to attract students' focus received an average percentage of 92%. Statement 10 shows that wordwall succeeded in increasing students' enthusiasm in solving problems with an average percentage of 100%. In addition, statement 11 regarding the effectiveness of wordwall in maintaining students' interest in learning shows an average percentage of 92%.

However, some aspects still need to be improved, such as the readability of the text in statement 1 which only obtained an average percentage of 58%, indicating that the font size, text color, or contrast with the background needs to be adjusted to be more optimal. The ease of understanding of the question language in statement 3 is also still low with an average percentage of 42%, indicating the need for language simplification to be more communicative and in accordance with the level of understanding of students.

Overall, based on the analysis of each statement item from 3 students, an average percentage of 81% was obtained in the very interesting category, indicating that this game is quite effective in attracting students' interest and attention. Differences in scores between students may reflect variations in experience or individual preferences for the media being tested. In general, the results of this evaluation provide good feedback and can form the basis for further improvements. The suggestion given by 2 out of 3 students was to increase the size of the text, so revisions were made according to this input. The results of the improvements are shown in Table 15.

Table 15. Revision results from the one to one evaluation stage

Student advice	Revision
The size of the writing on the question is too small	The size of the text is enlarged by Bolding the font
	

Small group

Revisions based on expert input and obstacles that arose during the one-to-one trial became the basis for improvement, which was then tested in small groups for further revision and continued to the field test stage (Amini & Ginting, 2024). At the small group stage, the media was tested on 9 students who represented high, medium and low ability levels. The response test results of the nine students can be seen in Figure 5.

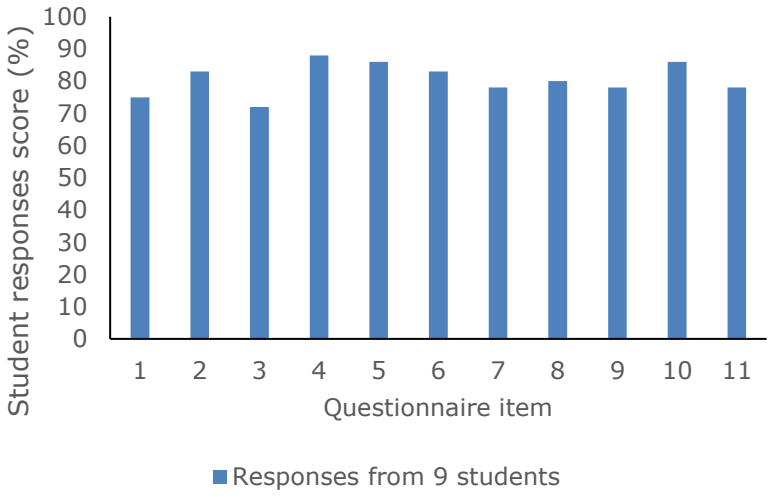


Figure 5. Small group response test results (n=9)

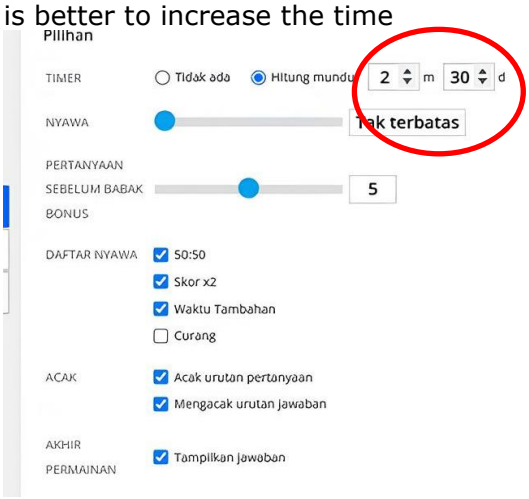
Based on the response test results of nine students at the small group stage, there was an increase in the average percentage compared to the one to one stage. This shows that after the improvements are made or with the involvement of more students, the understanding and experience in using wordwall is getting better. Some statement items showed a significant increase, such as in statement 1 regarding the readability of the text, which increased from 58% at the one to one stage to 75% at the small group stage, indicating an improvement in the readability aspect. Statement 3 regarding the ease of understanding the question language also increased from 42% at the one to one stage to 72% at the small group stage. Although it is still one of the aspects with the lowest percentage, this increase shows an improvement in the preparation of question language, although it still needs to be further simplified to make it easier students to understand. In addition, statement 7 regarding preference in working on questions using wordwall

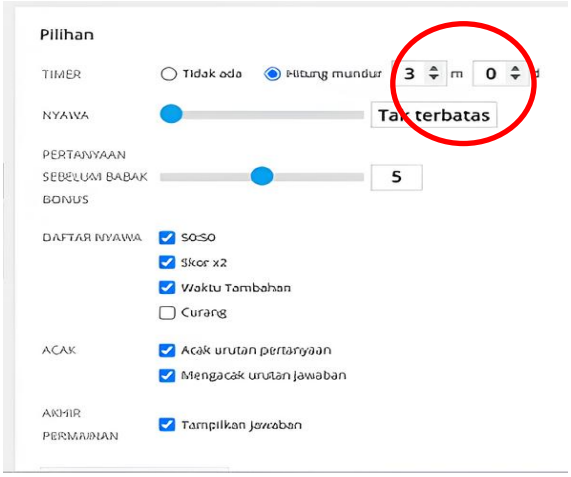
compared to the paper method increased from 67% at the one to one stage to 78% at the small group stage. This shows that after the improvement, more students feel comfortable with the use of wordwall as an assessment media.

Overall, the response test results at the small group stage showed an increase and positive response, with an average total percentage reaching 81%, which was categorized as very interesting. This shows that the wordwall-based assessment media is very well received and has a high level of satisfaction among students. This is in line with the finding that the assessment media tested received very positive responses from students (Pebriyanti, 2024). Meanwhile, the differences in scores that arise reflect variations in individual students' perceptions and experiences of the tested media, as explained by Gencoglu et al. (2021) differences in student perceptions in a class can be influenced by individual factors. One of the suggestions given by students is the addition of time to work on the questions. Some students provided input to add processing time, so revisions were made as in Table 17.

Table 17. Revised results of the small group stage

Student advice	Revision
The time to complete the question is too short if it is only 2 minutes 30 seconds, it is better to increase the time	The time to complete the questions is increased by 2 minutes 30 seconds to 3 minutes





Field test

After the small group test is carried out and validity is obtained, the next stage is the field test which is carried out in a class with between 25 and 35 students (Rayanto & Sugianti, 2020). Field tests are conducted to assess the feasibility, effectiveness, and validity of products in actual situations. This test aims to collect qualitative and quantitative data to obtain a more thorough evaluation and ensure that the product meets the needs of users. Field tests involve more respondents than the previous evaluation stage, thus providing a broader and more comprehensive picture of product performance in conditions close to real use. In line with the statement from Tessmer (2013) if the field test identifies weaknesses that may not have been detected in previous evaluation stages, it helps ensure that the media is ready for widespread use and meets the needs of users in actual situations. Thus, this testing allows the identification of potential problems that may not have been detected in smaller scale trials, as well as being the basis for final improvements before the product is implemented more widely. At the field test stage, the trial was conducted on 32 students, the results were obtained as shown in Figure 6.

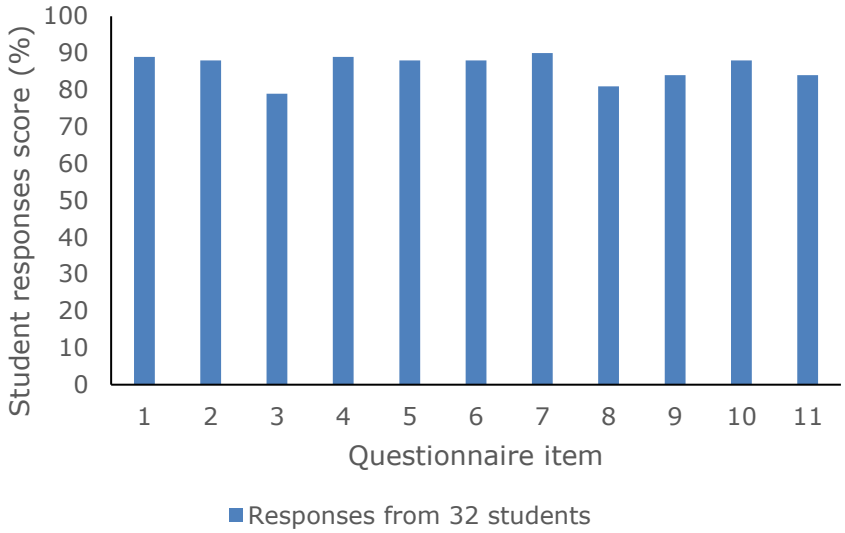


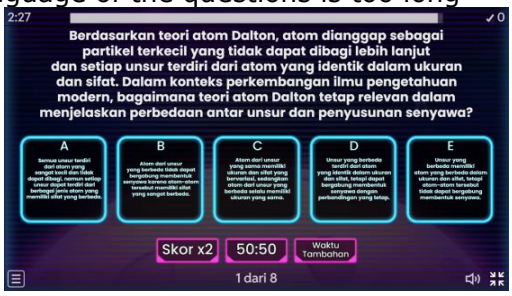
Figure 6. Student response scores for each item statement in the field test (n = 32).

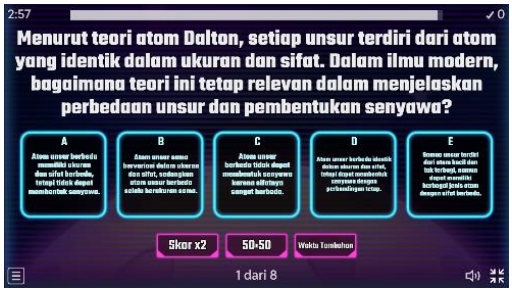
Based on the results of the field test response of 32 students, there was an increase in positive responses compared to the small group stage, indicating that the use of wordwall games is increasingly accepted on a larger scale. Of the 11 items tested, 10 of them experienced an increase in percentage, while one item, namely statement 10 regarding students' enthusiasm in solving problems using wordwall, experienced a slight decrease. However, the decrease is still in the high category, indicating that students remain motivated in working on problems with wordwall.

The results of the analysis of each statement item as a whole, the field trial results showed an average percentage of 86.3% with a very attractive category. This percentage reflects a positive response and a good level of acceptance of assessment media tested, and proves that wordwall can be an effective alternative in assessing learning outcomes. Although the results are very good, evaluation and improvement are still carried out to optimize the effectiveness of this media, both as an assessment tool and as a more attractive learning media. Some suggestions given by students in general are still the same, namely adding processing time, increasing the size of the text, and simplifying the language of questions that are too long. Therefore, revisions were made to the media by simplifying and shortening the question language so that the text size became larger and easier to read, as shown in Table 18.

Table 18. Revised results of the field test stage

Student advice	Revision
The writing of questions and answers is small and the language of the questions is too long	Questions and answers use simpler and shorter





Based on the results of the three stages of the student response test to the assessment media developed, a recap of the response test results is shown in Figure 7.

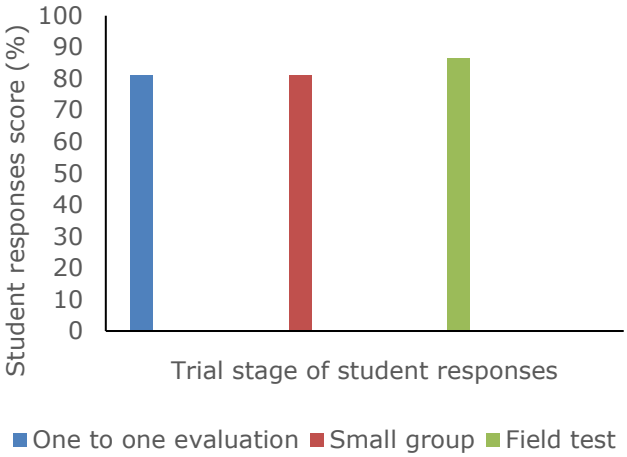


Figure 7. Recap of student response test results

The diagram in Figure 7 shows that the acceptance rate and interest of students increased along with the increase in the number of respondents at each stage of the trial. At the one to one stage, the media obtained a percentage of 81%, which was categorized as very interesting. Furthermore, at the small group stage, the percentage increased to 81%, which is categorized as very interesting. At the final stage, namely the field test, with a larger number of respondents, the percentage reached 86.3%, still in the very attractive category. So that the average percentage of the three stages of the trial was 82.76%. These results indicate that the assessment media developed received a positive response and was accepted by students after going through various stages of testing. The increase in percentage from each stage indicates that this media is effective in attracting interest (Pastilah & Putra, 2024) and supporting the assessment process.

Conclusion

The study concludes that the wordwall based formative assessment on atomic theory is of very high quality in terms of validity. The validation results showed a high level of validity, with a percentage of 95% for the question aspect and 91.67% for the media aspect. The results of the response test to chemistry teachers showed very positive results, with an average percentage reaching 88.8% which was categorized as very interesting and the response of students was 82.67% with a very interesting category.

References

Agustina, I., Joshua, W., Julanos, J., & Niva, M. 2024. The impact of implementing game-based learning on student motivation and engagement. *Journal Emerging Technologies in Education*, 2(3):241–253. https://doi.org/10.70177/jete.v2i3.1069

Amini, D., & Ginting, N. 2024. *Metode penelitian (kualitatif, kuantitatif, PTK, dan R&D)*. UMSU Press, Medan.

Ashari, M.K., Athoillah, S., & Faizin, M. 2023. Model e-asesmen berbasis aplikasi pada Sekolah Menengah Atas di era digital: Systematic literature review. *Ta'dibuna: Jurnal Pendidikan Agama Islam*, 6(2):132-150. https://doi.org/10.30659/jpai.6.2.132-150

Bez, S., Burkart, F., Tomasik, M.J., & Merk, S. 2025. How do teachers process technology-based formative assessment results in their daily practice? Results from process mining of think-aloud data. *Learning and Instruction*, 97:102100. https://doi.org/10.1016/j.learninstruc.2025.102100

Demekash, A.M., Degefu, H.W., & Woldeab, T.A. 2024. Secondary school EFL teachers' awareness for formative assessment for effective learning. *Heliyon*, 10(19):37793. https://doi.org/10.1016/j.heliyon.2024.e37793

Dewi, L.U., Irwandi, D., & Bahriah, E.S. 2019. Pengaruh media penilaian formatif online quizizz terhadap hasil belajar siswa materi sistem periodik unsur [The influence of online formative assessment media Quizizz on students' learning outcomes in the periodic table of elements.]. *Jurnal Riset Pendidikan Kimia*, 9(1):58–66. https://doi.org/10.21009/jrpk.111.04

Duda, H.J., Syafruddin, D., & Parida, L. 2023. Study of the use of assessment for learning and creative thinking skills of high school students. *Anatolian Journal of Education*, 8(2):69–84. https://doi.org/10.29333/aje.2023.825a

Efendi, M., Zulhimmah, Z., Nurhayani, & Harahap, H.A. 2024. penerapan asesmen formatif dan sumatif dalam kurikulum merdeka di Madrasah Aliyah Swasta Darul Hadits Huta Baringin. *Cognoscere: Jurnal Komunikasi Dan Media Pendidikan*, 2(2):64–72. https://doi.org/10.61292/cognoscere.169

Fatmawati, Yahya, F., & Sentaya, I.M. 2023. Pelatihan pelaksanaan asesmen diagnostik, formatif, dan sumatif berbantuan TIK untuk guru-guru Pasraman Widya Dharma. *Jurnal Pendidikan dan Pengabdian Masyarakat*, 6(3):154–161. https://doi.org/10.29303/jppm.v6i3.5595

Gencoglu, B., Helms-Lorenz, M., Maulana, R., & Jansen, E.P.W.A. 2021. A conceptual framework for understanding variability in student perceptions. *Frontiers in Psychology*, 12:725407. https://doi.org/10.3389/FPSYG.2021.725407

Hairida, Yani, A.T., Enawaty, E., Rasmawan, R., Muharini, R., Lestari, I., Ulfah, M., Hartoyo, A., Pranata, R., Seilendra, P.R., & Hafiz, M.I.A.. 2023. Training on making assessments and media based on technological pedagogical content knowledge (TPACK) in learning. *International Journal o f Public Devotion*, 6(2):139–146. https://doi.org/10.26737/ijpd.v6i2.4670

Hooda, M., Rana, C., Dahiya, O., Ali, R., & Hossain, M.S. 2022. Artificial intelligence for assessment and feedback to enhance student success in higher education. *Mathematical Problems in Engineering*, 2022:1-19. https://doi.org/10.1155/2022/5215722

Jusuf, H., & Istiyowati, L.S. 2023. *Penelitian R & D dalam bidang teknologi pendidikan*. Indonesia Emas Group, Bandung.

Kristanti, E., Kharisma, G.I., & Sari, N.P. 2021. Pelatihan penyusunan soal berbasis mobile learning sebagai upaya menghadapi era pendidikan 4.0 [Mobile learning-based question preparation training as an effort to face the era of education 4.0]. *Jurnal Widya Laksana*, 10(1):59-65 https://doi.org/10.23887/jwl.v10i1.28915

Leite, S.de S., Áfio, A.C.E., Carvalho, L.V.de, Silva, J.M.da, Almeida, P.C.de, & Pagliuca, L.M.F. 2018. Construction and validation of an educational content validation instrument in health. *Revista Brasileira de Enfermagem*, 71(4):1635–1641. https://doi.org/10.15900034-7167-2017-06 48

Maryanti, S., Hartati, S., & Kurniawan, D.T. 2022. Assessment for learning (AFL) melalui wordwall untuk pembelajaran biologi sekolah menengah oleh mahasiswa calon guru biologi. *Proceeding Biology Education Conference*, 19(1):216–222.

Muna, K.N., & Wardhana, S. 2022. Pengembangan media pembelajaran video animasi dengan model ADDIE pada pembelajaran bahasa indonesia materi perkenalan diri dan keluarga untuk kelas 1 SD. *EduStream: Jurnal Pendidikan Dasar*, 5(2):175–183. https://doi.org/10.26740/eds.v5n2.p175-183

Munawar, M., Hairida, H., & Hartoyo, A. 2024. Implementasi assesmen kurikulum merdeka di SD Negeri 03 Pontianak Selatan. *Jurnal Pendidikan Dasar Perkhasa: Jurnal Penelitian Pendidikan Dasar*, 10(1):521–533. https://doi.org/10.31932/jpdp.v10i1.3387

Nuraeni, F., Rahayu, P., Hasyim, B., Septiani, D., Khuluqiyah, D.A., & Nurinsani, D.A. 2022. Pengaplikasian wordwall sebagai media pembelajaran interaktif di Sekolah Dasar. *Sejahtera: Jurnal Inspirasi Mengabdi Untuk Negeri*, 2(1):60–68. https://doi.org/10.58192/sejahtera.v2i1.399

Pastilah, L., & Putra, A.P. 2024. Keperluan media wordwall pada materi sifat Allah di kelas VII MTs Terpadu Berkah Palangkaraya. *Muróbbî: Jurnal Ilmu Pendidikan*, 8(2):292–310. https://doi.org/10.52431/murobbi.v8i2.3158

Pebriyanti, V. 2024. The effectiveness of using quizizz as an assessment media in improving PAI learning outcomes in class vii.1 SMP Negeri 4 Lubuk Sikaping, *Proceedings of The Bukittinggi International Conference On Education*, 1:286–291.

Permatasari, S., Zulhafizh, Z., Septyanti, E., Mustika, T.P., Rasdana, O., Pernantah, P.S., & Rizka, M. 2023. Asesmen digital berbasis kahoot dalam evaluasi pembelajaran. *JIIP - Jurnal Ilmiah Ilmu Pendidikan*, 6(4):2710–2714. https://doi.org/10.54371/jiip.v6i4.1737

Rahmawati, H., Sufyan Zauri, A., Azami, M.I., Ismi, Y., & Ilmi, N. 2024. Pelatihan pembuatan asesmen digital dengan aplikasi quiz-maker i-spring bagi guru-guru SMA. *JMM (Jurnal Masyarakat Mandiri)*, 8(2):2292–2302. https://doi.org/10.31764/jmm.v8i2.21104

Rayanto, Y.H., & Sugianti. 2020. *ADDIE and R2D2 model development research: Theory & practice*. Lembaga Academic & Research Institute, Pasuruan.

Rorita, M., Ulfa, S., & Wedi, A. 2018. Pengembangan multimedia interaktif berbasis mobile learning pokok bahasan perkembangan teori atom mata pelajaran kimia kelas X SMA Panjura Malang. *Jinotep (Jurnal Inovasi dan Teknologi Pembelajaran) Kajian dan Riset Dalam Teknologi Pembelajaran,* 4(2):70–75. https://doi.org/10.17977/um031v4i22018p070

Saputro, B. 2016. *Manajemen penelitian pengembangan (R & D) bagi penyusun tesis dan disertasi.* Aswaja Pressindo, Yogyakarta.

Suparman, A. 2012. *Panduan para pengajar dan inovator pendidikan : desain instruksional modern*. Erlangga, Jakarta.

Serani, G., & Hairida, H. 2024. Implementasi asesmen pembelajaran kurikulum merdeka: kesulitan dan tantangan guru di Sekolah Dasar Kota Sintang. *Vox Edukasi: Jurnal Ilmiah Ilmu Pendidikan*, 15(1):79–90. https://doi.org/10.31932/VE.V15I1.3386

Sortwell, A., Trimble, K., Ferraz, R., Geelan, D.R., Hine, G., Ramirez-Campillo, R., Carter-Thuiller, B., Gkintoni, E., & Xuan, Q. 2024. A systematic review of meta-analyses on the

impact of formative assessment on k-12 students' learning: Toward sustainable quality education. *Sustainability,* 16(17):7826. https://doi.org/10.3390/su16177826

Sugihartini, N., Elmunsyah, H., Nurhadi, D., & Rahmawati, Y. 2025. Innovative web-based microteaching model: To improve the teaching skills of prospective informatics teachers in vocational high schools. *Social Sciences & Humanities*, 11:101344. https://doi.org/10.1016/J.SSAHO.2025.101344

Suprihanto, A. 2016. Pemanfaatan schoology untuk meningkatkan kemampuan membuat dokumen massal dengan mail merge siswa kelas x SMK Negeri 1 Bawen. *Skripsi*, Universitas Negeri Semarang.

Susetyo, B. 2015. *Prosedur penyusunan dan analisis tes untuk penilaian hasil belajar bidang kognitif (1st ed.).* Refika Aditama, Bandung.

Tessmer, M. 2013. *Planning and conducting formative evaluations*. Routledge, London.

Wiliyanti, V. & Shidqha, N.H. 2023. Penerapan PTS berbasis cbt untuk mengurangi limbah kertas dari lembar soal dan jawaban peserta didik, *Jurnal Abdimas Dosma* (JAD), 2(1):86–91. https://doi.org/10.70522/jad.v2i1.21

Zalillah, D., & Alfurqan, A. 2022. Penggunaan game interaktif wordwall dalam evaluasi mata pelajaran pendidikan agama islam di SDN 17 Gurun Laweh Padang. *Manazhim*, 4:491–504. https://doi.org/10.36088/manazhim.v4i2.1996