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Development Of Deep Learning-Based Teaching Modules Wordwall-Assisted To Improve Students Logical Thinking Ability

Nurlatifah[1], Raden Sri Ayu Ramadhana[2], Defri Rahmat[3], Rizki Kurniawan Rangkuti[4], Sri Tami Ningsih Daulay[5], Ebenezer Bonyah[6], Zohaib Hassan Sain[7]

[1,2,3,4]Mathematics Education, Faculty of Teacher Training and Education, Universitas Al Washliyah Labuhanbatu, Rantauprapat, Indonesia
[5]Biology Education, Faculty of Teacher Training and Education, Universitas Al Washliyah Labuhanbatu, Rantauprapat, Indonesia
[6]Mathematics Education, Faculty of Mathematics and Natural Science, Akenten Appiah Menka University, Ghana
[7]Mathematics Education, Faculty of Mathematics and Natural Science, Superior University, Pakistan
*Corresponding author, e-mail: nurlatifahazzahra881@gmail.com

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ABSTRACT

This study aims to develop a deep learning-based teaching module, assisted by Wordwall, on quadratic functions to improve students' mathematical logical thinking skills. The type of research used is Research and Development (R&D) with the ADDIE development model, which includes the stages of analysis, design, development, implementation, and evaluation. The subjects of the study were 36 students of class X8 of SMA Negeri 1 Rantau Selatan. The study showed that the developed teaching module was classified in the very valid category based on expert validation, with an average score of 3.81. The level of practicality of the module was also classified as very good based on the student response questionnaire with a percentage of 90.8%. In addition, the results of the effectiveness test showed an increase in students' mathematical logical thinking skills with an N-Gain value of 0.71, which is included in the high category, with an increase in the average pretest score of 54.96 to 85.50 in the posttest.

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INTRODUCTION

Mathematics plays a vital role in solving everyday problems, particularly those involving calculations. Mathematics is a fundamental science for developing modern science and technology. It plays a vital role in various disciplines and fosters human thought. Mathematics learning serves as a means to develop critical, logical, creative, and collaborative thinking skills, which students need in today's increasingly advanced world. Therefore, the learning process is expected to bring about changes in knowledge, skills, and reasoning by improving students' logical thinking abilities and attitude (Ahmad et al., 2022; Annur et al., 2025; Ritonga et al., 2025).

The ability to think logically, or what is known as systematic thinking (systems thinking), is a thinking process ability by integrating or connects learning with events in everyday life based on facts, in addition to using logical thinking consistently to reach a decision conclusion. The indicators of logical thinking ability are the sequence of thoughts and the ability to argue and draw conclusions (Annisa, 2023; Aqib et al., 2023; Ardiana et al., 2023).

Based on the results of observations of class X at SMA Negeri 1 Rantau Selatan which stated that students' logical-mathematical thinking ability is still low. This is also supported by the results of the initial test of logical thinking ability conducted on class X students at SMA Negeri 1 Rantau Selatan by giving 1 essay question on the quadratic function material obtained from 36 students, only 10 students were able to answer the question but did not meet the logical thinking indicator, and 26 other students were unable to solve the problem. The percentage of students who were able to solve the problem was 27.78%, and the percentage of students who were unable to solve the problem was 72.22%. Students were unable to observe the meaning of the question and were unable to analyze the problem given.

The tests given during the observation are as shown in Figure 1 below. In the picture on the side, it can be concluded that the student's answer is still not correct because he did not complete the steps for solving the answer in the question until the end. Observation Questions indicate that students' logical thinking skills are still low. One cause of this low logical thinking ability is the obstacles to achieving learning outcomes during the learning

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process. The teaching materials used by teachers and students in the learning process are still insufficiently supportive, resulting in low student interest due to the lack of engaging learning. Therefore, in line with this, innovation in student learning is essential for understanding the material. Supporting teaching materials are also needed.

The deep learning approach is considered relevant to addressing this challenge. In an educational context, deep learning is defined as a learning process that encourages in-depth conceptual understanding, the interconnections between concepts, and the ability to apply knowledge in real-world situations. Deep learning positions students as active subjects involved in the process of exploration, analysis, reflection, and problem-solving. Deep learning models can be presented alongside engaging and engaging teaching materials, thus facilitating students' mathematics learning (Jupriaman et al., 2021; Ekawati et al., 2021).

Deep learning models supported by educational games like Wordwall have several advantages. First, this model can improve students' mathematical connection skills by providing real-world contexts and practical applications of mathematical concepts. Second, the use of educational games can increase student motivation and engagement in learning, thus encouraging them to learn independently. Third, platforms like Wordwall enable teachers to create interactive and engaging learning materials, which can be tailored to students' needs and ability levels. In addition to learning approaches, the use of innovative learning media is also an important factor in improving the quality of learning (Ekawati et al., 2021; Hodiyanto et al., 2021; Astuti et al., 2025; Hofifah et al., 2025).

Selecting the right learning method to influence students' logical thinking skills involves developing learning modules. A learning module is a comprehensive and systematically packaged learning program that focuses on student engagement, enabling independent learning (Lubis et al., 2021; Setiawan et al., 2022). The presentation of a learning module will also be more engaging if the learning is complemented by engaging learning applications. Learning implementation can be made more engaging and enjoyable through the use of Wordwall learning applications, not just learning models and methods (Ramadhana et al., 2020; Badung, 2021; Nurzanna et al., 2026).

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Wordwall is a website-based platform for easily creating interactive learning media, such as quizzes, anagram matching, word scrambles, and other educational games. Wordwalls can increase student participation in learning, allowing teachers to create interactive activities such as quizzes, concept matching, and educational games to suit student needs, and can also increase student participation in learning (Lubis et al., 2020; Rangkuti, 2020; Rangkuti et al., 2021; Kusuma, 2025). Based on the problems that have been described, a learning innovation is needed that is able to accommodate students' needs in developing logical thinking skills.

RESEARCH METHOD

Types of research

This research is a type of research and development (Research and Development). This research aims to develop a deep learning- based teaching module using the Wordwall application to improve students' logical mathematical thinking skills. The development model used is the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation.

Place and Time of Research

This research was conducted at SMA Negeri 1 Rantau Selatan. The subjects were 36 students in class X8, consisting of 21 female students and 15 male students. The research was conducted in the even semester of the 2025/2026 academic year on the topic of quadratic functions.

Research Procedures

This research procedure uses the ADDIE development model. Instructional Design (Learning Design) was developed using the ADDIE approach, which stands for Analysis, Design, Development, Implementation, and Evaluation (Pasaribu et al., 2020; Rustandi, 2021; Rahmat et al., 2026). The resulting learning product is a learning module, which serves as a learning medium for mathematics at SMA Negeri 1 Rantau Selatan. The learning media is equipped with a learning module.

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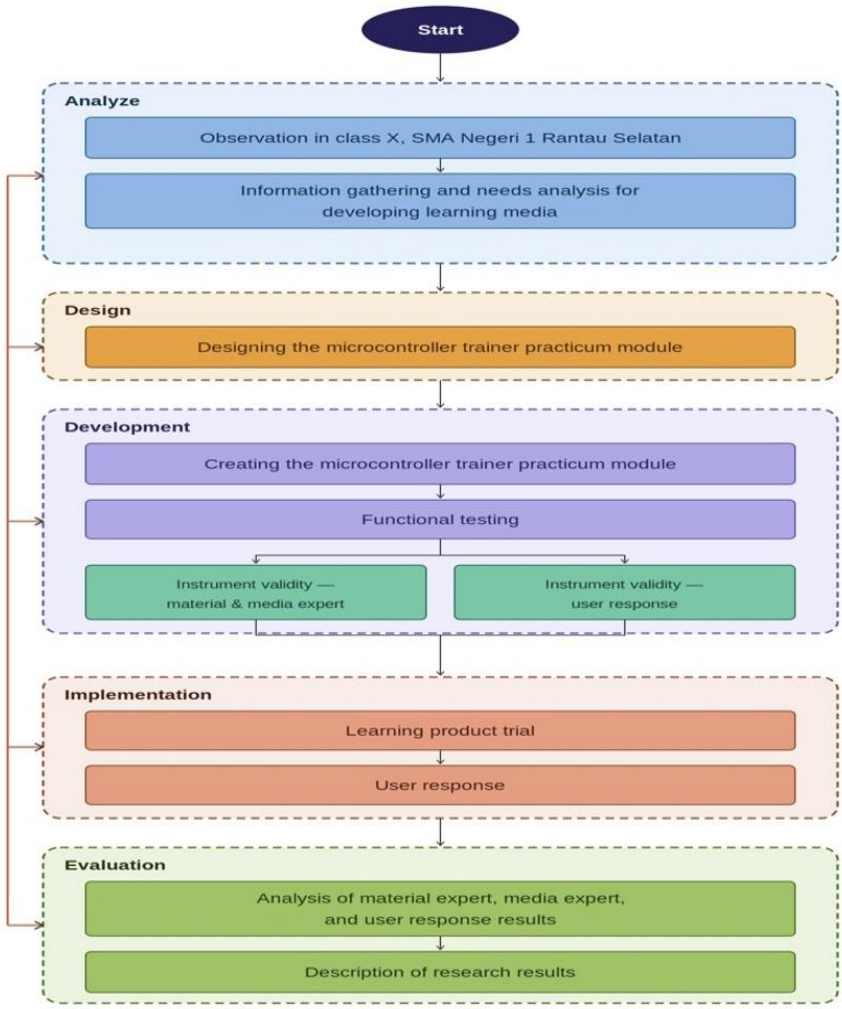


Figure 1. Flowchart of the ADDIE Development Model

This research procedure uses the ADDIE model with the following stages:

1. Analysis Stage

At this stage, a learning needs analysis is conducted to identify problems that occur in the classroom. The analysis includes: (a) Analysis of teacher needs in teaching mathematics, (b) Analysis of students' needs in understanding the concept of quadratic functions, (c) Analysis of students' mathematical logical thinking abilities, (d) Curriculum analysis (Independent Curriculum). The results of the analysis are used as a basis for designing a teaching module (Aeni et al., 2022).

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2. Design Stage

At this stage, a deep learning- based teaching module is designed. Activities carried out include: (a) Developing learning objectives, (b) Designing problem-based learning scenarios, (c) Developing contextual quadratic function material, (d) Designing the teaching module display, (e) Designing interactive activities using Wordwall.

3. Development Stage

This stage aims to produce an initial product in the form of a teaching module. Activities carried out include: (a) Compiling a complete teaching module (material, sample questions, exercises, and activities), (b) Creating interactive media using Wordwall, (c) Compiling research instruments, (d) Validation by subject matter and media experts. Validation results are used to revise the module to ensure it is suitable for use.

4. Implementation Stage

The developed teaching modules are applied in the classroom learning process. This stage aims to find out: (a) the practicality of the teaching module, (b) Student respons to learning, (c) Implementation of learning.

5. Evaluation Stage

The evaluation stage is carried out to assess the quality and effectiveness of the teaching module. The evaluation is based on: (a) the results of the students' logical thinking ability test, (b) the results of the student response questionnaire, (c) the results of observations. The evaluation results are used to improve the teaching module.

Data Collection Instruments and Techniques

1. Validation Shee

The validation sheet is used to assess the feasibility of the teaching module. The assessment is conducted by subject matter experts and media experts using a Likert scale of 1–5, as follows:

1 = very less
2 = less
3 = enough

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4 = go

2. Observation

Observation is a specific data collection technique to directly observe student activities regarding student attitudes and readiness in the learning process. Observations are used to monitor student activities and the implementation of learning. Observations are conducted before and during the use of the teaching module.

3. Student Response Questionnaire

The questionnaire was used to determine students' responses to learning. The scale used was:

1 = disagree
2 = disagree
3 = agree
4 = strongly agree

4. Mathematical Logical Thinking Ability

The test is in the form of descriptive questions that are used to measure students' logical thinking abilities. After learning data analysis techniques (important addition).

1. Validity Analysis

The validity value is calculated using the formula:

$$v = \frac{maximum\ score}{score\ obtained}\ x\ 100\%$$

(Adhiatma et al., 2025)

Information:
V = Percentage of validity
score obtained = total score validator
maximum score = highest possible score obtained

Criteria:
81 – 100% = very valid
61 – 80% = valid
41 – 60% = quined valid
≤40% = invalid

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The teaching module is declared valid if it obtains a percentage of ÿ 61% (valid or very valid category).

2. Practicality Analysis

Calculated from student response questionnaire:

$$P = \frac{maximum\ score}{score\ obtained}\ x\ 100\%$$

(Adhiatma et al., 2025)

Information:
P = percentage of practicality
score obtained = total score of questionnaire results
maximum score = highest possible score obtained

Criteria:
≥ 81% = very practical
61 – 80% = practical
41 – 60% = sufficient
≤ 40% = not practical
A product is declared practical if it obtains a percentage of ÿ 61% (practical or very practical category).

3. Effectiveness Analysis

A module is said to be effective if:

- ≥ 85% of students achieved minimum mastery criteria
- Average score increased
- Positive student response

RESULTS AND DISCUSSION

This research is a type of Research and Development (Sukma et al., 2022; Suprihatiningsih at al., 2025; Suprihatiningsih et al., 2026) with research products in the form of developing a Deep Learning- based teaching module assisted by Wordwall. The purpose of this study is to describe: (1) whether or not the developed teaching module is feasible; (2) the improvement of students' mathematical logical thinking skills on quadratic function material; (3) teaching modules that meet the criteria of being valid, practical, and effective in improving students' mathematical logical thinking skills at SMA Negeri 1 Rantau Selatan.

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The stages of developing a Deep Learning-based teaching module assisted by Wordwall consist of:

a. Analysis Stage (Analyze)

At this stage, an initial analysis was carried out as a basis for developing a teaching module (Samsir et al., 2021; Uripno et al., 2024; Nun et al., 2025; Tupulu et al., 2025) based on Deep Learning assisted by Wordwall on the quadratic function material. The analysis carried out includes the following: (1) Needs analysis, namely that learning quadratic functions still uses textbooks and PowerPoint (PPT) media and tends to be teacher-centered. This condition causes students to be less active in the learning process. (2) Student analysis shows that students still have difficulty understanding the concept of quadratic functions, especially in determining graphs, intercepts, axes of symmetry, and vertices. Students' logical mathematical thinking skills also need to be improved, as seen in students' difficulties in providing reasons, arranging sequential solution steps, and drawing conclusions. The results of the analysis of student characteristics show that students are more interested in learning that involves interactive media and activities that allow them to participate actively. (3) Analysis of material, namely that quadratic functions consist of the basic concepts of quadratic functions, quadratic function graphs, decimals, definitions, and their equations. (4) Analysis of learning objectives, namely that students can understand the concept of quadratic functions, determine the characteristics of quadratic function graphs, solve problems related to quadratic functions, and demonstrate logical mathematical thinking skills in the problem-solving process. (5) Analysis of learning media, namely that quadratic function learning still uses textbooks and PowerPoint (PPT) media.

b. Design Stage

At this stage, an initial design was carried out to develop a Deep Learning-based teaching module assisted by Wordwall on the quadratic function material. The activities carried out included the following steps: (1) Preparation of test instruments, namely compiling questions to measure students' logical mathematical thinking abilities on the quadratic function material. The preparation of tests was adjusted to the learning objectives

and the results of the analysis of student characteristics, (2) Preparation of teaching materials, namely preparing a Deep Learning-based teaching module assisted by Wordwall that contained quadratic function material, such as the general form of the quadratic function, function values, quadratic function graphs, points of intersection with the coordinate axes, axes of symmetry, and vertices. In addition, supporting media were also prepared. Such as whiteboards, markers, and other aids to help students understand concepts and solve problems given, (3) Format selection, namely determining the appearance of the module so that it is attractive, easy to understand, and appropriate to student characteristics. The selection of colors, layout, images, and presentation of material is designed to support a meaningful learning experience. The module format is also adjusted to the provisions of the Independent Curriculum and (4) Initial design, namely compiling an initial draft in the form of a Deep Learning-based teaching module assisted by Wordwall on the quadratic function material along with a test instrument for students' logical mathematical thinking abilities.

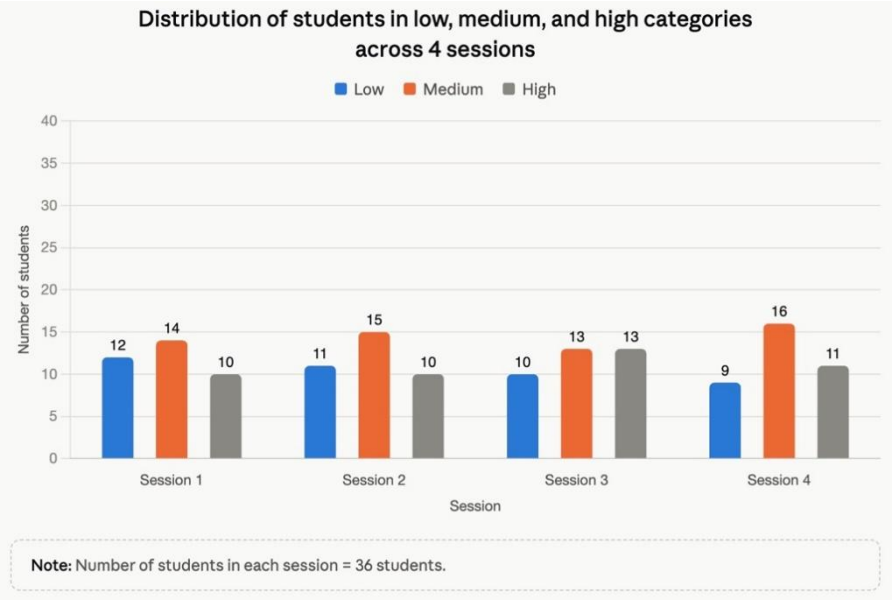


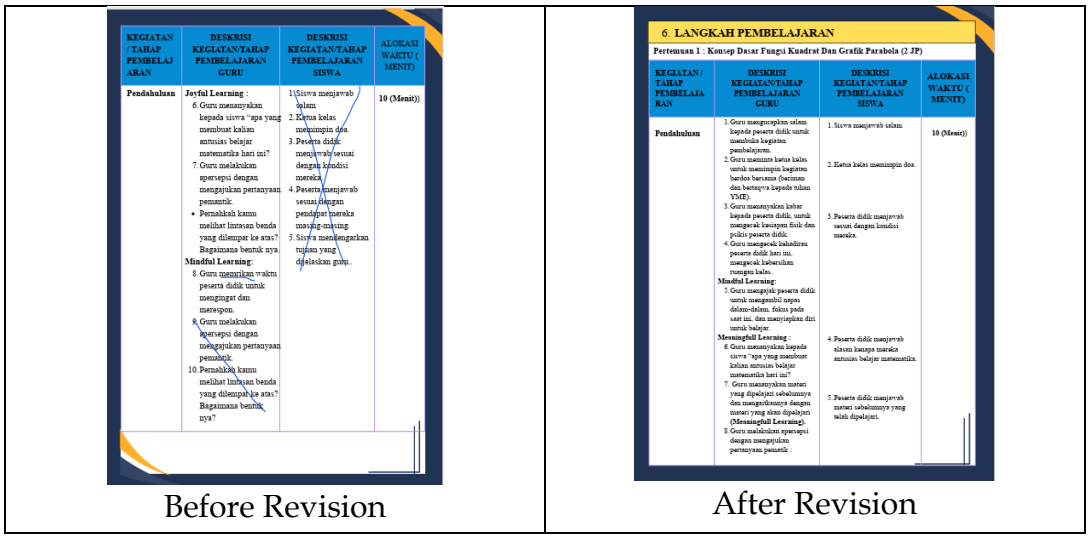
Figure 2. Results of Student Activity Observations

Based on the diagram "Distribution of Low, Medium, and High-Skilled Students in 4 Meetings," it can be seen that the number of students at each meeting remained constant, namely 36 students. This indicates that there was no change in the sample size during the research process.

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c. Development Stage

At this stage, the designed teaching module was validated by two experts in their respective fields (Rangkuti & Juniati, 2022; Rangkuti et al., 2023; Rangkuti et al., 2024; Rangkuti et al., 2024). The validation results of the Deep Learning-based teaching module assisted by Wordwall to improve students' logical mathematical thinking skills were carried out by one expert, namely a mathematics education lecturer at UNIVA Labuhanbatu, and one mathematics teacher at SMA Negeri 1 Rantau Selatan. The following is presented the contents of the teaching module that has been created in Figure 2 below:



Before Revision | After Revision

Figure 3. Teaching Module

The results of the validity test of the teaching module by two validators are presented in Table 1 below:

Table 1. Results of the Validity Test of the Teaching Module Assessment

Assessment Aspects	Validator 1	Validator 2	Average of Each Aspects (Ai)
Graphics	4,00	4,00	4,00
Presentaion	3,50	4,00	3,75
Language	3,50	4,00	3,75
Conent/Material	3,50	4,00	3,75
Total Average (Va)			**3,81**

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Based on Table 1, the validation results conducted by two validators on the Deep Learning-based teaching module assisted by Wordwall obtained an average total validity of 3.81, which is included in the very valid category. Each assessment aspect, namely graphics (4.00), presentation (3.75), language (3.75), and content/material (3.75), showed high and consistent values. This indicates that the developed learning module has met quality criteria in terms of appearance, material presentation, language use, and the appropriateness of the content to the learning objectives. The learning module has also integrated a Deep Learning approach that emphasizes meaningful, reflective, and contextual learning, and is supported by interactive Wordwall media to increase student engagement in the learning process (Rangkuti et al., 2019; Rangkuti et al., 2020; Rangkuti et al., 2021; Rangkuti et al., 2022; Rangkuti et al., 2023). Thus, the Deep Learning-based learning module assisted by Wordwall is declared suitable for use in improving students' logical thinking skills.

Next, the results of the validity test of students' logical thinking ability are presented in Table 2 below:

Table 2. Results of the Validity Test of Students' Logical Thinking Ability Instruments

Ability Indicators Logical Thinking	Number Question	Validator 1	Validator 2	Average Indicators (Ii)
The breakdown of thinking	Quuestion number1a	4	4	4,00
Argumentation ability	Quuestion number 1b	3	4	3,50
Drawing conclusions	Quuestion number 1c	4	4	4,00
Total Averge (Va)				**3,83**

Based on Table 2, the validation results conducted by two validators on the students' logical thinking ability test instrument obtained an average total validity of 3.83, which is included in the very valid category. Both validators concluded that the students' logical thinking ability instrument can be used without revision.

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d. Implementation Stage

This stage is to implement the teaching module design based on Deep Learning assisted by a Wordwall that has been developed in a real classroom situation (Ritonga et al., 2022; Ritonga et al., 2023; Ritonga et al., 2025; Ritonga at al., 2026). The learning material is delivered in accordance with the developed teaching module. The main objectives in the implementation stage include: (1) guiding students to achieve learning objectives, (2) applying the problem-solving process to problems encountered in the learning process, (3) improving students' logical mathematical thinking skills in the quadratic function material. In this case, the level of practicality of a teaching module can also be seen from students' responses to the teaching module provided. The following are the results of the student response questionnaire in Table 3 below:

Table 3. Results of Student Response Questionnaire Based on Small Classes & Large Classes

Component	Small Class	Big Class
Maximum Score Total	50	50
Average Score Obtained	46,2	44,8
Percentage	92,4%	89,6%
Percentage Level	80%–100%	80%–100%
Qualification	Very Good	Very Good

Based on Table 3, the results of the student response questionnaire show a difference between small and large classes. In small classes, the average score was 46.2 out of a maximum score of 50 with a percentage of 92.4%, while in the large class the average score was 44.8 with a percentage of 89.6%. Despite the differences in results, both classes remained in the 80%100%, making it a very good category. This indicates that the Deep Learning-based teaching module with Wordwall support continues to receive positive responses from students in both small and large classes. However, the response rate in small classes was slightly higher than in large classes, which may be due to differences in student interaction levels and learning focus in each class.

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e. Evaluation Stage

Evaluation is the final stage in the ADDIE development model, which aims to assess the quality and effectiveness of the Deep Learning-based teaching module assisted by Wordwall. Evaluation takes two forms: formative and summative. Formative evaluation is conducted throughout the learning process through interactive quizzes using Wordwall, discussion activities, and student worksheets. This evaluation aims to monitor the achievement of learning objectives and provide feedback on the learning process. Meanwhile, summative evaluation is carried out at the end of the learning process through the administration of learning outcome tests to measure students' logical thinking skills (SI Ritonga et al., 2025). The tests are structured based on indicators of logical thinking skills, namely logical thinking sequence, argumentation ability, and conclusion drawing (Yovi Aristya et al., 2025). The results of the summative evaluation are used to determine the level of achievement of students' logical thinking skills after participating in learning using the Deep Learning -based teaching module assisted by Wordwall. In addition, the evaluation results also serve as a basis for making improvements and refinements to the module to make it more effective and appropriate to student needs.

The following presents the results of the pretest and posttest of students' mathematical logical thinking abilities in the quadratic function material in Table 4 below:

Table 4. Results of the Pretest and Posttest of Students' Logical Thinking Ability

Number of Student	Avarege Pretest	Avarege Posttest	N-Gain Score	Criteria
36	54,96	85,50	0,71	High

Based on Table 4, the average pretest score for students' logical thinking ability was 54.96, while the average posttest score was 85.50 after students participated in learning using a Deep Learning-based teaching module assisted by Wordwall. The results of the N-Gain Score calculation showed a value of 0.71, which is considered high. This indicates an increase in students' logical thinking skills after using the Deep Learning-based teaching module with the aid of Wordwall. This improvement was evident in students' ability to develop sequential

problem-solving steps, present logical arguments supported by sound reasoning, and draw conclusions based on the results of their analysis. Thus, the Deep Learning -based teaching module assisted by Wordwall is effective in improving students' logical thinking skills.

CONCLUSION

Based on the research and development results, it can be concluded that the Deep Learning -based teaching module assisted by Wordwall on the quadratic function material was successfully developed using the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The developed teaching module meets the criteria of very valid with an average module validation of 3.81 and test instrument validation of 3.83. The teaching module also meets the criteria of very valid with an average module validation of 3.81 and test instrument validation of 3.83. Practical criteria, as shown by the results of the student response questionnaire with a percentage of 90.8% and a very good category. Furthermore, the learning module meets the criteria for effectiveness in improving students' logical thinking skills. This is demonstrated by the increase in the average pretest score from 54.96 to 85.50 on the posttest, with an N-Gain Score of 0.71, which is considered high. Therefore, the Deep Learning -based learning module with Wordwall support is suitable for improving students' logical thinking skills on quadratic functions.

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