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WORDWALL-ASSISTED PEOBLEM BASED LEARNING TEACHING MATERIALS TO IMPROVE STUDENTS' CREATIVE THINKING AND LEARNING MOTIVATION ON ELEMENTARY SCHOOL

Fefi Cahyuning Faynindy[1], Wahyu Hidayat[2], Masta Hutajulu[3]
[1]IKIP Siliwangi, Jl. Terusan Jend. Sudirman, Cimahi, Indonesia.
fefifaynindy@gmail.com
[2]IKIP Siliwangi, Jl. Terusan Jend. Sudirman, Cimahi, Indonesia.
wahyu@ikipsiliwangi.ac.id
[3]IKIP Siliwangi, Jl. Terusan Jend. Sudirman, Cimahi, Indonesia.
mastahutajulu@ikipsiliwangi.ac.id

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ABSTRACT

Mathematics learning in elementary schools requires learning experiences that encourage students to think creatively, solve problems, and participate in the learning process. However, students' creative thinking skills and learning motivation are not yet optimal, while the use of interactive teaching materials that support meaningful learning remains limited. This study aims to develop Problem-Based Learning (PBL)-based teaching materials assisted by Wordwall and to determine their validity, practicality, and effectiveness in improving students' creative thinking skills and learning motivation. This study employed a Research and Development method adapted from the Borg and Gall development model. The development process included needs analysis, planning, product development, expert validation, field testing, product revision, and operational testing. The research was conducted at an elementary school. Data were collected through observation, interviews, documentation, questionnaires, and creative thinking ability tests. The data were analyzed using descriptive and inferential statistics to determine the quality and effectiveness of the developed teaching materials. The results showed that the developed teaching materials met the criteria of validity and practicality based on expert assessments, practitioner evaluations, and positive student responses. The effectiveness test showed that students who learned using the PBL-based teaching materials assisted by Wordwall demonstrated better creative thinking skills and learning motivation than students who experienced conventional learning. Therefore, the developed teaching materials are feasible, practical, and effective for supporting mathematics learning. The integration of Problem-Based Learning and Wordwall provides an interactive learning experience that can encourage students to develop creative thinking skills and strengthen their motivation to learn mathematics.

Corresponding Author:

Fefi Cahyuning Faynidy,
Department of Mathematics Education,
Institut Keguruan dan Ilmu Pendidikan Siliwangi,
Jl. Terusan Jend. Sudirman, Cimahi, Indonesia
Email: fefifaynidy@gmail.com

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INTRODUCTION

Mathematics is a subject that plays a crucial role in equipping students with the logical, analytical, systematic, critical, and creative thinking skills needed to address various challenges in everyday life. According to the National Council of Teachers of Mathematics (National Council of Teachers of, 2000) , the objectives of mathematics learning are not only oriented toward mastering concepts, but also toward developing problem-solving, reasoning, communication, connections, and representation skills. Accordingly, the Independent Curriculum emphasizes student-centered learning through active, meaningful, and contextual learning experiences to develop 21st-century competencies, including critical thinking, creativity, communication, and collaboration. However, the results of the 2022 PISA (PISA) indicate that Indonesian students' creative thinking skills are still below the average of OECD countries, necessitating learning innovations that optimize the development of these competencies. Therefore, mathematics learning needs to be supported by innovative learning models, media, and teaching materials so that students gain a more active, meaningful learning experience and are able to optimally develop their creative thinking skills.

Creative thinking skills are one of the essential competencies that need to be developed in mathematics learning because they enable students to generate various ideas, strategies, and alternative problem-solving strategies flexibly and innovatively. According to Torrance, (1974), creative thinking skills are demonstrated through four indicators: fluency, flexibility, originality, and elaboration. Mastery of these skills is one of the demands of 21st-century learning because students are not only required to understand concepts but also to be able to develop various alternative solutions to the problems they face. Various studies in the last five years have shown that student-centered, problem-solving-based learning, and providing opportunities to explore various ideas independently, contribute positively to improving mathematical creative thinking skills. However, elementary school students' creative thinking skills have not yet developed optimally because the learning process tends to be oriented towards delivering material and solving routine problems, so that space for students to express ideas, try various strategies, and find solutions independently is still limited. Therefore, learning innovations are needed that can create active, challenging, and meaningful learning experiences to develop students' creative thinking skills. According to Hutajulu et al., (2022) , students' conceptualization process in solving mathematical problems reflects how higher-order thinking skills, including creative thinking, are formed through the experience of exploring various problem-solving strategies.

In addition to creative thinking skills, learning motivation is a crucial factor in determining student success in mathematics learning. According to Uno, (2016) , learning motivation is an internal and external drive that generates enthusiasm, directs, and maintains learning behavior, encouraging students to optimally achieve learning goals. Students with high learning motivation tend to be more active in learning, have a strong sense of curiosity, are more willing to express their opinions, and are persistent in solving problems. Various studies in the past five years have also shown that learning motivation has a positive effect on student engagement, involvement in the learning process, higher-order thinking skills, and mathematics learning outcomes. However, elementary school students' learning motivation remains a challenge in mathematics learning, as evidenced by low learning enthusiasm, lack of participation in discussion activities, and students' tendency to rely on teacher explanations. These conditions indicate the need for more innovative, interactive, and student-centered learning so that learning motivation can grow optimally and have an impact on improving the quality of mathematics learning. Hendriana et al. (2022) emphasized that a humanistic and contextual mathematics learning model is able to foster motivation and positive attitudes in students towards mathematics, so that learning becomes more meaningful and student-centered.

Based on these problems, a learning innovation is needed that can facilitate students to learn actively, build knowledge independently, and develop creative thinking skills and learning motivation. According Plomp & Nieveen (2013), the development of teaching materials aims to produce learning products that meet the aspects of validity, practicality, and effectiveness so that they can support the achievement of learning objectives. Furthermore, according to Arends (2012), Problem-Based Learning (PBL) is a learning model that uses authentic problems as a learning context to train students' higher-order thinking skills, problem solving, and learning independence. Hidayat et al. (2019) explain that mathematics learning needs to be designed in such a way as to be able to develop students' thinking skills through meaningful learning activities and supported by good learning motivation. On the other hand, Hutajulu et al., (2019) stated that learning motivation makes a positive contribution to mathematical problem-solving abilities so that it becomes one of the factors that need to be considered in the mathematics learning process. Therefore, the development of Problem-Based Learning- based teaching materials assisted by Wordwall is expected to create more active, interactive, and meaningful mathematics learning so that it can improve the creative thinking skills and learning motivation of third-grade elementary school students. This is in line with Kurniansyah et al., (2022) who showed that developing modules with a scientific contextual approach can improve students' cognitive and affective aspects simultaneously. Similarly, Hidayat et al., (2022) through the development of electronic modules (ePub) proved that systematically designed digital teaching materials can improve students' mathematical reasoning abilities. In line with that, Wijaya et al., (2024) found that innovative learning factors also contributed to the mathematics achievements of Indonesian students in PISA 2022, so the development of technology-based teaching materials is one of the strategic solutions to support the improvement of these competencies. The use of interactive media based on digital applications such as Wordwall is also in line with the findings of Pramularsih & Puspita (2025) which show that interactive learning applications such as Quizizz are effective in developing the character and critical reasoning skills of elementary school students.

Based on these problems, a learning innovation is needed that can facilitate students to learn actively, build knowledge independently, and develop creative thinking skills and learning motivation. According to Plomp & Nieveen (2013) , the development of teaching materials aims to produce learning products that meet the aspects of validity, practicality, and effectiveness so that they can support the achievement of learning objectives. One relevant alternative is the development of teaching materials based on Problem-Based Learning (PBL). According to Arends (2012) , Problem-Based Learning is a learning model that uses authentic problems as a learning context to train higher-order thinking skills, problem solving, and student learning independence. The effectiveness of PBL implementation can be further optimized through the use of digital learning media, one of which is Wordwall, which provides interactive learning activities so as to increase student involvement, interest, and motivation during the learning process. Therefore, the development of teaching materials based on Problem-Based Learning assisted by Wordwall is expected to be a solution that can create more active, interesting, and meaningful mathematics learning and support the improvement of creative thinking skills and learning motivation of elementary school students.

Various studies in recent years have shown that the implementation of Problem-Based Learning, the use of Wordwall media, and the development of teaching materials have made a positive contribution to improving the quality of mathematics learning in elementary schools. Previous studies reported that Problem-Based Learning is effective in developing creative thinking skills through problem-solving-oriented learning activities, while Wordwall is able to increase learning motivation, active participation, and student involvement in the learning process. In addition, research on the development of teaching materials also shows that the

developed products can improve learning effectiveness if designed according to student characteristics and curriculum needs. However, most of these studies still examine the effectiveness of Problem-Based Learning , Wordwall media, or teaching material development separately. Research that integrates Problem-Based Learning- based teaching materials assisted by Wordwall as a single learning product developed using the Research and Development method and tests its validity, practicality, and effectiveness in improving creative thinking skills and learning motivation in third-grade elementary school students is still limited. Therefore, this research was conducted to fill this gap by developing innovative, interactive teaching materials that are appropriate to the characteristics of students so that it is hoped that they will be able to contribute to the development of mathematics learning in elementary schools.

Based on the description, this study has a novelty in the development of Problem-Based Learning- based teaching materials assisted by Wordwalls designed to support mathematics learning in grade III of elementary school. In contrast to previous studies that focused more on the application of learning models, the use of media, or the development of teaching materials separately, this study integrates these three components into one learning product developed using the Research and Development method with the Borg and Gall model. The developed product not only went through a development and validation process by experts, but also tested for its practicality and effectiveness in improving students' creative thinking skills and learning motivation. Thus, this study is expected to provide theoretical contributions to the development of mathematics learning as well as practical contributions in the form of teaching materials that are innovative, interactive, and appropriate to the characteristics of elementary school students. Therefore, the objectives of this study are (1) to describe the process of developing teaching materials based on Problem-Based Learning assisted by Wordwall, (2) to analyze the level of validity of the teaching materials developed, (3) to analyze the effectiveness of teaching materials in improving the creative thinking skills of grade III elementary school students, and (4) to analyze the effectiveness of teaching materials in improving the learning motivation of grade III elementary school students.

METHOD

This study uses the Research and Development (R&D) method which aims to develop a product in the form of Problem-Based Learning (PBL) based teaching materials assisted by Wordwall in mathematics learning for grade III elementary school. According to Gall et al. (2003), research and development is a research method used to develop and validate educational products so that they are suitable for use in the learning process. The development model used refers to the ten stages of Borg and Gall, namely: (1) research and information collecting, (2) planning, (3) developing preliminary form of product, (4) preliminary field testing, (5) main product revision, (6) main field testing, (7) operational product revision, (8) operational field testing, (9) final product revision, and (10) dissemination and implementation. This research was conducted up to the eighth stage, namely operational field testing, because the research focused on product development, validation, practicality, and effectiveness. The final product revision and dissemination stages were not carried out due to time, cost, and scope limitations.

The research was conducted at SDN 1 Pasirhalang with the research subjects being third-grade elementary school students. The developed product was first validated by three validators consisting of two expert lecturers and one third-grade elementary school teacher as a learning practitioner. After being declared feasible, the product was tested in stages according to the research and development stages, namely preliminary field testing involving 10 students , main field testing involving 21 students, and operational field testing carried out in two classes, namely the experimental class consisting of 19 students and the control class consisting of 25 students.

Data collection techniques in this study include observation, interviews, documentation, questionnaires, and tests. Observations, interviews, and documentation were used in the needs analysis stage to obtain information regarding the conditions of mathematics learning, student characteristics, and teachers' needs for teaching materials. Questionnaires were used to obtain product validity data from validators, the practicality of teaching materials based on teacher and student responses, and student learning motivation after using the developed teaching materials. A mathematical creative thinking ability test was used to measure the effectiveness of teaching materials in improving students' creative thinking abilities after participating in learning using Problem-Based Learning- based teaching materials assisted by Wordwall.

The research instruments consisted of observation sheets, interview guidelines, expert validation sheets, teacher response questionnaires, student response questionnaires, learning motivation questionnaires, and a mathematical creative thinking ability test. All instruments were compiled based on the indicators of each research variable and validated before being used in the data collection process to ensure their suitability as research measurement tools.

Data analysis was conducted descriptively and inferentially in accordance with the research objectives. To answer the first problem formulation, namely the process of developing teaching materials based on Problem-Based Learning assisted by Wordwall, data from observations, interviews, documentation, and notes during the development process were analyzed descriptively qualitatively by describing each stage of the Borg and Gall model starting from needs analysis, planning, initial product development, expert validation, initial field trials, product revisions, main field trials, operational revisions, to operational field trials.

To answer the second problem formulation, expert validation data were analyzed using an average score to determine the level of product feasibility based on validity criteria. Furthermore, the practicality of the teaching materials was analyzed using the percentage of teacher and student response questionnaire scores as a basis for product improvement at each development stage. To answer the third and fourth problem formulations, the effectiveness of the teaching materials on creative thinking skills and learning motivation was analyzed using a One Sample t -test with a comparative value (test value) of 70. The test was conducted to determine whether the average creative thinking skills and learning motivation of students after using Problem-Based Learning- based teaching materials assisted by Wordwall were significantly higher than the established reference value. All statistical analyses were performed using IBM SPSS Statistics with a significance level of 5% ($\alpha = 0.05$).

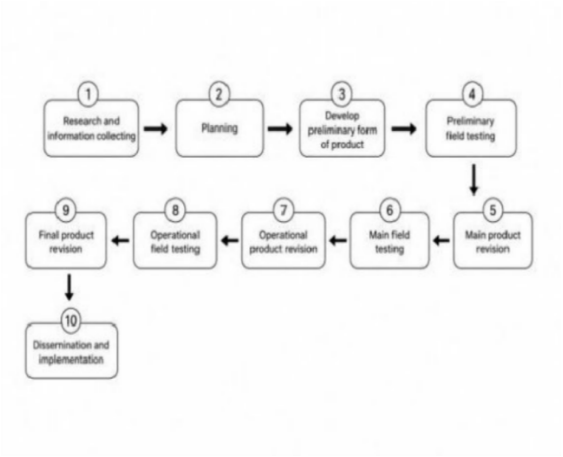

Figure 1. R&D Research Stages Adapted from Gall et al., (2003)

RESULTS AND DISCUSSION

Results

Process of Developing Wordwall-Assisted PBL Teaching Materials

Problem-Based Learning (PBL) -based teaching materials assisted by Wordwall in this study refers to the Borg and Gall research and development model which is implemented up to the eighth stage (operational field testing). The stages carried out include research and information collection, planning, developing a preliminary form of product, expert validation, preliminary field testing, main product revision, main field testing, operational product revision, and operational field testing. All stages are carried out systematically as a basis for producing teaching materials that are appropriate to the needs of mathematics learning in elementary schools before testing the validity, effectiveness, and practicality of the product.

The first stage in the development process is research and information collection, which aims to identify learning needs as a basis for developing teaching materials. This activity was carried out through observation of the learning process, interviews with third-grade teachers, and analysis of the learning tools used at SDN 1 Pasirhalang. The identification results showed that mathematics learning is still dominated by the use of textbooks as the main learning source, while the use of interactive learning media is not optimal. This condition results in students not having a learning experience that optimally encourages creative thinking skills through problem-solving activities, and learning motivation still needs to be improved. In addition, teachers conveyed the need for teaching materials that are able to integrate the Problem-Based Learning model with digital media that is easily accessible and appropriate to the characteristics of elementary school students. Based on these findings, the development of Problem-Based Learning- based teaching materials assisted by Wordwall is seen as a solution to support more active, contextual, and student-centered mathematics learning.

Based on the results of the needs identification, the next stage is planning and developing the initial product (develop preliminary form of product). At this stage, a design of teaching materials is prepared that includes learning outcomes, learning objectives, materials, student worksheets (LKPD), Wordwall-based learning media, and assessment instruments adapted to the characteristics of third-grade elementary school students. The development of teaching materials is designed by integrating the syntax of Problem-Based Learning, namely problem-oriented, organizing students to learn, guiding investigations, developing and presenting results, and reflecting on the problem-solving process. The results of this stage are in the form of an initial product of teaching materials that combines learning materials, problem-solving activities, LKPD, evaluation, and Wordwall media as an interactive learning tool. The initial product is then prepared to go through a validation process by experts before being implemented to students.

The initial product that has been developed then enters the expert validation stage as part of the refinement process before being implemented to students. Validation was carried out by two expert lecturers and one third-grade teacher as a learning practitioner to obtain input on aspects of the appropriateness of content, language, presentation, graphics, and the suitability of the implementation of the syntax of Problem-Based Learning assisted by Wordwall. Based on the validation results, the validator provided several inputs that focused on improving the quality of the teaching materials, especially on the formulation of learning objectives to be more operational, specific, and measurable according to learning indicators. In addition, improvements were made to the editorial in several parts of the material and adjustments to the presentation to be more systematic and easier to understand by students. All of these inputs were followed up through a revision process to obtain a product that is more appropriate to the

characteristics of elementary school students and ready for implementation in the preliminary field-testing stage.

After the product was revised based on input from the validator, the next stage was a preliminary field test involving 10 fourth-grade students of SDN 1 Pasirhalang. The selection of fourth-grade students aimed to obtain initial input on the readability, clarity of content, and ease of use of the teaching materials before being applied to the research subjects, namely third-grade students. The trial results showed that the teaching materials could be used well in the learning process and received positive responses from both teachers and students. However, several aspects were still found that needed to be improved, especially in the formulation of learning objectives to make them more operational, specific, and easy to understand. Based on this input, revisions were made to the learning objectives as an effort to improve the product before proceeding to the main field-testing stage.

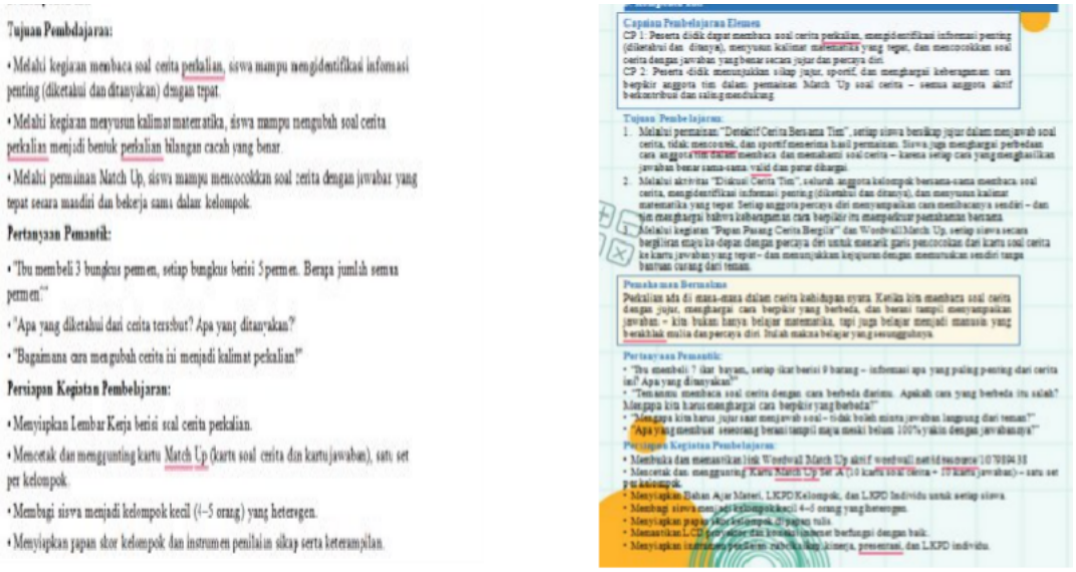

Figure 2. Comparison of the formulation of learning objectives before and after revision based on the results of the initial field trial.

After revisions were made based on the results of the preliminary field testing , the teaching materials were then implemented in the main field testing stage involving 21 third-grade students of SDN 1 Pasirhalang as the target users of the product. This stage aims to obtain information regarding the practicality of using the teaching materials in the learning process and identify aspects that still need improvement before being implemented in the operational field test. During the learning implementation, students were able to actively follow each stage of Problem-Based Learning , starting from understanding the problem, discussing in groups, completing student worksheets, to participating in the evaluation assisted by Wordwall. The teacher also stated that the teaching materials had supported the implementation of more interactive learning and made it easier for students to understand mathematical concepts. Based on the results of the main field trial, several inputs were obtained that became the basis for making product improvements at the operational revision stage before being implemented in the operational field test.

The input obtained during the main field testing phase became the basis for implementing the operational product revision . The revision focused on improving the ease of access and use of the learning media without changing the substance of the material or the syntax of the Problem-Based Learning that had been prepared. One of the improvements made was adding a Wordwall hyperlink directly to the learning activities section so that students could access interactive media more quickly and practically through the devices used during learning. In addition, layout

adjustments were made to several sections of the teaching materials so that the flow of learning activities became more systematic and easy to follow. These improvements resulted in a more practical product, easy to use by both teachers and students, and ready for implementation in the operational field testing phase.

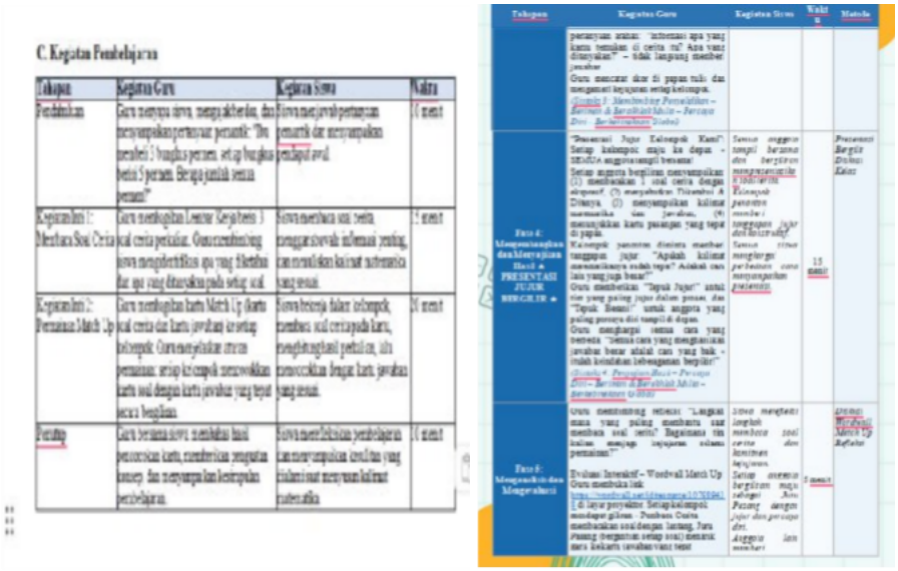

Figure 2. Comparison of the appearance of learning activities before and after adding Wordwall hyperlinks to teaching materials.

The final stage of this research was operational field testing , which was the implementation of the developed teaching materials in real-life learning conditions. This stage involved 19 students from the experimental class and 25 students from the control class at SDN 1 Pasirhalang. In the experimental class, learning was conducted using Problem-Based Learning -based teaching materials with the aid of a Wordwall, while the control class followed learning using teaching materials commonly used in schools. The purpose of the operational field testing was to obtain an overview of the application of the product in the learning process and to collect the necessary data to evaluate the effectiveness of the teaching materials on students' creative thinking skills and learning motivation. With the completion of this stage, the entire development process based on the Borg and Gall model up to the eighth stage has been carried out systematically, so that the resulting product is considered ready for further analysis based on the aspects of validity, effectiveness, and learning motivation in the following discussion.

Validity and Feasibility of Wordwall-Assisted PBL Teaching Materials

The validity of the teaching materials aims to ensure that the developed product meets the eligibility standards before being implemented in learning. The assessment was conducted by two expert lecturers using a validation sheet covering aspects of content feasibility, language, presentation, graphics, and the suitability of the implementation of Problem-Based Learning assisted by Wordwall. The validation data were analyzed descriptively quantitatively, while a summary of the assessment results is presented in Table 1.

Table 1. Summary of Teaching Material Validation Results

Component	Expert Validator 1	Expert Validator 2	Category	Practitioner Validator	Category
Learning Model	80%	80%	Valid	80%	Valid
Teaching Materials	81,25%	81,25%	Very Valid	83,33%	Very Valid

LKPD	80%	80%	Valid	85%	Very Valid
Instructional Media	78,57%	78,57%	Valid	75,89%	Valid
Open Module	82,29%	82,29%	Very Valid	88,54%	Very Valid
Evaluation Instruments	80%	80%	Valid	80%	Valid
Average	**80,35%**	**80,35%**	**Valid**	**82,13%**	**Very Valid**

Based on Table 1, the validation results indicate that the teaching materials were categorized as highly valid in all assessed aspects. The material presented aligns with the learning outcomes and characteristics of the students, supported by the use of communicative language, systematic presentation, and an attractive appearance. Furthermore, the application of Problem-Based Learning syntax integrated with the Wordwall media was deemed appropriate, making the teaching materials suitable for use in learning.

Validation results indicate that the teaching materials meet the criteria for a quality learning product. The alignment between content, language, presentation, and learning design supports a more focused and meaningful learning process. The integration of Problem-Based Learning with Wordwall media also strengthens the quality of the teaching materials by facilitating active and interactive learning activities.

Problem-Based Learning- based teaching materials with the help of Wordwall were declared to meet the valid criteria and therefore suitable for use in the trial phase. In addition to the validity aspect, product quality was also reviewed from the practicality aspect to determine the ease of use of the teaching materials by students during the learning process. The practicality of the teaching materials was analyzed based on student responses after using the teaching materials in the learning process. This assessment aims to determine the ease of use, clarity of presentation, and the attractiveness of the teaching materials from the user's perspective. A summary of the practicality assessment results is presented in Table 2.

Table 2. Results of the Practicality of Teaching Materials Based on Student Responses

Respondents	Percentage	Category
Learners	84%	Practical

Based on Table 2, the questionnaire results show that the teaching materials received a practical rating of 84.00%. These results indicate that students considered the teaching materials easy to use, the learning instructions easy to understand, and the display and integration of Wordwall media capable of supporting learning activities in a more engaging and interactive manner. Thus, the developed teaching materials have met the practicality aspect and can be used in the learning process.

Problem-Based Learning-based teaching materials with the aid of a Wordwall meet the practicality category based on student responses. These findings indicate that the product is easy to use and can support student engagement during learning. By meeting the validity and practicality aspects, the teaching materials are suitable for further testing their effectiveness on students' creative thinking skills and learning motivation.

Effectiveness of Wordwall-Assisted PBL Teaching Materials on Students' Creative Thinking

Problem-Based Learning -based teaching materials assisted by Wordwall on students' creative thinking skills was analyzed by comparing the pretest and posttest results in the experimental and control classes. The analysis was conducted to determine differences in creative thinking skills before and after learning and to measure the effectiveness of the developed teaching

materials. The descriptive statistics of students' creative thinking skills are presented in Table 3.

Table 3. Descriptive Statistics of Students' Creative Thinking Abilities

Test Stage	Group	n	Mean	Standard Deviation
Pretest	Experiment	19	36.42	2.24
	Control	25	36.64	1.89
Posttest	Experiment	19	77.26	2.75
	Control	25	62.76	2.15

Based on Table 3, the average pretest for creative thinking skills in the experimental class was 36.42, while in the control class it was 36.64, indicating that the initial abilities of both groups were relatively equal. After learning, the average posttest for the experimental class increased to 77.26, higher than the control class which obtained an average of 62.76. These results indicate that the use of Problem-Based Learning -based teaching materials assisted by Wordwalls provides a better increase in creative thinking skills compared to learning in the control class.

Table 4. Results of the Independent Samples t-Test of Students' Creative Thinking

Data	t	df	Sig. (2-tailed)	Average Difference
Pretest	−0.351	42	0.727	−0.21895
Posttest	19,680	42	0,000	14,50316

Testing criteria: if Sig. (2-tailed) < 0.05 then H is rejected. The t-test results on the pretest data show Sig. = 0.727 (> 0.05), so H is accepted, which means the initial creative thinking abilities of the two groups are indeed equal before treatment. On the other hand, the t-test results on the posttest data show Sig. = 0.000 (< 0.05), so H is rejected and H_1 is accepted. This proves that after learning, there is a significant difference in creative thinking abilities between the experimental class and the control class, with the achievement of the experimental class using Wordwall-assisted PBL-based teaching materials being significantly higher and having reached the KKM, while the control class has not yet reached the KKM.

Table 5. Results of N-Gain Analysis of Students' Creative Thinking

Group	N	Mean Rank	Sum of Ranks
Experiment	19	35.00	665.00
Control	25	13.00	325.00
Statistics			**Mark**
Mann-Whitney University			0,000
Wilcoxon W			325,000
Z			−5,627
Asymp. Sig. (2-tailed)			0,000

Based on Table 5, the results of the N-Gain analysis show that the increase in students' creative thinking abilities in the experimental class was higher than in the control class. This is evidenced by the results of the Mann–Whitney U test which showed a significant difference in improvement ($p < 0.001$), with the Mean Rank of the experimental class being 35.00, while the control class was 13.00. This finding indicates that Problem-Based Learning -based teaching materials assisted by Wordwall are more effective in improving students' creative thinking abilities compared to learning in the control class.

Problem-Based Learning- based teaching materials assisted by Wordwalls can improve students' creative thinking skills because learning is designed through the presentation of contextual problems, discussions, and collaborative problem-solving activities. In addition, the use of Wordwalls as interactive media encourages students to be more active, involved in the learning process, and dare to put forward various ideas and alternative solutions. Thus, the integration of the Problem-Based Learning model and Wordwall media is an effective learning strategy to develop students' creative thinking skills in elementary schools.

Effectiveness of Wordwall-Assisted PBL Teaching Materials on Students' Learning Independence

Problem-Based Learning- based teaching materials with the aid of Wordwall on students' learning motivation was analyzed by comparing the pretest and posttest results in the experimental and control classes. The analysis was conducted to determine differences in learning motivation before and after learning and to measure the effectiveness of the developed teaching materials. The descriptive statistics of students' learning motivation are presented in Table 6.

Table 6. Descriptive Statistics of Students' Learning Motivation

Group	N	Minimum	Maximum	Mean	Standard Deviation
Experiment	19	71	81	76.26	2.75
Control	25	57	65	61.04	2.05

Based on Table 6, the average pretest learning motivation in the experimental class was 47.47, while in the control class it was 47.88, indicating that the initial learning motivation of both groups was relatively equal. After learning, the average posttest of the experimental class increased to 76.26, higher than the control class which obtained an average of 61.04. These results indicate that the use of Problem-Based Learning -based teaching materials assisted by Wordwalls provides a better increase in learning motivation compared to learning in the control class.

Table 7. Results of the Independent Samples t-Test of Student Learning Motivation

Variables	t	df	Sig. (2-tailed)	Average Difference
Posttest	21,052	42	0,000	15,220

Based on Table 7, the results of the Independent Samples t-Test show that there is no significant difference in learning motivation between the experimental class and the control class during the pretest ($p = 0.505 > 0.05$), so that the initial learning motivation of both groups can be considered equal. In contrast, the posttest obtained a p value < 0.001, which indicates a significant difference between the two groups after learning. These results indicate that the use of Problem-Based Learning- based teaching materials assisted by Wordwalls has a better effect on increasing student learning motivation compared to learning in the control class.

Table 8. Results of N-Gain Analysis of Student Learning Motivation

Group	Average N-Gain	Category
Experiment	0.549	Moderate
Control	0.253	Low

Based on Table 8, the average N-Gain of learning motivation in the experimental class was 0.549, which is in the medium category, while the control class was 0.253, which is in the low

category (criteria by Hake (1999): $g < 0.30$ = low; $0.30 \leq g < 0.70$ = medium; $g \geq 0.70$ = high). The increase in learning motivation in the experimental class, which was higher than in the control class, strengthens the findings in Tables 6 and 7, namely that only the experimental class had an average posttest that significantly exceeded the KKM, while the increase in the control class was not enough to lead students to achieve this mastery. These findings consistently show that the use of PBL-based teaching materials assisted by Wordwall is more effective in increasing student learning motivation than conventional teaching materials.

Problem-Based Learning- based teaching materials assisted by Wordwalls can increase students' learning motivation through the presentation of contextual problems that encourage active involvement in the learning process. The use of Wordwalls as interactive, game-based media also increases students' attention, curiosity, and enthusiasm during learning. These findings are in line with intrinsic motivation theory, the concept of intrinsically motivating instruction from Malone, (1981) , and Keller's ARCS model (1987) which emphasizes the importance of attention, relevance, confidence, and satisfaction in increasing learning motivation. Thus, the integration of Problem-Based Learning and Wordwalls is an effective learning strategy to increase students' learning motivation in elementary schools.

Discussions

Problem-Based Learning- based teaching materials assisted by Wordwall were successfully developed through eight stages of Research and Development which resulted in gradual product improvements based on validation results, student input, and field trials. The systematic development process resulted in teaching materials that are appropriate to the characteristics of elementary school students and the needs of mathematics learning. This finding is in line with Sa'idah et al., (2024) who stated that the development of Problem-Based Learning- based teaching materials integrated with Wordwall is able to produce learning tools that are more systematic, suitable for use, and support the improvement of learning quality.

The findings of this study further demonstrate that the development process is an important factor in producing teaching materials that are appropriate for elementary school students. The product was developed by considering the needs identified during the preliminary research, student characteristics, curriculum requirements, and the integration of Problem-Based Learning with Wordwall. The revisions conducted during the development process were based on feedback from experts, practitioners, teachers, and students. Therefore, the final product was not only developed theoretically but also refined based on empirical findings obtained during the field testing process. This process contributed to the development of teaching materials that were more systematic, understandable, and suitable for mathematics learning.

The developed teaching materials met the feasibility and practicality criteria based on expert validation and positive student responses. This demonstrates that the integration of Problem-Based Learning with Wordwalls produces teaching materials that are easy to use, engaging, and support student engagement during learning. This finding is supported by Rahmawati et al., (2025) , who concluded that Wordwalls can increase student focus, interest, confidence, and learning satisfaction, thus making learning more active and enjoyable.

The validity and practicality findings also indicate that the developed teaching materials have characteristics that support their implementation in classroom learning. The validation process covered the learning model, teaching materials, LKPD, instructional media, module, and evaluation instruments. The results showed that each component obtained a positive assessment from the validators and practitioners. Meanwhile, the positive response from students indicates that the teaching materials were considered easy to use, understandable, and attractive. These findings are important because teaching materials need to be not only conceptually appropriate but also practical for teachers and students during the learning process.

Problem-Based Learning- based teaching materials assisted by Wordwalls effectively improve students' creative thinking skills. Problem-based learning provides opportunities for students to explore various alternative solutions, discuss, and develop ideas independently, while Wordwalls provide feedback that encourages active engagement in learning. This finding is supported by Firawaty et al., (2025) who stated that the application of Problem-Based Learning has a positive effect on the creative thinking skills and learning motivation of elementary school students.

The improvement in creative thinking skills can be explained by the learning activities designed according to the characteristics of Problem-Based Learning. Students were encouraged to understand contextual problems, discuss problems with their peers, explore possible strategies, and present the results of their thinking. Such activities provide opportunities for students to generate ideas, consider alternative solutions, and explain their reasoning. The use of Wordwall further supported these activities by providing interactive learning experiences and feedback. Thus, the combination of problem-oriented learning and interactive media created learning conditions that encouraged students to become more active in constructing and expressing their ideas.

In addition to improving creative thinking skills, the developed teaching materials have also been shown to increase students' learning motivation. Problem-based learning combined with Wordwall creates a more engaging learning experience through interactive activities, challenges, and direct feedback, enabling students to become more active and enthusiastic in participating in the learning process. This finding aligns with research by Khairunnisa et al., (2025), which concluded that the Wordwall-assisted Problem-Based Learning model significantly impacts the learning motivation of elementary school students. Furthermore, a meta-analysis by Wijnia et al. (2024) also demonstrated that problem-based learning consistently increases students' learning motivation compared to conventional learning.

The findings related to learning motivation also show that the developed teaching materials provided a more engaging learning experience. The integration of contextual problems, group activities, LKPD, and Wordwall allowed students to participate actively rather than only receive explanations from the teacher. Interactive activities through Wordwall also provided variation in learning activities, which could maintain students’ attention and interest during mathematics learning. This finding is consistent with Rahmawati et al. (2025), who reported that Wordwall can increase students’ focus, interest, confidence, and learning satisfaction. It also supports Khairunnisa et al. (2025), who found that Problem-Based Learning assisted by Wordwall positively affected elementary school students’ learning motivation.

From a practical perspective, the developed teaching materials can provide an alternative for elementary school teachers who need learning resources that are interactive and student-centered. Teachers can use the materials to organize mathematics learning systematically while providing students with opportunities to explore problems and develop their own solutions. The integration of Wordwall also provides flexibility in presenting evaluation and interactive activities. Therefore, the developed product has potential to support the implementation of meaningful mathematics learning while simultaneously addressing the need to improve students’ creative thinking skills and learning motivation.

Overall, the research results show that the integration of the Problem-Based Learning model and Wordwall media has a positive impact on students' creative thinking skills and learning motivation. Learning centered on problem-solving and supported by interactive media encourages students to be more active, creative, and motivated during the learning process. These results reinforce the findings of Nindy Amelya (2024), who, through a systematic literature review , concluded that the implementation of Problem-Based Learning assisted by

Wordwall consistently improves learning outcomes, activeness, learning interest, and student engagement at various levels of education.

CONCLUSION

Problem-Based Learning- based teaching materials assisted by Wordwall through eight stages of Research and Development adapted from the Borg and Gall model, starting from preliminary research to operational product testing. The developed teaching materials were declared feasible based on expert validation results and practical based on positive student responses to ease of use, display, and learning activities. The results of the effectiveness test showed that the use of Problem-Based Learning- based teaching materials assisted by Wordwall was more effective than learning in the control class in improving students' creative thinking skills and learning motivation. This was indicated by the increase in posttest results and higher N-Gain values in the experimental class compared to the control class. These findings indicate that the integration of the Problem-Based Learning model with Wordwall media is able to create more active, interactive, and student-centered learning so that it can support the development of creative thinking skills and increase learning motivation in elementary schools. Therefore, the developed teaching materials can be an alternative innovation in mathematics learning that is worthy of being applied to support the implementation of meaningful learning in elementary schools. Further research is recommended to involve a wider sample, carry out all stages of Research and Development up to the dissemination stage, and test the application of teaching materials on different materials and levels of education in order to broaden the generalization of research results.

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