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Quizizz Assisted Teaching Modules: Mathematics Problem Solving Abilities for Elementary School Students

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ABSTRACT

Students are less accustomed to working on problem-solving questions; this lack of familiarity affects their ability to solve problem-solving questions that are presented after routine questions. In addition, there has been no development of teaching modules carried out by teachers. Therefore, the purpose of this study is to develop a teaching module assisted by Quizizz to improve the ability to solve elementary school mathematics problems that are valid, practical, and effective. This type of research includes development using the ADDIE model design. The data collection methods used are teaching module validation sheets, response questionnaires, and problem-solving questions. The study's findings revealed that the validity of the instructional material, with an average value of 95.69, falls inside the "very valid" category. The practicality assessment conducted by the teacher and coworkers yielded average scores of 87.07 and 85.34, respectively, categorizing them as "very practical." The efficacy assessment is based on the paired sample t-test results, which demonstrate a significance value (2-tailed) of 0.000, signifying a difference in average scores between the pretest and posttest. Furthermore, the n-gain analysis produced a value of 0.519, classifying it as "moderate." The findings demonstrated that the training module that was created was valid, practical, and effective in enhancing mathematical problem-solving skills.

Keywords: teaching module, quizizz, mathematical problem-solving skills

INTRODUCTION

Education is a universal activity that exists in every part of the world and is present in everyday life [1]. Education is a human endeavor to cultivate and develop one's potential, leading to a better future, so that the knowledge gained is useful for both the individual and society [2]. Furthermore, education is carried out to improve one's results or potential and to determine the extent of an individual's abilities through conscious efforts to create comfortable learning conditions for both students and teachers. Education is inseparable from the increasingly sophisticated and modern curriculum [3], [4]. The curriculum is a component that plays a crucial role in the education system [5], [6].

The curriculum sets goals, clarifies the educational path, and outlines the learning experiences each student should have [7]. One of the subjects taught in the independent curriculum is mathematics. Mathematics is a discipline that can develop logic, thinking, reasoning, and argumentation, contributing to solving problems in everyday life and supporting the development of science and technology [8]. Given its essential nature, mathematics is a mandatory subject in the national education curriculum. In studying mathematics, students are not only required to understand the material taught but are also expected to possess mathematical skills useful for facing global challenges [9]. Mathematical aptitude can be categorized into five primary competencies: mathematical knowledge [10]; mathematical problem solving [11]; mathematical communication [12]; mathematical connections [13]; and mathematical reasoning.

Mathematical problem-solving skills encompass actions that entail deriving answers to mathematical challenges by utilizing all pertinent mathematical knowledge [14], [15]. Students with quantitative problem-solving abilities can resolve issues by employing appropriate mathematical procedures and principles. Polya delineates the phases for issue-solving as follows: a) comprehending the problem, b) devising a solution plan, c) executing the problem-solving strategy, and d) evaluating the outcomes of the problem-solving endeavor [16], [17]. In the end, students' problem-solving techniques are more structured and mathematically logical as a result of their mathematical problem-solving skills [18].

Martin indicated in the Trends in International Mathematics and Science Study (TIMSS) that Indonesian pupils have deficient mathematical skills, restricting them to the resolution of basic mathematical problems

[19]. Hornigold stated that approximately 6% of students have difficulty acquiring mathematical skills [20]. The abstract nature of mathematical concepts necessitates that students master previous concepts as a prerequisite for comprehending subsequent ones [21]. The facts found in the learning process that has been going on so far are only centered on teachers [22], so that the problem solving commonly used in schools is mathematical problems that use solving procedures presented in the form of certain symbols or variables.

The author's preliminary study at Public Elementary School Wringingintung 01 revealed a conventional, teacher-centered approach to fifth-grade mathematics learning. The teacher dominated the learning process, resulting in most students simply sitting and listening. Students simply accepted the teacher's delivery during the learning process, failing to independently seek supporting materials. Furthermore, the researcher obtained information from the teacher that students were less accustomed to working on problem-solving problems. The teacher attributed the issue to the placement of problem-solving problems after routine tasks, which left students with insufficient time to work on them. Furthermore, the researcher's observations revealed a lack of connections between the classroom learning process and everyday life. Most students struggled to relate their acquired knowledge to practical applications. Teachers had not developed any teaching modules.

Issues pertaining to mathematical problem-solving abilities necessitate resolutions. One approach to resolve this issue is by creating instructional modules. The Independent Curriculum (Curriculum Merdeka) teaching modules are considered essential instruments for the effective execution of learning through innovative models or paradigms, particularly in relation to the transformation brought about by the industrial and digital revolutions [23]. The Independent Curriculum (Curriculum Merdeka) teaching modules refer to a few media tools, methods, instructions, and guidelines designed systematically, engagingly, and, most importantly, tailored to student needs [24]. Teaching modules implement learning objectives based on learning outcomes for Pancasila students. Based on student progress, educational modules are designed. They regard learning stuff with defined aims. Long-term development underpins them.

Teachers must also grasp teaching modules to make learning more engaging and meaningful [25]. The Independent Curriculum allows teachers to create their own modules. Central government teaching modules can be chosen or modified by teachers. Modifications must follow the curriculum. Teachers tailor lessons to pupils. This follows learning and assessment requirements. Media aids in learning affect math problem-solving skills [26]. This study will utilize Quizizz-assisted media.

Quizizz can serve as an effective instrument to aid pupils in resolving mathematical difficulties [27], [28]. Quizizz enables students to engage in engaging and enjoyable learning while honing their problem-solving abilities through various questions and quizzes delivered in a game format. Mathematics problem-solving learning modules can be developed using Quizizz features to enhance motivation and deliver an engaging, enjoyable educational experience [29]. Students may utilize Quizizz to present problem-solving inquiries, obtain instantaneous feedback, and monitor their advancement [30].

This research, supported by Wirdaningsih et al., found that the mathematics lesson plan and student worksheet, using a contextual teaching and learning approach for grade 11 science students in high school, met the criteria for validity, practicality, and effectiveness [31]. Moreover, a study by Rahmawati et al. indicated that the produced educational aids were appropriate in both content and design for enhancing students' physics problem-solving abilities [32].

The deficiency addressed by this research was inadequate problem-solving skills and the absence of a tailored learning module to improve problem-solving abilities relevant to technology. This research is innovative, as the researchers created a learning module within the autonomous curriculum and utilized the Quizizz application. The specific purpose of this project was to create a Quizizz-assisted learning module to enhance primary school pupils' mathematics problem-solving abilities.

RESEARCH METHODS

The research methodology employed is research and development. This research and development initiative seeks to create new goods through a systematic development approach. This project seeks to create an effective Quizizz-assisted teaching module to strengthen the mathematical problem-solving skills of primary school students. The research design utilizes the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The test participants in this study comprised fifth-grade children from Wringingintung 02 Elementary School, whereas the subjects for the product test were fifth-grade students from Wringingintung 01 Elementary School

This study utilizes instructional modules, validation sheets for media and material experts, surveys for teachers and students, and questions assessing problem-solving abilities. The expert validation sheet was employed to assess the validity of the Quizizz-assisted teaching module. The instructor and student response questionnaires were utilized to assess the efficacy of the Quizizz-assisted teaching module. Problem-solving exam questions were employed to assess the efficacy of the Quizizz-assisted training module presented in descriptive form. The questions employed were pretested to ascertain validity, reliability, and difficulty levels. Upon validation, the questions might be utilized for pre-test and post-test assessments. The questions were created to assess mathematical problem-solving skills through the integration of problem-solving capabilities. Refer to

Table 1 below to ascertain the classification of question validity.

Table 1. Classification of Question Validity

Range	Description
0,81-1,00	Very high
0,61 - 0,80	High
0,41 - 0,60	Quite high
0,21 - 0,40	Low
0,00 - 0 0,20	Very low

The reliability criteria for question items are very high if the r-count is 0.80-1.00; high if the r-count is 0.60-0.79; medium if the r-count is 0.40-0.59; low if the r-count is 0.20-0.399; and very low if the r-count is 0.00-0.19. Meanwhile, the criteria for the Question Difficulty Level Test are the magnitude of the question difficulty index, with the symbol P between 0.00 and 1.00. Questions with P 0.00-0.30 criteria (difficult questions); P 0.31-0.70 criteria (medium questions); P 0.71-1.00 criteria (easy questions).

This research employed data collection approaches including tests, interviews, questionnaires, and documentation. This study involved a pretest administered prior to the implementation of the Quizizz-assisted teaching modules and a posttest conducted subsequently. This study aimed to assess the efficacy of the Quizizz-assisted learning module prior to and following its implementation.

The studied data comprised quantitative information derived from the validator evaluation questionnaire and the outcomes of the pretest and posttest about problem-solving skills. The percentage outcomes were subsequently transformed according to the following criteria.

Table 2. Percentage Criteria

Percentage (%)	Criteria
82 < score ≤ 100	Very valid
63 < score ≤ 81	Valid
44 < score ≤ 62	Quite valid
25 < score ≤ 43	Not valid

The empirical evaluation of the teaching module was derived from data collected using teacher response questionnaires. The percentage values were subsequently transformed according to the established criteria. Refer to Table 3 below.

Table 3. Percentage of Criteria

Percentage (%)	Criteria
82 < Score ≤ 100	Very good
63 < Score ≤ 81	Good
44 < Score ≤ 62	Quite good
25 < Score ≤ 43	Not good

The data produced in the field trial were the outcomes of a mathematical problem-solving skill assessment. An educational module is deemed effective if there is a disparity in mathematics problem-solving proficiency test scores prior to and subsequent to the implementation of the Quizizz-assisted learning module. The study necessitates certain prerequisites: 1) data from a normally distributed population and 2) homogeneity of variance and covariance across populations. To fulfill these criteria, multiple assumption tests were performed, including the normality test and the homogeneity of variance and covariance test.

The normality and homogeneity tests were conducted utilizing the SPSS 29 software tool. The decision-making procedure stipulates that if the significance value is greater than or equal to alpha, then the null hypothesis is accepted. If the significance value is less than alpha, then the null hypothesis is rejected. Upon satisfying all assumptions, the subsequent step is to conduct a paired sample t-test to evaluate the study hypothesis.

The Paired Sample T-Test is employed to ascertain if there is a distinction in the utilization of the Quizizz-assisted learning module. In the paired sample t-test, if the output result, "Paired Samples Correlations," is produced, the significance value is 0, which is inferior to 0.05. This indicates the rejection of H0 and the acceptance of H1. The N-Gain Average Improvement Test measures the difference between the pretest and posttest scores. The N-Gain decision-making criteria are outlined in Table 4 below.

Table 4. N-Gain Value Criteria

N-Gain Value	Interpretation
<0,00	Decrease
G=0,00	No increase
0,00-0,30	Low
0,30-0,70	Medium
0,70-1,00	High

RESULT AND DISCUSSION

This research resulted in a Quizizz-assisted teaching module to improve fifth-grade elementary school students' mathematical problem-solving abilities. The research was conducted using a research and development (R&D) approach with an ADDIE design consisting of five stages: analysis, design, development, implementation, and evaluation. The development process, data analysis, and conclusion drawing were conducted according to ADDIE data. The processes undertaken in this research are as follows:

1. Analysis Stage

Analysis is a fundamental step in understanding the situation on the ground and identifying learning issues, thus obtaining data for the teaching module to be developed. During the analysis phase, the researcher interviewed a fifth-grade teacher at elementary school Wringingintung 01. The analysis phase included curriculum analysis, material analysis, and student analysis. The researcher interviewed the fifth-grade teacher at elementary school Wringingintung 01 regarding the curriculum used. The results revealed that the school uses the Merdeka curriculum.

Material analysis was conducted through interviews with the fifth-grade teacher at elementary school Wringingintung 01. Based on the interview results, the researcher decided to cover the subject of LCM and GCF because many students did not yet understand the concepts of LCM and GCF and their application in everyday life. LCM and GCF are prerequisites for understanding subsequent material. Furthermore, LCM and GCF can be developed into mathematical problem-solving skills questions.

Observations related to the classroom learning process aim to determine student characteristics. It is important to know and understand student characteristics because they can influence their learning success [33], [34]. The students used in this study were fifth-grade students at elementary school Wringinggintung 01. Fifth-grade students are between 10 and 11 years old, entering the concrete operational stage, where they begin to think concretely in learning activities. Without tangible objects in front of them, they will still experience significant difficulties completing logical tasks. In the concrete operational stage, students focus their thought processes on observing real-life events. If the problem is concrete and not abstract, students can solve it.

The cognitive aspect of fifth-grade students aged 7-12 years is entering the concrete operational stage, where they can use logic, but only with existing physical objects. Without physical objects in front of them, students in the concrete operational stage will experience significant difficulties completing logical tasks [35]. Therefore, the educator's task is to teach using a guidebook that includes real-life examples so that students don't just imagine.

Mature social interactions, environment adaptation, and socialization characterize the socio-emotional aspect of student development. During social interactions, students experience various emotions, such as excitement over something new, boredom, a need for guidance, anger, or fear of someone. Their social environment, including their peers and teachers, greatly influences this development. Students' socio-emotional development depends on both maturity and learning factors [36], [37]. Therefore, educators must be able to provide learning experiences tailored to the students' varying socio-emotional needs.

The socio-emotional development of fifth-grade students at Wringingintung 01 Elementary School still requires clear guidance when carrying out learning activities. Therefore, the module created by the researcher includes guidance written in language that is easy for students to understand, ensuring they do not encounter difficulties. Students in class V of Wringingintung 01 Elementary School often form groups based on gender during learning activities: specifically, female students' group with other female students, and male students' group with other male students.

The language aspect of elementary school students generally does not fully comprehend the meaning conveyed, but students in higher grades are able to understand it, although some students are not yet able to fully grasp it [38], [39]. The language aspect of fifth-grade students at Wringingintung 01 Elementary School can be seen in students who are able to understand the meaning of each word or sentence but use simple language. Therefore, the module is designed for students using simple language appropriate to the developmental level of fifth-grade elementary school students so that the meaning can be understood.

Students rarely demonstrate active learning during lessons. They simply sit and listen to the teacher's explanation. Students' mathematical problem-solving abilities are not yet evident. Such behavior is evident when students are given story problems to solve; students are still confused and require teacher guidance. Students are not yet able to connect the main material to the story.

2. Design Stage

The design stage is where researchers draft the teaching module product. The product developed has a novelty in improving mathematical problem-solving skills using Quizizz. Quizizz was chosen as an alternative to encourage students to be more active in learning and to gradually understand mathematical concepts. This module consists of a cover, learning objectives, general information, core competencies, student worksheets, and assessments. The following is the design of a Quizizz-assisted teaching module to improve students' problem-solving skills in Figure 1.

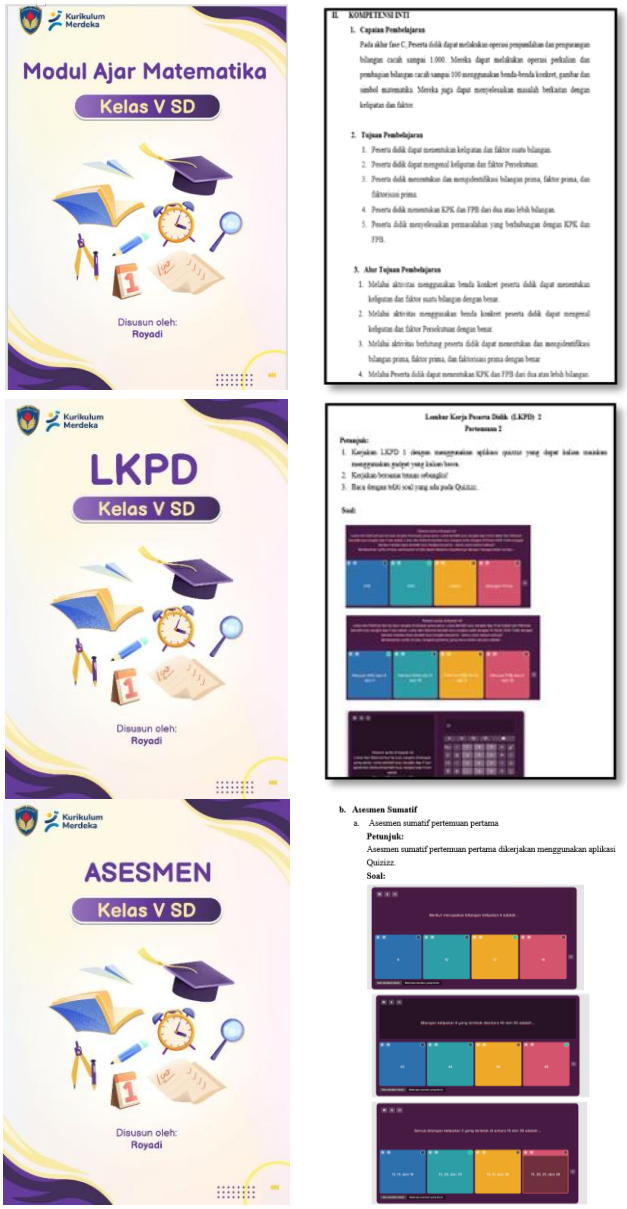

Figure 1. Teaching Module Design

3. Development Stage

The development of a teaching module encompasses its thoroughness, the quality of materials and information, the appeal of the design, the style of writing, and the color scheme. A conceptual framework for the implementation of a new product was developed in the preceding stage. The conceptual framework was subsequently converted into a product prepared for deployment [40]. The finalized training module concept was subsequently validated by domain experts. This validation aimed to assess the validity and feasibility of the generated product. The objective was to rectify faults and weaknesses in the instruments generated, enabling researchers to assess the viability of the created instruments for subsequent enhancement. Two professional instructors and practitioners spearheaded this development phase. Each expert received a grid, a teaching module product, and a questionnaire to evaluate the instruments developed. The findings of the teaching module validation are presented in Table 5.

Table 5. Results of Teaching Module Validation

Aspect	Validator		
	1	2	3
Module Identity	8	8	8
Learning Objectives Flow	12	11	12
Learning Materials	17	20	18
Learning Strategies	28	26	27
Quizizz	14	16	15
Selection of Learning Materials and	7	7	7

Aspect	Validator		
	1	2	3
Resources			
Learning Evaluation	24	24	24
Total Score	110	112	111
Value	94,83	96,55	95,69
Average	95,69		
Category	Very Valid		

The research findings indicate that the Quizizz-assisted learning module for LCM and GCF materials was deemed valid by experts, achieving an average score of 95.69, and suitable for mathematics instruction. The validation assessment of the learning module evaluated various components: module identity, learning objectives, learning materials, methods, Quizizz, selection of resources, and learning evaluation. Consequently, the validity of the created learning module is appropriate for enhancing mathematical problem-solving skills in mathematics education.

The module identity and learning evaluation yielded the highest percentages. Both the module identity and the learning evaluation received a 100% score. The module identity comprised the author's name, agency, phase, and time allocation. The learning evaluation, including module identity, also earned excellent results. The learning evaluation was meticulously constructed, encompassing emotive, cognitive, and psychomotor dimensions.

The requirements for a designed learning tool to attain an acceptable level of validity are those that meet a minimum threshold of validity. If the validity level is less than acceptable, adjustments are required based on expert recommendations. The validation procedure is thereafter reiterated. If it falls under the valid category, the device is prepared for field trials. The validity debate concludes that the Quizizz-assisted learning module is effective in enhancing mathematical problem-solving skills.

4. Implementation Stage

The implementation phase encompassed a trial of the Quizizz-assisted instructional module. This trial had nine kids: three high-achieving, three average-performing, and three low-performing pupils from the fifth grade at Wringingintung 01 Elementary School. This study was conducted to assess the feasibility of the teaching module. Following the trial, educators were administered a teacher response questionnaire. A teacher response questionnaire was utilized as the instrument.

The teacher response questionnaire is a tool administered to educators and peers to assess the readability and usefulness of the created teaching module. The instrument was developed to encompass several components, including teaching module identity, flow and objectives, contents, learning methodologies, Quizizz, selection of learning materials and resources, and learning assessment. The outcomes of the practicality assessment are presented in Table 6 below.

Table 6. Results of Practitioner Responses to the Practicality of the Teaching Module

Assessor	Score	Category
Class Teacher	87.07	Very Practical
Peer	85.35	Very Practical

The teaching module created by the class teacher received a score of 87.07 for practicality/readability, classified as highly practical. The peer review yielded a score of 85.35, classified as highly practical. Consequently, practitioners' assessments suggest that the devised teaching module effectively enhances mathematical problem-solving abilities.

The practicality of the teaching module was implemented in a single stage. Based on the results of the practitioner's responses received by a fifth-grade teacher at Wringingintung 01 Elementary School, the practitioner did not provide any suggestions or improvements, so the module was considered suitable for testing without revision. After receiving the practitioner's responses, a product trial was conducted to determine its practicality and whether the module received a positive response.

A product is considered practical if it is simple to use and can be implemented effectively [41]. The practicality of a product significantly supports creating a conducive learning environment and achieving the desired results. Therefore, to determine the practicality of the module, the researcher used a teacher response questionnaire. The enthusiasm of students and the positive results align with previous research by Wulandari et al., which found that learning outcomes for students using interactive e-modules were higher and led to improved understanding [42]. One area of improvement that the researcher noted was the difficulty in determining homogeneous and heterogeneous mixtures during the worksheets, as the instructional sentences were word-only. Therefore, the researcher will replace the images with concrete images so that students don't just imagine them.

This research is aligned with research conducted by Anwar et al., which found that teaching modules or learning media that include videos or images can increase student enthusiasm for learning and prevent boredom [43]. This conclusion confirms the practicality of the module product the researcher developed for learning purposes.

Furthermore, the validated and practical training module is now prepared for research application. Currently, instruction is conducted with the Quizizz-assisted teaching module. The objective of this step is to assess the efficacy of the Quizizz-assisted teaching module. The educational process occurred across two sessions. A pretest was administered before the learning process utilizing the Quizizz-assisted teaching module. The pretest was utilized to evaluate the preliminary mathematics problem-solving ability of fifth-grade students at Wringingintung 01 Elementary School. The subsequent phase involved conducting research with the Quizizz-assisted teaching module across two sessions. A posttest was performed following the learning process utilizing the Quizizz-assisted teaching module. The posttest evaluates students' problem-solving skills following instruction with Quizizz-assisted teaching modules. The result is a description of the pretest and posttest scores derived from the teaching module, as presented in Table 7.

Table 7. Description of the Results of the Pretest and Posttest Scores for Mathematical Problem-Solving Ability

Activities	Minimum Score	Maximum Score	Total	Average
Pretest	60	80	550	67.35
Posttest	73	93	1940	84.30

Analysis of Variance (ANOVA) can assess the efficacy of the instructional module in enhancing students' mathematical problem-solving skills. ANOVA analysis necessitates the fulfillment of specific criteria, including: The data originates from a population characterized by a multivariate normal distribution. The equality of variance-covariance among the populations is consistent. To meet these requirements, multiple assumption tests were conducted, specifically, 1) the Normality Test and 2) the Homogeneity Test of Equality of Variance-Covariance. The Shapiro-Wilk column presents the outcomes of the pretest and posttest normally assessments of students' mathematical problem-solving competencies, with a degree of freedom value below 50. The normality test findings for the pretest data indicate a significant value of 0.124. The posttest normality test findings indicate a significance value of 0.214. Since the significance value of the data exceeds 0.05, it can be inferred that the pretest and posttest mathematical problem-solving abilities are regularly distributed. A homogeneity test is subsequently conducted. The significance column presents the outcomes of the homogeneity test. If the significance value surpasses 0.05, it indicates that the variances of two or more data populations are homogeneous. The data utilized in the homogeneity test comprised the pretest and posttest outcomes of mathematical problem-solving proficiency. The homogeneity test findings revealed a significance value of 0.851, indicating that the pretest and posttest data were homogeneous. A hypothesis test was subsequently performed with a paired sample t-test.

A paired sample t-test was performed using SPSS 25 to see if there was a difference in the application of the teaching module between the pretest and posttest of mathematical problem-solving skills. H0: If the significance value (Sig.) exceeds 0.05, there is no difference in the mean scores of the pretest and posttest for mathematical problem-solving abilities. H1: A significant value (Sig.) below 0.05 indicates a difference in mathematical problem-solving abilities between the pretest and posttest. The data obtained from SPSS are presented in Table 8 below.

Table 8. Results of the Paired Sample T-Test of Mathematical Solving Ability

	Paired Differences			t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean			
Pair 1 - Grade - Class	74.326	9.603	1.416	52.492	45	.000

The paired samples t-test table presents the outcomes of the pretest and posttest data. The "Paired Samples t-test" output indicates a two-tailed significance value of 0.000, which is less than 0.05. Consequently, H0 is dismissed and H1 is affirmed. Consequently, a disparity exists in the mean scores of the pretest and posttest regarding students' mathematical problem-solving skills. The paired sample t-test results on mathematical problem-solving abilities reveal a disparity in the averages of the pretest and posttest data. An N-gain test was subsequently performed to assess the magnitude of the increase in pretest and posttest data.

The efficacy of the learning module creation was assessed by the n-gain test. The n-gain exam measures the level of improvement in students' problem-solving abilities. This improvement is evident from the pupils' n-gain scores presented in the table. The n-gain test results from the pretest and posttest observations are summarized in Table 9.

Table 9. N-Gain Results of Mathematical Problem-Solving Ability

Components	Findings	
	Pretest	Posttest
Number of Students	23	23
Mean Score	67,35	84,30
Normality Gain	0,519	
Category	Medium	

The data analysis reveals that the normalcy of gain signifies an enhancement in the mathematical problem-solving abilities of fifth-grade pupils at Wringingintung 01 Elementary School, as demonstrated by the pretest and posttest outcomes. The normalcy analysis indicates that fifth-grade pupils exhibit a mean gain of 0.519 in mathematical problem-solving ability, categorizing it as moderate.

The data analysis indicates that the Quizizz-assisted learning module enhances students' problem-solving skills. Consequently, it can be inferred that the Quizizz-assisted learning module effectively enhances the problem-solving skills of fifth-grade pupils at Wringingintung 01 Elementary School.

5. Evaluation Stage

Evaluation and revision were conducted at each stage of development to ensure the module was considered valid. Researchers made improvements at each stage and process to ensure the module could be used for fifth-grade elementary school mathematics instruction on the GCF and LCM topics.

Two evaluations were conducted: 1) formative evaluation, conducted from the beginning of the development stage to the end of the product research and development process. This evaluation took place at the design stage, where the researcher determined the appearance of the module, including the selection of images, materials, and quizzes to be used. We used evaluations, such as suggestions and comments from expert validators, during the development stage to refine the product. During small-group trials, an evaluation was conducted at the implementation stage, which was based on teacher responses, allowing for improvements.

Summative evaluation was conducted at the final stage after all development stages had been completed. The purpose of summative evaluation was to measure the module's effectiveness and evaluate the product after the trial. This evaluation stage included reviewing aspects related to the development of the Quizizz-assisted teaching module. The evaluation aimed to obtain feedback on the success of the Quizizz-assisted teaching module. Evaluation can be conducted at every stage of the ADDIE model. Validators provide numerous suggestions, criticisms, and input throughout the development process. Revisions at each stage use these suggestions, criticisms, and input as guidelines or benchmarks to further improve the product.

The efficacy of the Quizizz-assisted learning module for mathematical problem-solving skills is evaluated according to established effectiveness criteria. An effective learning module is characterized by a disparity in average pretest and posttest scores, along with an enhancement in mathematical problem-solving ability, as reflected in these scores.

Various normality tests, homogeneity tests, paired sample t-tests, and n-gain tests demonstrate that the Quizizz-assisted learning module significantly enhances mathematical problem-solving skills. Azzahra and Kowiyah's research corroborates these findings, demonstrating that students' mathematical problem-solving skills improved following the utilization of Quizizz learning media [44]. Moreover, research by Logan et al. indicates that the creation of valid and practical modules would enhance student learning effectiveness, thereby attaining the desired educational results [45]. Logan et al. and Ananda et al. asserted that teaching modules that fulfill satisfactory criteria are essential for directing students towards achieving satisfactory learning outcomes aligned with the educators' established learning objectives [45], [46].

Oracki posits that problem-solving is a process of surmounting obstacles faced to attain a desired objective [47]. Furthermore, Wu and Molnár states that problem-solving can be viewed as a process by which students discover combinations of previously learned rules that can be used to solve new problems [48].

Problem-solving is a fundamental skill in mathematics learning, helping individuals think analytically [49]. Acquiring mathematical problem-solving skills fundamentally involves developing the ability to think, reason, and utilize current knowledge. Mathematical problem-solving cultivates critical and creative thinking while enhancing further mathematical problem-solving abilities [49], [50]. Polya state that mathematical problem solving can be implemented in four stages: understanding the problem, planning a problem-solving strategy, implementing the problem-solving process, and reviewing the results [51].

Quizizz provides questions that train problem-solving skills for fun math learning. It can be played on each student's smartphone, encouraging everyone to participate and be more active in the learning process by completing the quizzes. Such participation can lead to high quiz

scores and an impact on improving student learning outcomes [52]. Quizizz also features themes, memes, avatars, and music to entertain students while they work independently on quizzes. Chang et al. assert that game-based learning possesses significant promise as an effective educational medium due to its ability to engage both visual and verbal elements [53].

Building upon the findings, Quizizz learning media can improve mathematical problem-solving skills because it makes learning more engaging with quizzes for evaluation and slide displays, which makes students more enthusiastic about learning. Students can enhance their problem-solving results by revisiting the learning slides in Quizizz, enabling them to establish their learning objectives. The Quizizz learning platform can improve problem-solving results by clearly sharing information, making learning fun, allowing students to study on their own based on their skills, and providing a more enjoyable experience while still following important educational principles.

Furthermore, using the Quizizz app has its advantages and disadvantages. The advantage of Quizizz is that it allows teachers to examine students' answers and identify any errors in them. Furthermore, with this app, students can flexibly complete questions anytime and anywhere. As Mulyati and Evendi stated in their research, using the app on a smartphone is flexible and can minimize paper usage, improve ICT skills, and increase student motivation [54]. In addition to its advantages, Quizizz also has a disadvantage in terms of time duration. A fifth-grade student at elementary school Wringingintung 01 revealed that the disadvantage of Quizizz is that each quiz question has its own time duration, which sometimes makes students nervous and uneasy while working. Students feel rushed and lose focus. They would prefer Quizizz if it wasn't timed. Teachers will address this issue by changing the question system rules so that students don't have to worry about the countdown when completing questions. According to research by Kristiani et al., time allocation is a drawback of Quizizz, as all questions have a specific time limit, making it uncomfortable for students with poor time management skills [55].

The implications of this research are that the theory used in this study can serve as a reference for conducting similar research. Practically, the results can serve as examples for teachers, demonstrating that there are many areas in which students can learn and develop their skills. This research serves as a first step for schools in understanding their students' learning situations. The Quizizz development can activate students' learning and strengthen their problem-solving skills. This development research impacts teachers in implementing changes in the learning process and can explain or resolve problems experienced by teachers, preventing them from resorting to conventional methods. Furthermore, this development research encourages and motivates teachers to utilize existing school facilities and infrastructure and use them effectively, as media is crucial in supporting a more engaging learning process.

CONCLUSION

The Quizizz-assisted teaching module designed to enhance the mathematical problem-solving skills of fifth-grade students has been validated as highly credible by experts and practitioners, deemed practical with a commendable rating by teachers, and proven effective in improving these skills among fifth-grade students. The validity test findings, evaluated by specialists, yielded an average score of 95.69, categorizing it as very valid. The class teacher's practicality test yielded an average score of 87.07, categorized as very practical, while colleagues achieved a score of 85.34, also classified as very practical. The effectiveness assessment commenced with the normality test, followed by homogeneity, paired sample t-test, and n-gain analysis. The normalcy test findings indicated a significant value of 0.124 for the pretest and 0.214 for the posttest. The homogeneity test yielded a significant score of 0.815. The paired sample t-test results indicated an average difference between the pretest and posttest data. The evaluation of fifth-grade students' mathematical problem-solving abilities revealed an average score of 0.519, categorizing it as modest.

As a suggestion, educators can use Quizizz in various subjects. Teachers need to optimize student abilities to further develop them. Teachers also need to create teaching modules tailored to student needs and expected abilities. Schools should provide easy facilities for teachers and students to use to learn.

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