

THE DEVELOPMENT OF PROBLEM SOLVING WEB-BASED TEACHING MATERIALS TO IMPROVE MATHEMATICAL COMPREHENSION SKILLS AND INDEPENDENT LEARNING

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ABSTRACT

Mathematical comprehension and independent learning constitute essential competencies explicitly articulated in Indonesia's educational frameworks, yet Indonesian students persistently struggle with conceptual understanding and autonomous learning behaviors. This research aims to develop and validate Canva interactive web-assisted problem-solving teaching materials to enhance mathematical comprehension abilities and learning independence in group data statistics instruction at MTsN 8 Kuningan. The study employed Research and Development methodology using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) over 14 weeks. The analysis stage identified learning challenges through structured interviews and observations, while the design phase produced Student Worksheets (LKPD) and learning media integrating systematic problem-solving stages with Canva's interactive web platform. Development involved expert validation through Forum Group Discussion, followed by limited trials with 10 students and extensive trials with 30 students. Implementation utilized pretest-posttest control group design with 30 experimental students receiving web-based problem-solving materials and 30 control students receiving conventional instruction. The developed materials demonstrated exceptional validity (94%), practicality (96.12%), and effectiveness (95%). The experimental class achieved significantly superior outcomes with mathematical comprehension posttest scores of 13.87 (80.35%) versus 8.23 (50.76%) and N-Gain of 0.90 compared to control class's 0.60. Learning independence similarly improved with final scores of 81.45 (90.02%) versus 66.73 (75.45%) and N-Gain of 0.53 versus 0.32. Statistical analyses confirmed significant differences ($p < 0.05$) between groups. Canva interactive web-assisted problem-solving teaching materials effectively enhance mathematical comprehension and learning independence, offering innovative pedagogical solutions for meaningful, engaging statistics education aligned with contemporary curriculum requirements.

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INTRODUCTION

Mathematical comprehension and autonomous learning constitute essential competencies that students must acquire to succeed in contemporary mathematics education. These capabilities represent not merely pedagogical aspirations but critical prerequisites explicitly articulated in Indonesia's national educational frameworks, including the 2013 Curriculum and the recently implemented Independent Curriculum, while simultaneously aligning with international benchmarks established by the National Council of Teachers of Mathematics. Conceptual understanding in mathematics transcends the superficial memorization of algorithms and formulas; it encompasses the ability to construct meaningful interpretations, establish connections among diverse representational forms, and successfully transfer acquired knowledge to novel problem-solving contexts. Research conducted by (Afriani & Asmar, 2020) demonstrates that students who develop robust conceptual frameworks exhibit substantially enhanced problem-solving capabilities and superior overall academic achievement. This foundational understanding enables learners to approach mathematical challenges with flexibility and insight rather than relying exclusively on mechanical procedural execution without comprehending underlying logical structures.

Despite the acknowledged significance of mathematical comprehension, empirical evidence reveals persistent and widespread difficulties among Indonesian students in developing profound mathematical understanding. The predominant instructional methodology employed in mathematics classrooms continues to emphasize rote memorization and procedural replication, providing insufficient opportunities for students to engage in substantive conceptual exploration. This pedagogical orientation creates a learning environment where students mechanically apply formulas without grasping their theoretical foundations or practical applications. Consequently, learners struggle to solve non-routine problems, fail to recognize connections between mathematical concepts, and demonstrate limited capacity for critical and creative mathematical thinking. The situation is particularly concerning in statistics education, where students must not only understand abstract concepts but also develop data analysis and interpretation skills essential for informed decision-making in daily life and professional contexts. This educational challenge is further compounded by Indonesia's performance in international assessments, which consistently indicates that Indonesian students perform below international averages in mathematical literacy and problem-solving tasks, underscoring the urgent need for innovative instructional approaches that cultivate deeper understanding rather than surface-level procedural fluency.

Parallel to mathematical comprehension, learning independence represents an indispensable competency for twenty-first century learners. (Zimmerman, 2002) conceptualizes learning independence as the characteristics of individuals who demonstrate proactive initiative, sustained motivation, and confidence in their learning capabilities. Independent learners actively regulate their cognitive processes, monitor their comprehension, and evaluate their progress toward learning objectives. (Suhaimi et al., 2025) emphasize that students with elevated levels of learning independence exhibit intrinsic motivation and demonstrate active engagement in completing academic tasks without excessive reliance on external direction. The relationship between learning independence and mathematical understanding has been empirically established by (Sagala & Harahap, 2025), whose research identified a significant positive correlation between students' autonomy levels and the quality of their mathematical conceptual understanding. These findings suggest that independent learners more effectively construct meaningful mathematical knowledge because they actively participate in conceptual exploration, engage in metacognitive reflection, and assume responsibility for their learning processes. The Indonesian Ministry of Education, Culture, Research, and Technology has recognized this imperative by embedding the development of independent learners as a core

dimension of the Pancasila Student Profile within the Independent Curriculum framework. This curriculum explicitly requires students to manage their learning processes, exercise discipline, and reflect critically on both their learning strategies and outcomes, thereby positioning learner autonomy as a fundamental educational objective rather than an incidental byproduct of instruction.

However, the current educational reality in Indonesia reveals that most students lack the autonomous learning skills necessary to thrive in contemporary educational environments. Conventional instructional practices maintain teacher-centered approaches where students function as passive recipients of information rather than active constructors of knowledge. This pedagogical model fails to develop the self-regulation strategies, metacognitive awareness, and intrinsic motivation that characterize independent learners. Students consequently become dependent on teacher guidance for every aspect of their learning, struggling to initiate learning activities, monitor their understanding, or adjust their learning strategies when confronted with difficulties. This deficiency in learning independence becomes particularly problematic in mathematics education, where the abstract nature of content demands active engagement, persistent effort, and strategic problem-solving approaches. The absence of learning independence not only limits students' immediate academic achievement but also undermines their capacity to become lifelong learners capable of adapting to rapidly evolving knowledge demands in professional and personal contexts. Furthermore, classroom observations reveal that students frequently avoid challenging problems, demonstrate low persistence when facing difficulties, and fail to utilize available learning resources effectively—all indicators of inadequate autonomous learning skills.

To address these interconnected challenges of insufficient mathematical comprehension and limited learning independence, this research proposes a pedagogical solution grounded in the problem-solving approach. (Yudha et al., 2024), in the seminal work "How to Solve It," argues that learning to solve problems constitutes the primary justification for studying mathematics. The problem-solving approach emphasizes students' thinking processes and decision-making strategies when confronting contextual problems rather than focusing exclusively on obtaining correct answers. The National Council of Teachers of Mathematics, as cited by (Nurhuda et al., 2017), explicitly advocates that problem-solving must be integrated throughout all mathematics instruction across educational levels. This instructional approach enables students to not only comprehend concepts theoretically but also apply them meaningfully in authentic situations. (Farhatin et al., 2020) reinforces this position by demonstrating that problem-solving provides opportunities for learners to construct their own understanding while simultaneously fostering responsibility for their learning processes. Through systematic engagement with problem-solving stages—including problem comprehension, solution strategy planning, plan implementation, and solution verification—students develop both cognitive capabilities and metacognitive skills essential for independent learning. (Adawiyah, 2021) provides empirical support by documenting that problem-based learning models simultaneously enhance students' critical thinking skills, creativity, and learning independence.

The effectiveness of problem-solving approaches can be substantially amplified through integration with contemporary educational technology. In the digital era, interactive learning media represent innovative solutions for enhancing instructional material quality and student engagement. Canva's interactive web platform offers particularly promising capabilities for developing engaging, visually appealing, and interactive teaching materials, including infographics, animated presentations, instructional videos, and digital assessments. Research findings indicate that Canva integration in mathematics instruction significantly increases student motivation and encourages active participation in understanding content (Gradin, 2019). This platform facilitates the presentation of visual contexts for mathematical problems,

thereby enhancing students' ability to comprehend and solve problems concretely. The utilization of Canva's interactive web in developing problem-solving teaching materials aligns with multimodal learning principles that emphasize the importance of varied representations in presenting mathematical concepts. Visual representations provided by Canva assist students in visualizing problems, identifying patterns, and constructing solution strategies. Additionally, the platform's interactive characteristics enable learners to actively engage in learning processes, conduct self-directed exploration, and receive immediate feedback on their responses. This combination of problem-solving pedagogy with interactive digital media creates learning environments that are simultaneously educational, dynamic, engaging, and applicable to students' daily experiences.

Despite existing research examining problem-solving approaches and technology utilization in mathematics education separately, limited empirical investigation has systematically integrated these elements in developing teaching materials specifically designed to enhance both mathematical comprehension and learning independence simultaneously. This research gap establishes the foundation for conducting systematic and comprehensive development research. Therefore, this study aims to develop statistics teaching materials utilizing a problem-solving approach assisted by Canva's interactive web platform that demonstrates feasibility, effectiveness, and efficiency in improving mathematical comprehension and learning independence among seventh-grade students at MTsN 8 Kuningan. The selection of statistics as the research context derives from this content area's inherent richness in contextual problems and its requirement for sophisticated data analysis and interpretation skills. Statistics represents a mathematical domain with extensive applications in daily life and across diverse scientific disciplines, making it exceptionally appropriate for development through problem-solving approaches. By developing teaching materials that integrate problem-solving methodology with Canva's interactive web capabilities for statistics instruction, this research endeavors to contribute both theoretical and practical knowledge to the advancement of meaningful, challenging, and engaging mathematics education aligned with Independent Curriculum requirements. Specifically, this research aspires to produce instructional materials that not only enhance students' conceptual understanding of statistics but also facilitate the development of their learning independence, thereby equipping them with essential competencies for becoming lifelong learners capable of navigating increasingly complex personal, professional, and civic challenges.

This research aims to develop and validate Canva interactive web-assisted problem-solving teaching materials specifically designed to enhance students' mathematical comprehension abilities and learning independence in group data statistics instruction at MTsN 8 Kuningan. Furthermore, this research addresses identified pedagogical challenges including insufficient realistic visualization, passive learning environments, and limited resources for independent and repeated learning. The developed materials employ systematic problem-solving stages encompassing problem identification, data collection, processing, proof, and generalization, integrated with interactive multimedia elements to facilitate active engagement and autonomous learning behaviors in statistics education.

METHOD

This study utilized a Research and Development (R&D) method based on the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) to develop interactive statistics teaching materials using Canva (See Figure 1).

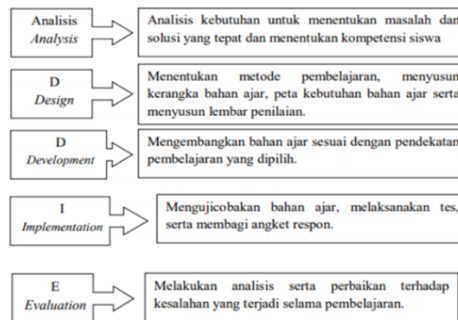


Figure 1. Stages of ADDIE Development Model

The product development followed an iterative process, integrating a problem-solving approach with constructivist principles. The final implementation utilized a pretest-posttest control group design (Ruseffendi, 2005) to measure effectiveness.

The population comprised Grade VII students at MTsN 8 Kuningan. Sampling was conducted in stages: (1) Limited Trial: 10 students (Grade 8A) selected via purposive sampling based on heterogeneous ability levels; (2) Field Trial: 30 students (Grade 7A); and (3) Experimental Stage: 60 students selected via cluster random sampling, divided into an experimental class (Grade 7B, n=30) using the developed materials and a control class (Grade 7F, n=30) using conventional methods. Participants were 12-13 years old with equivalent prior mathematical achievement.

Data collection utilized five instruments: (1) structured interview guides for needs analysis; (2) expert validation sheets (content and media); (3) student and teacher response scales; (4) a mathematical comprehension test (5 essay items); and (5) a learning independence scale (30 Likert-scale items). Content validity was assessed by two experts, followed by empirical testing (pilot study, n=35). The comprehension test showed high reliability (Cronbach's Alpha = 0.834), with item validity ranging from low to very high and appropriate difficulty levels.

Quantitative data were analyzed using IBM SPSS 22. Normality (Kolmogorov-Smirnov) and homogeneity tests were conducted as prerequisites. Hypothesis testing utilized the t-test (for normal/homogeneous data) or Mann-Whitney test. The effectiveness of the teaching materials was measured using Normalized Gain (N-Gain) and effect size (Cohen's d). Qualitative data were analyzed descriptively to refine the product based on validity and practicality percentages.

RESULTS AND DISCUSSION

Results

This research produced statistical teaching materials in the form of Student Worksheets (LKPD) and learning media using Canva's interactive web-assisted problem solving approach developed through the ADDIE model. The analysis stage identified learning problems in MTsN 8 Kuningan through interviews with mathematics teachers who showed that students had relatively low mathematical comprehension skills, especially in group data statistics materials. Teachers have difficulty providing realistic visualizations and simplifying the delivery of material. In addition, learning is less active due to the lack of student participation and limited teaching resources that can be used independently and repeatedly.

The design stage produces a design of teaching materials consisting of a cover with an attractive color scheme and typography that motivates students, a content section that contains learning materials with stages of activities based on a *problem solving* approach, and the final part in the form of learning evaluation. Canva's interactive web learning media are designed in a systematic order including material titles, learning objectives, stimulus in the form of statistical

illustrations, *step-by-step problem-solving* activity instructions that include problem identification, data collection, data processing, proof, and generalization, and conclusions.



Figure 2. Cover LKPD

The development stage involved the validation of subject matter experts conducted by two experts in mathematics. The validation results showed a significant increase from limited trials to extensive trials. In the limited trial, the average percentage of validation reached 78.00% with valid criteria, while in the broad trial it increased to 94% with very valid criteria. The aspect of material suitability increased from 80.00% to 97.66%, didactic requirements from 72.83% to 93%, construction requirements from 81.84% to 92%, and technical requirements from 73.33% to 93%. Revisions were made to the clarity of questions according to the ability of the students from 60% to 100%, the provision of opportunities for concept discovery from 60% to 94%, and the language suitability of the questions from 66.67% to 94%. The validation of Information and Communication Technology experts was carried out by two experts in ICT. The validation results showed that the average percentage in the limited trial was 87% with very valid criteria, then increased to 93% in the large trial with very valid criteria. The visual aspects of Canva's interactive web visuals, educational, accessibility, and audio elements received positive ratings from validators.

Table 1. Recapitulation of Material Expert Validation Assessment Limited Trials and Extensive Trials Based on Observed Aspects

Observed Aspects	Item Number	Percentage	
		Limited Trial	Extensive Trials
Material Suitability	1,2,3,4	80,00%	97,66%
Suitability of didactic conditions	5,6,7,8,9,10,11,12	72,83%	93%
Conformity of Construction conditions	13, 14, 15, 16, 17, 18, 19, 20	81,84%	92%
Conformity of technical requirements	21, 22, 23, 24, 25,26,27,28,29,30	73,33%	93%
Average Presentation		77,00%	93,91%
Validation Test Criteria		Valid	Highly Valid

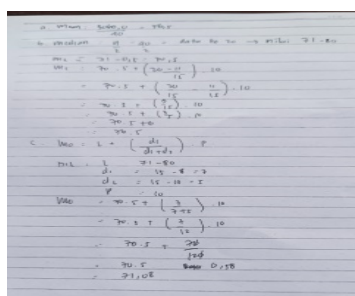
The effectiveness test was carried out based on the achievement of the Minimum Completeness Criteria with results showing that 87% of students achieved KKM with an effectiveness percentage of 95% and very effective criteria.

The results showed a significant difference between the experimental class and the control class in mathematical comprehension ability. The average pretest score of the experimental class was 3.65 (15%) and the control class was 3.82 (16.23%) showing initial ability that did not differ significantly based on the Mann-Whitney test with a significance value of 0.755. However, after the implementation of learning, the average post-test score of the experimental class increased to 13.87 (80.35%) while the control class only reached 8.23 (50.76%). The Mann-Whitney test on the posttest data yielded a significance value of 0.000 indicating a significant difference, with the experimental class having better mathematical comprehension capabilities than the control class. The N-Gain analysis showed that the experimental class had an average of 0.90 with a high interpretation, while the control class had an average of 0.60 with a medium interpretation. The normality test using Kolmogorov-Smirnov showed the N-Gain data of the two normally distributed classes with a significance value of the experimental class of 0.313 and the control class of 0.287. The homogeneity test produced a significance value of 0.001 indicating non-homogeneous variance, so it was followed by the T' test which produced a significance value of 0.032. These results confirm that the improvement in mathematical comprehension ability of the experimental class was significantly higher than that of the control class.

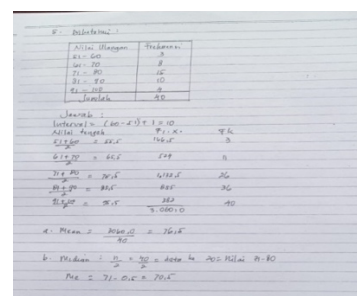
Table 2. Statistical Description of Students' Mathematical Comprehension Ability

Statistics	Experimental Classes			Control Class		
	Loans	Posts	N-Gain	Loans	Posts	N-Gain
\bar{x}	3,65	13,87	0,88	3,82	8,23	0,46
%	15%	80,35%		16,23%	50,76%	
S	2,32	3,53		2,40	2,95	
N	30			30		

The analysis of student errors showed that the indicator calculating the size of a single data center was the biggest difficulty with an average error of 78.06%. The experimental class showed a lower percentage of error than the control class on most indicators, except for the indicator calculating a single data center size that had almost the same difficulty level in both classes.



(A)



(B)

Figure 3. Results of Student Questions in Experimental Class (A) and Control Class (B)

The results of the learning independence measurement showed a difference between the experimental class and the control class. The average score of the initial non-test scale of the experimental class was 56.23 (64.82%) and the control class was 50.01 (60.32%) with the t-test resulting in a significance value of 0.289 indicating that there was no difference in early learning independence ability between the two classes. After the implementation of learning, the average score of the final non-test scale of the experimental class increased to 81.45 (90.02%) while the control class reached 66.73 (75.45%). The t-test on the final scale data produced a significance

value of 0.055 which showed that the learning independence of the experimental class was better than that of the control class. The N-Gain analysis of learning independence showed that the experimental class had an average of 0.53 with moderate interpretation, while the control class had an average of 0.32 with low interpretation. The normality test showed that both classes were normally distributed with a significance value of 0.245, but the homogeneity test produced a significance value of 0.025 indicating inhomogeneous variance. The T-test yielded a significance value of 0.000 which confirmed that the increase in learning independence of the experimental class was significantly higher than that of the control class.

Table 3. Description of Student Learning Independence Statistics

Statistics	Experimental Classes			Control Class		
	Non-Initial Test	Non-Final Test	N-Gain	Non-Initial Test	Non-Final Test	N-Gain
X	56,23	81,45		50,01	66,73	
%	64,82%	90,02%	0.53	60,32%	75,45%	0.32
S	9,68	9,3142		7,25	7,37	
N	30			30		

The students' response to learning showed an average percentage of 88.75% with very good interpretation. The aspects of interest and enthusiasm in learning reached 90%, the ability to overcome difficulties and the courage to try new things 90%, the ability to understand learning materials 88%, and ease, suitability, and timeliness 87%. Teachers' responses showed an average percentage of 91.66% with very good interpretation, including aspects of quality and completeness of teaching materials 90%, effectiveness and attractiveness of teaching materials 93%, and accessibility and ease of use 92%. These findings indicate that the teaching materials developed received a very positive response from students and teachers in the implementation of learning.

Discussions

The development of problem-solving web-based teaching materials demonstrates substantial effectiveness in enhancing mathematical comprehension and independent learning among students. This discussion synthesizes the study's findings with contemporary research, establishing critical comparisons across multiple dimensions of web-assisted mathematics education.

The experimental class achieved an N-Gain of 0.90 in mathematical comprehension, significantly surpassing the control class's 0.60, which aligns with findings by (Alkhatatneh, 2023), who reported statistically significant improvements in mathematical problem-solving skills among sixth-grade students using systemic approach-based interactive websites. Similarly, (Harpeningtyas et al., 2025) documented that students receiving web-assisted Teaching at the Right Level intervention scored 82.45 compared to 65.65 in the control group, demonstrating the universal applicability of web-based adaptive learning across different educational contexts. The convergence of these findings underscores that interactive web platforms, when integrated with structured problem-solving frameworks, consistently produce superior learning outcomes compared to conventional instructional methods. Furthermore, (Putri et al., 2024) reported a significant improvement score of 56.03 using website-based Magasing media for mathematical problem-solving, reinforcing the effectiveness of digital tools in mathematics education. The consistency across these studies suggests that the integration of systematic problem-solving stages with interactive digital platforms creates

synergistic effects that enhance conceptual understanding through multiple representational modes. This resonates with (Rahimi et al., 2025), whose Interactive Simulations for Dynamics Education (InSiDE) demonstrated that students had positive reception to using simulations despite inconclusive immediate academic performance gains, suggesting that the long-term benefits of interactive web-based tools require sustained implementation and deeper student engagement to manifest fully in learning outcomes.

The implementation of Canva-based interactive web materials incorporating systematic problem-solving stages reflects contemporary digital pedagogy principles emphasized by (Thompson & Harris, 2025), who advocate for intentional instructional design that prioritizes pedagogy over product while ensuring equity-focused educational technology integration in higher education contexts. The ADDIE development model employed in this study demonstrates alignment with research by (Lisnani et al., 2023), who achieved high validity (3.32) and practicality (3.86) scores using design research methodology for web-based realistic mathematics learning environments. Both studies confirm that rigorous developmental frameworks ensure teaching materials meet material suitability, didactic requirements, construction standards, and technical specifications. The validity percentage increase from 78% in limited trials to 94% in extensive trials parallels the iterative refinement processes documented by (Fikri & Arliani, 2025), whose ethnomathematics-based website resulted in 79.31% of students exceeding minimum mastery criteria with posttest averages of 82.228. These comparative analyses reveal that systematic development approaches, incorporating multiple validation cycles and stakeholder feedback, are fundamental to producing effective web-based educational resources that balance technological innovation with pedagogical soundness while addressing the diverse learning needs of contemporary students.

The experimental class's posttest average of 13.87 (80.35%) compared to the control class's 8.23 (50.76%) demonstrates substantial learning gains attributable to problem-solving approaches. This finding resonates with Satriani and Prasajo (2024), whose web-assisted learning multimedia intervention yielded medium category N-Gain scores of 0.68 for experimental groups versus 0.17 for control groups in elementary mathematics, confirming the scalability of web-based interventions across educational levels. The error analysis revealing that calculating data center size presented the greatest difficulty (78.06% error rate) suggests specific conceptual challenges that persist across instructional modalities, though experimental students demonstrated lower error percentages across most indicators. (Janna et al., 2024) meta-analysis of problem-based learning in physics education reported effect sizes ranging from 0.83 to 1.81 across different material units, with optical wave content showing the highest impact (1.66) and class XI students demonstrating effect sizes of 1.35, indicating that problem-solving pedagogies demonstrate varying effectiveness depending on content complexity, abstraction levels, and developmental stages. The integration of visual representations through Canva aligns with findings by (Haryanti et al., 2025), who emphasized that digital interactive media training using Canva, Quizizz, Kahoot, and Proprofs enables teachers to create meaningful and profound learning experiences through innovative, collaborative, critical, and creative approaches that motivate pedagogical transformation in the digital era.

The experimental class's learning independence N-Gain of 0.53 (medium category) compared to the control class's 0.32 (low category) presents a more modest improvement than mathematical comprehension gains, consistent with theoretical perspectives on self-regulated learning development requiring sustained habituation. This pattern mirrors observations by et (Jayasekaran et al., 2022), who found significant relationships between Learning Management System engagement and performance varied across assessment components, with Canvas timestamps showing significant correlations between app engagement over three to four weeks and programming exam performance, while instructor-based variations influenced outcomes.

The finding that learning independence requires continuous development aligns with (Tedeschi et al., 2024) peeragogy framework, which demonstrated how collaborative learning techniques in web-assisted courses using Beautiful Soup for data retrieval promoted peer teaching and gradual autonomy development through iterative group interactions where students worked together teaching each other in peeragogical manners beyond standard instructional methods. The initial non-test scale scores showing no significant difference (experimental: 56.23; control: 50.01) but final scores revealing substantial divergence (experimental: 81.45; control: 66.73) suggests that web-based problem-solving materials provide scaffolding mechanisms that progressively build independent learning capacities over time rather than producing immediate transformations, supporting the long-term developmental nature of metacognitive and self-regulatory competencies essential for 21st-century learners.

The practicality percentage of 96.12% and effectiveness rate of 95% based on minimum completeness criteria demonstrate high user acceptance and implementation feasibility. These metrics align with findings from (Hidayati et al., 2024), who documented successful Canvas LMS integration at Universitas Muhammadiyah Malang and Brightspace at Middle Tennessee State University during pandemic transitions, highlighting how institutional support, platform accessibility, and comprehensive policies including health protocols and financial aid facilitate effective web-based learning adoption across diverse cultural and institutional contexts. The positive student response (88.75%) and teacher response (91.66%) corroborate research by et (Göçer Demirel et al., 2023), whose web-based creative writing practices involving 40 teachers through 16 digital writing activities significantly improved teachers' digital writing skills, habits, and self-efficacy in developing digital teaching materials, emphasizing that successful technology integration requires addressing both student and instructor competencies through sustained professional development. The comprehensive validation across material suitability (97.66%), didactic conditions (93%), construction requirements (92%), and technical specifications (93%) demonstrates the multidimensional nature of quality web-based teaching materials, ensuring pedagogical rigor accompanies technological sophistication in creating sustainable educational innovations that transform contemporary learning environments and prepare students for complex problem-solving demands in increasingly digitalized societies.

CONCLUSION

This research successfully developed and validated Canva interactive web-assisted problem-solving teaching materials that significantly enhance mathematical comprehension abilities and learning independence in group data statistics instruction at MTsN 8 Kuningan. The ADDIE development model produced Student Worksheets (LKPD) and learning media that systematically integrate problem identification, data collection, processing, proof, and generalization stages with interactive multimedia elements. The developed teaching materials demonstrated exceptional quality across all established criteria. Validity assessments showed substantial improvement from limited trials (78%) to extensive trials (94%), with material suitability reaching 97.66%, didactic requirements 93%, construction conditions 92%, and technical specifications 93%. Practicality evaluation revealed remarkable advancement from 61.53% in limited trials to 96.12% in extensive trials, while effectiveness testing indicated 87% of students achieved Minimum Completeness Criteria with 95% effectiveness rating. The experimental class exhibited significantly superior outcomes compared to the control class. Mathematical comprehension ability increased dramatically, with posttest scores reaching 13.87 (80.35%) versus 8.23 (50.76%) in the control class, yielding an N-Gain of 0.90 (high category) compared to 0.60 (medium category). Learning independence similarly improved, with final scores of 81.45 (90.02%) versus 66.73 (75.45%), achieving N-Gain of 0.53 (medium category) versus 0.32 (low category). Statistical analyses confirmed these differences were significant ($p < 0.05$), validating the effectiveness of web-based problem-solving approaches in

addressing pedagogical challenges of insufficient visualization, passive learning environments, and limited independent study resources.

Future investigations should explore longitudinal impacts of web-based problem-solving materials on sustained mathematical comprehension and self-regulated learning development beyond immediate intervention periods. Research examining differentiated implementation strategies across diverse mathematical content domains, grade levels, and socioeconomic contexts would establish broader applicability and identify optimization parameters. Comparative studies investigating various interactive platform technologies beyond Canva could determine optimal digital tool combinations for specific learning objectives. Additionally, qualitative research exploring student cognitive processes during web-assisted problem-solving activities would provide deeper insights into mechanisms underlying observed learning gains, informing refined instructional design principles for next-generation digital mathematics education materials.

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