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CANVA AND GEOGEBRA-ASSISTED PROBLEM BASED LEARNING WORKSHEET TO IMPROVE STUDENTS' MATHEMATICAL PROBLEM SOLVING ABILITY AND LEARNING INTEREST ON SENIOR HIGH SCHOOL

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ABSTRACT

The low levels of students' mathematical problem-solving ability and interest in learning, particularly in the topic of the Three-Variable Linear Equation System (SPLTV), become the primary context of this study. This research aims to develop learning tools in the form of Student Worksheets (LKPD) and learning media based on the Problem-Based Learning model, assisted by the Canva and Geogebra, that are valid, practical, and effective. The research method used was Research and Development (R&D), following the nine development stages of the Borg and Gall model. Subjects involved Grade X and Grade XI students from SMAN 1 Batujajar and SMAN 2 Cimahi. Instruments included validation sheets, teacher and student response questionnaires (Likert scale), a mathematical problem-solving ability test, and a student learning interest attitude scale. Results showed that the developed learning tools were considered very valid based on the assessments of material and media experts, and met the criteria of being very practical based on the responses given by teachers and students. In addition, the learning tools were effective, as indicated by increases in N-gain scores, improved classical mastery criteria in the experimental class compared with the control class, and a significant improvement in the student learning interest attitude scale. Statistical tests confirmed that the use of these learning tools significantly improved students' problem-solving ability and interest in learning compared with conventional learning. The Problem-Based Learning mathematics learning tools, assisted by Canva and GeoGebra, are feasible and effective as an innovative solution for senior high school learning.

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INTRODUCTION

Problem-solving ability is the most crucial ability for students in facing an era full of changes (Hidayat & Sariningsih, 2018). Problem-solving ability is a skill that enables students to make appropriate decisions, both in the individual domain and in their social environment (Tambunan, 2019). Problem-solving can build students' self-confidence in solving mathematical problems (Hendriana et al., 2017). In addition, students who have mathematical problem-solving ability can solve problems using correct mathematical steps and principles, and can improve decision-making in everyday life (La'ia & Harefa, 2021). In line with the opinion of Cooney (Ishaqiyah et al., 2023), the possession of problem solving ability helps students think analytically in making decisions in daily life and helps improve critical thinking ability in facing new situations.

Mathematical problem-solving ability is an essential competence that not only functions to solve problems in the classroom, but also trains students to think analytically and make decisions in facing various new situations in everyday life (Surya et al., 2017). However, this urgency is not consistent with the realities of the educational context. The reality in the field indicates that students' mathematical problem-solving ability remains well below the ideal. This is supported by the findings of Azzahra and Pujiastuti (2020), which indicate that the mathematical problem-solving ability of Grade X IPS 3 students at SMAN 5 Kota Serang in the topic of the Three-Variable Linear Equation System (SPLTV) remains low. In line with the research results of Sriwahyuni and Maryati (2022) it is shown that students' mathematical problem-solving ability in the topic of Statistics is still low and therefore needs serious attention from all parties. A similar condition is also confirmed by the findings of Meika and Sujana (2017), which indicates that students' creative and problem-solving abilities in the topic of Function Derivatives have not been optimal or remain very low. Based on initial observations and academic data from SMA Negeri 1 Batujajar, students show low mathematical problem-solving ability. In general, students' academic achievement remains classified as low, including in mathematics. This condition may be caused by various factors, such as educational background, learning environment, and learning motivation. This phenomenon is clearly reflected in the test and daily assessment results of Grade X students at SMA Negeri 1 Batujajar, which remain below the Minimum Mastery Criteria (KKM), indicating that many students experience difficulties solving mathematics problems, particularly those requiring reasoning and concept application. Students tend to memorize formulas without understanding the principle concept, resulting in significant difficulties when applying them to various problem situations.

The implementation of formal learning requires teachers to possess adequate competence in fostering students' enthusiasm and interest in learning (Hadisaputra et al., 2019). One factor that determines success in learning is students' interest in participating (Gunawan et al., 2021). Learning activities are effective when individuals engage in them with enjoyment, that is, when there is interest in learning (Zulfikar et al., 2022). Students with high learning interest are more likely to achieve their learning objectives. Conversely, when learning interest is low, students tend to be uninterested in the subject matter and may even show attitudes of dislike or rejection toward the teacher (Armania et al., 2018). Learning interest is important in the learning process because, without interest, students cannot fully engage in learning (Silfitrah & Mailili, 2020). Learning activities can be carried out effectively when students' interest in learning emerges. A problem that often arises in the classroom is the presence of students who show a lack of respect and focus toward learning, while teachers do not understand this condition (Trismayanti, 2019). The low level of learning interest is consistent with the findings of Gazali and Atsnan (2017), who reported that the motivation and interest in learning mathematics among Grade VIII students at SMP Negeri 7 and SMP Negeri 24 Banjarmasin remained low. A similar condition

is evident in the findings of Ndraha et al. (2022), which indicate that students at SMK N 1 Sogaeadu show very low interest in mathematics. Furthermore, Ayu et al. (2021) reported that Grade IV students at MI Mambaul Ulum still have low interest in mathematics, as they perceive it as difficult.

In an effort to improve students' problem-solving ability and learning interest in the digital era, the mathematics learning process must be directed toward activities that encourage direct student participation based on information technology. One learning innovation that can be applied is the development of Student Worksheets (*Lembar Kerja Peserta Didik*; LKPD) using a Problem-Based Learning approach, assisted by Canva and GeoGebra. The integration of the Problem-Based Learning model with Canva media aims to present learning materials more creatively and aesthetically, while GeoGebra provides greater accuracy in mathematical exploration, thereby making their collaboration an effective tool for stimulating students' analytical thinking and learning motivation.

Research on improving mathematical problem-solving ability through the Problem-Based Learning model has been widely conducted (Ramadhanti et al., 2022; Darmawan, Sutiarso & Nurhanuwati, 2024). One of these studies is the development of Student Worksheets (LKPD) based on Problem-Based Learning in mathematics subjects for the SMP MTs level. As well as the development of Problem Based Learning based mathematics learning tools designed to facilitate the problem-solving ability of Grade VIII students at SMP MTs. This is also in line with the utilization of digital media, such as Canva, to enhance visual attractiveness (Tanjung & Faiza, 2019). Similarly, the development of problem-based E-LKPD assisted by Canva aims to stimulate visual literacy and numeracy skills (Oktariya, 2023). As well as the development of interactive learning media assisted by Canva to improve students' motivation in learning mathematics on the topic of the Pythagorean theorem at SMP Negeri 4 Palopo (Awaliya, 2025). The utilization of GeoGebra for concept visualization has also been reported (Mukarramah et al., 2022). The development of Student Worksheets assisted by GeoGebra has been conducted to facilitate students' visual thinking ability (Asngari, 2018). Furthermore, the development of learning tools using the Missouri Mathematics Project (MMP) model, assisted by GeoGebra software, has been implemented to improve students' conceptual understanding (Aufa et al., 2021). However, research that specifically integrates the Problem-Based Learning model with both applications in a single learning tool package remains limited. This study aims to fill this gap by integrating Canva and GeoGebra to improve students' problem-solving ability and learning interest simultaneously.

The novelty of this study lies in integrating the Problem-Based Learning (PBL) model with two digital applications, namely Canva and GeoGebra, within a single learning tool package. In contrast to previous studies that generally employed only one type of media, this innovation integrates Canva's visual design to enhance learning interest and the precision of GeoGebra to strengthen problem-solving ability. These learning tools were specifically designed to address the challenges of low academic achievement and student motivation in the topic of the Three-Variable Linear Equation System (SPLTV) at the senior high school level.

Based on the problems described above and assisted by previous studies, the researcher therefore conducted a development study entitled "Student Worksheets with a Problem-Based Learning Approach Assisted by Canva and GeoGebra to Improve Senior High School Students' Mathematical Problem-Solving Ability."

METHOD

The research was a development study (Research and Development) aimed at developing Student Worksheets (LKPD) and learning media based on the Problem-Based Learning model, using Canva and GeoGebra. The products developed included Student Worksheets (LKPD),

and mathematics learning media. The implementation of this research was carried out by following the development stages of the Borg and Gall model, as shown in Figure 1 below:

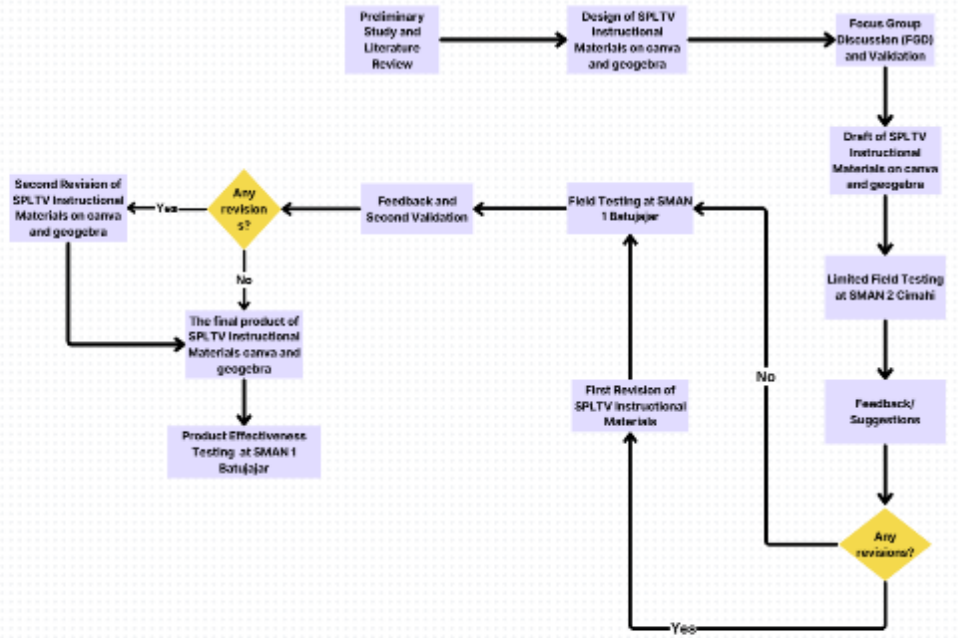


Figure 1. Flow of the Borg and Gall Development Stages

These stages included: (1) preliminary study and literature review; (2) designing mathematics Student Worksheets based on Problem-Based Learning, using Canva and GeoGebra; (3) a Focus Group Discussion (FGD) and expert validation; (4) product revision; (5) limited trial; (6) second product revision; (7) broader trial; (8) final product refinement; and (9) final product implementation.

The research subjects involved students and teachers from SMAN 1 Batujajar and SMAN 2 Cimahi. The trials were conducted in three distinct phases, a limited trial with 10 Grade XI students, a broader trial with 34 Grade X students, and a final implementation phase involving experimental and control classes to assess the tools' effectiveness.

Data collection instruments consisted of interview guidelines, expert validation sheets (for material and media), and response questionnaires for teachers and students using a Likert scale. To measure students' progress, the researcher utilized a mathematical problem-solving ability test and a learning interest attitude scale.

The data analysis techniques used consisted of descriptive statistics and inferential statistics. The feasibility of the product including its validity and practicality was calculated using the percentage formula:

$$P = \frac{NS}{NM} \; x \; 100\%$$

Description:

P: Feasibility percentage

NS: Total score obtained

NM: Maximum total score

The results were then categorized based on predetermined criteria to determine the level of validity and practicality. Effectiveness was evaluated through N-gain score analysis for problem-solving abilities and percentage analysis for the learning interest scale. Finally, an

independent-samples t-test (or a non-parametric alternative) was conducted at a significance level of $\alpha = 0.05$ to test the research hypotheses.

RESULTS AND DISCUSSION

Results

1. Development Process of Problem-Based Learning Learning Tools Assisted by Canva and GeoGebra

Preliminary Study and Literature Review

At the preliminary study stage, the researcher conducted an interview with the mathematics teacher at SMA Albidayah Batujajar, Mrs. Dewiyana, S.Pd., on September 17, 2024. The interview results showed that the topic of the Three-Variable Linear Equation System (SPLTV) is the most difficult material for Grade X students due to its abstract nature and the high level of accuracy required in calculations. In addition, the limited use of ICT based media and the dominance of conventional teaching methods (lecturing) have an impact on students' low learning interest. These findings provided a strong foundation for the researcher to develop Student Worksheets using a Problem-Based Learning approach, assisted by Canva and GeoGebra.

This information-gathering stage indicates the need to develop learning tools for the Three-Variable Linear Equation System (SPLTV) material that integrate the Problem-Based Learning model, using Canva and GeoGebra. These learning tools are designed to facilitate visualization, simplify complex calculations, and foster a more conducive classroom environment for Grade X students in senior high school.

Product Design

At this stage, the researcher developed the initial product design to address learning constraints in senior high school. This design focused on integrating the Problem-Based Learning model into learning tools comprising Student Worksheets (LKPD) and visual media to improve students' mathematical problem-solving ability and learning interest. To provide an overview of the developed product, the visualization of the initial design of the learning tools, which consist of Student Worksheets (LKPD) and Geogebra media, is presented in the figures below:

Student Worksheets (LKPD)

The Student Worksheets (LKPD) developed in this study were designed for four sessions, each designed for a learning meeting. Each student worksheet (LKPD) was prepared using the Canva application by integrating the syntax of the Problem-Based Learning (PBL) model to facilitate students' mathematical problem-solving ability. The following is a description of the initial design:

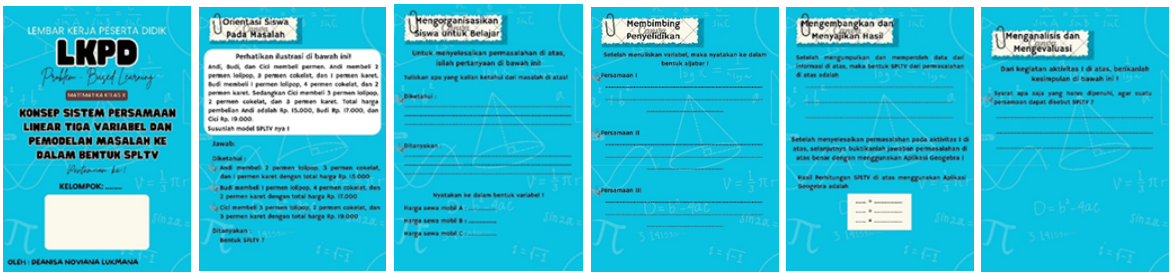


Figure 2. Initial Design of Problem-Based Learning Student Worksheets Assisted by Canva

The initial design of the GeoGebra learning media was developed as a visualization tool to support the Problem-Based Learning model in the topic of the Three-Variable Linear Equation

System (SPLTV). This media was designed dynamically to enable students not only to view static graphs but also to interact directly with mathematical objects. The initial design of the GeoGebra learning media is presented in the figure below:

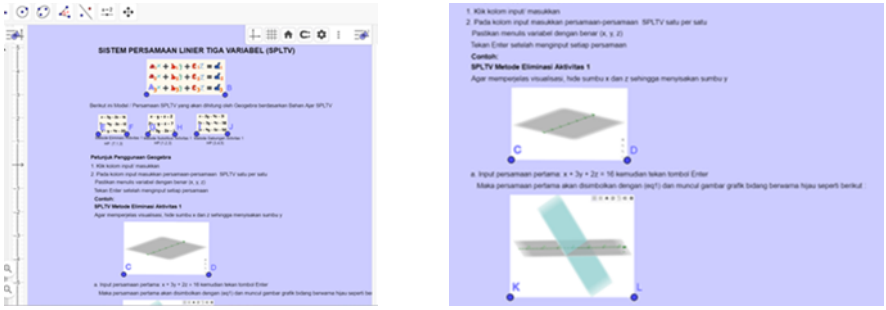


Figure 3. Initial Design of GeoGebra Assisted Learning Media

Focus Group Discussion and Validation

After the initial prototype (Prototype I) was completed, a validation stage was conducted by material experts and media experts. This validation aimed to examine the feasibility of the content, readability, and usefulness of the media before it was implemented with the research subjects. The data obtained consisted of quantitative scores and qualitative suggestions for improvement.

Revised Product Draft

Based on the validators' comments and suggestions, several improvements were made to the design aspects in Canva and to the interactivity features in GeoGebra. These revisions were carried out to ensure that the product met the expected validity criteria. A summary of the validators' suggestions and the corrective actions taken by the researcher is presented in the following table:

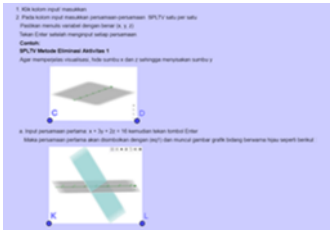
Table 1. Summary of Validators' Improvement Suggestions

No	Validator	Comments / Suggestions for Improvement	Corrective Actions / References
1	Expert Lecturer	The Student Worksheets (LKPD) for the first meeting have not been able to measure the achievement of the Learning Objectives	Optimizing the achievement of learning objectives through synchronization of each stage of the Problem-Based Learning process in the Student Worksheets (LKPD).
		The stages or syntax of Problem-Based Learning have not been able to measure the achievement of the Learning Objectives	Restructuring the Student Worksheets (LKPD) through separation of concept and modeling sections, strengthening prerequisite material on the Two Variable Linear Equation System (SPLDV) in the orientation phase, and adding guidance on modeling steps
2	Practitioner Teacher	The Learning Objectives of the Student Worksheets (LKPD) for the first meeting were not yet	Synchronizing the stages of the Problem-Based Learning model to optimize the achievement of the learning objectives

No	Validator	Comments / Suggestions for Improvement	Corrective Actions / References
		aligned with the learning activities conducted	
3	Media Expert	The integration of GeoGebra with students' complex thinking processes needs to be aligned with the instructional scenario and delivery strategy	Optimizing the media by integrating prerequisite material on the Two Variable Linear Equation System (SPLDV), synchronizing the PBL phases, and strengthening the visualization of intersecting lines and intersection points as solutions to the Three-Variable Linear Equation System (SPLTV), which were condensed into two learning meetings

Based on the details of the revisions presented in Table 1 (Expert Comments Table), the researcher implemented comprehensive design adjustments to the developed product. Documentation of the visual changes from Prototype I to Prototype II, as physical evidence of the revision implementation, is presented in Table 2 below:

Table 2. Comparison of Design Before and After Revision

Component / Section	Before Revision (Prototype I)	After Revision (Prototype II)
Student Worksheets (LKPD)		
Learning Media	 	 

Limited Trials

After the products prototype was validated by experts in mathematics matery and media, the next stage was to conduct a limited trial. This stage aimed to identify initial constraints, assess the readability of instructions in the Canva-based Student Worksheets (LKPD), and evaluate the ease with which students could operate the GeoGebra media on a small scale. The trial was conducted with 10 students to examine their responses to learning using teaching materials,

Student Worksheets (LKPD), and a Three-Variable Linear Equation System (SPLTV) learning media, assisted by Canva and GeoGebra, based on the Problem-Based Learning model. To examine students' and teachers' responses to the product, student response questionnaires and teacher response questionnaires were administered:

Table 3. Summary of Improvement Suggestions in the Limited Trial

Respondent	Product	Comments / Suggestions for Improvement	Corrective Actions (Revision)
Mathematics Teacher	Student Worksheets (LKPD)	Add evaluation questions	
	Learning Media	Create an online version of the media so that students can access the material anywhere	

Field Trial

The field trial was conducted with 34 students to examine students' responses to learning using Student Worksheets (LKPD), and learning media supported by Canva and GeoGebra, based on the Problem-Based Learning model. The results of the field trial showed no suggestions for revision from students or teachers; thus, the learning tools were declared final.

Final Product Trial

After the product was revised based on the results of the limited trial and the field trial, it was tested in the final product trial. The product trial was conducted at SMA Negeri 1 Batujajar, with Class X-A as the experimental class and Class X-B as the control class. In the initial stage, the researcher administered a pretest to both classes to assess students' mathematical problem-solving ability and interest in learning. Furthermore, the researcher provided treatment to the experimental class by implementing learning using teaching materials, Student Worksheets (LKPD), and Three-Variable Linear Equation System (SPLTV) learning media assisted by Canva and GeoGebra, based on the Problem-Based Learning model. Meanwhile, the control class conducted learning as usual across six meetings: four for the learning process and two for the pretest and posttest.

2. Feasibility of Problem-Based Learning Learning Tools Assisted by Canva and GeoGebra to Improve Mathematical Problem-Solving Ability and Students' Learning Interest

A feasibility analysis was conducted to assess the extent to which the developed Student Worksheets (LKPD) and learning media met the criteria for use in mathematics learning. In this study, feasibility was reviewed from four main aspects, namely: the validity aspect based on assessments by two expert lecturers and one practitioner teacher, the practicality aspect based

on teachers' and students' responses, the mathematical problem-solving ability aspect through test results, and the students' learning interest aspect through the completion of an attitude scale. All feasibility data were obtained through a series of expert validations and trials conducted in the following stages: limited trial, field trial, and final product trial. The detailed results of the feasibility analysis are presented as follows:

Table 4. Student Worksheets (LKPD) Validation Results

Product	Expert Lecturer Score (%)	Practitioner Teacher Score (%)	Average Score (%)	Category
LKPD	90%	80%	85%	Very Valid

Table 4 above shows that the validation results of the Student Worksheets (LKPD) received very positive assessments from the experts. The expert lecturer's validation resulted in a score of 90%, whereas the practitioner teacher's assessment yielded 80%. From both assessments, a final average score of 85% was obtained. Referring to the established validity criteria, this score places the Student Worksheets (LKPD) in the "Very Valid" category

The results of the assessment by the media expert regarding the feasibility of the developed GeoGebra media are presented in the following table:

Table 5. GeoGebra Media Validation Results

Product	Expert Lecturer Score (%)	Category
Media	95.79%	Very Valid

Based on Table 5, the media expert's assessment of the GeoGebra media yielded a score of 95.79%. According to the established assessment criteria, this score is classified as Very Valid.

The recapitulation of the practicality scores of the learning tools by teachers at each trial stage is presented in Table 6 below:

Table 6. Recapitulation of Practicality Scores by Teachers at Each Trial Stage

Trial Stage	Student Worksheets (LKPD) (%)	Learning Media (%)	Average per Stage (%)	Category
Limited Trial	95.86%	90%	92.93%	Very Practical
Field Trial	86.90%	89.09%	87.99%	Very Practical
Final Product Trial	88.28%	87.27%	87.77%	Very Practical
Overall Average	90.35%	88.78%	89.56	Very Practical

Based on the table above, in the limited trial stage, a practicality score of 92.93% was obtained, followed by 87.99% in the field trial, and 87.77% in the final product trial. Overall, the total average practicality score from the three stages was 89.67% with the Very Practical criterion. This indicates that the Student Worksheets (LKPD) and learning media remain easy to use and efficient for teachers in classroom management.

The recapitulation of practicality scores provided by students at each trial stage is presented in Table 7 below:

Table 7. Recapitulation of Practicality Scores by Students at Each Trial Stage

Trial Stage	Student Worksheets (LKPD)	Learning Media (%)	Average per Stage (%)	Category
Limited Trial	89.91%	88.21%	89.06%	Very Practical
Field Trial	81.63%	81.83%	8173%	Very Practical
Final Product Trial	84%	83.37%	83.68%	Very Practical
Overall Average	85.18%	84.47%	84.82%	**Very Practical**

Based on the table, the recapitulation results for students' responses from the limited trial stage to the final product show stable, consistent scores, with an overall average of 84.82%. This achievement falls within the Very Practical category, indicating that the developed Student Worksheets (LKPD) and learning media are easy to understand and appealing to students.

3. Effectiveness of Problem-Based Learning Learning Tools Assisted by Canva and GeoGebra in Improving Mathematical Problem-Solving Ability and Students' Learning Interest

Certain tests were conducted to determine how far the developed Student Worksheets (LKPD) with a Problem-Based Learning approach assisted by Canva and GeoGebra were able to improve students' mathematical problem-solving ability and learning interest. This testing involved two classes: the Experimental Class, which used the developed Student Worksheets (LKPD), and the Control Class, which used conventional learning.

Analysis of Students' Mathematical Problem-Solving Ability and Learning Interest

Effectiveness in this aspect was measured through a comparison of the pretest and posttest results between the two classes, with the following results:

Table 8. Recapitulation of Students' Mathematical Problem-Solving Ability Test Results

Statistics	Experimental Classes			Control Class		
	Pretest	Posttest	N-Gain	Pretest	Posttest	N-Gain
Mean	52.52	83.14	0.65	52.98	77.34	0.52
Percentage	52.52%	83.14%	65.33%	52.98%	77.34%	0.52%
Standard Deviation	4.82	7.22	0.14	3.67	4.10	0.08
Number of Students	45			45		

Maximum Ideal Score = 100

Based on the data in Table 8, both classes began the learning process with equivalent initial abilities, with the mean pretest score for the experimental class being 52.52 and for the control class 52.98. However, following treatment, there was a significant difference in improvement between the two groups. The experimental class that used Student Worksheets with a Problem-Based Learning approach, assisted by Canva and GeoGebra, achieved a mean post-test score of 83.14 (83.14%), whereas the control class achieved 77.34 (77.34%). The N Gain value of the experimental class was 0.65, and that of the control class was 0.52, placing both classes in the Medium category. Nevertheless, the experimental class showed numerically greater improvement in mathematical problem-solving ability than the control class.

In addition to cognitive ability, the effectiveness of the Student Worksheets with a Problem Based Learning approach assisted by Canva and GeoGebra was also reviewed from the affective aspect, namely students' learning interest. Learning interest data were obtained through questionnaires administered to students in the experimental class and the control class after the entire sequence of learning activities had been completed. A summary of the results of the students' learning interest questionnaire is presented in the following table:

Table 9. Comparison of Students' Learning Interests

Statistics	Experimental Class	Control Class
	Posttest	Posttest
Mean	71.16	60.64
Percentage	88.94%	75.81%
Standard Deviation	8.16	9.61
Number of Students	45	45

Maximum Ideal Score = 80

Based on the data in Table 9, there is a significant difference in learning interest between the two classes. The control class had a mean score of 60.64 (75.81%), categorizing in the High category. Meanwhile, the experimental class achieved a higher score of 71.16 (88.94%), placing it in the Very High category. The 13.13% difference indicates that the use of Student Worksheets with a Problem-Based Learning approach, assisted by Canva and GeoGebra, is more effective at increasing students' interest in learning than conventional instruction.

Hypothesis Testing

Before conducting hypothesis testing, a prerequisite normality test was performed. This test aimed to determine whether the distribution of the research data was normally distributed or not, which would subsequently determine the type of statistical test (parametric or non-parametric) used for hypothesis testing. The results of the normality test using the Shapiro–Wilk technique (because the sample size was < 50) are presented in the following table:

Table 10. Recapitulation of Data Normality Test Results

Classes	Variable	*Shapiro-Wilk*		
		Statistic	***Df***	***Say.***
Experimental	Pretest	.921	45	.005
Control		.942	45	.026
Experimental	Posttest	.933	45	.012
Control		.906	45	.002
Experimental	N-Gain	.953	45	.065
Control		.874	45	.000
Experimental	Learning Interest	.814	45	.000
Control		.802	45	.000

Based on the table above, it can be observed that only the N Gain data of the experimental class has a Sig. value greater than 0.05. Meanwhile, the N Gain data of the control class, the pretest and posttest data, and the learning interest data of both classes have Sig. values less than 0.05.

Based on the decision criteria for the normality test, most of the research data are not normally distributed. Therefore, because the normality assumption was not fully met, hypothesis testing could not be conducted using a parametric test (e.g., an independent-samples t-test). As a solution, hypothesis testing was conducted using the Mann–Whitney test to assess significant differences between the experimental and control classes.

The Mann–Whitney test was used to assess the significance of differences in mean ranks between the experimental and control classes, using a one-tailed test. The research hypothesis was accepted if the Asymp. Sig. value was < 0.05. The Asymp. Sig. (1-tailed) value was obtained by taking half of the Asymp. Sig. (2-tailed) value. A summary of the hypothesis testing results using SPSS is presented in the following table:

Table 11. Hypothesis Testing Results (*Mann – Whitney U)*

Classes	Variabel	Mean Rank	Asymp. Sig. (2-tailed)	Asymp. Sig. (1-tailed)
Experimental	Pretest	42.99	.357	.178
Control		48.01		
Experimental	Posttest	55.91	.000	.000
Control		35.09		
Experimental	N-Gain	59.44	.000	.000
Control		31.56		
Experimental	Learning Interest	59.70	.000	.000
Control		31.30		

Based on the results in the table above, Pre-test results showed no significant difference in students' initial problem-solving abilities (0.178 > 0.05). However, post-test and N-gain analyses yielded a significance value of 0.000 < 0.05, confirming that the Therefore, it can be concluded that students' mathematical problem-solving ability improved more when learning was delivered using Student Worksheets with a Problem-Based Learning approach, assisted by Canva and GeoGebra, than in conventional learning. Furthermore, in the learning interest test result 0.000 < 0.05, it can be concluded that students' interest in mathematics learning was higher when using Student Worksheets with a Problem-Based Learning approach, assisted by Canva and GeoGebra, than in conventional learning.

Discussions

The development of Student Worksheets (LKPD) with a Problem-Based Learning approach assisted by Canva and GeoGebra was grounded in the results of the preliminary study conducted at SMA Albidayah Batujajar, which indicated that the topic of the Three-Variable Linear Equation System (SPLTV) was considered difficult due to its abstract nature and lengthy calculation processes. The low level of students' interest in learning was also caused by the dominance of lecturing methods and the non-optimal use of ICT-based media in the school. To address these obstacles, the researcher integrated the Problem-Based Learning model with technological media. The use of GeoGebra aimed to provide dynamic visual representations to concretize the initially abstract concept of the intersection of three planes. Meanwhile, the Canva application was used to design visually appealing Student Worksheets (LKPD) to enhance students' engagement and focus.

At this stage, the researcher prepared the initial product design to address learning constraints at the senior high school level, focusing on integrating the Problem-Based Learning model into learning tools. The developed tools included Student Worksheets (LKPD) and visual media designed to improve students' mathematical problem-solving ability and interest in learning.

The Student Worksheets (LKPD) were developed in Canva for four learning sessions to enhance students' problem-solving skills and stimulate learning interest through an aesthetically appealing visual design. Each Student Worksheets (LKPD) was systematically arranged following the syntax of Problem Based Learning, namely: (1) student orientation to the problem, in which students are presented with contextual problems that are attractively displayed in the initial section; (2) organizing students for learning, which helps students understand the tasks and the division of roles within groups; (3) guiding the investigation, which contains directions for gathering information and seeking solutions to the given problems; (4) developing and presenting the results, in which students organize the results of group discussions to be presented; and (5) analyzing and evaluating, which invites students to review and evaluate the problem solving process that has been carried out.

In addition to the Student Worksheets (LKPD), learning media using GeoGebra were developed as a visualization tool for the SPLTV material. This media was designed dynamically so that students can directly observe the manipulation of mathematical objects, rather than merely viewing static graphs. Through accurate 3D graph visualization, it is expected that the concept of the intersection point of three planes, which was initially considered abstract by students, becomes more concrete and easier to understand.

After the initial prototype (Prototype I) was reviewed and revised, a validation stage was conducted by material experts and media experts. This validation process aimed to assess the content feasibility, readability, and usefulness of the media before it was tested with research subjects. The data obtained from the experts included quantitative scores to assess validity and qualitative recommendations to refine the product.

Based on the validation results, several improvements were made to Canva's design and to GeoGebra's interactivity features to ensure that the product met the expected validity criteria. One important suggestion from the material expert concerned the Student Worksheets (LKPD) for the first meeting, which was considered insufficiently capable of measuring achievement of the learning objectives. The researcher followed up on this suggestion by revising the learning activities at each stage of the Problem-Based Learning process within the Student Worksheets (LKPD). In addition, the validators suggested that the distribution of the Problem-Based Learning syntax in the Student Worksheets (LKPD) be separated more explicitly between the basic concept section and the modeling section. The researcher responded to this suggestion by dividing the LKPD structure into conceptual and modeling sections and by adding prerequisite material on the Two-Variable Linear Equation System (SPLDV) and step-by-step modeling examples to facilitate students' understanding of the transition from conceptual material to real problem solving.

In the media domain, the media expert provided recommendations for integrating technology into students' complex thinking processes to improve the systematic delivery of content. In response to this suggestion, the researcher added a prerequisite materials-stimulation section and embedded the phases of Problem-Based Learning directly within the GeoGebra media interface to guide students' learning flow. In addition, there was input to optimize the visualization of the SPLTV material so that it does not only display plane graphs. The researcher then improved the visualization by adding clearer intersecting lines and intersection points to represent SPLTV solutions, and by simplifying the visual presentation to make it more concise and easier for students to understand, without reducing its mathematical accuracy. This series

of improvements resulted in Prototype II, which was declared valid and ready for use in subsequent trial stages.

Based on the results of the limited trial, several points were identified that required further improvement to enhance the quality of the Student Worksheets (LKPD). The mathematics teacher provided suggestions regarding the Student Worksheets (LKPD) component, recommending that the researcher include evaluation questions to assess students' understanding following completion of the learning activities. The researcher followed up on this input by adding a relevant evaluation-question section to the Student Worksheets (LKPD).

In addition, there were suggestions regarding the accessibility of the learning media, recommending that it be made available online. This was intended to provide students with the flexibility to access the material at any time and from any location, without being constrained by offline devices. The researcher responded to this suggestion by providing access links to the online GeoGebra interface that covered the material for each learning meeting. The entire series of revisions resulting from the limited trial ensured that the learning tools were not only theoretically valid but also practical and aligned with the needs of the research subjects before proceeding to the field trial stage.

Based on the observations and evaluations at this stage, the mathematics teacher provided very positive responses to the use of all components of the Student Worksheets (LKPD) and learning media. In the summary of suggestions and follow-up improvements, the teacher reported that no further technical or content-related issues were identified. Therefore, no additional revisions were required for either the Student Worksheets (LKPD) or the learning media. This indicates that Prototype II, having been previously refined, met users' needs and was ready for use as the final product.

Following completion of the field trial with no significant revision notes, the learning tools were established as the final product. The product was subsequently used in an experimental study at SMA Negeri 1 Batujajar to assess its feasibility and its effect on students' mathematical problem-solving ability and learning interest.

After being revised in the limited and field trials, the Student Worksheets (LKPD) entered the final product trial stage at SMA Negeri 1 Batujajar. This study involved Class X-A as the experimental class (using PBL-based LKPD and Canva–GeoGebra media) and Class X-B as the control class (conventional learning). The trial sequence comprised six meetings: a pretest, four teaching and learning activities, and a posttest. Through the integration of technology and the Problem-Based Learning model, students in the experimental class were actively encouraged to solve contextual problems in a dynamic manner. The comparison results between the two classes served as a benchmark for the effectiveness of the Student Worksheets (LKPD) in improving students' problem-solving ability and learning interest.

Based on the explanation above, it can be concluded that the development of Student Worksheets (LKPD) using a Problem-Based Learning approach, assisted by Canva and GeoGebra, aligns with the stages of the Borg and Gall research model. This finding is consistent with the study by Khotimah et al (2020) which developed mathematics E-LKPD based on Strengthening Character Education (PPK) for Grade V elementary school students. In addition, this result is supported by the research of Septina et al (2018) who developed Student Worksheets (LKS) using a scientific approach based on problem-solving ability at SMPN 1 Liwa. In line with these findings, the results are also supported by the study of Fortuna et al (2021) regarding the development of Student Worksheets (LKPD) based on Problem-Based Learning, aimed at improving higher-order thinking skills of junior high school students

Based on the validity and feasibility tests, the developed Student Worksheets (LKPD) using a Problem-Based Learning approach, assisted by Canva and GeoGebra, were categorized as very valid and very practical. This finding is consistent with the results of the study by Agustin et al. (2024), which showed that the development of Student Worksheets (LKPD) using the Problem-Based Learning model assisted by Canva in vocational high schools can be classified as very valid and very practical. In addition, these results are supported by the findings of Juliangkary et al. (2025), which show that the development of Problem-Based Learning (PBL)- based Student Worksheets (LKPD) to improve the mathematical literacy of secondary school students falls into the very valid and very practical category. In line with this, the study by Effendi et al. (2021) indicates that the development of mathematics Student Worksheets (LKPD) based on Problem-Based Learning at the elementary school level is categorized as very valid and practical. Furthermore, research by Rambe and Siagian (2023) confirms that the development of problem-solving-based LKPD to improve mathematical problem-solving skills for Grade X students is categorized as very valid and very practical. Complementing these findings, Rabbiasti (2024) revealed that Canva-assisted E-LKPD based on Problem-Based Learning designed to enhance students' mathematical creative thinking skills also achieved a very valid and very practical status.

Furthermore, the factors that seemed to support this Student Worksheets (LKPD) being categorized as very valid and very practical are as follows. From a validity perspective, this Student Worksheets (LKPD) was systematically designed using the Problem-Based Learning framework, aligned with curriculum requirements and students' problem-solving abilities. This aligns with the findings of Effendi et al. (2021), who indicate that Problem-Based Learning (PBL) is highly relevant to curriculum demands because it requires students to actively explore problem-solving strategies in a logical manner. The use of GeoGebra also enhances mathematical accuracy by dynamically visualizing concepts of the Three-Variable Linear Equation System (SPLTV), thereby reducing the risk of misconceptions in this material. This is consistent with the findings of Joshi and Singh (2020), who emphasize that GeoGebra enables students to view accurate graphical representations in real time, thereby clarifying abstract concepts in linear equation systems and reducing misunderstandings. Meanwhile, the practicality aspect is assisted by the Student Worksheets (LKPD) design developed in Canva, whose visually appealing layout and typography facilitate students' independent understanding of the work instructions. This is consistent with research findings stating that graphic design principles in Canva, such as color contrast and appropriate typography, play an important role in clarifying message delivery, thereby enabling students to process information and work instructions more quickly and independently. This aligns with the findings of Rosmana et al. (2024), who report that visual modifications using Canva in Student Worksheets (LKPD) make instructional materials more communicative and engaging, thereby fostering students' independence in completing classroom tasks. Overall, the combination of a structured learning model with user-friendly technological media makes these learning tools not only theoretically feasible, according to expert assessments, but also easy and efficient to implement in classroom learning processes.

Based on the effectiveness test described above, the development of Student Worksheets (LKPD) using a Problem-Based Learning approach, assisted by Canva and GeoGebra, was classified as effective. The results of the effectiveness analysis indicate that the improvement in students' mathematical problem-solving ability falls within the moderate category. This finding demonstrates that integrating the Problem-Based Learning model, which requires students to solve contextual problems, optimally enhances their cognitive abilities in a deeper manner. This finding is reinforced by the study by Widyastuti and Airlanda (2021), which confirmed that Problem-Based Learning is highly effective in the learning process, particularly

in improving elementary school students' mathematical problem-solving ability compared with conventional learning practices. Consistent with this, Siagian et al. (2019) reported that structured support in Problem-Based Learning enables students to explore problem-solving strategies without receiving direct answers from the teacher, thereby sharpening their cognitive abilities in problem solving. This is further emphasized by the findings of Simamora et al. (2019), which state that systematic instruction in Problem-Based Learning helps students organize complex information into logical problem-solving steps. This aligns with the findings of Nurmayanti et al. (2026), who show that the Problem-Based Learning model assisted by Augmented Reality has a significant effect on the critical reasoning ability of Grade XI students at SMAN 1 Labuapi. In addition, the results by Yanti (2017) also support the argument that students taught using the problem-based learning model outperformed those in conventional classes in terms of mathematical problem-solving skills.

The effectiveness of these learning tools is further confirmed through the results of the one-tailed hypothesis testing, in which the experimental class showed a significantly greater improvement in ability compared to the control class. In addition, a study by Ariyanto et al. (2024) also revealed a moderate improvement in students' mathematical problem-solving abilities following the implementation of a problem-based learning model assisted by Borobudur Temple ethnomathematics-based SWOTE-MATH media.

The use of GeoGebra in these learning tools is crucial for helping students visualize abstract concepts, thereby making the problem-solving process more structured and easier to understand. As stated by Mukarramah et al. (2022), the use of GeoGebra provides accurate visual representations, thereby making concepts initially considered abstract by students more concrete and easier to understand. This is consistent with the findings of Jelatu et al. (2018), who emphasize that integrating GeoGebra into instruction effectively improves students' problem-solving ability by providing dynamic visualizations of geometric and algebraic concepts. Furthermore, the study by Septian et al. (2020) states that the visualizations provided by GeoGebra minimize conceptual errors (misconceptions) and accelerate students' understanding in modeling complex mathematical problems. In addition, research by Ziatdinov and Valles Jr (2022) demonstrates that GeoGebra's dynamic interface features provide accurate visualizations that significantly enhance problem-solving effectiveness across various educational levels. This is further reinforced by Nuritha and Tsurayya (2021) research, which indicates that GeoGebra serves as a dynamic graphical medium, allowing students to experiment by manipulating points and lines to discover problem solutions independently

In addition to being evaluated through learning outcomes, the developed learning tools were shown to be highly effective in improving students' affective outcomes. This is evident in the experimental class's learning interest, which successfully reached the Very High category. This achievement was supported by the Student Worksheets (LKPD) design developed in Canva, which is visually appealing and helps maintain students' focus and increase their emotional engagement during the learning process. This is supported by the findings of Tanjung and Faiza (2019), who indicate that visually designed learning media created with Canva can enhance students' emotional engagement and focus in mathematics learning. In line with this, Hapsari and Zulherman (2021) state that user-friendly and aesthetically pleasing designs in Canva can create an enjoyable learning environment, thereby directly stimulating positive emotional engagement among students. Additionally, research by Stark et al. (2020) proves that the use of Canva can trigger positive emotions, which enable students to become more focused on problem-solving activities. On the other hand, research by Fitriani et al. (2024) reveals that Canva's structured design helps students focus on key points, thereby accelerating the process of conceptual understanding. Furthermore, Imam et al. (2024) conclude that Canva's attractive

features enhance the learning process and significantly increase students' interest at the senior high school level.

CONCLUSION

Based on the results of the research and development that have been conducted, it can be concluded that Student Worksheets (LKPD) based on Problem-Based Learning (PBL), assisted by Canva and GeoGebra on the SPLTV material, have met all the established quality criteria.

First, the development of Student Worksheets (LKPD) using a Problem-Based Learning approach, supported by Canva and GeoGebra, aligns with the stages of the Borg and Gall research model and can improve students' mathematical problem-solving ability and learning interest.

Second, the development of Student Worksheets (LKPD) using a Problem-Based Learning approach, supported by Canva and GeoGebra, falls within the very valid category, and its practicality is categorized as very practical. Consequently, this Problem-Based Learning-oriented LKPD is feasible for use in instruction, particularly in mathematics education.

Third, students' mathematical problem-solving ability improves more through learning using Student Worksheets (LKPD) with a Problem-Based Learning approach, assisted by Canva and GeoGebra, than through conventional learning. This indicates that implementing Student Worksheets (LKPD) using a Problem-Based Learning approach, supported by Canva and GeoGebra, is effective in improving students' mathematical problem-solving ability.

Fourth, students' interest in learning using Student Worksheets (LKPD) with a Problem-Based Learning approach, supported by Canva and GeoGebra, is higher than that in conventional learning. This indicates that the use of Student Worksheets (LKPD) with a Problem-Based Learning approach, supported by Canva and GeoGebra, can increase students' learning interest.

Future research should explore the effectiveness of this LKPD in other mathematical topics, such as Solid Geometry or Calculus, to broaden its application.

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