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DEVELOPMENT OF STUDENT WORKSHEET BASED ON THE CREATIVE PROBLEM SOLVING MODEL TO FACILITATE MATHEMATICAL CREATIVE THINKING SKILLS

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ABSTRACT This research aims to develop a student worksheet based on the Creative Problem Solving (CPS) model to facilitate students' mathematical creative thinking skills on the topic of systems of linear equations in two variables. The development process follows the 4-D model: define, design, develop, and disseminate. During the define phase, problems in current learning resources were identified through interviews and observations. The design phase involved the creation of a worksheet aligned with CPS syntax and learning objectives. In the develop phase, expert validations and student trials were conducted, resulting in a validity score of 91% and a practicality score of 92%, indicating the product is very valid and very practical. The final product was disseminated through seminars and school distribution. The results show that the CPS-based student worksheet is feasible and can serve as an effective learning resource to enhance students' mathematical creative thinking skills.

Keywords: student worksheet, Creative Problem Solving, mathematical creative thinking, systems of linear equations

ABSTRAK Penelitian ini bertujuan untuk mengembangkan lembar kerja peserta didik berbasis model Creative Problem Solving (CPS) guna memfasilitasi kemampuan berpikir kreatif matematis siswa pada materi sistem persamaan linear dua variabel. Proses pengembangan mengikuti model 4-D: define, design, develop, dan disseminate. Pada tahap define dilakukan identifikasi masalah pembelajaran melalui wawancara dan observasi. Tahap design mencakup perancangan lembar kerja berdasarkan sintaks CPS dan tujuan pembelajaran. Tahap develop dilakukan validasi oleh ahli dan uji coba kepada siswa, dengan hasil validitas sebesar 91% dan kepraktisan sebesar 92% yang menunjukkan produk sangat valid dan sangat praktis. Produk akhir diseminasi melalui seminar dan distribusi ke sekolah. Hasil penelitian menunjukkan bahwa lembar kerja berbasis CPS layak digunakan sebagai sumber belajar untuk meningkatkan kemampuan berpikir kreatif matematis siswa.

Kata-kata kunci: lembar kerja peserta didik, Creative Problem Solving, berpikir kreatif matematis, sistem persamaan linear

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INTRODUCTION

According to the Regulation of the Minister of National Education No. 05 of 2022, mathematics learning aims to enhance students' abilities to think logically, analytically, systematically, critically, and creatively. This is because mathematics education requires students to be capable of solving mathematical problems in creative ways. In the context of 21st-century education, students are expected to think creatively and develop solutions independently. This is in line with Suherman and Vidákovich (2022), who state that students will be prepared to face global challenges if they possess the ability to think creatively by producing new solutions or developing existing ones. The regulation emphasizes that mathematics should be taught to cultivate creative, systematic, critical, and logical thinking.

Mathematical creative thinking ability refers to the way students think in understanding problems, making hypotheses, and constructing solutions based on their own ideas (Lubis et al., 2022). Students are said to be thinking creatively if they can generate new insights or unique approaches to mathematical problems (Amelia & Wardani, 2022). According to Agustina and Nurrahmah (2021), there are four indicators of creative thinking: fluency, flexibility, originality, and elaboration. Therefore, creative thinking can be interpreted as students' ability to generate new ideas or approaches in solving mathematical problems.

Empirical findings from previous studies indicate that these indicators have not been fully facilitated. Tinda et al. (2019) found that on the originality indicator, students had difficulty providing novel responses, and on the fluency indicator, they struggled to express ideas when solving problems. Likewise, Amalia et al. (2014) reported that students were unable to present multiple ideas or write complete answers that included known data and what was being asked. These results show that the indicators of mathematical creative thinking ability are not yet well-supported.

One contributing factor to this condition is the learning process, which is still dominated by conventional methods. Tinda et al. (2019) and Afriansyah (2014) revealed that teaching through lectures and note-taking, with minimal contextual motivation, results in students becoming passive in expressing ideas. To address this, a learning model that supports the development of creative thinking is needed, one of which is the Creative Problem Solving model (Puspita et al., 2018).

According to Sutiawan et al. (2019), the Creative Problem Solving model allows students to express opinions and generate ideas as part of problem-solving. Harefa (2020) also explains that it is a model that enables students to find solutions creatively. As stated by Sari et al. (2020), this model consists of four main steps: clarifying the problem, generating ideas, evaluating and selecting, and implementing solutions. Thus, Creative Problem Solving is a student-centered learning model that encourages the generation of original ideas in solving problems.

To support students' creative thinking skills, teachers are expected to utilize appropriate learning tools, one of which is the use of students worksheets. Nurdin

(2019) asserts that a students worksheet is a learning resource that facilitates efficient learning and understanding. According to Prastowo (2014), it contains material and instructions to help students achieve learning objectives. Studies by Anjani et al. (2018), Sulistyowati (2014), and Fauzan and Suhandri (2023) demonstrate that students worksheets developed using the Creative Problem Solving model can support mathematical creative thinking ability. However, based on observations in one school in Pekanbaru, the available students worksheets had not yet included contextual mathematical problems or facilitated creative thinking indicators. Therefore, there is a need to develop students worksheets that accommodate students' creative thinking abilities more effectively.

One of the mathematics topics that requires creative thinking is the topic of linear equations in two variables. This topic is highly relevant to everyday life and demands students to develop creative solutions (Wulandari et al., 2016; Rasnawati et al., 2019). Rasnawati et al. (2019) found that in this topic, students still lacked creative thinking skills, as reflected in the percentage of each indicator: flexibility (48%), fluency (36%), originality (22%), and elaboration (3%). Based on these findings, this study aims to develop a students worksheet using the Creative Problem Solving model on the topic of linear equations in two variables to facilitate students' mathematical creative thinking ability. Previous studies and observations in two schools in Pekanbaru show that such a worksheet has not yet been developed. Therefore, this research is intended as an innovation to develop a valid and practical students worksheet that supports mathematical creative thinking ability in the topic of linear equations in two variables.

METHODS

This research is a type of development research, also known as Research and Development (R&D), which focuses on creating a product in the form of a students worksheet based on the Creative Problem Solving (CPS) model for the topic of linear equations in two variables. The objective is to facilitate students' mathematical creative thinking skills. The development process adopts the 4-D model by Thiagarajan, Semmel, and Semmel (1974), which includes four stages: define, design, develop, and disseminate.

In the define stage, the researcher analyzes the problems faced by schools, teachers, and students, which justify the need for the development of the students worksheet. The design stage involves preparing the initial draft of the students worksheet and developing the necessary validation and practicality instruments. In the develop stage, the worksheet is validated by experts and tested on students to obtain input and ensure its validity and practicality. Finally, the disseminate stage includes final product packaging, distribution, and publication of research articles.

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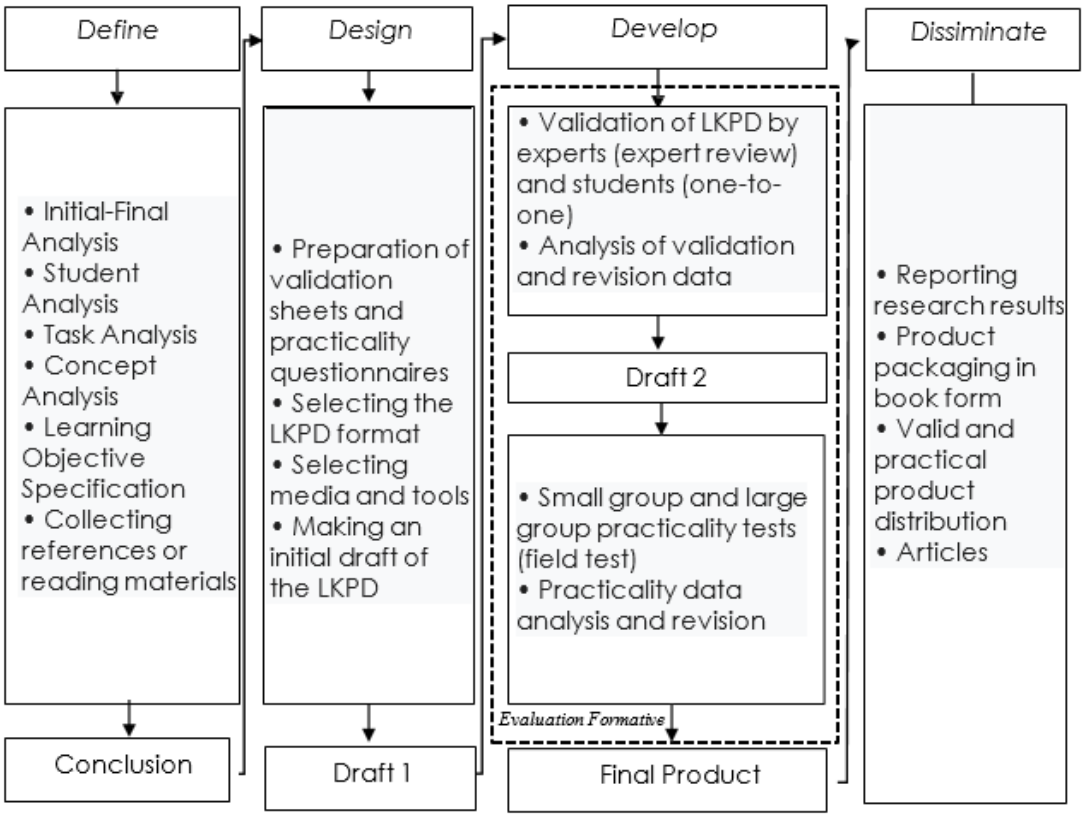

Figure 1. Flowchart of the 4-D Development Model Process for Students Worksheet Design

Figure 1 illustrates the development process based on the 4-D model. At the develop stage, a formative evaluation is carried out to gather feedback from students. The sample for this research consists of eighth-grade students from SMPN 08 Pekanbaru. For the individual readability test (one-to-one), three students with heterogeneous abilities (high, medium, and low), based on teacher recommendations, are selected. In the small group trial, six students with varying abilities are involved. The large group test includes students from class VIII.E at the same school.

The data collection techniques include interviews, observations, expert validation questionnaires, and practicality questionnaires. The validation instrument uses the Likert and Guttman scales. Three mathematics education lecturers from Riau University, PGRI Jombang University, and Medan State University serve as expert validators. They complete a validation questionnaire and provide feedback on the worksheet draft. The practicality questionnaires, filled out by students during the small and large group tests, use the Likert scale.

The validity criteria of the students worksheet refer to Akbar and Holid (2013), as shown in Table 1:

Table 1. Validation Criteria for the Developed Student Worksheet

Interval	Validity Level
85% < Va ≤ 100%	Very valid or usable without revision
70% < Va ≤ 85%	Valid or usable with minor revisions
50% < Va ≤ 70%	Less valid or requires major revisions
0% < Va ≤ 50%	Invalid or not suitable for use

The students worksheet is considered valid if it achieves a score greater than 70%. If it does not reach this threshold, the worksheet must be revised and revalidated.

The practicality criteria refer to Hamdunah (2015), as listed in Table 2:

Table 2. Practicality Criteria for the Developed Student Worksheet

Interval	Practical Level
80% < P ≤ 100%	Very practical
60% < P ≤ 80%	Practical
40% < P ≤ 60%	Quite practical
20% < P ≤ 40%	Less practical

The students worksheet is considered quite practical if it achieves a score greater than 40%, and less practical if the score is 40% or below.

FINDING AND DISCUSSION

Define

This stage aimed to collect and analyze information to justify the need for developing a student worksheet using the Creative Problem Solving (CPS) model to support students' mathematical creative thinking skills. The process was carried out through literature studies, interviews, and classroom observations at SMPN 08 Pekanbaru.

The initial and final analysis sought to identify problems encountered in learning resources. Based on teacher interviews, the worksheets previously used in class did not implement the CPS model, consisted merely of questions without procedural guidance, and failed to engage students. Observations revealed that teaching was teacher-centered and students were passive due to the absence of supportive learning materials beyond printed textbooks.

The student characteristics analysis indicated that students remained passive during lessons, primarily due to a lack of additional learning resources. Most students were unengaged unless supported with alternative materials or media. This is consistent

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with the findings of Rasnawati, Fatahillah, and Nasrullah (2019) and Sultoni and Agoestanto (2013), who reported that student passivity is often caused by the lack of instructional media developed by teachers.

Furthermore, the researcher formulated learning objectives aligned with Phase D of the curriculum. Based on task analysis, learning objectives for the topic "system of linear equations in two variables" were derived according to the Independent Curriculum, particularly under the Algebra domain: “By the end of Phase D, students can solve the system of linear equations in two variables using various strategies.”

Table 1. Learning Objectives for the System of Linear Equations in Two Variables

Code	Learning Objectives	Time Allocation
A.1	Students can express two-variable linear equations based on contextual problems	2
A.2	Students can formulate systems of two-variable linear equations from contextual problems	
A.3	Students can distinguish between single equations and systems of two-variable linear equations	
A.4	Students can transform contextual problems into two-variable linear equations and their systems	
A.5	Students can solve systems of two-variable linear equations using the graphing method	2
A.6	Students can apply graphing methods to contextual problems involving systems of linear equations	
A.7	Students can solve systems using the substitution method	2
A.8	Students can solve contextual problems using the substitution method	
A.9	Students can solve systems using the elimination method	2
A.10	Students can solve contextual problems using the elimination method	
A.11	Students can solve systems using the mixed method	2
A.12	Students can solve contextual problems using the mixed method	
	Total	**10**

Design

At this stage, the student worksheet was designed using the Creative Problem Solving (CPS) model to facilitate students’ mathematical creative thinking skills. The

researcher developed two main instruments: a validation questionnaire and a practicality questionnaire.

The validation instrument was adapted and modified from the works of Solihin (2021), Rianti (2024), and Akbar and Holid (2013), and consisted of three assessment components: preliminary validation, content validation, and construct validation. The instrument employed both the Guttman and Likert scales.

Meanwhile, the practicality questionnaire was developed based on modifications from Solihin (2021), Rianti (2024), and Ariani (2022), and included three components: visual appearance of the student worksheet, content presentation, and ease of use. This instrument utilized the Likert scale.

Figure 2. Initial Design of the Student Worksheet Cover Page

The worksheet format selected for development included:

- Cover page – displaying group name, class, learning objectives, and instructions.
- Main content – containing the CPS learning syntax: (1) problem clarification, (2) idea generation, (3) evaluation and selection, and (4) implementation.
- Let's Practice section – consisting of descriptive tasks to measure students' understanding.

In Figure 2, the initial draft of the LKPD cover consists of the group name, class, Learning Objectives (TP), and LKPD instructions. The initial draft of the contents of the LKPD in Figure 3.

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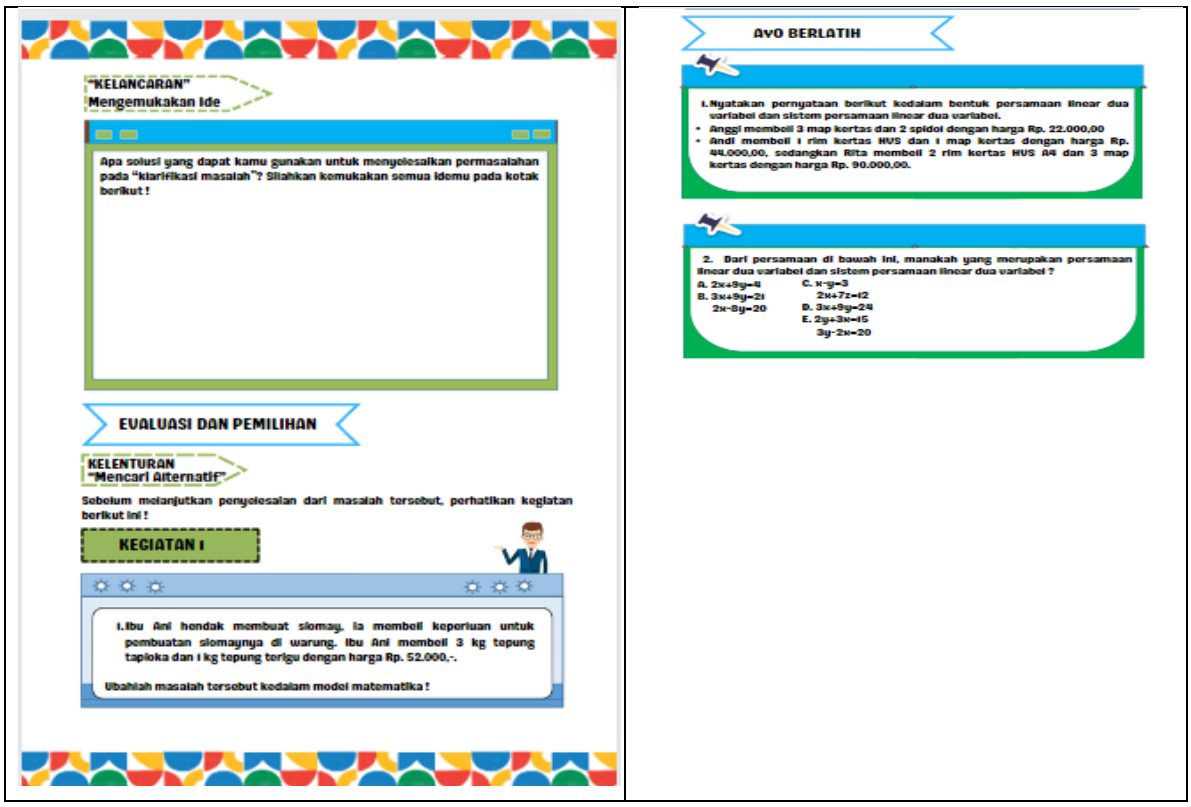

Figure 3. Initial Draft and Lets Practices of Student Worksheet Contents

In Figure 3, the initial draft of the contents of the student worksheet incorporates the syntax of the Creative Problem Solving (CPS) model, which consists of four stages: (1) Problem Clarification, (2) Disclosure of Opinions, (3) Evaluation and Selection, and (4) Implementation. In addition to the main content, the draft also includes a *Let's Practice* section that contains descriptive questions designed to assess students' understanding. These components were carefully structured to reflect the characteristics of the CPS model and to support indicators of creative thinking, including fluency, flexibility, originality, and elaboration.

Develop

At this stage, the researcher conducted validation of the student worksheet, a readability test, a small group test, and a field test. A formative evaluation was carried out to obtain feedback to make the student worksheet suitable for use. Initially, the researcher discussed the product with the research team (self-evaluation). Then, Draft 1 was submitted to three validators to assess the validity of the student worksheet developed. The validation results showed an average score of 91%, categorized as very valid, referring to Akbar and Holid (2013, p. 155), meaning it can be used without revision.

The validation results showed an average score of 91%, indicating that the developed student worksheet met the criteria of "very valid" and could be used without revision, as referred to by Akbar and Holid (2013). However, the researcher

received the following suggestions from the validators. One of the validators suggested enlarging the space provided for students to write their group identity on the worksheet. This feedback was considered important to ensure students could clearly record their information. Although the revised version has been implemented, the related illustration is not presented here.

In addition, validators also recommended adding explanations about the types of solutions in a system of linear equations in two variables—namely, systems with one solution, many solutions, or no solution. This addition aims to help students better understand the characteristics of each solution type and apply this understanding when solving problems. The comparison between the initial and revised versions of this content is presented in Figure 4, which illustrates the *before* and *after* revisions.

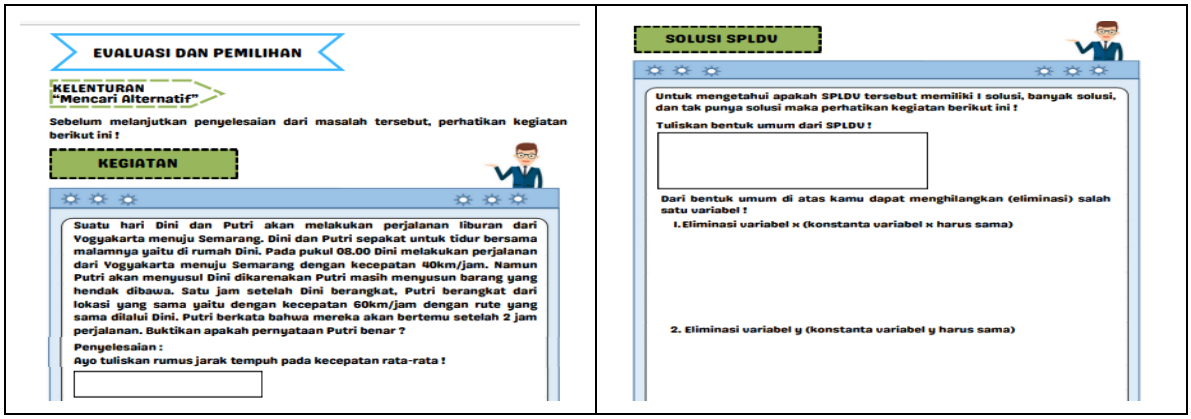

Figure 4. Types of Solutions in a System of Linear Equations in Two Variables (Before and After Revision)

A readability test was conducted involving three students from class VIII.D at SMPN 08 Pekanbaru with heterogeneous academic abilities (high, medium, and low), based on teacher recommendations. The students provided several constructive comments regarding the student worksheet. The first student noted that the worksheet was very engaging, with an attractive color scheme and font choice. Instructions were considered clear and easy to follow, and the illustrations were appealing. A suggestion was made to include introductory materials or sample questions to support better understanding. The second student also appreciated the design and readability but found some sentences to be slightly awkward. A recommendation was given to include page numbers to help navigate the worksheet more easily. The third student found the worksheet visually interesting but mentioned that a few sentences were difficult to comprehend.

Following these inputs, the student worksheet was revised to accommodate the feedback provided. The revised version was then tested in a small group of six students from class VIII.D, selected to represent various academic abilities. After completing the worksheet, students filled out a response questionnaire. The analysis showed a very practical rating with a score of 92%. A subsequent field test was conducted with a larger group of 36 students from class VIII.E, who worked

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collaboratively in heterogeneous groups and completed the same response questionnaire. The practicality analysis from the field test also resulted in a score of 92%, indicating a consistent level of practicality.

These findings indicate that the student worksheet developed using the Creative Problem Solving (CPS) model is valid and practical for facilitating mathematical creative thinking skills. The CPS model encourages the generation of original ideas and supports key indicators of creative thinking, such as fluency—students generate multiple ideas—and flexibility—students examine problems from various perspectives. This demonstrates the potential of the CPS approach in enhancing creative thinking in mathematics learning. Based on the validation and practicality analyses, the CPS-based student worksheet on the topic of systems of linear equations in two variables meets the necessary criteria for use in classroom settings.

Disseminate

The final stage involves dissemination activities, including presenting the research findings at a scientific seminar held on December 18, 2024. In addition, the developed product—student worksheets based on the Creative Problem Solving (CPS) model—was distributed in printed book format and submitted to SMPN 08 Pekanbaru, as well as to mathematics teachers, to serve as an alternative learning resource for the topic of systems of linear equations in two variables. These actions were taken following the validation and practicality results, which confirmed that the worksheets met the necessary criteria for classroom use. Furthermore, the development process culminated in the preparation of scientific articles intended for publication. However, the effectiveness of the product in improving learning outcomes has not yet been tested in this study and is suggested for future research.

CONCLUSIONS AND RECOMMENDATIONS

This study aimed to develop a product in the form of student worksheets based on the Creative Problem Solving (CPS) model to facilitate indicators of students' mathematical creative thinking skills on the topic of systems of linear equations in two variables. The worksheets were designed for use in five learning sessions and developed using the 4-D model (define, design, develop, and disseminate). Based on the validation results, the student worksheets achieved a score of 91%, indicating a very valid category. Furthermore, the practicality tests conducted in both small group and field settings yielded a score of 92%, categorizing the worksheets as very practical. Therefore, it can be concluded that the CPS-based student worksheets developed for systems of linear equations in two variables meet the criteria for both validity and practicality, making them suitable for use in learning activities for grade VIII students.

This development was limited to the systems of linear equations in two variables as mathematical content and focused specifically on the Creative Problem Solving model to enhance mathematical creative thinking skills. It is recommended that

further research explore the development of similar worksheets for other mathematical topics or educational levels using the same model and skill focus. Additionally, future studies are encouraged to continue the development to the effectiveness-testing stage to determine the impact of the worksheets on student learning outcomes. Since the product meets the criteria for validity and practicality, it can be considered a viable learning resource for use by teachers and schools in mathematics instruction.

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