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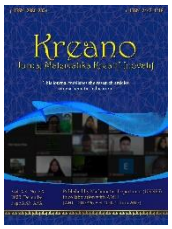

Development of Student Worksheets on Pythagorean Theorem Content Based on Creative Problem Solving to Facilitate Mathematical Reasoning Ability

Elfis Suanto[1], Efni Rianti[1], Armis[1], and Hutkemri Zulnaidi[2]

[1]Program Studi Pendidikan Matematika, Universitas Riau, Pekanbaru, Indonesia
[2]Department of Mathematics and Science Education, University of Malaya, Malaysia

Correspondence should be addressed to Elfis Suanto: elfis.suanto@lecturer.unri.ac.id

Abstract

Mathematical reasoning ability is one of the most important parts of mathematics learning. However, the facts show that students' mathematical reasoning ability is still low, especially in the context of the Pythagorean theorem. One attempt to facilitate this is using students' worksheets based on creative problem solving (CPS). This research aims to develop valid and practical student' worksheets. It refers to the 4D development model, which includes defining, designing, developing, and disseminating. The instruments used are validation and practicality questionnaire sheets. The results of the validity assessment of students' worksheets were very valid, with an average percentage of 95,07%. The results of the practicality assessment of students' worksheets were very practical, with an average rate of 89,38%. Thus, it is in accord with the valid and practical requirements, so the worksheet is usable. This research aims to make it easier for students to build knowledge independently in mathematics learning so that mathematical reasoning abilities can be facilitated.

Keywords: Creative Problem Solving; student worksheet; Teorema Pythagoras

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Abstrak

Kemampuan penalaran matematis (KPM) menjadi salah satu aspek yang terpenting dalam pembelajaran matematika, namun fakta menunjukkan KPM peserta didik masih rendah khususnya pada konten teorema Pythagoras. Salah satu upaya untuk memfasilitasi masalah tersebut dengan menggunakan Lembar kerja peserta didik (LEMBAR KERJA SISWA) berbasis Creative Problem Solving (CPS). Tujuan penelitian ini adalah mengembangkan LEMBAR KERJA SISWA yang valid dan praktis. Penelitian pengembangan ini mengacu pada model pengembangan 4D yang meliputi define, design, develop, dan disseminate. Instrumen yang digunakan adalah angket validasi dan angket praktikalitas. Hasil analisis data angket validasi diperoleh bahwa LEMBAR KERJA SISWA dikategorikan sangat valid dengan persentase rata-rata yaitu 95,07%. Hasil analisis data angket praktikalitas diperoleh bahwa LEMBAR KERJA SISWA dikategorikan sangat praktis dengan persentase rata-rata yaitu 89,38%. Maka, LEMBAR KERJA SISWA pada penelitian ini telah memenuhi syarat valid dan praktis sehingga dapat digunakan dalam kegiatan pembelajaran. Implikasi dari penelitian ini adalah untuk mempermudah peserta didik dalam membangun pengetahuan secara mandiri pada pembelajaran matematika sehingga kemampuan penalaran matematis dapat terfasilitasi.

INTRODUCTION

Mathematics learning in the Independent Curriculum aims to develop mathematical reasoning (Kemendikbudristek, 2022). Mathematical reasoning is drawing conclusions based on several statements whose truth is known (Setialesmana et al., 2021). Mathematical reasoning ability is the ability of students to formulate and conclude a strategy to solve problems (Rosidah et al., 2020). Therefore, this mathematical reasoning ability is important for students at every level of education, including junior high school (Permatasari et al., 2020). (Hidayat et al., 2018) also stated that mathematical reasoning ability is one of the abilities that can build students' thought patterns in the development of mathematics learning. This shows that mathematical reasoning ability is an important part of learning mathematics.

The facts show that mathematical reasoning ability is still considered low. Research results by Absorin & Sugiman (2018) found that some students needed help to express mathematical ideas through pictures. Of the 390 junior high school students in Indramayu Regency, only around 67 students could apply the correct reasoning steps. This shows that the mathematical reasoning abilities of grade VIII junior high school students still need to improve. Pradana & Murtiyasa (2020) showed that students' mathematical reasoning in solving problems had yet to reach the standard.

The Pythagorean theorem is one of the materials that has problems in mathematical reasoning. The results of the study by Demİrcİoğlu & İlter (2022) stated that mathematical reasoning ability in the Pythagorean theorem material is still said to be low, where there are several difficulties in visualization, conceptual knowledge gaps for proof purposes, and difficulties in formal proof. Another fact shows that there are still problems in students' mathematical reasoning abilities based on research on the content of Cartesian coordinates and the Pythagorean theorem to 22 students in class VIII-E MTsS Darul Hikmah Pekanbaru. The results of measuring the mathematical reasoning abilities of class VIII-E MTsS Darul Hikmah Pekanbaru students using the mathematical reasoning ability scoring guidelines in Table 1.

Table 1. Percentage of Students' Maximum Scores for Each Indicator of Mathematical Reasoning Ability

No	Indicators of Mathematical Reasoning Ability	N*	Percentage
1	Presenting mathematical statements in writing, diagrams, and pictures	13	59,1%
2	Carrying out mathematical manipulations	6	27,3%
3	Arrange reasons for the truth of the	5	22,7%

No	Indicators of Mathematical Reasoning Ability	N*	Percentage
4	solution Concluding logically	5	22,7%

N*: number of students who can achieve the indicators

The percentage of the indicator presenting mathematical statements in writing, diagrams, and images is 59.1%, meaning that more than half of the students can correctly present statements in questions in the Cartesian plane. Other participants still need to make mistakes and need help even to present statements in questions in the Cartesian plane. Other reasoning ability indicators show that the average percentage of students who can meet these indicators is 22.6%. This indicates that most students need help to perform mathematical manipulation, compile and provide reasons for the truth of the solution, and draw logical conclusions from statements correctly.

Mathematical reasoning is the most essential ability students must have in mathematics. (Tum, 2024). However, according to Chuang et al. and Chuang et al. (2021), the facts show that students need a higher understanding of abstraction, where students often need help understanding the abstract concepts necessary to solve logical problems. Students also depend on external assistance to analyze information, and student awareness is needed to generate new ideas for effective problem-solving strategies.

An alternative learning model that can help improve mathematical reasoning is Creative Problem Solving (CPS) because students are encouraged to be able to reason faster in solving problems (Hamid et al., 2023). The CPS model is related to mathematical reasoning because, in reasoning, facts are connected to solving problems creatively. (Çoban & Tezci, 2022). Various research results also state that reasoning abilities can be effectively improved by using the CPS model (Wasiran & Andinasari, 2019). Özaydin & Arslan (2022) also showed that applying the CPS model can improve students' mathematical reasoning. Therefore, using the CPS model is considered to facilitate mathematical reasoning abilities.

The definition of the Creative Problem Solving (CPS) model is a learning model that focuses on teaching and problem-solving skills and strengthening skills (Septian et al., 2020). The CPS model introduces, understands, and applies information and teaches to analyze and solve problems (Kartikasari et al., 2022). One of the advantages of the CPS model is that it allows students to develop their thinking skills to solve problems quickly (Fathonah et al., 2023). CPS provides challenges for students so that curiosity arises from solving issues, resulting in students being more actively involved in learning (Eladl & Polpol, 2020). CPS is based on constructivist learning theory, which states that learning is an active process carried out by students. (Thampinathan, 2022). The learning process is interactive, and students will exchange ideas related to the problems presented so that they can analyze and solve them well. (Septian et al., 2020).

There are three CPS model procedures, namely (1) Fact Finding, which involves defining the problem, collecting and analyzing related data and information; (2) Idea Finding, which is related to generating and modifying ideas about strategies for solving problems; and (3) Solution Finding, namely an evaluative process that culminates in finding the final solution (Kartikasari et al., 2022). The main phases of the creative process are (1) the imaginative phase, generating and debating new ideas that emerge to obtain ideas for solving problems, and (2) the practical phase, where ideas are evaluated and implemented (Septian et al., 2020). Therefore, the CPS stages in

mathematics learning are (1) Clarification of the problem, including ensuring that all students understand what kind of solution is required for the problem; (2) Brainstorming, students are given the freedom to express ideas or thoughts about various problem-solving strategies; (3) Evaluation and selection, each group member will evaluate the pros and cons of each opinion until deciding on a final choice; and (4) Implementation, carrying out mathematical calculations using the final choice resulting from the previous stage (Kartikasari et al., 2022).

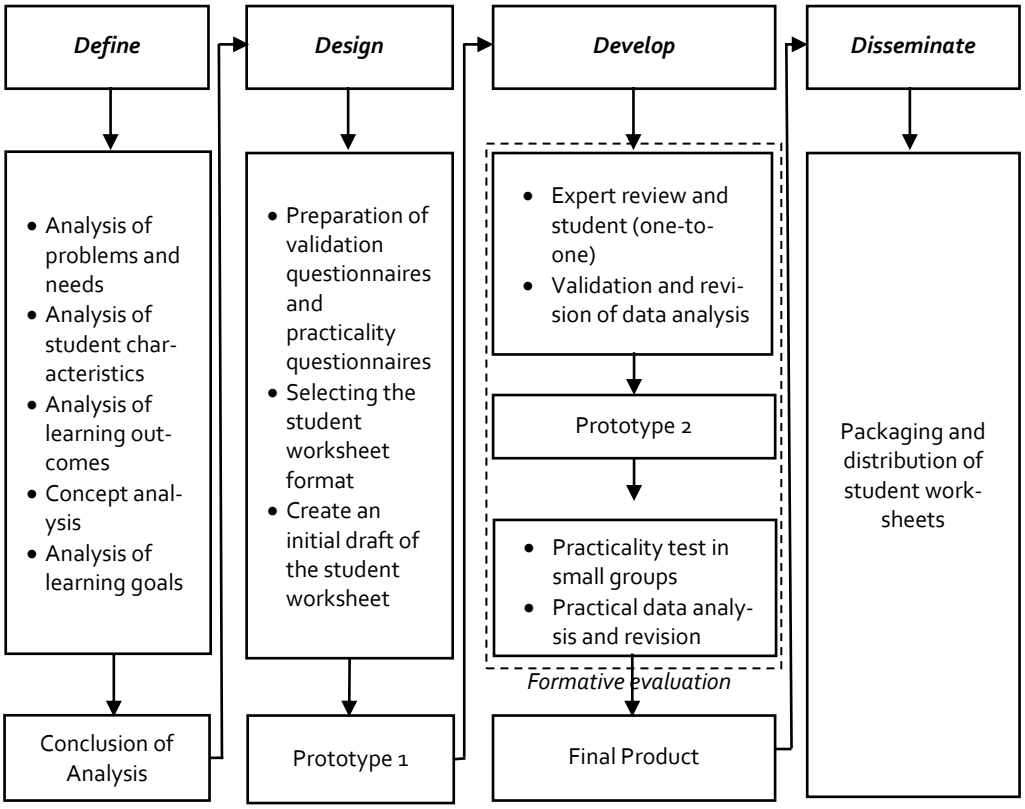
The implementation of CPS needs to be supported by learning media that can develop mathematical reasoning skills. Mathematical reasoning impacts mathematics learning outcomes; increasing mathematical reasoning will also improve learning outcomes or vice versa (Chuang et al., 2021; Ramazan et al., 2023). Student worksheets are a learning resource that can increase activity and learning outcomes (Munifah et al., 2019). Student worksheets are sheets containing instructions for use, questions that students and materials must complete, and a summary explaining the basic competencies that must be achieved (Basuki & Wijaya, 2019). Applying student worksheets in the learning process is expected to motivate students to improve their reasoning skills. Student worksheets are learning products that facilitate students to experiment, increase activity, and achieve learning goals (Bayram et al., 2003).

The observations and interviews with mathematics teachers at MTsS Darul Hikmah Pekanbaru and SMPN 8 Pekanbaru showed that student worksheets still need to be improved. The worksheets only contain practice questions, so they do not facilitate students' mathematical reasoning. Student worksheets should consist of questions and activities that include instructions on completing tasks according to basic competencies and learning outcome indicators to be achieved (Yasin et al., 2019). Therefore, the research focused on developing student worksheets on Pythagorean theorem content based on Creative Problem Solving (CPS) to facilitate the mathematical reasoning abilities of phase D students.

METHOD

This research is included in the research and development category, which is defined as developing a product through the planning process of conducting product validity tests. (Sugiyono, 2021). Development research aims to produce new products or refine and improve existing products. The products made in this study are student worksheets based on CPS on the content of the Pythagorean theorem for grade VIII phase-D.

The development model used in this research is the 4D development model by Thiagarajan et al. (1974), with stages including define, design, develop, and disseminate. Figure 1 shows the development procedure in this study.



Picture 1. The step of Development Research

Define

Activities in the define stage are problem analysis and data collection for needs analysis. Activities to analyze problems and needs, student characteristics, learning outcomes, concepts, and learning objectives are five steps in the define stage. Problems are analyzed from research and literature studies (Sugiyono, 2021). Data collection techniques at the define stage through observation, interviews, and conducting tests on students' mathematical abilities. Observations and interviews were conducted with teachers of SMPN 8 and MTsS Darul Hikmah Pekanbaru. Mathematical reasoning ability tests were conducted on MTsS Darul Hikmah Pekanbaru class VIII-E students. The results of the define stage are conclusions from the analysis activities that will be used as a basis or focus in the form of problems and solutions from this study.

Design

The design stage is the stage of designing a product that is developed according to the data obtained from the analysis results of the define stage. The design stage includes four steps, namely (1) compiling criteria through compiling a validation sheet to measure the validity of the product being developed, then compiling a practicality questionnaire sheet to measure the practicality of the product being developed; (2) format selection, namely designing learning media, selecting strategies, methods, approaches, and learning resources; (3) media selection, selecting programs that will be used to support product development; and (4) initial product design, creating an initial product or product design that will then be assessed at the developing stage. The design stage produces prototype 1 through a validation questionnaire, a practicality questionnaire, and an initial

product design. Student worksheets were created, which will be assessed later in development. Student worksheets will contain the title of the material, instructions, learning objectives, material, and practice questions. Student worksheets are arranged based on the CPS syntax, namely (1) problem clarification, (2) expressing opinions, (3) evaluation and selection, and (4) implementation (Shoimin, 2020).

Develop

The development stage is carried out by developing student worksheets from the design stage. First, the student worksheets are validated by expert validators using validation questionnaire instruments. The development stage is divided into two steps, namely Expert Appraisal and Development Testing. An expert appraisal is an activity to validate the product being developed. Developmental testing is a trial activity of a product that has been created on the actual target. During this trial, response data, reactions, or comments from the product's target users are sought. The results of the trial are used to improve the product.

Expert review is an initial activity, namely the process of one or more experts reviewing a rough version of a product or product still in design. Expert assessment of student worksheets includes three aspects, namely face validity, content validity, and construct validity. The validation results are analyzed and revised. After the student worksheet is declared valid and revised according to the suggestions given by the validator, one-to-one sessions are held. The one-to-one activity obtains input and comments from students, which will be used to revise the student worksheet. Then, a small group practicality test is carried out to assess the practicality of the student worksheet. The practicality assessment uses a practicality questionnaire that students will fill out. This questionnaire includes four assessment aspects: ease of use, presentation, readability, and time. The results of the practicality questionnaire are analyzed, and then the student worksheet is revised. The result of this stage is the final product in the form of a valid and practical student worksheet.

Disseminate

Spreading a tested product for the use of others is known as dissemination (Sugiyono, 2021). Disseminate is handing over products to school teachers so they can be used in learning activities (Faizah et al.,2023). Therefore, this stage is used for the packaging and disseminating the final student worksheet products.

The data of this study are quantitative and qualitative. The data sources in this study were obtained through several activities: (1) Observation, namely taking data through observation of the learning process carried out at SMPN 8 Pekanbaru. Then, written in the researcher's notes: (2) Validation: this data was obtained from the validation questionnaire the validator had filled out. The validation questionnaire used a scale of 4 to obtain quantitative data. It was equipped with a comment column to obtain qualitative data in the form of suggestions and input, and (3) Trial data was obtained from the results of observations of one-to-one activities and students who had filled out the practicality questionnaire in small groups with class VIII students of SMPN 8 Pekanbaru as research subjects. The one-to-one stage obtained qualitative data related to product clarity and time usage. The small group used a practicality questionnaire using a scale of 4 to obtain quantitative data. It was equipped with a comment column to obtain quali-

tative data through suggestions and input.

The data collection instrument for this study was a questionnaire. A questionnaire is a data collection instrument that provides written questions that respondents must answer. The questionnaire used in this study was a validation questionnaire filled out by the validator and a practicality questionnaire that students would fill out. Both questionnaires used a Likert scale format. The component assessment scale in the validation questionnaire for answers very appropriate was given a score of 4, appropriate was given a score of 3, inappropriate was given a score of 2, and very inappropriate was given a score of 1. The practicality questionnaire contained questions using a scale of 4 to strongly disagree, disagree, agree, and strongly agree.

Validity is measured using a validity questionnaire, which is useful for assessing product quality. (Chotimah & Festiyed, 2021). The design of student worksheet validation questionnaire was designed based on three aspects, namely (a) face validity with indicators of supporting elements of presentation, integration of student worksheets, suitability of images, and suitability of writing; (b) content validity with indicators of suitability of material with Learning Achievements, the accuracy of the material, up-to-dateness of material, encouraging student activity, and suitability of material with student thinking level; and (c) construct validity with indicators of suitability of student worksheets with CPS model and indicators of mathematical reasoning ability, attracting user attention to learn, clarity of presentation, and accuracy of language use. The design of the validation questionnaire grid was modified by Nainggolan (2022) and Akbar & Holid (2017).

Paskevicius & Irvine (2019) stated that practicality is practical or easy to use. The practicality questionnaire was designed based on four aspects, namely (a) ease of use with indicators of ease of use assessment based on appearance, ease of implementation in the learning process, and the availability of adequate answer space to be filled in (b) presentation with indicators of clarity of problem presentation assessment, and understanding of the content on the Student Worksheet; (c) readability with indicators of clarity of text or writing so that it can be read, use of simple and understandable language, and clarity of instructions for using the student worksheet; and (d) time with indicators of efficiency of learning time assessment towards the speed of student learning. The design of the practicality questionnaire grid was modified by Pahrudin et al. (2020).

Data analysis is finding and formulating data collected systematically from observations, field notes, interviews, questionnaires, and documentation. This process includes making easy conclusions by organizing data into categories, describing them into units, synthesizing, and creating patterns. This study analyzes qualitative and quantitative data. Qualitative data analysis reduces data, which is then presented descriptively. Data reduction is the analysis process by sorting out important data that researchers need. Quantitative data analysis is obtained from validation questionnaires and practicality questionnaires.

Validity analysis is seen from the validation questionnaire filled out by the validator with the developed student worksheets considered valid if they have a validity value of more than 70%. If the validity value does not reach 70% in the study, it means that the student worksheets are declared less valid, and a validity test is carried out again by the researcher. Analysis of the practicality of

the student worksheets seen from the contents of the practicality questionnaire with the developed student worksheets is considered practical if they have a practicality value of more than 70%. If the practical quality value does not reach 70% in the study, then the student worksheets are revised, and the researcher carries out a practicality test again.

RESULTS AND DISCUSSION

Results

This study produces student worksheets on Pythagorean theorem content based on CPS to facilitate valid and practical mathematical reasoning skills in the D-phase through the following stages.

Define

The define stage analyzes problems and needs, student characteristics, learning outcomes and concepts, and learning objectives. Based on the analysis activities, conclusions were obtained consisting of several things, including (1) Low mathematical reasoning skills in mathematics learning, especially in the content of the Pythagorean theorem for grade VIII phase-D; (2) low use of student worksheets and even no CPS-based student worksheets have been found that can measure students' reasoning abilities in mathematics learning; (3) In terms of student characteristics, students need LEMBAR KERJA SISWA so that they are more active and enthusiastic in the learning process; (4) student worksheets for the Pythagorean theorem content are based on learning outcomes that refer to BSKAP No. 033/H/KR/2022 and the Pancasila student profile in accordance with the independent curriculum; and (5) The content of the Pythagorean theorem refers to student mathematics books and teacher guide mathematics books for grade VIII phase-D of the 2022 independent curriculum consisting of 7 learning objectives with a total of 14 lesson hours. This analysis becomes the basis or foundation for carrying out the next stage.

The result of the define stage is the Learning Objective Flow of the Pythagorean theorem content. Learning Objective Flow design is based on learning outcomes. Learning Outcomes (CP) are knowledge, attitudes, and skills arranged into a single continuous process to build complete competencies from a subject. Learning outcomes are competencies students must possess at each phase (Badan Standar Kurikulum dan Asesmen Pendidikan, 2022). The Learning Objective Flow design results can be seen in Table 2.

Table 2. Learning Objective Flow Pythagorean Theorem Content

Unit Learning Objectives	Students can demonstrate the truth of the Pythagorean theorem and use it to solve problems (including the distance between two points on the Cartesian coordinate plane).	
Learning Objectives Flow	G.1	Proving the Pythagorean theorem
	G.2	Calculating the hypotenuse and other sides of a right triangle using the Pythagorean theorem
	G.3	Determining Pythagorean triples
	G.4	Determining the length of a triangle's side using the Pythagorean theorem
	G.5	Comparing the sides of a special right triangle
	G.6	Solving problems in everyday life related to the Pythagorean theorem
	G.7	Applying the Pythagorean theorem to find the distance between two points on the Cartesian coordinate plane t Cartesian).
Element	Geometry	
Content	Pythagorean Theorem	
Total lesson hours	14	

Profile of Pancasila Students	Critical, creative, and collaborative thinking
Glossary	Hypotenuse, Pythagoras, right triangle, acute triangle, obtuse triangle, theorem, Pythagorean theorem

The content arrangement in this study refers to the independent curriculum, namely that listed in the BSKAP Kemendikbudristek 2022 learning guide. The student worksheets developed are based on the Learning Objective Flow in Table 1. The content of the Pythagorean theorem is divided into seven topics, namely proving the Pythagorean theorem, finding the length of the hypotenuse, Pythagorean triples, the length of the sides of a triangle with the Pythagorean theorem, Special triangles, applying the Pythagorean theorem, and the distance between two points on the Cartesian coordinate plane.

Design

The design stage consists of designing validation and practicality instruments that will be used to measure the validity and practicality of student worksheets. Researchers also select a format adjusted to the CPS model and the media chosen, namely printed media in the form of student worksheets. The final activity at this stage is to create an initial design of the student worksheet consisting of 7 subtopics of the Pythagorean theorem on geometric elements referring to BSKAP No.033/H/KR/2022. The results of this stage are prototype 1 in the form of a validation questionnaire, a practicality questionnaire, and an initial design of the CPS-based Pythagorean theorem student worksheet.

The product of developing student worksheets based on CPS on the Pythagorean theorem content to facilitate reasoning skills in the form of a book with a structure of cover, foreword, table of contents, learning flow and objectives, concept maps, and student worksheets. The learning flow and objectives page contains the identity, unit learning objectives, learning objectives, rationale for compiling the learning flow and objectives, and the learning objective flow. The components of the student worksheet consist of the cover, the student worksheet's contents, the student worksheet, and the end of the student worksheet. The student worksheet's cover consists of the student worksheet's title, the material's title, supporting images, student identity, learning objectives, and instructions for completing the student worksheet. The learning objectives for each student worksheet are made based on the learning material for each meeting.

The content of the student worksheet is designed according to the CPS model, which consists of 4 stages: problem clarification, opinion expression, evaluation and selection, and implementation. The initial part of the student worksheet presents a contextual problem related to students, or students can imagine that. Furthermore, at the problem clarification stage, a column is given known and asked, and several questions that can trigger students' understanding of the problem given. Students' answers at the problem clarification stage indicate that they have understood the problem presented and the plan for solving it. The second stage is opinion expression. At this stage, students are asked to fill in what opinions or strategies will be used by students to solve the problem. The third stage is evaluation and selection; each group discusses the right strategy to solve the problem and works on the activities presented on the student worksheet that can help find the strategy. The fourth stage is implementation. At this

Table 3. Results of Student Worksheet Validation Analysis

Validator Rating Average	Aspects of Assessment			Validation Average
	Face Validity	Content Validity	Construct Validity	
student worksheet -1	96,35%	93,06%	96,21%	95,21%
student worksheet -2	95,83%	92,36%	96,21%	94,80%
student worksheet -3	95,83%	92,36%	95,45%	94,55%
student worksheet -4	95,83%	93,75%	96,21%	95,26%
student worksheet -5	96,88%	93,06%	94,70%	94,88%
student worksheet -6	96,35%	93,75%	97,73%	95,94%
student worksheet -7	95,31%	93,06%	96,21%	94,86%
average	96,05%	93,06%	96,10%	95,07%
Category	Very Valid	Very Valid	Very Valid	Very Valid

stage, students solve the problem until it is finished using the previously agreed strategy.

The final part of the student worksheet contains the activities "Conclusion" and "Let's Practice!". Students are asked to make conclusions from the material in the student worksheet activities. Furthermore, in the Let's Practice section, 1 or 2 questions regarding the related material are given. The questions are contextual, meaning familiar or close to the students' daily lives.

Develop

Prototype 1, produced from the design stage, was discussed again with the supervising lecturer. The student worksheets that the supervising lecturer had approved were then validated by three validators: two lecturer validators and one practitioner validator. The validators in this study were: (1) L1, validation was carried out face-to-face. She is a lecturer from Mathematics Education, University of Riau; (2) L2, validation was carried out via mail review. She is a lecturer from Mathematics Education, University of PGRI Jombang; and (3) L3, validation was carried out face-to-face. She is a driving teacher for the mathematics subject from SMPN 4 Pekanbaru. Validation activities help obtain assessments and suggestions for improving student worksheets. The results of the validation of student worksheets by the validators can be seen in Table 3. The average percentage for all student worksheets in the aspects of face validity, content validity, and construct validity was obtained at 96.05%, 93.06%, and 96.10%, respectively, with a very valid category.

The average percentage of validation results of the three validators for the entire student worksheet obtained based on Table 3 is 95.07% with a very valid category. The average percentage of validation values for each student worksheet from the three validators obtained is 95.21% for student worksheet-1 with a very valid category, 94.80% for student worksheet-2 with a very valid category, 94.55% for student worksheet-3 with a very valid category, 95.26% for student worksheet-4 with a very valid category, 94.88% for student worksheet-5 with a very valid category, 95.94% for student worksheet-6 with a very valid category, and 94.86% for student worksheet-7 with a very valid category. The validator concluded that the student worksheet was worth being tested with revisions according to suggestions. The average validation results by the three validators for the entire student worksheet were 95.07% with a very valid category, meaning that the CPS-based student worksheet with Pythagorean theorem content to facilitate the mathematical reasoning abilities of phase-D students has met the validity aspects used.

The student worksheets have undergone considerable improvements af-

ter being revised according to the suggestions given by the validator. The resulting student worksheets included problems based on the indicators of mathematical reasoning ability. Contextual images accompany the student worksheets to describe problems in real situations. The student worksheets also include supporting sources of information that can foster students' reasoning abilities. The sentences on the student worksheets have been written clearly and are easy to understand. The end of the student worksheet contains evaluation questions to measure the achievement of students' mathematical reasoning abilities, one of which is contextual.

The result of the overall revision based on the suggestions and input given is a valid student worksheet. The student worksheet has been declared valid qualitatively and quantitatively. The student worksheet is qualitatively declared valid based on the results of comments and suggestions from the validator. The student worksheet has been quantitatively declared valid based on the questionnaire results with the "very valid" category.

The student worksheets were then given to three students at SMPN 8 Pekanbaru to carry out one-to-one activities. The purpose of the one-to-one activity was to determine the readability of the student worksheets and the reactions of students who had heterogeneous ability levels when working on the student worksheets, which were used to improve the student worksheets. The researcher provided an introduction before the students worked on the worksheets. The researcher provided instructions on reading and understanding each activity in the student worksheets to the maximum. The researcher also allowed students to ask questions if they needed help understanding the instructions on the student worksheets.

The results of the one-to-one activity were that students could complete the student worksheets according to the specified time, which was 35 minutes for one student worksheet. The time recorded included the questioning activity. It shows that student worksheets can be used in learning activities at school with a minimum of two lesson hours for one student worksheet. At the end of the one-to-one activity, the researcher discussed with students the student worksheets developed to obtain suggestions and comments from students, namely the presence of incorrect use of words, difficult-to-understand problem sentences, and typing errors on the student worksheets. Based on these suggestions and comments, the researcher improved the student worksheets. The results of the improvements to the student worksheets from the one-to-one stage are called prototype 2.

The next stage is a small group where student worksheets are given to 15 students of class VIII SMPN 8 Pekanbaru for seven meetings. Each student is given a worksheet to work on and discuss in groups. The researcher briefly explains the instructions for completing the student worksheets that will be worked on. The researcher accompanies and directs students if they need help completing the student worksheets. The researcher also observes the activities and responses of students when working on the student worksheets.

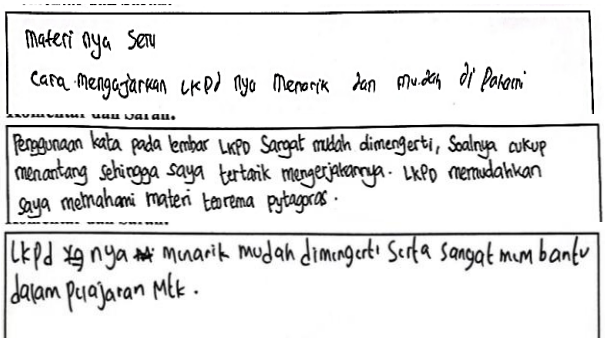
Table 4. Results of the Student Practicality Questionnaire in Small Group Activities

Assessment Aspects	Average Value of Student Practicality Questionnaire for Student Worksheets (%)							Average
	1	2	3	4	5	6	7	
Ease of Use	92,78	95,00	90,83	92,78	90,83	90,83	89,17	91,75
Presentation	91,67	90,67	88,67	87,67	87,67	85,00	87,00	88,34
Readability	88,33	89,00	89,33	90,00	90,67	91,33	88,33	89,57
Time	88,33	89,17	87,50	87,50	86,67	87,50	88,33	87,86
Average Practicality	90,28	90,96	89,08	89,49	88,96	88,67	88,21	89,38
Category	Very Practical	Very Practical	Very Practical	Very Practical	Very Practical	Very Practical	Very Practical	Very Practical

Based on the researcher's observations, some students had doubts at the beginning of the learning process and asked questions when completing the student worksheet. After students understood the work procedure and discussed it with their group members, students became more active in completing the activities on the student worksheet. The researcher distributed a practicality questionnaire to students after completing the student worksheet. The results of this practicality questionnaire assessed the student worksheet's practicality. The results of the practicality analysis are shown in Table 4.

Based on Table 4, it is obtained that the average percentage of the practicality questionnaire from student worksheet-1, student worksheet-2, student worksheet-3, student worksheet-4, student worksheet-5, student worksheet-6, and student worksheet-7 are respectively 90.28%, 90.96%, 89.08%, 89.49%, 88.96%, 88.67%, and 88.21% with a very practical category. Regarding ease of use, the average percentage of the practicality questionnaire for student worksheet-1 to student worksheet-7 is 91.75%, meaning that the student worksheet is easy to use or has been categorized as practical. The readability aspect obtained an average percentage of 89.57%, meaning that the writing of sentences is clear so that it can be understood. The presentation aspect obtained an average percentage of 88.34%, meaning that the presentation of the material has been presented well so that it is categorized as very practical. The time aspect obtained the lowest average percentage value of 87.86%, which means that some respondents still feel that more time is needed to complete student worksheets. The results of the practicality questionnaire on student worksheets on the Pythagorean theorem content based on CPS for students in phase D show that student worksheets meet the very practical category with an average practicality score of 89.38%.

In the comments and suggestions section of the practicality questionnaire, students stated that the developed student worksheets could help them understand the content of the Pythagorean theorem. Students stated that the student worksheets had a display design and color composition that was quite attractive, so they were enthusiastic about working on the student worksheets. Some of the comments and suggestions from students can be seen in Figure 2. Small group activities such as student worksheets experienced slight improvement. The results of small group activities are called final products in the form of valid and practical student worksheets.



Translated

The material is exciting

The way to teach student worksheets is interesting and easy to understand.

The use of words on student worksheets is very easy to understand, the questions are challenging so I am interested in doing them. Student worksheets make it easier for me to understand the Pythagorean theorem material.

Student worksheets are interesting, easy to understand and very helpful in math lessons.

Figure 2. Comments and Suggestions on the Practicality Questionnaire

Disseminate

The dissemination stage consists of 2 activities: product packaging and product distribution to product users to schools by submitting student worksheets to the school, namely SMPN 8 Pekanbaru. The following is a cover display of the packaging of student worksheets for the Pythagorean Theorem content based on CPS, which can facilitate the mathematical reasoning abilities of phase-D students.

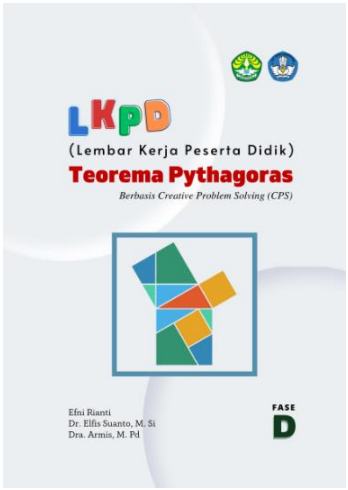


Figure 3 Final Product Cover

Discussion

This research and development study used the stages in the 4-D development model. In the define stage, the researcher reviewed the analysis of problems and learning needs, student characteristics, curriculum, and materials. This analysis shows that learning in schools uses the Merdeka curriculum, and students need student worksheets that can facilitate reasoning skills by the CPS model, thus helping students review and solve problems faced by using the information obtained. The results at this stage are analytical conclusions used to proceed to the design stage.

Researchers compile validation and practicality questionnaires to measure validity and practicality in the design stage. Researchers also select student worksheet formats that are adjusted to the CPS model. The final activity at this stage is to create an initial design of student worksheets consisting of 7 subtopics of the Pythagorean Theorem on geometry elements that refer to the Merdeka curriculum. The results at this stage are called prototype 1.

Prototype 1 was discussed with the supervisor and continued to the next development stage. This stage is divided into two activities, namely (1) expert appraisal consisting of expert review and one-to-one activities and (2) development testing; the activities carried out in this study were small groups. The results of the expert appraisal and development testing stages were, respectively, prototype two and the final product. The results of the expert review and one-to-one activities were in the form of student worksheets declared valid. The average percentage results of the overall validation questionnaire from the three validators were 95.07% with a very valid category. A student worksheet's validity is

based on the opinion that student worksheets can be considered valid if they have a validity value of more than 70% (Akbar & Holid, 2017).

Regarding face validity, the student worksheets obtained an average validity percentage of 96.05% with a very valid category. Namely, the student worksheets already have a good appearance based on the integration and suitability of the presentation of supporting elements, images, and writing. In line with Gustiningsi et al. (2022) & Widodo et al. (2023), student worksheets are attractive to motivate students to follow the learning process. The average percentage of validity obtained by the student worksheet in the content validity aspect is 93.06% with a very valid category, meaning that the material or content of the student worksheet has been included and adjusted to the learning achievements and learning objectives to be achieved, relevant to the 8th-grade junior high school mathematics textbook. (Tohir et al., 2022). Regarding construct validity, the student worksheet obtained an average validity percentage of 96.10% with a very valid category, meaning that the student worksheet was by the CPS syntax according to Shoimin (2020) and indicators of mathematical reasoning ability according to Linola (2017). Therefore, the CPS-based student worksheet on the Pythagorean theorem content has fulfilled the validity aspect. Nur Hasanah et al. (2023) also stated that the student worksheets were valid and could then be tested.

The validated student worksheets were given to 3 students to be done one to one. The revision of the student worksheets at this stage was only in the form of improvements to the use of words, more straightforward problem sentences, and typos on the student worksheets. The result of revising the student worksheets was prototype 2, which was valid and could be continued to small group activities.

Small group activities were conducted to assess the practicality of student worksheets based on the practicality questionnaire data analysis results. The average percentage of practicality results for all student worksheets is 89.38% in the very practical category, meaning that student worksheets based on CPS with Pythagorean theorem content facilitate mathematical reasoning abilities that meet the practicality aspect.

The average percentage of the practicality questionnaire obtained on the ease of use aspect of student worksheet-1 to student worksheet-7 is 91.75%, with a very practical category. The aspect is assessed based on ease of use in appearance so that students can easily use student worksheets when studying. Pahrudin et al. (2020) stated that one of the advantages of using student worksheets is clarity and ease of use during implementation in the learning process. In terms of presentation, the average percentage of practicality obtained is 88.34%, which is a very practical category. The material, learning activity flow, and problems have been presented well. The readability aspect obtained an average percentage of practicality of 89.57%, which is a very practical category, which means that the writing of sentences is clear and can be easily understood. Fitni et al. (2023) stated that student worksheets are practical with clear and easy-to-understand writing, language, and sentences. The time aspect obtained the lowest average percentage of 87.86%, including the very practical category. Several respondents felt the need for more time to complete student worksheets due to limited time availability during the study. Fitriyani et al. (2023) stated that students only completed

some questions on the student worksheet due to the short implementation time. Students also commented on the developed student worksheet, saying that it was interesting and easy to understand, and the writing on the student worksheet was clearly legible. The results of the small group activities were analyzed and revised to produce a final product in the form of a valid and practical student worksheet.

Each activity on the student worksheet is adjusted to the CPS syntax and the reasoning ability indicators to be achieved. This includes (1) presentation of contextual problems so that students feel familiar or close to them; (2) students are asked to understand the problem so that they can present mathematical statements independently; (3) students are allowed to express their opinions and discuss with groups so that they can carry out mathematical manipulation and provide truth to the solution; and (4) solve problems based on the information obtained until finally making a logical conclusion. This study is in line with the statement that student worksheets are a learning resource that can increase student activity and learning outcomes, which impact students' mathematical reasoning abilities. (Pahrudin et al., 2020).

The changes in students' mathematical reasoning abilities are supported by students' involvement in active learning, in accordance with students' comments, which stated that they were more enthusiastic and interested in participating in the learning process. This is in line with Kartikasari et al. (2022) & Septian et al. (2020), who stated that CPS also resulted in students being more active in learning. According to Vygotsky, the quality of learning depends on the quality of student interaction in the learning process (Mota-Valtierra et al., 2019). This is in accordance with the theory of constructivism, which has the principle of an active process in learning so that students can construct their knowledge well (Thampinathan, 2022). According to Sulistyowati & Sugiman (2014), learning with CPS is related to the theory of constructivism because the exchange of ideas carried out by students in learning activities with CPS results in students being able to solve the problems given so that they obtain good learning outcomes. Good learning outcomes can also have an impact on students' mathematical reasoning abilities (Chuang et al., 2021; Ramazan et al., 2023).

CPS has an important role in influencing mathematical reasoning ability in this study. This is in accordance with several research results which state that the application of the CPS model has been proven to improve mathematical reasoning ability effectively (Hamid et al., 2023). This shows empirical evidence that CPS-based student worksheets can have a positive impact on students' reasoning ability.

The advantages of this study are that the student worksheets have an attractive appearance, and the problems given are familiar to students. The product consists of seven student worksheets, meaning it covers the entire scope of the Pythagorean theorem content. However, the disadvantage of this study is that it has yet to measure the effectiveness of the student worksheets. In addition, the items in the validation and practicality questionnaires have yet to show the CPS model and indicators of mathematical reasoning ability specifically.

Implication of the Research

The results of this study have implications for mathematics learning, especially on the Pythagorean theorem material,

namely that teachers can use student worksheets as a reference for learning media in the teaching and learning process according to the current Merdeka curriculum. Research on developing CPS-based student worksheets on the Pythagorean theorem material that can facilitate mathematical reasoning skills. Therefore, this study can be used as a source of information as well as a reference for other studies that want to develop student worksheets using different materials or abilities. The development of CPS-based Pythagorean theorem content student worksheets has met the requirements for validity and practicality but has yet to reach the point of measuring effectiveness. This allows for further research to be carried out on an effectiveness test so that trials can be carried out on a wider scale.

Limitation

This research employs the 4D method, encompassing distinct stages where the researcher undertakes specific activities. While precision is emphasized at each stage, achieving absolute perfection is not the primary focus. Further testing is required to assess the effectiveness of the resulting product across a broader range of subjects.

CONCLUSION

This study produced a product in the form of a student worksheet on the Pythagorean theorem content that was adjusted to CPS so that mathematical reasoning abilities were facilitated. The student worksheet produced has been validated and tested to obtain a very valid and practical category. Therefore, the student worksheet on the Pythagorean theorem content based on CPS to facilitate the mathematical reasoning abilities of phase-D students has met the requirements of being valid and practical.

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