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A PROBLEM-BASED LEARNING WORKSHEET: AN EFFORT TO SUPPORT STUDENTS' CRITICAL THINKING SKILLS ON CARTESIAN COORDINATES TOPIC

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ABSTRACT

Critical thinking is one of the essential skills in this 21st century. Students' critical thinking in mathematics has yet to be optimal. Therefore, this study aims to produce Problem-Based Learning Worksheets, particularly on the Cartesian Diagram topic, that are valid and practical to support students' critical thinking skills. The critical thinking skills indicators are giving simple explanations, building basic skills, concluding, giving advanced reasons, and devising strategies. This research uses a 4-D development model consisting of 4 stages: define, design, development, and disseminate. However, this article will only discuss the first three stages. This study involved two experts in mathematics content, two in mathematics learning media, and 34 eight grade public junior high school students in Kartasura, Central Java, Indonesia. The data collection method applied in this study is questionnaires. Based on the data analysis, the worksheet developed is valid (with the good category), with an average score of 4,1 and 4,0 from the content and learning media experts, respectively. At the same time, students' responses on the practicality of the worksheets were an average of 4,2, which is in the excellent category. In addition, it shows that 64,70 % of students reaching the minimum score requirement (75) for the critical thinking test. Therefore, the Problem-Based Learning worksheets developed reach valid and practical categories to support students' critical thinking skills.

Keywords: Student Worksheets, Problem-Based Learning, Critical Thinking Skills, Cartesian Coordinates

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PRELIMINARY

One of the lessons that are the basic of other sciences in which there is the ability to count, logic, and think is mathematics (Nasrulloh & Umardiyah, 2020). Regulation of the Minister of National Education of the Republic of Indonesia Number 22 (2006) states that mathematics learning objectives in schools include that students can understand mathematical concepts, explain the relationship between concepts, reason, solve problems, and communicate ideas. Mathematics learning trains students' ability to think critically, systematically, logically, and creatively and work together effectively (Ministry of

Education, 2007). In learning mathematics many students still think that mathematics is a complex subject because it discusses the calculation of symbols, numbers, and abstract concepts that must be understood with more concentration when working (Nurfitriyanti, 2016). Therefore, mathematics learning needs to be developed with teaching methods that are fun, relevant to everyday life, and use a suitable learning model to create a fun learning environment and support critical thinking skills. In addition, learners to understand mathematics learning must be active not just pay attention to the teacher Sari et al. (2016). Meanwhile, teachers must strive so that students can build and improve their critical thinking skills Rokhimah & Rejeki (2018).

The reality in Indonesia shows that the quality of mathematics students in lower secondary schools still needs to improve. Based on an interview and observation, the same case happened in a public school in Kartasura, Central Java, Indonesia. In fact, through learning mathematics, students can master higher-order thinking skills, namely critical thinking skills Rokhimah & Rejeki (2018). According to TIMSS (*Trends in International Mathematics and Science Study*), data in 2015 (Nizam, 2016) showed the 44th rank out of 49 participating countries, while in 2019 Indonesia did not participate. In the mathematics category, the average OECD (*Organisation for Economic Co-operation and Development*) score of students in 2018 for mathematics was 379, which is below the average of 79 PISA (*Program* for *International Students Assessment*) participating countries in 2018, with a score of 489 for students' mathematical ability (OECD, 2019). This result shows a decrease in PISA test results from the previous year. In 2015 the average score of Indonesian students was higher at 386 for mathematical ability (OECD, 2016). The low quality of mathematics among students in Indonesia indicates that students' critical thinking ability still needs to improve, so it must be improved.

The ability to think critically is described as one of the solutions for problem-solving in everyday life because it involves logical reasoning, interpretation, analysis, and evaluation of information to enable someone to contain reliable and valid decisions (Widana et al., 2018). The ability to think critically in mathematics learning can help students to reach a deeper understanding (Faiziyah & Priyambodho, 2022). According to Demiral (2018) critical thinking skills can make students open-minded, formulate problems, collect information and assess it relevantly, conclude with solutions based on ideas, and communicate effectively in solving complex problems with others.

Given the low ability to think critically in learning, solutions are needed to improve student's critical thinking skills through literature reviews that affect it. In addition, in

learning, it is essential for teachers to choose learning models/strategies and teaching materials that support students' critical thinking skills (Sholihah & Rejeki, 2020). The ability to think critically is influenced by two factors, namely internal and external factors. However, the factors that most influence critical thinking skills are external factors, including learning methods and strategies (Trivette et al., 2009). One of the learning methods recommended in the 2013 Curriculum is *Problem-Based Learning* (PBL) (Ministry of Education and Culture, 2014). According to Hosnan (2014) the PBL method has the primary purpose of not only conveying knowledge to students but also developing critical thinking skills and problem-solving skills as well as the ability of students to acquire their knowledge actively.

The PBL method begins with orienting students to problems, organizing students to learn, guiding individual and group investigations, developing and presenting work results, and analyzing and evaluating the problem-solving process (Arends, 2012). The PBL method prepares students to think critically and analytically and to find and use the right learning resources (Yulianti & Gunawan, 2019). One of the learning resources to support learning is teaching materials that stimulate student interest (Septian et al., 2019). However, in using ready-to-use teaching materials, Prastowo (2013) stated that there are risks, including teaching materials that are not contextual, boring, monotonous, and unsuitable for students. Teaching materials consist of several forms, namely printed, audio, audio-visual, and interactive teaching materials (Prastowo, 2013).

Based on observations at a public junior high school in Kartasura, Central Java, Indonesia, it was found that students in learning activities felt bored with teaching materials, textbooks, and worksheets because they needed to be more exciting and varied. This finding indicates that selecting learning resources must be engaging and fun and increase creativity. Teachers must choose teaching materials that support the learning process. The Student Worksheet is one form of printed teaching material that creatively, innovatively, and interestingly supports the learning process. The worksheets students use can help improve student learning activities, create effective interactions between teachers and students to encourage students to work independently, and direct students to develop concepts (Relia, 2016).

Mathematics learning at this time still tends to be teacher-centered, so learners are passive in their learning activities, only focusing on listening, taking notes, and obeying teacher orders (Niken et al., 2012). Therefore, teachers must plan enjoyable learning and actively involve students to increase student enthusiasm. Teachers can use teaching

materials to assist activities in learning mathematics. In learning activities, students are less interested in reading package books because the colors are less attractive and the books are thick. The solution to this problem is that teachers can make teaching materials simpler and more attractive by using Student Worksheets.

The selection of printed teaching materials, namely the PBL Worksheet, is one of the selected learning resources and is designed to attract students' learning interests. In addition, it supports students' critical thinking skills in learning, which later students with different levels of intelligence can follow, understand and find solutions to the problems given and make new understandings (Sanjaya et al., 2017).

Based on several previous studies have been carried out, such as Sanjaya et al., (2017) producing mathematical worksheets to support valid, practical, and effective PBL models in terms of students' mathematical critical thinking skills on the Pythagoras topic. Another research from (Zulfah et al., 2018) states that worksheet based on PBL strategies has been proven to improve problem-solving skills and help students develop solving skills in Cartesian Coordinates topic. Abdillah and Astuti (2020) stated that a PBL-based worksheet is expected to help students to be actively involved in learning angles, more motivated in reading books, and understand learning materials more efficiently.

Based on the description above, there still needs to be more study on developing student worksheet which integrates the PBL model to support students' critical thinking skills. The integration can be seen in the activities provided, which are in line with and supported by the PBL steps. Therefore, this study aims to develop valid, practical, and effective PBL-based worksheets to support students' critical thinking skills.

METHODS

The research applied *Research & Development* (R&D) method. The *Research and Development* (R&D) method is a development research method that aims to find new products/find something *new*, or improve products that have been produced (Saputro, 2021). The R&D method was adapted from the research and development stage of the 4D model (*four-D model*) according to Thiagarajan et al., (1974), consisting of defining (*define*), design stage (*design*), development stage (*develop*), and *dissemination (disseminate*). Due to time limitations in research, this paper only focuses on describing the first three stages.

In this study, the *define* stage aims to determine and define learning requirements. This stage consists of five steps, namely: (1) Front-end, (2) Learner analysis, (3) Concept analysis, (4) Task analysis, and (5) Learning objectives specifications (Thiagarajan et al., 1974). The *design* stage is used to carry out the development and design stages based on the PBL learning model. In addition, improvements were made to the weaknesses and shortcomings of the PBL-based Worksheet. The *development* stage is the validation of the worksheet by experts, and the practicality test of the worksheet by students. The assessment of the expert validator and student responses is then measured by eligibility with criteria according to (Widoyoko, 2017) as described in Table 1.

Table 1. The Eligibility Criteria of Expert Validators and Student Responses

No	Average interval of scores	Category
1	$\bar{x}$ > 4,2	Excellent
2	3,4 < $\bar{x}$ > 4,2	Good
3	2,6 < $\bar{x}$ > 3,4	Good enough
4	1,8 < $\bar{x}$ > 2,6	Not good
5	$\bar{x}$ > 1,8	Very unfavorable

Besides using a student response questionnaire, the practicality of the worksheet was assessed by students' critical thinking test provided in the worksheet. After that, categorize the percentage of students who completed with academic proficiency assessment criteria (Widoyoko, 2017) as described in Table 2. Learning media is said to be effective if the percentage of many students reaches the minimum scores (75) of more than 60%. The test is carried out by determining the test results, then calculating the students who are complete and the percentage of students who are completed with the formula:

$$\text{Percentage of completed students} = \frac{The\ number\ of\ students\ completed}{Many\ students\ in\ the\ class}\ x\ 100\%$$

This research develops *Problem-Based Learning* (PBL)-based Student Worksheets that are valid and practical in learning mathematics cartesian coordinate material that supports students' critical thinking skills. The subjects in this study were 34 students in grade eight at a public junior high school in Kartasura, Central Java, Indonesia. The stage is carried out in the odd semester of the 2022/2023 academic year in August 2022. Research instruments in this study include questionnaires of validation of material and media experts, student response questionnaires, and student answer result sheets.

RESULT AND DISCUSSION

This study used 4D (four-D) stage that-stage. The stages of 4D model development that have been carried out in this development research are as follows:

1. Defining Stage

   Identification was carried out in learning cartesian coordinates at the school. The identifier consists of the learning process and medium used. The identification process is carried out through observation, interviews, and analyzing the results of previous research.

   a. End-to-End Analysis

      In this analysis, researchers identified the fundamental problems faced in learning cartesian coordinates by asking the school's mathematics teacher through direct interviews. The identification of the problem gets information about several descriptions of the facts of the problem, obstacles faced by teachers, and suggestions for better learning to facilitate the development of student worksheets. This stage analyzes the curriculum used by the school, the 2013 curriculum. The analysis produces information about the parts that still need to be developed, namely Core Competence and Basic Competence, broken down into indicators and learning objectives.

   b. Student Analysis

      In this study, students' characteristics were analyzed by looking for information from mathematics teachers in grade eight. In addition, researchers observe students in learning cartesian coordinates and the conditions of the learning process desired by students. In this case, the results of the analysis of the characteristics of students who need more mathematical foundations, cannot understand the material, take a long time to understand the material, are lazy, not thorough, and not interested and new material. Students expect the learning process to use engaging learning media, examples of questions related to everyday life, and simple and easy-to-understand formulas.

   c. Concept Analysis

      In this analysis, the identification of teaching materials will be compiled systematically and taught by students based on *problem-based learning* and supporting critical thinking skills. This analysis is the basis for structuring learning objectives. The material analysis carried out by researchers on cartesian coordinate material is to identify and analyze the position of a point, analyze contextual

problems related to the position of a point, solve problems related to the position of points and lines.

d. Task Analysis

Task analysis on the cartesian coordinate material in semester 1 is to understand cartesian coordinates and be able to explain and solve the position of points associated with contextual problems in everyday life. The success criteria for learning mathematics on cartesian coordinate material can be seen from the ability of students to solve point and line position problems and explain the position of points connected to contextual problems.

e. Learning objective specifications

At this stage, according to the analysis of the tasks that have been done, the specification of objectives that are indicators of students achieving the learning process is the increase in students' critical thinking skills in solving problems related to cartesian coordinates.

2. Designing Stage

At the design stage, make an initial design of the PBL Worksheet following the define stage. At this design stage, it produces an initial draft of PBL-based Worksheet on cartesian coordinate material to support critical thinking skills.

English Version:

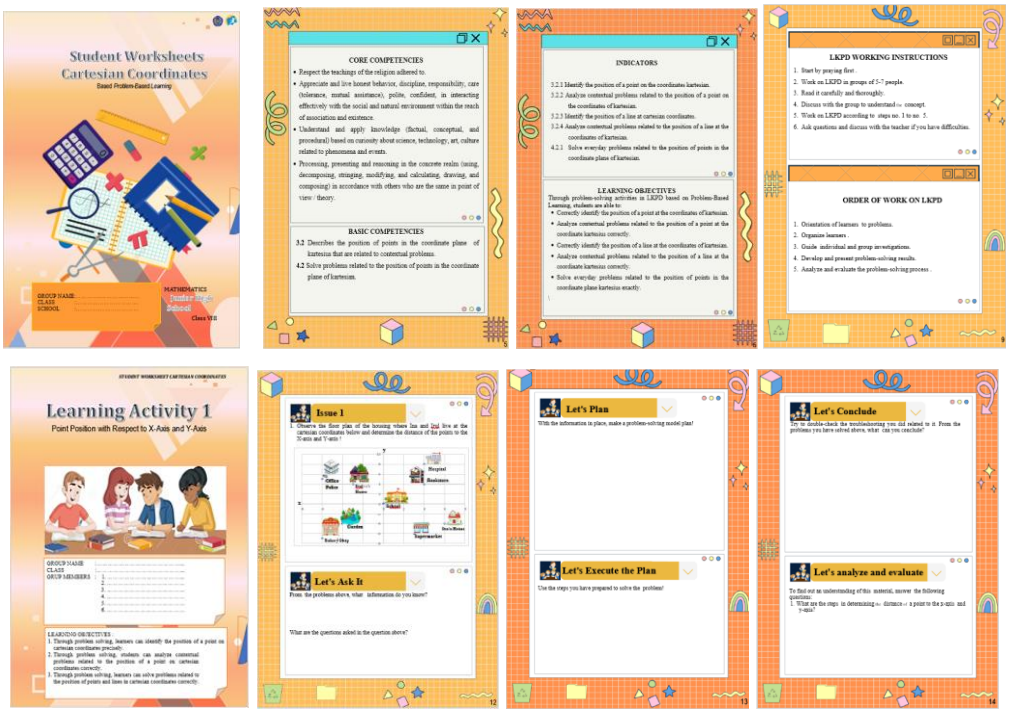


Figure 1. Initial Draft of The PBL Worksheet

3. Development Stage

At the development stage, namely validation and revision activities. The activities include validating the worksheet and testing its practicality. In addition, for research instruments, namely student response questionnaires. The Worksheets and instruments were given to validators, namely two mathematics education lecturers and mathematics teachers in junior high school. The assessment instrument is filled with validators to assess the validity of the PBL Worksheet. At the same time, the student response questionnaire is filled out by students. From the data, the validation results are described in Table 2 and Table 3.

Table 2. The Content Validation Results

No	Indicator Achievement	Aspects	Number of Assessment Items	Average validation score		Average Score	Category
				V_1	V_2		
1	Student Worksheets	Contents presented	8	4	4,1	4,1	Good
		Language	7	4	4,1	4,1	Good
		Graphics	3	4	4	4	Good

No	Indicator Achievement	Aspects	Number of Assessment Items	Average validation score		Average Score	Category
				V_1	V_2		
2	*Problem-Based Learning*	*Problem-Based Learning* Model	2	4	3,5	3,75	Good
	Total		20	16	15,7	4,1	Good

The aspects assessed by the content experts are Content presented, Language, and Graphics. In these three aspects, an average score of 4,1 was obtained with a good category, so it was concluded that the PBL-Worksheet were declared valid based on the content validity assessment.

Table 3. The Media Validation Results

No	Assessment Aspect	Number of Questions	Scores	Average Score	Category
1	Worksheet Size	2	8	4	Good
2	Cover Design	8	32	4	Good
3	Worksheet Design	19	76	4	Good
	Total	29	116	4	Good

The media experts assess Worksheet size, Worksheet Cover Design, and Worksheet Design. In these three aspects, an average score of 4 was obtained with an good category, so it was concluded that that the PBL-Worksheet were declared valid based on the learning media validity assessment. However, there are some comments and sugesstions for revisions from the experts, which can be seen in Table 4 and Table 5.

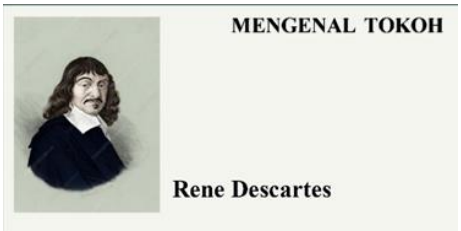
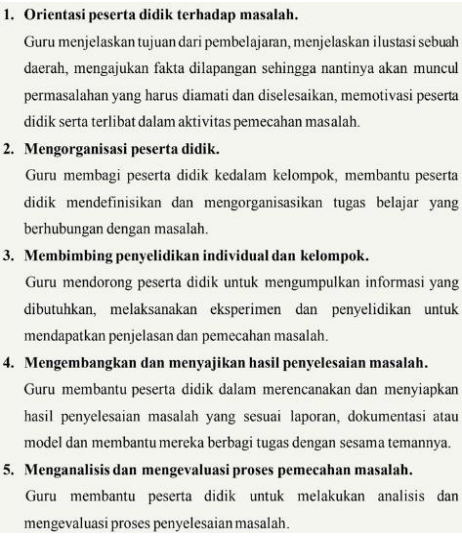
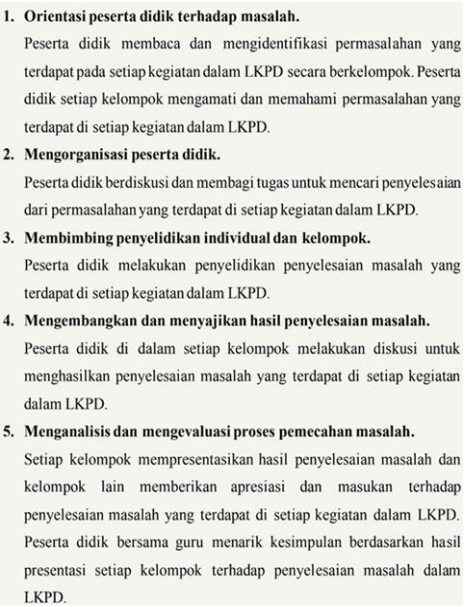
Table 4. Content Revision

No	Content Revision
1	Subheadings recognizing the characters and their sources can be added.
2	The arrangement of worksheet instructions should be *student-centered*.
3	Adjust the worksheet order with PBL syntax (The syntax/steps of the PBL learning model are: 1) orientation of students to problems, 2) organizing students to learn, 3) guiding individual and group investigations, 4)

No	Content Revision
	developing and presenting problem solving results, 5) analyzing and evaluating the problem-solving process).
4	Use images that do not have watermarks.
5	The worksheet should start with contextual problems that students will solve.

Table 5 shows experts' comments regarding the content of the worksheet. Afterwards, Table 5 shows the revision based on the media experts' comments.

Table 5. Media Revision

No	Media Revision	
1	Before Revision	After Revision
		
	In the Character Biography section, as shown in the image before revision, there is no title. It should be titled "Knowing Figures or *Mengenal Tokoh*" as in the image after revision.	
2	Before Revision	After Revision
		

No	Media Revision

English Version:

1. **Orientation of learners to problems.**
   The teacher explains the objectives of learning, explains the illustration of an area, submits facts in the field so that later problems will arise that must be observed and solved, motivate students and engage in problem-solving activities.
2. **Organize learners.**
   The teacher divides students into groups, helping students define and organize problem-related learning tasks.
3. **Guide individual and group investigations.**
   Teachers encourage learners to gather needed information, carry out experiments and investigations to obtain explanations and solve problems.
4. **Develop and present problem-solving results.**
   Teachers assist learners in planning and preparing problem-solving outcomes according to reports, documentation or models and help them share tasks with their peers.
5. **Analyze and evaluate the problem-solving process.**
   Teachers help learners to analyze and evaluate the problem-solving process.

1. **Orientation of learners to problems.**
   Students read and identify problems contained in each activity in LKPD in groups. Students in each group observe and understand the problems contained in each activity in LKPD.
2. **Organize learners.**
   Students discuss and divide tasks to find solutions to problems contained in each activity in LKPD.
3. **Guide individual and group investigations.**
   Students conduct investigations to solve problems contained in each activity in LKPD.
4. **Develop and present problem-solving results.**
   Students in each group conduct discussions to produce solutions to problems contained in each activity in LKPD.
5. **Analyze and evaluate the problem-solving process.**
   Each group presented the results of problem solving and the other group gave appreciation and input to solving problems contained in each activity in LKPD. Students together with teachers draw conclusions based on the results of each group's presentation on problem solving in LKPD.

In the Worksheet Instructions section, there is a PBL stage and an explanation in which the diction focuses on the teacher. In this explanation, the focus of the selected diction should be shown to students, not teachers.

3 Before Revision After Revision

5. Kerjakan LKPD sesuai dengan langkah no 1 sampai no 5.

5. Diskusikanlah dengan kelompok untuk memahami konsep.

English Version:

5. Work on LKPD according to steps no. 1 to no. 5.

5. Discuss with the group to understand the concept.

In the Worksheet Working Instructions section in step no 5, it should be clarified what kind of step is meant.

4 Before Revision After Revision

URUTAN PENGERJAAN LKPD

1. Orientasi peserta didik terhadap masalah.
2. Mengorganisasi peserta didik.
3. Membimbing penyelidikan individual dan kelompok.
4. Mengembangkan dan menyajikan hasil penyelesaian masalah.
5. Menganalisis dan mengevaluasi proses pemecahan masalah.

SINTAKS PROBLEM BASED LEARNING

1. Mari menanya.
2. Mari merencanakan.
3. Mari melaksanakan rencana.
4. Mari menyimpulkan.
5. Mari menganalisis dan mengevaluasi.

English Version:

SEQUENCE OF WORK

1. Learners' orientation towards problems.
2. Organize students.
3. Guide individual and group investigations.
4. Develop and present problem-solving results.
5. Analyze and evaluate the problem-solving process.

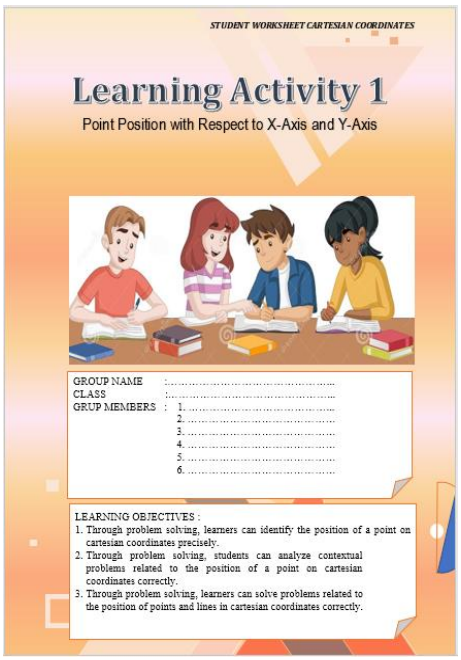
PROBLEM BASED LEARNING SYNTAX

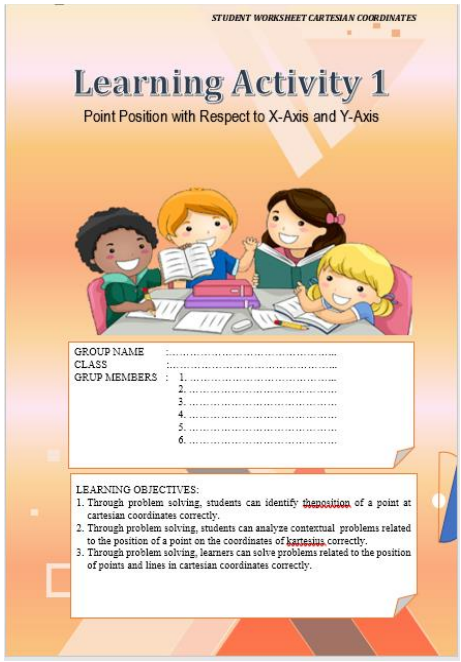
1. Let's ask it.
2. Let's plan.
3. Let's carry out the plan.
4. Let's concluded.
5. Let's analyze and evaluate.

In the Order of Work, the syntax should follow the design of the worksheet.

No	Media Revision	
5	Before Revision	After Revision

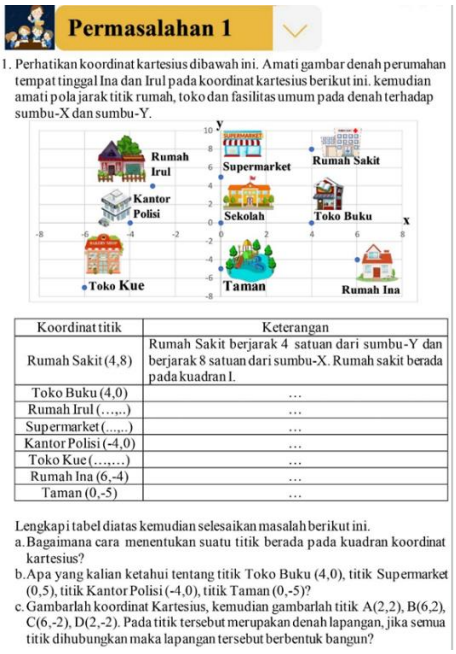
English Version:





On the Learning Activities Cover, the image used on the cover should be replaced with an image without the watermark.

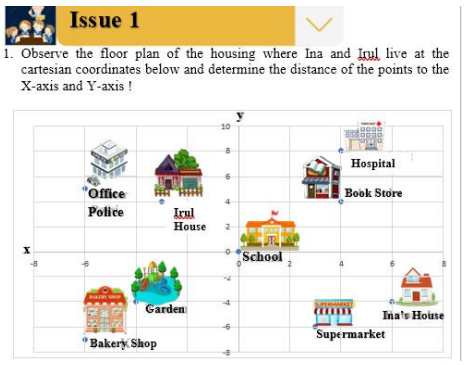
No	Media Revision	
6	Before Revision	After Revision

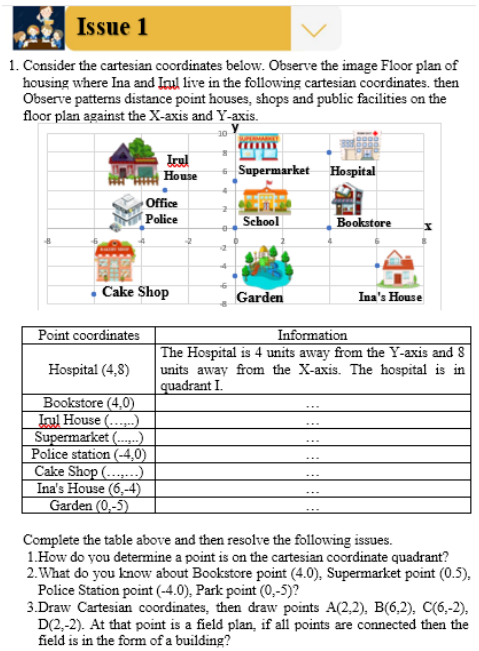


Koordinat titik	Keterangan
Rumah Sakit (4,8)	Rumah Sakit berjarak 4 satuan dari sumbu-Y dan berjarak 8 satuan dari sumbu-X. Rumah sakit berada pada kuadran I.
Toko Buku (4,0)	…
Rumah Irul (…..)	…
Supermarket (…..)	…
Kantor Polisi (-4,0)	…
Toko Kue (…..)	…
Rumah Ina (6,-4)	…
Taman (0,-5)	…

Lengkapi tabel diatas kemudian selesaikan masalah berikut ini.
a. Bagaimana cara menentukan suatu titik berada pada kuadran koordinat kartesius?
b. Apa yang kalian ketahui tentang titik Toko Buku (4,0), titik Supermarket (0,5), titik Kantor Polisi (-4,0), titik Taman (0,-5)?
c. Gambarlah koordinat Kartesius, kemudian gambarlah titik A(2,2), B(6,2), C(6,-2), D(2,-2). Pada titik tersebut merupakan denah lapangan, jika semua titik dihubungkan maka lapangan tersebut berbentuk bangun?

English Version:



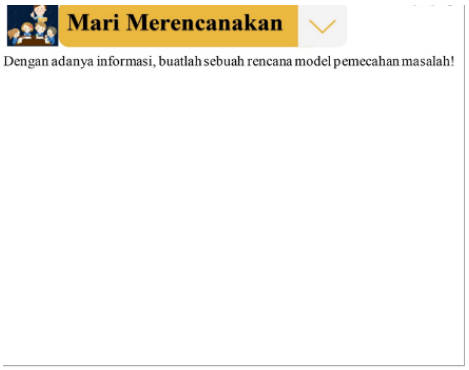


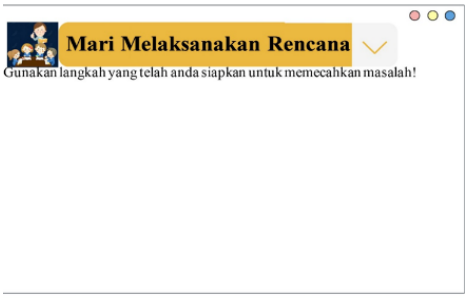
Point coordinates	Information
Hospital (4,8)	The Hospital is 4 units away from the Y-axis and 8 units away from the X-axis. The hospital is in quadrant I.
Bookstore (4,0)	…
Irul House (…..)	…
Supermarket (…..)	…
Police station (-4,0)	…
Cake Shop (…..)	…
Ina's House (6,-4)	…
Garden (0,-5)	…

Complete the table above and then resolve the following issues.
1. How do you determine a point is on the cartesian coordinate quadrant?
2. What do you know about Bookstore point (4.0), Supermarket point (0.5), Police Station point (-4.0), Park point (0,-5)?
3. Draw Cartesian coordinates, then draw points A(2,2), B(6,2), C(6,-2), D(2,-2). At that point is a field plan, if all points are connected then the field is in the form of a building?

Problem 1 should be a contextual problem that students will solve.

No	Media Revision	
	Before Revision	**After Revision**





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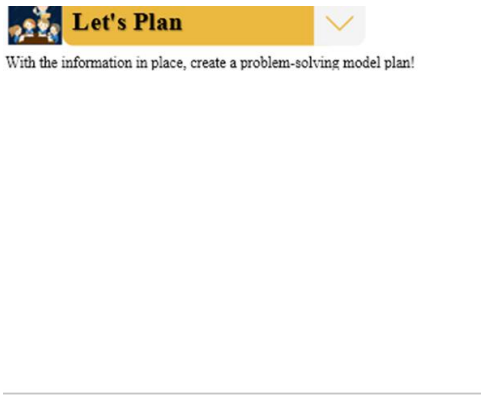
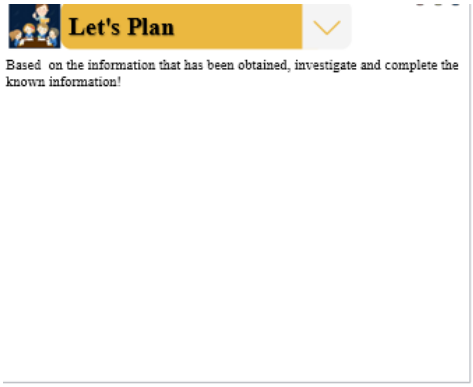
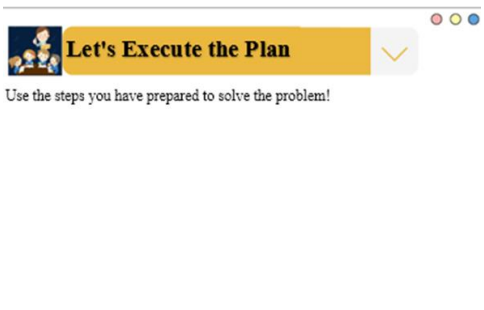
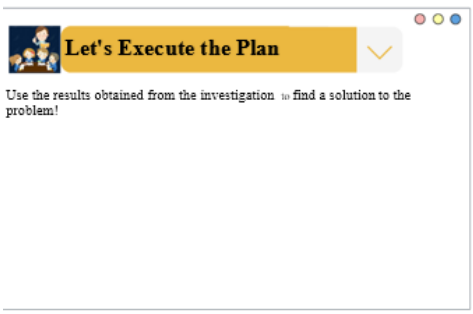






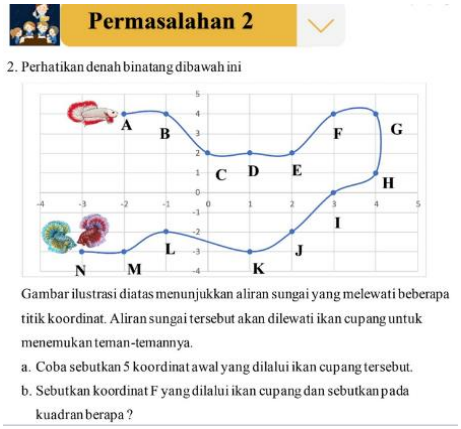


In the **PBL syntax**, the Let's Plan and Let's Implement the Plan section should be adjusted to explain the PBL stage in the worksheet instructions.

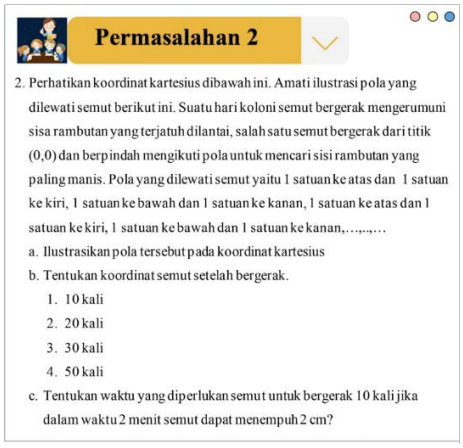
No	Media Revision

7

Before Revision



After Revision



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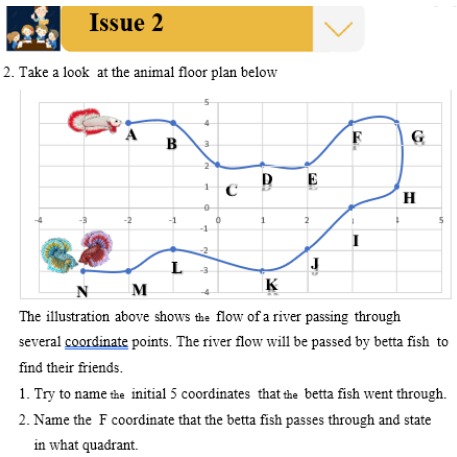
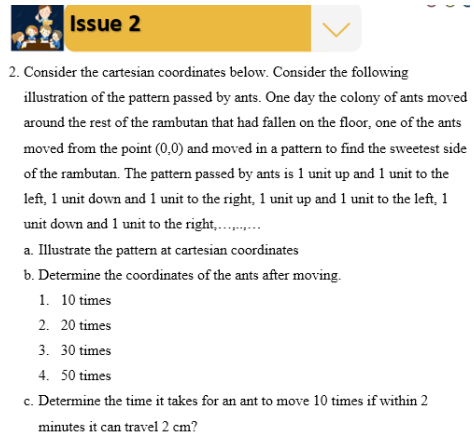
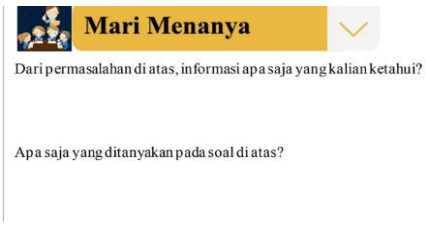




Problem 2 should be a contextual problem that students will solve**.** The question section should only be used as a collection phase, not a problem orientation phase.

Before Revision



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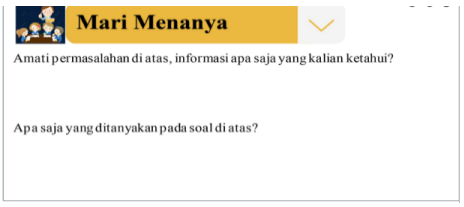

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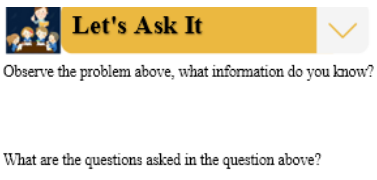
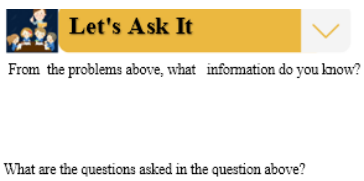




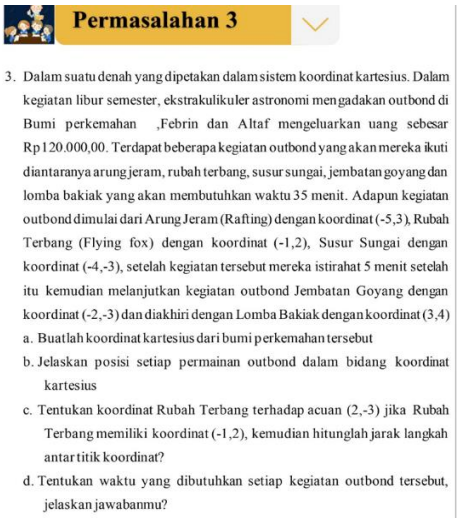
No	Media Revision

In the **PBL syntax**, the Let's Ask It section should be adjusted to the explanation of the PBL stage in the Worksheet instructions.

8

Before Revision

After Revision



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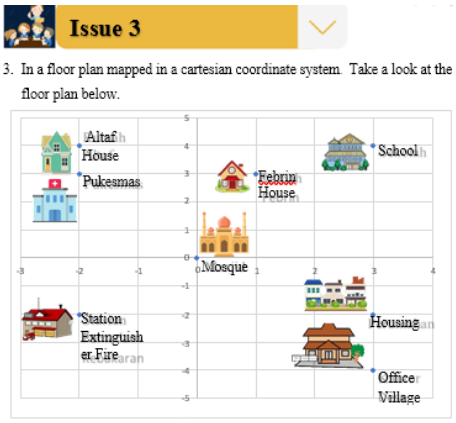
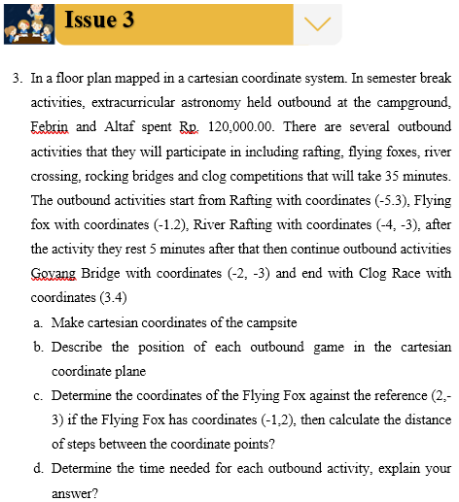
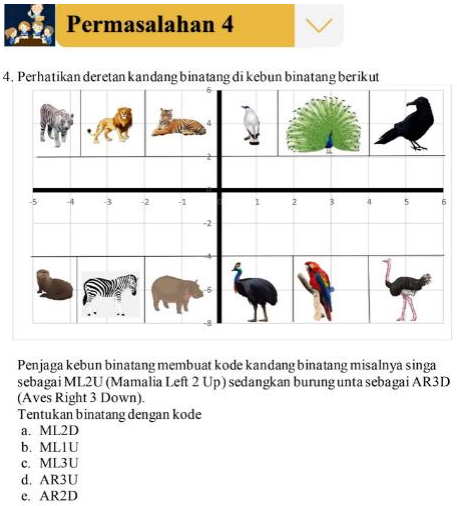
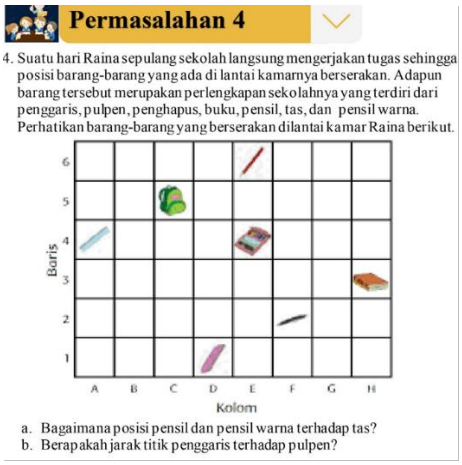




In **problem 3**, it should be a contextual problem that students will solve during the learning process, and questions a to e should be replaced as problems.

No	Media Revision	
9	**Before Revision**	**After Revision**





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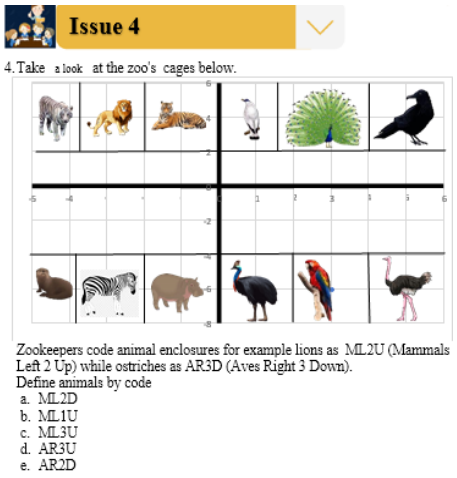

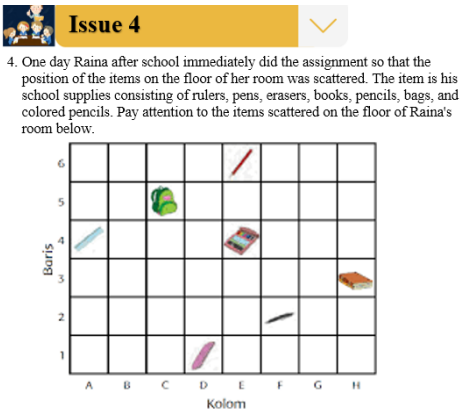

In **problem 4**, it should be modified to be more contextual.

No	Media Revision	
10	**Before Revision**	**After Revision**

Permasalahan 5

5. a.Gambarlah bidang koordinat kartesius yang memuat 4 kuadran dengan titik A(4,2),B(4,-6),dan C(-4,3) pada bidang koordinat Kartesius!
   b.Buatlah garis melalui titik A dan B, melalui titik A dan C, serta melalui titik B dan C pada bidang koordinat kartesius!
   c. Bagaimana kedudukan garis-garis yang terbentuk tersebut terhadap sumbu-X dan sumbu-Y?

Permasalahan 5

5. Suatu hari pada liburan sekolah akhir tahun Raina, Febrin, dan Dito akan berkunjung ke tempat wisata yang berada di Yogyakarta diantaranya Monumen Tugu Yogyakarta, Malioboro, Keraton Yogyakarta, dan Gembira Loka Zoo. Mereka berencana untuk berkumpul di Malioboro karena rumah mereka berada di desa berbeda sebelum menuju destinasi berikutnya. Dari malioboro mereka menuju Keraton Yogyakarta yang berkoordinat (-2,-6), mereka berkeliling dan berfoto disana. Selanjutnya mereka menuju tempat wisata Gembira Loka Zoo yang berkoordinat (8,-6) disana mereka melihat binatang, bermain dan memberi makan binatang serta berfoto. Kemudian mereka menuju wisata terakhir tetapi mereka berhenti untuk makan siang di Kafe Basabasi Sorowajan di koordinat (8,2), kemudian mereka melanjutkan ke destinasi wisata terakhir yaitu Monumen Tugu Yogyakarta yang berkoordinat (4,2).
   a. Gambarkan koordinat-koordinat titik dan rute perjalanan dalam cerita diatas ?
   b. Jika dibuat garis melalui titik Keraton Yogyakarta menuju Gembira Loka Zoo. Bagaimana kedudukan garis tersebut terhadap sumbu-X dan sumbu-Y?
   c. Jika dibuat garis melalui titik Gembira Loka Zoo menuju Kafe Basabasi Sorowajan. Bagaimana kedudukan garis terhadap sumbu X dan sumbu Y?
   d. Jika dibuat garis melalui titik Monumen Tugu Yogyakarta menuju Gembira Loka Zoo. Bagaimana kedudukan garis terhadap sumbu X dan sumbu Y?

English Version:

Issue 5

5. a. Draw a cartesian coordinate plane containing 4 quadrants with points A(4,2),B(4,-6),and C(-4,3) in the cartesian coordinate plane!
   b.Draw a line through points A and B, through points A and C, and through points B and C on the cartesian coordinate plane!
   c. What is the position of the formed lines with respect to the X-axis and Y-axis?

Issue 5

5. One day during Raina's year-end school holidays, Febrin, and Dito will visit tourist attractions in Yogyakarta including Tugu Yogyakarta Monument, Malioboro, Yogyakarta Palace, and Gembira Loka Zoo. They plan to gather in Malioboro because their home is in a different village before heading to their next destination. From Malioboro they went to Yogyakarta Palace with coordinates (-2,-6), they went around and took pictures there. Then they went to the tourist spot Gembira Loka Zoo coordinates (8, -6) where they saw animals, played and fed animals and took pictures. Then they went to the last tour but they stopped for lunch at Kafe Basabasi Sorowajan at coordinates (8.2), then they continued to the last tourist destination, namely Tugu Yogyakarta Monument which coordinates (4.2).
   a. Draw the coordinates of the points and travel routes in the story above?
   b. If a line is made through the point of Yogyakarta Palace to Gembira Loka Zoo. How do the lines stand with respect to the X-axis and Y-axis?
   c. If a line is made through the point of Gembira Loka Zoo to Kafe Basabasi Sorowajan. How is the line positioned with respect to the X axis and Y axis?
   d. If a line is made through the point of Tugu Monument Yogyakarta to Gembira Loka Zoo. How is the line positioned with respect to the X axis and Y axis?

In **problem 5**, it should be changed into contextual problem.

After revision, the PBL worksheet was tested on 34 students to asses its practicality. A learning process was conducted using the worksheet and ended with a critical thinking test provided in the worksheet. The practicality of the worksheet was assessed by a questionnaire of students' responses and critical thinking test results.

Table 6. Results of Student Response Questionnaire

No	Assessment Aspect	Number of Questions	Scores	Average Score	Category
1	Giving a simple explanation	3	15	5	Excellent
2	Building basic skills	4	16	4	Good
3	Concluding	1	4	4	Good
4	Giving an advance explanation	1	4	4	Good
5	Devising strategy	1	4	4	Good
	Total	10	43	4,2	Good

Based on Table 6, it is known that the average results of the student response questionnaire to the worksheet are 4,2. Hence, it is concluded that the worksheet has met the practicality aspect with a good category.

Table 7. Achievement Results of Critical Thinking Ability

No	Completeness	Number of Students	Percentage
1	Completed students	22	64,70 %
2	Incomplete students	12	35,29 %
	Total	34	100 %

Based on Table 6, it is concluded that the highest score of students' critical thinking skills is on giving a simple explanation of 5, which is included in the excellent category, while the others are in a good category. Moreover, Table 7 shows that more than 60% of students scored above the minimum score requirement (75). Therefore, the PBL Worksheet met the practicality.

This development research produces worksheets based on problem-based learning on the material Cartesian coordinates to support the critical thinking skills of grade eight junior high school students. The stages of problem-based learning are applied to activities in a worksheet. Problem-based learning worksheet developed meets the criteria of validity based on material expert assessment and media expert assessment. Moreover, based on students' responses, the worksheets meet the feasibility criteria. Learning media or teaching materials in the form of problem-based learning worksheets are of decent quality and can

be used as a source of learning cartesian coordinate material. Judging from the color of the worksheet, students feel enthusiastic about learning using this *problem-based* learning worksheet learning media. This finding is like previous research with an attractive display of teaching materials that can make it easier for students to learn learning materials (Rahimah et al., 2020).

Previous studies that align with this research are researches on developing worksheets based on *problem-based* learning on an angle topic for junior high school students, showing that the learning media developed is in the excellent category, based on material expert assessments (Abdillah & Astuti, 2020). The practicality of learning media is reviewed from teacher assessments and the results of student responses that show that learning media are practical. Previous development research that shows valid and practical worksheet results is *problem-based learning* worksheet development research on social arithmetic material for grade seven junior high school students (Ridwan et al., 2016).

The results showed that the average results of the analysis of students' critical thinking problems amounted to 3,97 which was in the high category. This finding indicates that the evidence used meets the indicators of critical thinking skills because worksheet is designed according to *the problem-based learning* model to support critical thinking skills. Teachers should get used to giving hots questions to foster students' critical thinking skills (Saraswati & Agustika, 2020). This finding is like research Yuliantaningrum and Sunarti (2020) which states that learning to apply hots questions can stimulate students' critical thinking skills. In addition, research Sanjaya et al. (2017) states that the development of problem-based learning worksheet impacts students' cognitive outcomes and supports students' critical thinking skills. In line with research Mahmudah and Bahtiar (2022) that results in the development of hots-based worksheet can improve critical thinking skills.

Thus, problem-based learning worksheets developed by researchers can support students' critical thinking skills. The learning process using problem-based worksheets significantly improves students' critical thinking skills more than conventional models (Al-Fikry et al., 2018). Research Astuti et al. (2018) shows that the results of worksheet development impact students' critical thinking skills.

The worksheet resulting from this development research gets a positive response from students who are shown by students who are more enthusiastic and motivated in learning activities using engaging learning media, seen from the content and appearance. The worksheet learning media that looks attractive is essential to encourage students' curiosity. This finding is in line with research by Fitri et al. (2017) shows that the attractive

display of student worksheets, pictures, and illustrations makes students happier to learn them.

In addition, the worksheet is presented with stages according to the problem-based learning model, namely orientation of students to problems, organizing students, guiding investigations, developing works, and analyzing and evaluating problem-solving processes that help students to find their knowledge with meaningful activities. With the given stages, learners are guided to see concepts in cartesian coordinates. In line research by P. H. M. Astuti et al, (2021) shows that the application of problem-based learning in mathematics learning can relate problems given to real life, learning activities carried out are more meaningful and student-centered, can improve memory through direct problem-solving activities, and can collaborate in the problem-solving process.

CONCLUSION

Based on the description of the results and discussion above, the research results on developing student worksheets based on Problem-Based Learning (PBL) are learning media in the form of PBL-Worksheet, developed based on problem-based learning on feasible cartesian coordinate material. The feasibility of LKPD from the material validation results is 4.1, with the category of material validation results being good. The results of media validation are 4 with good categories. The practicality of LKPD developed received results from student questionnaires, namely 4,2 with good categories. The developed worksheet received the results of achieving students' critical thinking skills, with 64,70 % of students reaching the minimum score requirement (75) for the critical thinking test. It indicated that PBL-based LKPD is declared feasible to support students' critical thinking skills.

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