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DEVELOPMENT OF PROBLEM BASED LEARNING TOOLS TO IMPROVE CRITICAL THINKING SKILLS AND COLLABORATION SKILLS OF CLASS VIII JUNIOR SCHOOL STUDENTS

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Abstract

This research uses an R&D approach by applying the ADDIE model which consists of five main stages: analysis, design, development, implementation and evaluation. The aim of the research is to evaluate the validity, practicality and effectiveness of problem-based learning (PBL) based learning tools to improve students' critical thinking and collaboration skills at SMPN 7 Menui Satap. Data collection methods include observation, critical thinking skills tests, and questionnaires to measure collaboration skills. Research instruments include tests, assessment sheets, rubrics, as well as validation sheets for PBL-based lesson plans and LKPD. The results of data analysis show that this learning tool is effectively able to improve critical thinking skills, with pretest and posttest results showing an increase from an average score of 40.00 to 78.00, as well as an effect size value of 0.95, which indicates a positive effect. very large. Apart from that, this tool is also effective in improving students' collaboration skills, with scores for each meeting increasing gradually from the first to the third meeting. At the first meeting, the average score was 2.52 with a percentage of 63.00%, at the second meeting it increased to 3.04 with a percentage of 76.00%, and at the third meeting it increased further to 3.61 with a percentage of 90.25 %. Overall, this learning tool has a significant positive impact on students' critical thinking and collaboration skills.

Keywords: Learning tools, problem-based learning, critical thinking skills, student collaboration skills

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Introduction

Technological advances in the 21st century have influenced almost all aspects of life, including education. This phenomenon attracts the interest of many people, especially those who work as educators, because there are various concerns about readiness to face the era of globalization. This era had a significant impact on the development of human culture. Continuous developments in technology and information can change the way students think and behave. Therefore, it is very important for students to have strong character and skills that enable them to compete well in the future (Priyono & Sinurat, 2020).

The learning process is an integral part of a system that interacts with various other components. Preparation for the learning process in the 21st century involves the use of various learning tools in every learning activity. These tools include learning implementation plans (RPP), teaching materials, student worksheets (LKPD), learning media, and assessment instruments (Nismidawati et al., 2022).

Learning tools based on problem based learning can be an effective solution to overcome problems in science learning. One of the goals of learning science at school is to develop process skills in investigating the natural environment, solving problems and making decisions. These activities (investigating, solving problems, and making decisions) are included in higher order thinking skills.

The 21st Century Learning Framework describes the skills, knowledge and expertise that students must master to be successful in work and life. One of the main skills emphasized is the 4C skills, which include critical thinking, communication, collaboration and creativity. Students need to be good communicators, creators, critical thinkers and reliable collaborators (4C) in order to compete in a global society. 21st century skills can be developed through various efforts, such as encouraging communication and collaboration, emphasizing problem-based learning, and designing learning activities that are relevant to real life (Lestari, 2023).

21st century learning through the implementation of the 2013 curriculum supports the development of students' skills known as 4C, namely Critical Thinking, Collaboration (the ability to work well together),

Communication (the ability to communicate), and Creativity (creativity). These 4C skills must be mastered by students in preparation for facing the challenges of the 21st century. These skills include the ability to develop and improve cooperation in groups to solve problems, communicate in solving problems, and think critically and creatively in solving problems and linking various concepts (Monica, et al., 2021).

The problem based learning (PBL) learning model places the teacher as a facilitator who helps students find information through deduction and construction. PBL was developed to hone problem-based critical and collaborative thinking skills. This skill is important for students to think and produce innovative work (Ariyanto, et al., 2019).

According to Maryam, et al. (2020), critical thinking, as a higher-order thinking skill, includes the ability to analyze, synthesize, solve problems, conclude, and evaluate. Critical thinking is a reasoning process to gather information and make rational decisions (Yulanda, et al., 2023). This skill is essential in science learning to understand abstract concepts and find ideas and solutions through reasoning. Apart from that, collaboration skills are also very important to face developments in science and technology in the 21st century. Collaboration involves teamwork competencies, which can be seen from participation in discussions, sharing opinions, and group responsibility. Lack of collaboration skills is characterized by low participation and motivation in learning (Nurcahyo, et al., 2018).

Observation results at SMPN 7 Menui Satap show that students' critical thinking skills are still low, around 35%, including indicators such as asking questions, analyzing arguments, asking and answering questions, and considering sources of information. Some students have not been able to provide various answers or develop new ideas to solve problems. This difficulty is caused by habits or limitations in critical thinking, as well as a lack of collaboration skills with other students or teachers.

Collaboration skills also need to be improved, only around 35% of students demonstrate these skills during group discussions. Only some students actively collaborate, while others tend to be passive and do not respond. Apart from that, students often feel bored during learning because the media used is less varied and monotonous.

Based on the description above and previous research, it is necessary to develop learning tools that suit student characteristics and the school environment to improve critical thinking and collaboration skills. This research will develop learning tools based on problem based learning with material on the circulatory system, which is expected to improve students' critical thinking and collaboration skills more effectively. Shows that problem based learning tools are effective and suitable for use in science learning. However, at SMPN 7 Menui Satap, teachers have never implemented this kind of learning tool. Therefore, researchers consider it important to develop problem based learning oriented learning tools with the title "Development of Problem Based Learning Based Learning Tools to Improve Critical Thinking Skills and Collaboration Skills of Class VIII Students of SMP Negeri 7 Menui Satap".

Methods

This research is R and D research that uses the ADDIE (Analysis, Design, Development, Implementation and Evaluation) development method. The focus is to produce learning tools based on problem based learning for science subjects at SMPN 7 Menui Satap. The analysis stage involves collecting information about subject needs, student competencies, and class VIII characteristics. The design stage includes designing lesson plans and worksheet based on problem based learning, taking into account the structure and function of the circulatory system and its disorders. The development stage involves preparing an initial draft of the product, validation by material experts and media experts, as well as limited trials with students. The implementation phase involves field testing with the entire class to evaluate its effectiveness through pretest and posttest based on One Group Pretest-Posttest Design. Evaluation is carried out to collect responses from teachers and students for further improvement.

This research will be carried out in April-May at SMPN 7 Menui Satap with a population of class VIII even semester students, consisting of 4 boys and 11 girls with an average age of 15 years. The research was carried out over 3 meetings with learning material on the circulatory system, heart and blood vessels, meeting 2 and disorders or abnormalities in the circulatory system in humans, meeting 3. Critical thinking information using 7 essay test questions, collaboration skills using observation sheets. Where is the questionnaire? used with 10 question numbers.

This research uses primary data collected through direct observation at school, as well as secondary data obtained from related books and journals. Data collection techniques include observation, critical thinking skills tests, and the use of questionnaires to measure students' collaboration skills. The research instruments include question-based tests, learning tool assessment sheets, critical thinking skills rubrics, and collaboration skills rubrics, all of which have been validated by experts to ensure their validity.

Analysis of the validity of PBL-based RPP and LKPD products is carried out using a formula that includes

validation results by lecturers and validation sheet instruments.

$$IN_{ah} = \frac{T_{Se}}{T_{Sh}} \; x \; 100\ \% \qquad (1)$$

Information :

IN_{ah} : Expert Validation

T_{Se} : Total Empirical Score Achieved

T_{Sh} : Total Expected Score

Analysis of the practicality of PBL-based RPP and LKPD products involves the use of teacher and student response questionnaires to evaluate the practicality of the product in the learning process. The data from the questionnaire was then analyzed using the formula introduced by Milah et al. (2012).

$$\text{PK} = \frac{Total\ score\ resulting\ from\ data\ collection}{Criterion\ Score} \; x \; 100\ \% \qquad (2)$$

Information :

PK = Percentage of Practicality (%)

Criterion Score = Maximum practicality score

Effectiveness is analyzed through Effect Size to see whether E-LKPD has a big effect on students' critical thinking abilities. Effect size calculated using the formula Cohen's (2007) as follows:

$$S_{of} = \sqrt{\frac{Spre^2 + Spost^2}{2}}$$

Effect Size d can be calculated as:

$$\text{d} = \frac{\bar{d}}{S_{of}} \qquad (3)$$

Information:

S_{of} = Standard deviation of test scores

$\bar{d}$ = Average test score ($M_{Posttest}$ - $M_{Pretest}$)

S_{pre} = Pretest standard deviation

S_{post} = Posttest standard deviation

Spears et al. (2013) states that standard deviation is best for paired designs and also as an option *standardizer* the best is S_{of}. Analysis of students' collaboration skills can be calculated based on the percentage of responses from questionnaires filled out by students regarding the use of RPP and LKPD based on problem based learning. The formula used to calculate the percentage can refer to the method introduced by Sari et al. (2016).

$$\text{V} = \frac{A}{B} \; X \; 100\% \qquad (4)$$

Information :

V = Percentage Value

A = Total Score achieved

B = Maximum Total Score

Analysis of the effectiveness of RPP and LKPD based *problem based learning* done in the following way:

a. Recapitulate the score results from the observation sheet
b. Calculate the average percentage in the following way:

$$\%\ Rating = \frac{Total\ score\ obtained}{Total\ total\ score\ obtained} \times 100\% \qquad (5)$$

c. Determine effectiveness criteria by matching the average percentage of aspects with practicality criteria.

Results and Discussion

The results of research on the development of student worksheets (LKPD) based on problem based learning are described based on the ADDIE development model with five stages, namely analysis, design, development, implementation and evaluation.

Level of analysis

At the analysis stage, data collected from observations of science teachers and class VIII students at SMPN 7 Menui Satap produced several solutions to overcome challenges in learning material about the human circulatory system. These solutions include the application of a problem-based learning model with PBL steps, the use of various learning media such as PowerPoint and other supporting media, as well as the implementation of RPP and LKPD based on problem based learning. Apart from that, the use of high difficulty level (HOTS) questions about the circulatory system was also chosen to increase students' knowledge about blood, heart and blood vessels, as well as to identify disorders or abnormalities in the system. The use of observation sheets is also proposed as a tool to assess students' collaboration skills in this learning context.

These solutions were then evaluated and submitted to the class VIII science teacher to obtain further input regarding their implementation in class VIII learning, especially regarding the material on the human circulatory system. The results of the analysis and input from science teachers indicate that the strategy to be taken is to improve students' critical thinking skills and collaboration skills through the application of problem based learning RPPs and LKPD based on this material.

Planning level

At the design stage, RPP and LKPD based on problem based learning were designed based on the results of observing the needs of students at SMPN 7 Menui Satap. From this observation, it was revealed that the current use of RPP and LKPD does not involve certain learning models such as problem based learning. Learning is still centered on the teacher, causing students to tend to be passive with low interest in learning and motivation, as well as abilities in problem solving and collaboration that still need to be improved. As a result, many students have not reached the KKM, which is around 35%. Apart from that, there was no strong curiosity about the learning material.

Based on these findings, researchers designed lesson plans and worksheet based on problem based learning to improve students' critical thinking and collaboration skills. Analysis of the K13 curriculum shows that the most

appropriate material for developing this skill is the human circulatory system.

This product design includes a description of Competency Standards (SK), Basic Competencies (KD), and Indicators on circulatory system material in accordance with the K13 curriculum. The initial stage of product development involves the initial design of RPP and LKPD based on problem-based learning, with LKPD structured into initial, core and final sections to facilitate active learning and encourage students in problem solving and collaboration.

Development stage

In developing student worksheets (LKPD) based on problem-based learning, the steps begin with finding sources of material about the human circulatory system.

The next process is to collect supporting material to support the development of the LKPD. This development will be carried out between April and May 2024, with LKPD designed to facilitate learning activities based on the approach described by Irawati (2020). This approach includes orienting students to the problem, organizing them to learn, guiding individual and group investigations, developing and presenting the results of work, as well as analyzing and evaluating the problem solving process, and drawing conclusions from learning.

The questions prepared to develop critical thinking skills are based on Ennis's (1995) cognitive theory, covering various aspects such as providing simple explanations, building basic skills, concluding, providing further explanations, and using strategies and tactics in solving problems. Meanwhile, students' collaboration skills refer to the Trilling and Fadel (2009) framework, which emphasizes cooperation, flexibility, responsibility, compromise, and communication of values as important aspects in interaction and cooperation between students.

There are several validation results, namely as follows

a. RPP validation results

The results of the RPP validation on human circulatory system material by experts/validators can be seen in Table 1

Table 1. RPP Validation analysis results

Description	Validator 1	Validator 2
Total score	77	79
Rate-rate	4.53	4.65
Percentage (%)	90.59	92.94
Interpretation	Very Valid	Very Valid

Based on Table 1 above, it can be seen that the validation results for validator 1 obtained an average score of 4.53, a percentage of 90.59% with a very valid category and validator 2 obtained an average score of 4.65, a percentage of 92.94%. with a very valid category. RPPs that have been validated are included in the very valid category, but need to be revised based on suggestions for improvement provided by the validator

b. LKPD validation results

The LKPD created is validated by expert validators. The purpose of this validation is to measure and evaluate the level of validity of the product being developed. The validation instrument uses a scale *Likert.* As for the results of the LKPD validation analysis can be seen in Table 2.

Table 2. LKPD validation analysis results

Evaluation Aspects	Acquired Score	
	Validator 1	Validator 2
Learning	5	5
	5	5
	4	4
Material Contents	5	5
	5	5
	5	5
	5	5
	5	5
	5	5
Suitability of LKPD with problem-based learning steps	5	5
	4	4
	5	5
	5	5
	5	5
	5	5
Appearance	5	5
	5	5
	4	4
	5	5
	5	5
	5	5
Accessibility	4	5
	4	5
	5	4
	5	5
Total score	**120**	**121**
Rate-rate	**4.29**	**4.32**
Percentage (%)	**85.71**	**86,43**
Interpretation	**Very Valid**	**Very Valid**

Based on Table 2 above, it can be seen that the validation results for validator 1 obtained an average score of 4.29, a percentage of 85.71% in the very valid category, validator 2 obtained an average score of 4.32, a percentage of 86.43% in the very valid category. valid, but improvements still need to be made based on suggestions for improvements provided by the validator.

c. Critical thinking skills test validation results

The results of the validation analysis of the critical thinking skills test sheet can be seen in Table 3.

Table 3. Results of critical thinking skills test validation analysis

Description	Validator 1	Validator 2
Total score	66	65
Rate-rate	4.71	4.64
Percentage (%)	94.29	92.86
Interpretation	Very Valid	Very Valid

Based on Table 3 above, it can be seen that the validation results for validator 1 obtained an average score of 4.71, a percentage of 94.29% with a very valid category and validator 2 obtained an average score of 4.64, a percentage of 92.86%. with a very valid category, but improvements still need to be made based on suggestions for improvement provided by the validator. Analysis Results of Collaboration Skills Observation Sheet

The results of the validation analysis of the collaboration skills observation sheet can be seen in Table 4.

Table 4. Results of Validation Analysis of Collaboration Skills Observation Sheet

Description	Validator 1	Validator 2
Total score	89	90
Rate-rate	4.45	4.50
Percentage (%)	89	90
Interpretation	Very Valid	Very Valid

Based on Table 4 above, it can be seen that the validation results for validator 1 obtained an average score of 4.45, a percentage of 89% with a very valid category and validator 2 obtained an average score of 4.50, a percentage of 90% with a very valid category. However, improvements still need to be made based on suggestions for improvements provided by the validator.

d. RPP Practicality Trial Results

The practicality of the RPP through the assessment results from the teacher response questionnaire during the learning process carried out in class VIII. The practical results of the RPP are presented in Table 5.

Table 5. Practical results of RPP

No	Rated aspect	Rate-rate Assessment	Category
1	Introduction	3.72	Practical
2	Core activities	3.60	Practical
3	Closing	3.75	Practical
	Percentage	91.67	Very Practical

Based on Table 5 above, it shows that the practicality value of the RPP is in the very practical category, namely 91.67%. It can be said that lesson plans are very practical to use in learning.

e. Results of Practicality Testing of LKPD from Teacher Responses

The LKPD is assessed by 3 science subject teachers. The purpose of assessing the teacher's response is to determine the practicality of the LKPD in learning. The results of the analysis of teacher responses can be seen in Table 6.

Table 6 Results of analysis of teacher responses to LKPD

Aspects that are assessed	I	II	III
Knowledge Construction	3.00	3.75	4.00
Design	4.00	4.00	4.00
Language	4.00	4.00	4.00
Problem-based learning activities	4.00	4.00	3.60
			96.50% Very Practical

Based on Table 6 above, it can be seen that the results of assessor 1 obtained an average score of 3.80, a percentage of 95% with the category very practical to use, assessor 2 obtained an average score of 4.00, a percentage of 100% with the category very practical to use , and rater 3 obtained an average score of 3.40, a percentage of 85% in the very practical use category.

f. Result of LKPD practicality trial from small group trial

The small group test was carried out by 8 (eight) students. This small group test was carried out at a different school, namely in class VIII at SMPN 4 Menui Satap. This small group test was carried out in different schools because the state of the SMPN 7 Menui Satap school only consisted of 1 class VIII group, by looking at the characteristics of the same students, namely by looking at the SMPN 4 Menui Satap school which had the characteristics of students who had critical thinking skills and collaboration skills. low which is the same as the situation or condition of the characteristics of students at SMPN 7 Menui Satap.

The results of the small group test analysis can be seen in Table 7.

Table 7. Results of Small Group Test Analysis

Description	Results
Total score	262
Rate-rate	3.25
Percentage (%)	90.97
Interpretation	Very Practical

Based on Table 7 above, it can be seen that the small group test results obtained an average score of 3.25 with a percentage of 90.97 in the category of being very practical for use in learning.

Results of the implementation stage

LKPD based product development problem-based learning on human circulatory system material that has been validated by expert validators, and has been tested on small groups, then enters the next stage, namely the application of LKPD products that are tested on large groups or field trials. This field test used one class, namely class VIII SMPN 7 Menui Satap, totaling 15 people. Students learn, then undergo a series of tests, where these tests are carried out to test the effectiveness of the product. There are teachers and students who assess the effectiveness of the product using teacher response questionnaires and student response questionnaires.

Students' critical thinking skills

The critical thinking skills observed in this lesson consist of five aspects, namely: providing simple explanations, building basic skills, concluding, making further explanations, and strategies and tactics.

Students' critical thinking skills are measured from the results of the pretest and posttest critical thinking skills tests. The test questions used consist of seven essay questions. Results of the effectiveness test of LKPD based on problem-based learning on human circulatory system material.

Learning is carried out in Class VIII in 3 meetings includes: the first meeting consists of giving HOTS questions about the human circulatory system (*pre-test*), 3 learning times (first, second and third meetings) with a meeting time of 2 x 40 minutes. The activity begins with teacher direction, conveying learning objectives and conducting basic learnings problem-based learning using LKPD 1 "Blood", at the first meeting, using LKPD 2 "Heart and blood vessels", at the second meeting, and using LKPD 3 "Disorders of the circulatory system in humans" at the third meeting. The final meeting, the third meeting, was in the form of an evaluation (*post-test*) at the end of learning. The results of the LKPD effectiveness test show that after using Student Worksheets (LKPD) based on problem-based learning, the analysis shows an effect size value of 0.95, which indicates a very large effect from using LKPD on student learning outcomes, which shows the effectiveness of using problem-based LKPD based learning in improving the critical thinking skills of class VIII students at SMPN 7 Menui Satap.

These results are consistent with previous research by Fitria et al. (2020), who found that problem based learning LKPD was able to improve students' high-level thinking skills. The development of this LKPD helps students master learning concepts better. The greatest improvement was seen in the aspects of asking simple questions and building basic skills from the first to the third meeting, indicating that students were increasingly able to formulate appropriate hypotheses during the learning process. This is caused by the problem-based learning LKPD learning device which encourages students to think critically and develop hypotheses based on observations and data analysis.

The lowest increase occurred in the aspect of making further explanations from the first to the third meeting. Although there is improvement, it is relatively lower compared to other aspects of critical thinking skills. This is because students need more practice and guidance in developing these skills.

Student collaboration skills

Students' collaboration skills are measured using an observation sheet with 10 assessment aspects, which have been validated by experts. The assessment is carried out by comparing the overall percentage scores obtained by class VIII students from the first to the last meeting. Data results on students' collaboration skills can be seen in Table 8.

Table 8. Description of student collaboration skills score

Description	Class VIII		
	P1	P2	P3
Total Shoes	378	456	541
Rate-rate	2.52	3.04	3.61
Percentage (%)	63.00	76.00	90.25
Interpretation Category	Effective enough	Effective	Very effective

Based on Table 8, it can be seen that the average score of students' collaboration skills increased from the first meeting to the third meeting. At the first meeting, the average score was 2.52 with a percentage of 63.00%, at the second meeting it increased to 3.04 with a percentage of 76.00%, and at the third meeting it increased further to 3.61 with a percentage of 90.25 %. This analysis shows that the use of problem based learning LKPD on human circulatory system material is effective in improving students' collaboration skills.

Improvement occurred from the first meeting to the third meeting. This shows that there was a significant improvement during learning. This increase was caused by the use of problem based learning LKPD which encouraged students to collaborate and work together.

Evaluation

The final stage of developing this LKPD is an evaluation to assess the feasibility of problem based learning LKPD based on the results of response questionnaires from teachers and students. The success of developing this LKPD is measured from the feedback provided by students through the questionnaires they fill out.

Results of teacher response questionnaire analysis

The success of developing the LKPD is also assessed based on the feedback provided by teachers through the questionnaires they fill out. The results of the teacher response questionnaire analysis are displayed in Table 9.

Table 9. Results of analysis of teacher responses to LKPD

Description	Appraiser 1	Appraiser 2	Appraiser 3
Total score	38	40	34
Rate-rate	3.80	4.00	3.41
Percentage (%)	95	100	86
Interpretation	Very effective	Very effective	Very effective

Based on Table 9, the results of the average teacher responses show that rater 1 got an average score of 3.80 with a percentage of 95%, rater 2 got an average score of 4.00 with a percentage of 100%, and rater 3 got an average score 3.41 with a percentage of 86%, all in the very effective category. This indicates that LKPD based on problem based learning on human circulatory system material is very effective for use in learning.

Results of student response questionnaire analysis

At the final stage of developing the LKPD, an evaluation was carried out to assess the feasibility of the LKPD based on problem-based learning from the students' perspective. The success of developing this LKPD is measured from the feedback given by students through the questionnaires they fill out. The results of the analysis of student response questionnaires are presented in Table 10.

Table 10. Results of student response questionnaire analysis

Description	Results
Total score	544
Average score	3.63
Percentage (%)	90.75
Interpretation	Very effective

Based on Table 10, the average score for student responses shows 3.63 with a percentage of 90.75%, which is included in the very effective category. This shows that LKPD based on problem based learning on human circulatory system material is very effective for use in learning.

Developing LKPD based on problem based learning using the ADDIE model

This research aims to develop a product in the form of a problem based learning (PBL) based worksheet on human circulatory system material to improve students' critical thinking and collaboration skills. This LKPD is prepared based on core competencies, basic competencies, competency achievement indicators, and includes the syntax of the PBL learning model. LKPD is also equipped with learning objectives, activity instructions, practice questions, and a bibliography. It is hoped that the LKPD developed can help students in the learning process in the classroom. This research uses the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation.

Level of analysis

The results of research on the application of problem based learning LKPD to class VIII students show that this method is effective in training students' critical thinking skills and collaboration skills. Data analysis shows that there is a need for innovative solutions in learning material about the human circulatory system. This solution includes the use of learning models that train critical thinking and collaboration skills, as well as supporting media such as PowerPoint, problem based learning-based LKPD, and HOTS (Higher Order Thinking Skills) questions. Based on input from the class VIII science teacher, the solution chosen was to train critical thinking and collaboration skills using problem based learning LKPD.

This research is in line with several previous studies which emphasize the importance of problem based learning in increasing students' understanding of scientific concepts. For example, research by Rizani et al. (2022) concluded that problem based learning can improve students' analytical and problem solving abilities compared to traditional learning methods. In this context, the use of problem based learning LKPD supports the development of critical thinking skills and collaboration skills by giving students the opportunity to be actively involved in the discovery and exploration of the concept of the human circulatory system.

In addition, the use of learning media such as powerpoint, learning tools, and HOTS questions also enriches the learning process. According to research by Redhana (2019), the use of media and learning tools can improve student understanding because it helps visualize abstract concepts. Collaboration skills are also an important component of learning in the classroom. As expressed by Hayati (2020), students' understanding can increase when they are actively involved in learning that is relevant to their daily lives.

Design stage

At this stage, the researcher prepared a problem based learning worksheet using the Canva application, which consisted of three parts: the beginning, the core and the end. The initial part includes a cover page, core competencies, basic competencies, competency achievement indicators, learning objectives, and instructions for use. The core section contains LKPD 1

(Blood), LKPD 2 (Heart and blood vessels), and LKPD 3 (Disorders of the circulatory system in humans), which are arranged according to the steps of problem-based learning (PBL). The final section contains practice questions and a bibliography. Attractive LKPD designs with colorful colors and QR or Barcode technology improve the critical thinking and collaboration skills of class VIII students at SMPN 7 Menui Satap.

The design of LKPD using the problem based learning (PBL) model is supported by many studies that show its effectiveness in improving critical thinking and collaboration skills. For example, research by Wahyuni et al. (2021) shows that PBL can improve students' high-level thinking abilities. However, research by Yusuf (2023), highlights that the success of PBL is highly dependent on the level of guidance provided. Without adequate guidance, students may experience confusion, which can hinder their learning.

While this design exhibits many advantages, there are several disadvantages worth noting. One is the lack of emphasis on personalized learning. Research by Zhang and Basham (2020) emphasizes the importance of personalization in learning to meet students' individual needs. LKPD that is designed in general may not fully meet the needs of every student, especially those who have different learning styles and speeds. In addition, comprehensive and ongoing evaluation needs to be implemented to ensure that learning objectives are achieved effectively, as suggested by Magdalena et al. (2023).

Development stage

The results of research regarding the development of problem based learning LKPD using the ADDIE model show good validity and practicality based on validation results, teacher response questionnaires and trials. The average validation score for the LKPD product reached 86.43%, indicating that the LKPD design meets the standards required for use in learning. This validation includes aspects of material relevance, clarity of instructions, and suitability to learning objectives. Prasetya's research (2022) confirms that clear and relevant instructions are very important in problem-based learning. Although there is a need for revision, this indicates there is room for improvement, especially in clarifying instructions or increasing the relevance of the material to the learner's context.

The practicality test in a small group showed very practical results, with a score of 90.97%. This shows that this LKPD is easy to use and understand by students. These results emphasize that practicality is an important factor in implementing problem-based learning, where students must feel comfortable and be able to follow instructions without significant difficulties (Safitri et al., 2024).

The teacher's response to this practical LKPD reached a score of 3.85, indicating that teachers consider this LKPD to be an effective and easy to use tool in teaching. Support from teachers is very important in successful implementation in the classroom, as highlighted by Zhang and Basham (2020), who emphasize the importance of teacher involvement in technology-based learning and new methods. However, it is important to ensure that teachers have received adequate training to make optimal use of these LKPD.

Implementation stage

The results of data analysis regarding critical thinking skills show that the pretest and posttest questions as well as the collaboration skills observation sheet show very good results. The effect size value is 0.95, which indicates a very large effect from the use of LKPD on student learning outcomes. This shows that LKPD based on problem-based learning is effective in developing these two skills in students.

Based on the results of this analysis, the LKPD developed can be considered valid and suitable for further use with an average validation percentage reaching 86.43%. The advantages of this development include a high level of validity and practicality, as well as a positive response from teachers to its use. However, there is a need for revision in several aspects, such as clarifying instructions or increasing the relevance of the material to the learner's context. Other challenges include potential difficulties in implementation without adequate guidance, which must be addressed to increase learning effectiveness.

The effectiveness test was carried out by evaluating students' critical thinking skills through pretest and posttest in class VIII SMPN 7 Menui Satap. The resulting effect size value is 0.95, which indicates a very large effect from using LKPD, indicating that the use of LKPD based on problem based learning is very effective in improving critical thinking skills compared to conventional LKPD.

The use of observation sheets to measure collaboration skills showed a significant increase from the first to the third meeting, with the percentage increasing from 63.00% to 90.25%, indicating that problem-based learning LKPD is also very effective in improving students' collaboration skills.

Evaluation stage

Evaluation in developing LKPD based on problem-based learning is carried out formatively and summatively. Formative evaluation is carried out at each development stage using the ADDIE model. The analysis stage includes evaluation of the curriculum, student characteristics, learning materials, and learning objectives to ensure

conformity with the LKPD being developed. At the design stage, evaluation is carried out by ensuring that the product being developed complies with the problem-based learning syntax. The development stage involves evaluation based on input from validators to make necessary improvements.

Summative evaluation is carried out at the final stage to evaluate the effectiveness of the LKPD. This evaluation involves collecting feedback and responses from teachers and students through completed questionnaires. The results of the analysis showed that the teacher responses from the three assessors showed very effective percentages, namely 95%, 100% and 86%. Meanwhile, student responses reached 90.75%, also in the very effective category. This shows that LKPD based on problem-based learning with a problem based learning model on the human circulatory system material is effective in improving the critical thinking and collaboration skills of students in class VIII SMPN 7 Menui Satap.

This finding is consistent with previous research which shows that the use of problem-based learning can significantly improve students' critical thinking and collaboration skills compared to conventional learning methods. Studies by Fiorella (2023) and Barz et al. (2024) supports these findings, confirming that the problem-based learning approach provides opportunities for students to be actively involved in learning.

Continuous evaluation needs to be carried out to ensure that these LKPD remain relevant and effective in diverse learning contexts, as well as to identify areas that need improvement in subsequent implementation.

Conclusions

Based on the results of the research that has been carried out, it can be concluded that the development of learning tools based on problem based learning on human circulatory system material for class VIII students at SMPN 7 Menui Satap is very valid with a percentage of 86.43%. This device is also considered very practical based on teacher responses which reached 96.50% and student responses of 90.97%. Effectively, this learning tool is able to improve critical thinking skills with pretest and posttest results showing an increase from an average score of 40.00 to 78.00, as well as a effect size of 0.95, which indicates a very large effect. Apart from that, this tool is also effective in improving students' collaboration skills with scores for each meeting increasing gradually from the first to the third meeting. This confirms that this problem-based learning tool has a significant effect in improving students' critical thinking and collaboration skills.

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Conflict of interest

The authors declares that there is no conflict of interest in this research. All parties involved have given their consent and contributed without any bias or influence that could affect the research results.

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