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Research Article

Development *of Problem-Based Learning*-Oriented Student Worksheet to Improve *High Order Thinking Skills* in Magnet Material in Elementary Schools

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ABSTRACT

This study aims to develop a *Problem-Based Learning*-oriented worksheet to improve students' higher-order thinking skills in magnetics at elementary school. The research subjects were 23 fourth-grade students at SDIT Pelita Khoirul Ummah. The development stages used the ADDIE model, which consists of five steps: *analyze, design, development, implementation, and evaluation.* The research data types used were quantitative and qualitative. This product was tested using a *Likert scale* scoring system. The data analysis technique for product effectiveness used *the N-gain score*, with a *pre-test* score *of 71.04* in the high category and a *post-test* score of *88.39* in the high category. The conclusion of this research on the development of *Problem-Based Learning-based* worksheets in elementary schools is that they are suitable for use in improving the higher-order thinking skills of fourth-grade elementary school students.

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INTRODUCTION

Education is one aspect of developing students' potential, the realization of which must be able to respond to the needs and challenges of the nation. The development of students' potential cannot be separated from the learning process that can develop students' skills and thinking abilities. The learning process currently held in schools is based on the curriculum. The curriculum currently being developed is the independent curriculum. The independent curriculum requires students to be independent by not compartmentalizing learning concepts, both inside and outside of school, and this curriculum can also provide a platform for teachers and students to be creative (Manalu, J.B., et al, 2022). One-way learning, commonly referred to as *student-centered* learning*,* will have an impact on the potential for developing students' thinking processes (Yusrizal et al, 2017). This factor will result in low student activity in developing their thinking skills.

This requires teachers to change the concept of student thinking processes. Teachers should not only provide information to students but also create learning that focuses on students' cognitive processes so that they are able to understand concepts in depth in developing higher-level thinking skills (Astuti, S. et al., 2018). This learning process is in line with the constructivist learning theory, which is used to build their own understanding based on realistic experiences in their surroundings. According to Badar (2014), in constructivist theory, students must discover and transform information themselves, check new information, and connect it with the information they already have. Therefore, in the context of learning theory, all views that provide opportunities for students to actively build their own knowledge and skills using their prior knowledge are part of the constructivist learning theory.

In the constructivist learning paradigm, presentations in the form of simulations of problems that occur in the field can be used (Harper et al., 2000). Problem-based learning is very effective in supporting *student-centered* learning processes. Learning that presents contextual problems in the surrounding environment can construct students' understanding in supporting higher-order thinking skills. In the learning process, educators pay less attention to learning activities that spark higher-order thinking skills. Choosing a learning model that suits the characteristics of students will be very effective in improving higher-order thinking skills in constructing students' curiosity in finding solutions to problems. According to Hamruni (2012), problem-based learning has advantages in developing students' higher-order thinking skills in adapting to new knowledge because it helps transfer their knowledge to understand real-world problems. Problem solving is carried out through collaboration and using higher-order thinking skills, namely analysis, synthesis, and evaluation or discovery in order to solve a problem.

The characteristics of *high-order thinking* skills (HOTS) in research journals (Widana, 2017) include problem-solving skills, higher-order thinking skills, creative thinking, opinion-forming skills, and decision-making skills. According to Sofyatiningrum, et al., (2018), the characteristics of *high order thinking skills* (HOTS) include *analyzing, evaluating, creating, critical thinking,* and *problem solving.* Therefore, educators must be accustomed to teaching students to understand and solve complex problems. One learning model that can develop students' *high-order thinking skills* (HOTS) is the *problem-based learning* (PBL) model. According to Kamdi (2017) in the research by Royantoro, Mujasam, Yusuf, & Widyaningsih (2018), the *problem-based learning* (PBL) model involves students in solving problems in accordance with the stages of the scientific method, so that students' *high order thinking skills* (HOTS) can be developed.

The purpose of the *problem-based learning* (PBL) model is to improve the ability to apply concepts to new or real problems, integrate high-order thinking skills (HOTS), increase motivation to learn, guide self-learning, and improve skills (Ariyana, Pudjiastuti, Bestary, & Zamroni, 2018, p. 32). *High*-order thinking as one aspect of *high-order thinking skills* is a process of searching for, producing, analyzing, collecting, and conceptualizing information as a reference with personal

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awareness and the ability to enhance creativity (Yildirim and Ozkharaman, 2011; Putri et al., 2021). One of the subjects that requires high order thinking skills (HOTS) is science. The science learning process emphasizes providing direct experiences to develop competencies in exploring and understanding the natural world. According to the Ministry of Education and Culture (Depdiknas) 2006, science has four elements, namely attitude, process, product, and application. The connection between higher-order thinking in science learning is the need to prepare students to become resilient problem solvers, mature decision makers, and people who never stop learning (Fahmi, 2020). Therefore, higher-order thinking is an integral part of the transformation carried out in science learning.

Implementing *the problem-based learning* model requires a support system that supports learning as a learning resource or learning medium, one of which is by developing Student Worksheet. Based on the development of Student Worksheet in schools, there are several findings, namely that Student Worksheet is not yet able to support the stimulation of higher-order thinking skills and is not appropriate for use in *the problem-based learning* model. Student Worksheet can be used as a guide for educators and as a form of learning activity for students. Student Worksheet is defined as printed teaching materials in the form of sheets of paper containing materials, summaries, and instructions for learning tasks that must be carried out by participants with reference to the Basic Competencies that must be achieved (Prastowo, 2011). Student worksheet based on the *problem-based learning* model is expected to be able to improve high-level critical thinking in elementary school students.

Observations and interviews conducted with students and educators at SDIT Pelita Khoirul Ummah revealed that the Student Worksheet used by students did not guide them to solve problems in their immediate environment because the Student Worksheet used was not yet tailored to students' needs. In addition, the Student Worksheet used in schools has not been able to improve high-level critical thinking, nor has it been able to facilitate differences in students' learning styles (Effendi, R., 2021). Given the importance of Student Worksheet in teaching and learning activities, it is necessary to pay attention to its quality in terms of content, design, media, and development methods. Through *problem-based learning-based* Student Worksheet, high-level thinking in learning can be improved, and the delivery of lesson material can be made easier by using Student Worksheet.

Student learning completeness is determined by the achievement of learning, where students are required not only to master concepts but also to be able to implement these concepts in the form of work that can be used to solve problems that arise in life (Astuti, S. P. 2022). The refore, the learning outcomes used to develop the Student Worksheet are phase B learning outcomes with the theme of magnets. It is hoped that these learning outcomes can achieve the learning objectives. In phase B, students are introduced to a system of interconnected elements that operate according to certain rules to perform specific functions, particularly those related to how nature and social life are interrelated in the context of diversity. Students take action, make decisions, or solve problems related to everyday life based on their understanding of the material they have learned.

The analysis of the *problem-based learning-based* student worksheet development model to improve *high-order thinking skills (HOTS)* uses the ADDIE (*analyze, design, development, implementation, and evaluation)* development model (Amelia & Abdurrohman, 2021). The purpose of this analysis is to analyze the needs of student worksheet that are in accordance with the *problem-based learning* model to stimulate students' *high-order thinking skills*. The analysis was carried out in terms of curriculum, learning resources, characteristics of educators and students, and needs.

METHOD

The research method used in this study is development research. Sugiyono (2016) states that research and development have the function of developing and validating products. This study

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developed a product in the form of *a Problem-Based Learning-based* Student Worksheet to improve *High Order Thinking Skills (HOTS)* in Magnet Material in Elementary Schools. This product is teaching material for students, with content focused on basic competencies in natural sciences, namely "magnetism." This research uses the ADDIE development model. Based on (Amelia & Abdurrohman, 2021), the steps that can be implemented in the development of this media consist of five stages, including (1) *Analysis,* (2) *Design,* (3) *Development,* (4) *Implementation,* (5) *Evaluation (*Amelia & Abdurrohman, 2021). The description in this study is as follows:

1. *Analysis* is the initial stage carried out by researchers to analyze problems and needs, thereby determining whether or not it is necessary to develop Student Worksheet based on *Problem-Based Learning* (Apriliani & Radia, 2020). In addition, the researchers reviewed theories or studies related to student worksheet concepts, analyzed the Learning Outcomes and Learning Objectives (TP) to be achieved in order to improve *High Order Thinking Skills (HOTS).*
2. *Design:* In this stage, the researcher develops a draft product, the result of which is a prototype of *a Problem-Based Learning-based* Student Worksheet.
3. *Development*: This stage involves several steps, including planning Student Worksheet based on *Problem Based Learning*. Researchers must design it in detail to avoid misunderstandings when delivering the material. The development of Student Worksheet based on *Problem Based Learning* is also tailored to the characteristics of the students. At this stage, validation activities are also carried out by language, material, and media experts to determine whether the product is suitable and feasible for use.
4. Implementation *of Problem-Based Learning*: After refining the product, researchers must retest the developed product to determine its level of success and suitability. Practicality tests are conducted on fifth-grade students in elementary school. Next, the effectiveness of *Problem-Based Learning*-based Student Worksheet is tested to observe students' *High Order Thinking Skills (HOTS)*. At this stage, empirical product testing was conducted using *a One Group Pretest-Posttest Design,* which is a form of *pre-experimental* research method. This design uses one group.
5. *Evaluation,* refinement of the product results of field testing, to improve product deficiencies so that it is perfected after being developed and adjusted to real conditions in the field based on product testing.

Research Design & Procedures

Data analysis of the results of expert validation, namely media experts, language experts, and material experts, as well as assessment instruments and question validation sheets, was carried out using the following Aiken index formula:

$$V = \frac{\sum_{i=1}^{n} s_n}{n(c-1)}$$

Explanation:
V : Index of validator agreement regarding item validity
S : Score given by the assessor minus the lowest score in the category
r : The category score chosen by the validator
lo : Lowest score in the scoring category
n : Number of validators
c : Number of categories that validators can choose from

Next, categories are used to determine the validity of Student Worksheet based on the content validity value of V Aiken's, as shown in Table 1 below:

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Table 1. Product Validity Criteria Categories

Score Range	Category
V > 0.8 – 1	Highly valid
$V > 0.6 - 0.799$	Valid
$V > 0.4 - 0.599$	Fairly valid
$V > 0.2 - 0.399$	Less Valid
$V \leq 0.2$	Not Valid

(Suhardi, 2022)

Meanwhile, the average score for each assessment aspect uses the formula (Andi Rustandi & Rismayanti, 2021).

$$Mean\ (\bar{x}) = \frac{\sum x}{N}$$

Explanation:

$\bar{x}$: Skor rata-rata
$\sum x$: Jumlah Total Skor
N : (Indikator × Responden)

Meanwhile, to read the data on the practicality of the assessment responses of educators and students, a *Likert* scale is used with the scoring criteria as shown in Table 2 below.

Table 2. Practicality Categories for Educators and Students

Feasibility Scale	Category
80%, x ≤ 100%	SB
60%, x ≤ 80%	B
40%, x ≤ 60%	C
20%, x ≤ 40%	D
00%, x ≤ 20%	E

Key: *A (Excellent), B (Good), C (Fair), D (Poor), E (Very Poor).* (Purwanto, 2013)

The effectiveness of Student Worksheet based on *Problem-Based Learning* can be analyzed by administering *pretest* and *posttest* questions to students. The resulting assessment scores serve as a measurement tool for the use of Student Worksheet in science education, to determine students' progress in developing higher-order thinking skills. The formula used for analysis is as follows (Nizaar et al., 2021).

$$g = \frac{(\%\ rata-rata\ posttest) - (\%rata-rata\ pretest)}{100 - \%rata-rata\ pretes}$$

The *N-gain score* category can be determined based on the N-gain value in the form of a percentage. The division of the N-gain score category (Nizaar et al., 2021) can be seen in Table 3 below**:**

Table 3. N-gain Criteria

Criteria for Gain Improvement	Normalized Score
g-High	$g \geq 0.7$
g-Medium	$0.7 > g \geq 0.3$
Low g	$g < 0.3$

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Variables

The study is divided into independent and dependent variables. The independent variable (X 1) is the use of the Problem-Based Learning model. Meanwhile, (Y1) is the effort to improve students' higher-order thinking skills. The data source for variable Y1 is the effort to improve students' higher-order thinking skills based on the development of Student Worksheet using *the Problem-Based Learning model*.

RESULT AND DISCUSSION

This research was conducted with an analysis stage or preliminary study to analyze the initial conditions, including field needs analysis and Learning Achievement and Learning Objective Mapping analysis, as well as student needs analysis in grade VI at SDIT Pelita Khoirul Ummah. This analysis stage was carried out by interviewing fourth-grade teachers at SDIT Pelita Khoirul Ummah. The interviews were conducted by asking questions related to the curriculum, approach, methods, strategies, and materials that were difficult for students to understand. Based on the interview results, it was found that the science subject that was currently difficult for students to understand was magnets. Therefore, the researcher developed worksheets that focused on the subject of magnets using a *problem-based learning* approach. The analysis aimed to provide an overview and analysis results that could be used as guidelines in product development to suit the needs in the field. Based on the initial analysis, it was found that educators already use Student Worksheet in the learning process, but its use is not yet optimal. The Student Worksheet that has been developed does not yet support the needs of students as it only contains questions that students must answer. The Student Worksheet is not very interesting and is not interactive.

The second stage is design, which includes the preparation of *a Problem-Based Learning*-oriented worksheet framework with a display and the design of assessment instruments. These worksheets are designed using the *Canva Pro* application, printed on A4 paper, and with image quality that attracts the attention of students. The objective of this stage is to design the initial product, validity and practicality assessment instruments based on the Student Worksheet specifications analyzed in the previous stage. The results of the *problem-based learning-oriented* Student Worksheet design can be seen in the image below.

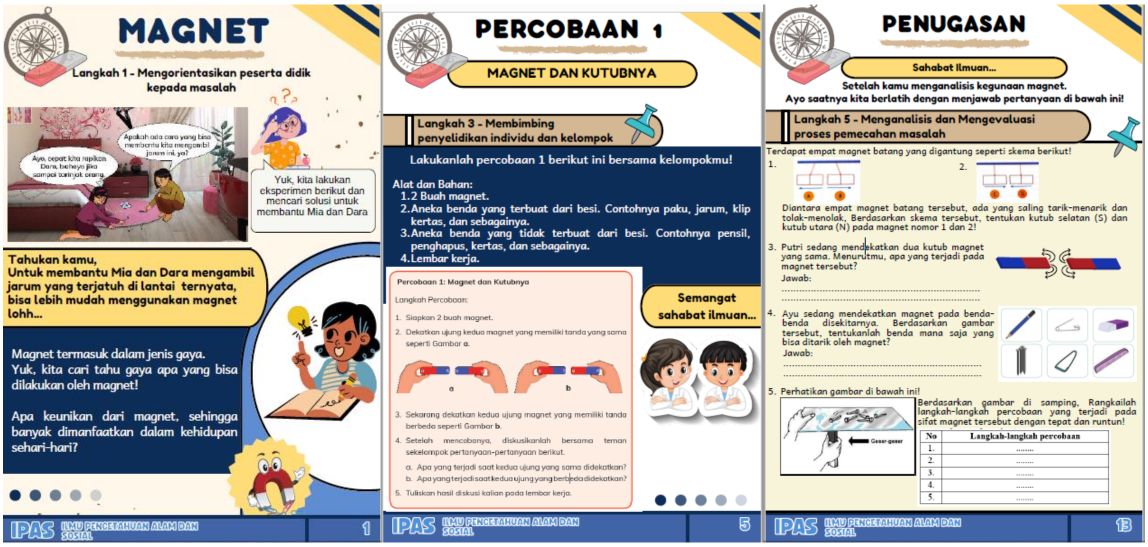

Figure 1. Appearance of *problem-based learning* student worksheet

The Student Worksheet display is a *problem-based learning-based* Student Worksheet that has been improved/revised. The student worksheet is teaching material developed to see improvements in students' higher-order thinking skills.

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In the third stage of development, this Student Worksheet was developed in accordance with the needs of students on magnet-oriented material based on *problem-based learning.* This stage was carried out to validate the *Problem-Based Learning-based* student worksheet product by 9 validator lecturers consisting of 3 material experts, 3 media experts, and 3 language experts. The testing was used to assess the validity of the *Problem-Based Learning-based* Student Worksheet, followed by improvements based on input and suggestions from the validators before the product was field-tested. The results of the validation by subject matter, media, and language experts on *the Problem-Based Learning-based* Student Worksheet can be found in the table below.

Table 4. Results of Content Expert Validation

Aspects evaluated	Score Range	Category
Curriculum	0.8452	Highly valid
Content suitability	0.8125	Highly valid
Average	**0.8278**	**Highly valid**

Based on Table 4 above, it can be seen that the overall material validation results obtained *an Aiken Index* of 0.8278 with a very valid category. The data results were obtained based on the curriculum aspect and content feasibility aspect. The curriculum aspect obtained a score of 0.8452, categorized as highly valid, and the content feasibility aspect obtained a score of 0.8125, categorized as highly valid. Therefore, it can be concluded that the results of the material validation in *the Problem-Based Learning*-based Student Worksheet are highly valid and feasible for field testing.

Table 5. Results of Media Expert Validation

Aspects assessed	Score range	Category
Media Design	0.8125	Highly valid
Text	0.8333	Highly valid
Graph	0.8667	Highly valid
Average	**0.8375**	**Highly valid**

Based on Table 5 above, it can be seen that the overall media validation results obtained *an Aiken Index* of 0.8375 with a very valid category. The data results were obtained based on the aspects of media design, text, and graphics. The media design aspect obtained a score of 0.8125, categorized as highly valid, while the text aspect obtained a score of 0.8333, and the graphics aspect obtained a score of 0.8667, categorized as highly valid. Therefore, it can be concluded that the results of the media validation in the *Problem-Based Learning*-based student worksheet are highly valid and suitable for field testing.

Table 6. Language Expert Validation Results

Aspects evaluated	Score Range	Category
Linguistic	0.8106	Highly valid

Based on Table 6 above, it can be seen that the overall language validation results obtained *an Aiken Index* of 0.8106 with a category of highly valid. Therefore, it can be concluded that the language validation results in the *Problem-Based Learning*-based Student Worksheet are highly valid and suitable for field testing.

In the implementation stage, the researcher re-tested the developed product to determine its validity. The practicality test was conducted on 15 fourth-grade students and teachers at SD IT Pelita Khoirul Ummah. Before giving the product, students were given *a pre-test* to determine their initial knowledge, after which the product could be implemented. The next stage was *a post-test* to determine whether there was a difference in learning outcomes before and after using the *Problem-*

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Based Learning-based Student Worksheet. The testing stage used a *Likert* scale. The results of the implementation validator for students and educators can be seen in the table below.

Table 7. Practicality Results of Students

Aspects evaluated	Score Range	Category
Use of student worksheet	85	Very Good
Time Efficiency	68	Good
Student Worksheet Display	85	Very Good
Easy to Implement	81	Very Good
Average	**80**	**Good**

Based on Table 7 above, it can be seen that the practicality results of students on *the Problem-Based Learning-based* Student Worksheet developed as a whole obtained a result of 80% with a good category. The practicality results of educators were based on the aspects of Student Worksheet use, time efficiency, Student Worksheet display, and ease of implementation. In terms of student worksheet usage, the result was 85% with a very good category; in terms of time efficiency, the result was 68% with a good category; in terms of Student Worksheet appearance, the result was 85% with a very good category; and in terms of ease of implementation, the result was 81% with a very good category.

Table 8. Results of Educator Practicality

Aspects evaluated	Score Range	Category
Use of student worksheet	96	Highly Valid
Time Efficiency	90	Very Valid
Student Worksheet Display	100	Highly Valid
Easy to Implement	96	Highly Valid
Average	**96**	**Highly Valid**

Based on Table 8 above, it can be seen that the practicality of educators in the *Problem-Based Learning-based* Student Worksheet developed as a whole obtained a score of 96% with a good category. The practicality of educators was based on the aspects of Student Worksheet use, time efficiency, Student Worksheet display, and ease of implementation. In terms of Student Worksheet usage, the result was 96% in the excellent category; in terms of time efficiency, the result was 90% in the good category; in terms of Student Worksheet appearance, the result was 100% in the excellent category; and in terms of ease of implementation, the result was 96% in the excellent category.

Next*,* the *evaluation* stage was carried out to test the effectiveness of *problem-based learning-based* Student Worksheet to see the improvement in students' higher-order thinking skills through *pre-tests* and *post-tests.* The following are the average *pre-test* and *post-test* results of 23 students in the experimental class, as shown in the table below.

Table 8. Pre-Test and Post-Test Results

Effectiveness Test	Results	N-Gain Score	N-Gain Score %	Criteria	Category
Pre-Test	71.04	0.57	57.39	Moderate	Fairly Effective
Post-Test	88.39				

From the data analysis that has been carried out, it can be said that the use of *Problem Based Learning-based* Student Worksheet has a significant effect on students' higher-order thinking skills. This can be seen from the N-Gain test score data in the moderate category, which is 0.57 with a percentage of 57.39%. The following is a graph of the average *pre-test* and *post-test* results of the students.

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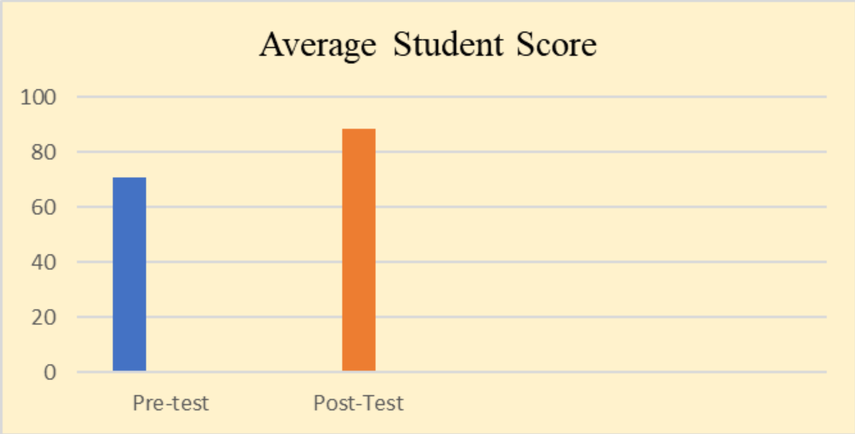

Figure 2. Average *pre-test* and *post-test* results of students.

From the data above, it can be seen that there is a difference between before the treatment (pre-test) and after the treatment (post-test) using *Problem-Based Learning-based* worksheets. This can be proven by the pre-test results of 65 and the post-test results of 85. Thus, it can be concluded that there is a significant difference between before and after the treatment using the *problem-based learning*-based student worksheet.

CONCLUSION

Based on the above discussion, it can be concluded that *Problem Based Learning-based* worksheets can improve *High Order Thinking Skills* in magnetics, as evidenced by the N-gain test, which shows that there is a difference between before and after the treatment using *Problem Based Learning*-based *worksheets.*

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