

Development of Problem-Based Student Worksheets to Improve Students' Numeracy Skills in Managing Household Electricity Usage

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Abstract – Recent changes in Indonesia's education policy, particularly the removal of the National Examination and its replacement with the National Assessment, aim to improve the quality of learning. One of the key components of the National Assessment is the Minimum Competency Assessment (AKM), which evaluates students' literacy and numeracy skills. However, results from the Programme for International Student Assessment (PISA) indicate that Indonesian students' numeracy skills are still relatively low, including those at SMA Negeri 1 Bantarsari, where no significant improvement has been observed over the past two years. This study aims to develop a problem-based Student Worksheet (LKPD) designed to enhance students' numeracy skills in managing household electricity consumption. The research employed a Research and Development approach using the ADDIE model, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. The participants were 12th-grade students at SMA Negeri 1 Bantarsari. The LKPD was validated by content and media experts, and its feasibility was assessed by both teachers and students. The results show that the LKPD received a validity score of 80 percent, indicating that it is highly suitable for use without the need for major revisions. Additionally, positive feedback from teachers and students suggests that the LKPD is effective for problem-based learning and can support the development of students' numeracy skills. Therefore, the problem-based Student Worksheets is expected to serve as an innovative learning resource that enhances the quality of physics instruction and strengthens students' numeracy literacy.

Keywords: Minimum Competency Assessment; numeracy; problem-based Student Worksheets; electrical energy; ADDIE model.

INTRODUCTION

Education policy in Indonesia has undergone continuous change in an effort to improve the quality of learning. One significant change made by the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) is the replacement of the National Examination (UN) with the National Assessment (AN). This reform aims to provide a more comprehensive mapping of education quality in Indonesia and to enhance the process and outcomes of learning within educational institutions. Results from the Programme for International Student Assessment (PISA) indicate that Indonesian students' learning abilities remain relatively low, particularly in primary and secondary

education. According to the OECD survey in 2022, the average mathematics performance score of Indonesian students was 366, far below the OECD average of 472 points.

More specifically, the education quality report at SMA Negeri 1 Bantarsari reveals that students' numeracy skills were still classified in the yellow category in 2022, and there was no significant improvement in 2023. This situation suggests that improving numeracy competence remains a challenge that requires immediate attention. The Minimum Competency Assessment (AKM), as part of the National Assessment, is designed to measure students' foundational skills in reading literacy and numeracy. Numeracy competence is very important because it

helps students solve everyday problems by applying mathematical concepts.

According to Cockroft in Goos, numeracy is the ability to solve practical problems using numbers and mathematical concepts (Goos et al., 2011). Numeracy includes the use of various numbers and mathematical symbols to solve problems in different life contexts, analyze information presented in various formats (graphs, tables, charts, and diagrams), and interpret the results of such analyses for decision-making (Kemdikbud, 2017). Therefore, a learning strategy that can improve students' numeracy competence is required, one of which is problem-based learning (PBL).

Problem-based learning can serve as an innovative solution that links learning material with real-world challenges, such as managing household electricity usage. Through this approach, students are invited to understand and calculate electricity usage, analyze energy consumption patterns, and seek efficient ways to save energy. This approach also encourages students to think critically, work collaboratively, and discuss and share ideas when solving more complex problems. However, implementing problem-based learning requires appropriate learning resources so that educational objectives can be optimally achieved.

One learning resource that can support the improvement of numeracy competence is the Student Worksheet (LKPD). Umbaryati's research shows that LKPD can facilitate the teaching-learning process by building effective interaction between teacher and students, which positively impacts learning outcomes (Umbaryati, 2016). Some research also assert that LKPD based on AKM is valid and practical for implementation in mathematics instruction (Miftah & Setyaningsih, 2022). However, previous research has not extensively developed AKM-based LKPD in the context

of problem-based learning for the subject of physics.

Based on this background, this study aims to develop a problem-based LKPD to improve students' numeracy competence in managing household electricity usage. The results of this study are expected to contribute to the development of learning resources that not only align with the principles of the Merdeka Curriculum but also respond to students' real-world needs, especially in the area of household energy management.

THEORETICAL FRAMEWORK

A. Problem-Based Learning (PBL)

The Problem-Based Learning (PBL) model is a learning approach that uses real-world problems as a context for students to develop critical thinking and problem-solving skills, as well as to acquire essential knowledge and concepts from the learning material. Problem-based learning is applied to stimulate higher-order thinking in problem-oriented situations, including learning how to learn (Maryati, 2018).

The PBL model is designed to encourage students to learn collaboratively by constructing and connecting their existing knowledge and learning experiences with the problems presented by the teacher. In this model, the teacher's role is to present the problem, ask guiding questions, and facilitate inquiry and dialogue (Maryati, 2018).

The PBL model offers several advantages. It provides opportunities to explore multidimensional phenomena from deeper perspectives, thus promoting students' critical thinking and problem-solving skills. It also fosters learners' self-directed and self-regulated learning abilities, enhances social skills, and encourages students to acquire new concepts while solving problems. However, PBL also has

some limitations: teachers may face challenges in adapting their teaching styles, and students may require more time to complete the problem-solving process (Zainal, 2022).

B. Numeracy Competence

Numeracy assessment is conducted to measure students' ability to use mathematical concepts, procedures, facts, and tools (Maryuliana et al., 2016). The measurement of numeracy skills is carried out through problem-solving tasks presented in various relevant contexts. Since the numeracy assessment instrument is still under development, it requires pilot testing to examine its theoretical design and construct validity.

The purpose of developing numeracy assessment is to measure students' thinking ability in applying mathematical concepts, procedures, facts, and tools to solve real-life problems across different contexts. The main components assessed in numeracy competence include numbers, geometry and measurement, data and uncertainty, and algebra.

Numeracy assessment is developed to identify students' numeracy skills as they relate to mathematical proficiency. Moreover, numeracy competence is closely linked to various other fields, particularly science. Science involves the study of natural phenomena through investigation, research, and measurement to clarify cause-and-effect relationships, all of which require numeracy skills. Activities in science help provide evidence needed to answer scientific questions and address real-life problems (Yuanita & Kurnia, 2019).

To measure students' numeracy skills effectively, clear and measurable indicators are required. These indicators encompass three key components, as presented in Table 1 below.

Table 1. Indicator of Numeracy

No.	Indicators
1.	Able to use various numbers and symbols related to basic mathematics in solving everyday life problems.
2.	Able to interpret information presented in various forms (graphs, tables, diagrams, charts, and similar representations).
3.	Able to interpret the results of such analysis to make predictions and decisions.

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C. Household Electrical Energy Management

Electric Power and Electrical Energy

Electric power is defined as the rate at which electrical energy is transferred within an electric circuit. The SI unit of electric power is the watt, which represents the amount of electrical energy flowing per unit of time (joules per second). When an electric current flows through a circuit with resistance, it performs work. Electrical devices convert this work into various useful forms of energy, such as heat (in electric heaters), light (in light bulbs), kinetic energy (in electric motors), and sound (in loudspeakers).

Electrical energy is required by electrical appliances to operate motors, provide lighting, generate heat or cooling, and drive mechanical equipment to produce other forms of energy. The unit of power, 1 joule per second, is referred to as a watt, while electrical energy is expressed in watt-hours (Wh).

The relationship between these units is as follows: $1 \text{ Wh} = 1 \text{ J/s} \times 3600 \text{ s} = 3600 \text{ J}$

$1 \text{ kWh} = 1000 \text{ Wh} = 3,600 \text{ kJ}$.

Electrical energy refers to the ability to perform or produce electrical work—essentially, the capacity needed to move electric charges from one point to another—and is denoted by the symbol W .

One of the common instruments used to measure electrical power consumption is the *APP (Alat Pengukur dan Pembatas)*,

which includes a *kWh meter* and serves as both a measuring device and a current limiter. This device is managed as part of the operational responsibility of the national electricity company (PLN).

D. The Importance of Electrical Energy Management

In residential buildings, managing electricity consumption is a crucial aspect of daily operation. Effective household energy management involves two key steps: Selecting energy-efficient appliances and regulating the use of electrical devices according to needs.

a. Selection of Energy-Efficient Appliances

Many household appliances rely on electricity, and today, numerous manufacturers offer products designed to be energy efficient. It is important to choose energy-saving appliances among the various household devices commonly used. This selection helps reduce overall energy consumption without compromising functionality or comfort in daily activities.

b. Regulation of Appliance Usage

In managing household appliances, these devices can generally be categorized into two types based on their operational patterns: continuous and discontinuous use. For continuously operating appliances, energy conservation can be achieved by selecting devices with appropriate power ratings that match actual household needs. For discontinuously operating appliances, energy savings can be realized by scheduling or alternating their use according to necessity. Proper management and timing of appliance usage not only optimize energy efficiency but also

prevent electrical overloads and extend the lifespan of household equipment.

RESEARCH METHODS

This study employed a Research and Development (R&D) method using the ADDIE development model. This model was chosen because it is systematic and straightforward, making it highly suitable for developing learning materials, particularly student worksheets (LKPD) for physics subjects (Andarwati & Hernawati, 2013). According to (Sari, 2017), the ADDIE model consists of five stages:

Analysis Stage

This stage aims to identify the needs of the school or to obtain an overview of the requirements related to the development of the LKPD.

Design Stage

At this stage, the design of the LKPD is created. It includes several steps, such as product preparation, developing the basic framework of the LKPD, and constructing assessment instruments consisting of validation sheets, student response questionnaires, and teacher response questionnaires.

Development Stage

During this stage, the LKPD design is realized through the process of creating the LKPD and its instruments, followed by expert validation.

Implementation Stage

This stage involves testing the validated and revised LKPD in the classroom.

Evaluation Stage

The final revision of the LKPD is carried out based on feedback and suggestions obtained during the trial phase.

The research subjects consisted of 34 students from Grade XII of SMA Negeri 1 Bantarsari.

The instruments used for data collection in this study included validation

sheets and questionnaires designed to assess the validity and feasibility of the developed LKPD. The aspects evaluated were content quality, presentation, language, didactic elements, construction, technical quality, and media. The validity process involved two expert validators: a material and media expert, Dr. Irma Sukarelawan from the Postgraduate Program in Physics Education, Universitas Ahmad Dahlan (UAD), and a physics teacher from SMA Negeri 1 Bantarsari, Mrs. Siwi Purnamasari, S.Pd.

The data analysis technique for the validity results employed the Likert scale and the Guttman scale formulas. Based on these formulas, the level of validity of the developed LKPD was determined. The feasibility criteria were categorized as follows:

$75\% \leq SP \leq 100\%$	Valid without revision
$50\% \leq SP < 75\%$	Valid with minor revisions
$25\% \leq SP < 50\%$	Not yet valid, requiring major revisions
$SP < 25\%$	Invalid

Meanwhile, the data obtained from the questionnaires were analyzed by calculating

the percentage of each aspect. The formula used for data processing was as follows:

$$PSA = \frac{\text{Selected answer alternatives for each aspect}}{\text{Ideal alternatives for each aspect}} \times 100\%$$

$$PSP = \frac{\sum \text{Percentage of all aspects}}{\sum \text{Number of aspects}} \times 100\%$$

RESULTS AND DISCUSSION

Development of Problem-Based Student Worksheets (LKPD)

The research findings show that the development of the LKPD followed a systematic process in accordance with the ADDIE model. During the analysis stage, students' needs related to numeracy competence in managing electrical energy were identified. The design stage included preparing the basic framework of the LKPD and developing assessment instruments, while the development stage involved creating the LKPD and validating it with material and media experts. The implementation stage was carried out by testing the LKPD with twelfth-grade students at SMA Negeri 1 Bantarsari, and the evaluation stage focused on revising the LKPD based on trial results and feedback from validators and users.

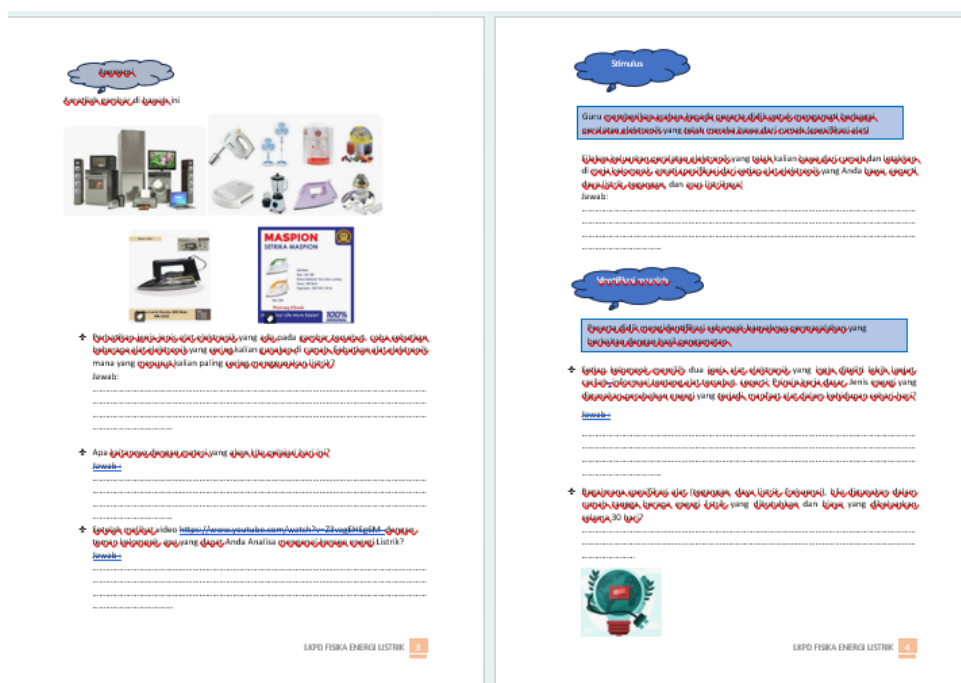


Figure 1. Design of LKPD

Validation of the LKPD by Material and Media Experts

The validation process was carried out by material and media experts to assess the feasibility of the LKPD in terms of content, quality, presentation, language, didactics, construction, technical aspects, and media. Several indicators were taken into consideration, such as the clarity of information in the LKPD, the systematic

structure of the presentation, and the readability and font size that needed slight adjustments to optimize student use. Based on the validation results, the LKPD achieved a percentage score of 80%, which falls into the category of valid without significant revision. This indicates that the developed LKPD meets the eligibility standards as a teaching material suitable for use in physics learning.

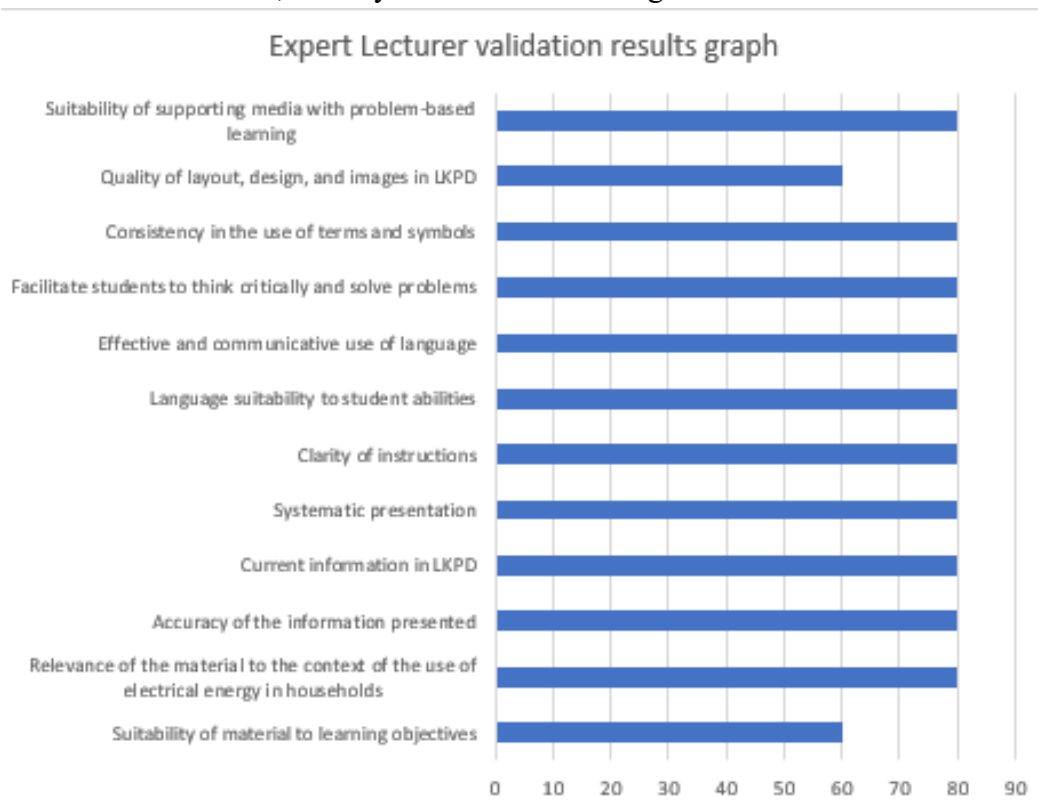


Figure 2. Analysis of expert validation data results

A. Teacher's Response to the LKPD

The teacher's assessment of the LKPD indicated that the material presented was relevant to the learning needs, the information was accurate and comprehensive, and the presentation was well-organized. The teacher also noted that the LKPD helped students better understand the concept of electrical energy usage through numerical analysis. The teacher's questionnaire results showed a feasibility percentage of 80%, which falls into the "highly feasible" category for classroom implementation.

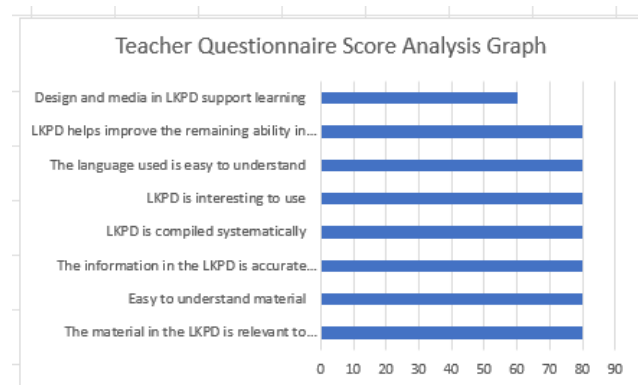


Figure 3. Analysis of teacher questionnaire scores

B. Student's Response to the LKPD

Based on the validity analysis using Aiken's V, which was visualized through a

bar chart, it can be concluded that most aspects of the instrument demonstrated good validity. All aspects scored above 0.75, except for “Design and media support,” which had a value of 0.7375. This suggests that improvements could be made in the

design and media elements to enhance their effectiveness in supporting the learning process. Overall, the instrument was considered sufficiently valid according to Aiken’s V standards.

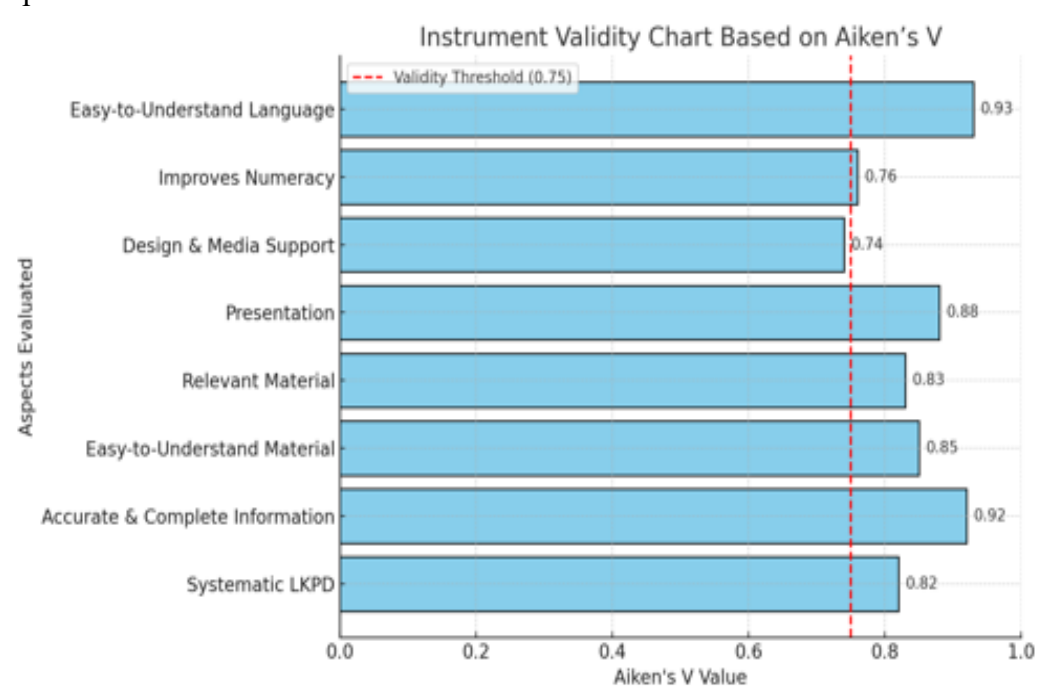


Figure 4. Validity Results of the Student Questionnaire Instrument

LKPD Feasibility Level

Based on data analysis, the developed LKPD achieved a validity level of $\geq 75\%$, placing it in the “valid without revision” category. From the students’ response questionnaire, the LKPD’s effectiveness level also exceeded 76%, which is categorized as “highly feasible.” Therefore, this problem-based LKPD is considered suitable for use in improving students’ numerical competence in physics learning, particularly regarding the use of electrical energy in households.

CONCLUSION

The problem-based LKPD developed through the ADDIE model is designed to enhance students’ numerical competence in managing household electrical energy use. The learning approach guides students to

solve real-world problems, encouraging analytical and practical understanding.

The validation results from material and media experts indicated that the LKPD achieved a feasibility level of 80%, categorized as “highly feasible” for classroom use without significant revisions. In addition, both teacher and student questionnaires showed positive responses, with feasibility percentages above 80%, suggesting that the LKPD is effective for improving students’ numerical understanding of electrical energy concepts.

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