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Development of Project-Based Learning Student Worksheets on Measurement in the Science Curriculum for Seventh-Grade Students at SMP Negeri 1 Ayamaru Utara, Maybrat Regency

Debora Sara Arne*, Mustika Irianti, Endra Putra Raharja

Sains Education, Universitas Pendidikan Muhammadiyah Sorong, Sorong, Indonesia
* Corresponding author: deboarne086@gmail.com

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ABSTRACT

This study aims to develop Project-Based Learning (PjBL)-based Student Worksheets (LKPD) on the topic of measurement for seventh-grade students at SMP Negeri 1 Ayamaru Utara in Maybrat Regency, as well as to determine the feasibility and effectiveness of their use in science education. This study employed the Research and Development (R&D) method using the ADDIE development model, which includes the stages of analysis, design, development, implementation, and evaluation. Data were collected through expert validation sheets, pretest and posttest assessments, and student response questionnaires. The product was validated by subject matter experts and then pilot-tested with 18 seventh-grade students. The validation results showed that the worksheets achieved a feasibility percentage of 82.92%, falling into the "highly feasible" category. The implementation results indicated an increase in students' average learning outcomes from 46.11 on the pretest to 83.33 on the posttest. The average N-Gain value was 0.689, or 68.91%, which falls into the "moderate" category based on the criteria used. Meanwhile, student responses to the worksheets achieved a 100% approval rate, classified as "very high," indicating that the worksheets were considered engaging, easy to understand, and helpful for the learning process. Thus, the PjBL-based worksheets developed are deemed suitable for use and have the potential to enhance students' understanding of measurement concepts through active, contextual, and project-based learning experiences.

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INTRODUCTION

Education is a key component of human resource development because the learning process is not only focused on acquiring knowledge but also on students' ability to apply that knowledge to understand and solve problems in everyday life. In Science education at the junior high school level, students need to gain learning experiences that enable them to observe phenomena, take measurements, process information, and draw conclusions based on evidence. The topic of measurement is a crucial foundational concept because it relates to the ability to use quantities, units, and measuring instruments accurately in various scientific activities. Mastery of this concept serves as the foundation for students to understand more complex science material. However, teaching methods that remain focused on conventional content delivery risk limiting students' opportunities to gain hands-on and contextual learning experiences.

The demands of 21st-century learning increasingly underscore the importance of learning that actively engages students in the process of acquiring and applying knowledge. Skills such as critical thinking, problem-solving, creativity, communication, and collaboration need to be developed through learning experiences that enable students to tackle problems and generate solutions. In this context, Project-Based Learning (PjBL) is a particularly relevant approach because it positions students as the primary agents of their own learning through activities such as investigation, problem-solving, collaboration, and the creation of project products or outcomes. A systematic review by Lestari and Ilhami (2022) indicates that the implementation of PjBL in science education has the potential to develop students' creative thinking skills. These characteristics make PjBL particularly relevant for measurement topics, as the concepts must not only be understood theoretically but also applied through observation and measurement of real-world objects.

One of the learning tools that can be used to implement PjBL is the Student Worksheet (LKPD). The LKPD serves as a learning guide that directs students to carry out learning activities systematically, from understanding the problem, following activity procedures, recording observations, engaging in discussions, to drawing conclusions. Student Worksheets designed using the PjBL framework can provide a clear structure for students to carry out the project stages while also allowing them space to engage in both independent and collaborative activities. Thus, Student Worksheets do not merely function as a collection of questions or exercises but can serve as a tool that integrates content, investigative activities, hands-on experiences, and learning reflections. The use of contextually designed worksheets also has the potential to make learning more engaging and help students connect concepts to situations they encounter in their daily lives.

The need for these activity-based worksheets is becoming increasingly apparent based on the results of preliminary observations at Ayamaru Utara 1 Public Junior High School in Maybrat Regency. The results of observations and interviews with the science teacher, Ms. Marfince Manuputty, S.Pd., indicate that most students still struggle to understand measurement concepts, particularly when applying units of measurement and using measuring instruments accurately. In the learning process, teachers are still limited to using textbooks and worksheets containing questions, while students' opportunities for hands-on practice remain limited. Instruction is also still dominated by lecture-based methods, so student engagement in the learning process is not yet optimal. These conditions indicate a gap between the needs of science learning—which requires hands-on experience—and the learning resources available at the school. Therefore, there is a need for student worksheets that not only present material and questions but also guide students to conduct hands-on measurement activities through systematic project-based steps.

The development of PjBL-based worksheets on measurement is also relevant to the characteristics of seventh-grade students, who require concrete learning experiences when studying science concepts related to observation and measurement activities. In the developed

worksheets, students do not merely read explanations about measurement; instead, they are guided to observe objects in their surroundings, select objects to measure, use simple measuring tools such as rulers or tape measures, record measurement results, compare results across groups, discuss possible differences in results, and draw conclusions. This series of activities provides students with the opportunity to directly experience the measurement process while understanding the importance of using units and measuring tools correctly. Thus, the developed worksheets are oriented toward "learning by doing," rather than merely verbal mastery of concepts. This activity design also supports the characteristics of Project-Based Learning (PjBL), which emphasizes experience, investigation, collaboration, and task completion through a product or piece of work.

Although worksheets and Project-Based Learning (PjBL) have been widely used in science education, there is still room for improvement that needs to be addressed. Some studies on PjBL focus on enhancing creative thinking skills or general learning outcomes, whereas the development of instructional materials that specifically integrate PjBL-based worksheets with measurement concepts for seventh-grade students—particularly in schools where the use of interactive learning media remains limited—still requires further development. This study aims to address this gap by developing worksheets that combine measurement concepts, hands-on activities using simple measuring tools, observations of real objects, group discussions, and the formulation of conclusions within a single project-based learning sequence. Thus, the novelty of this study does not lie in the use of PjBL or worksheets separately, but in the integration of both into a measurement materials learning package designed based on the real needs and conditions of students at SMP Negeri 1 Ayamaru Utara, Maybrat Regency.

Based on these issues and gaps, this study aims to develop Project-Based Learning (PBL)-based worksheets on measurement for seventh-grade students at SMP Negeri 1 Ayamaru Utara in Maybrat Regency, as well as to determine the feasibility of the worksheets, student responses, and changes in learning outcomes following the use of the developed product. The development was carried out using the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The resulting product is expected to serve as a suitable and practical learning tool to help students understand measurement concepts through active, contextual, and project-based activities.

METHOD

This study employed the Research and Development (R&D) method using the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was chosen because it provides systematic development stages ranging from needs identification to the evaluation of the implemented product. The product developed is a Project-Based Learning (PjBL)-based Student Worksheet (LKPD) on measurement for seventh-grade students at SMP Negeri 1 Ayamaru Utara in Maybrat Regency. The research was conducted during the odd semester of the 2024/2025 academic year. The selection of the location was based on the results of preliminary observations, which indicated that PjBL-based LKPDs had not yet been implemented in science instruction at the school and that the teaching of measurement topics still faced limitations in hands-on activities.

The analysis phase was conducted to identify learning needs, student characteristics, learning conditions, and the alignment of the materials with the school's curriculum. The needs analysis was carried out through observations and interviews with 7th-grade science teachers. The results of the analysis served as the basis for determining the characteristics of the worksheets to be developed, particularly the need for instructional materials that could enhance student engagement in hands-on activities and project-based learning. Next, the design phase was carried out by drafting the worksheets based on learning objectives and the characteristics of the measurement material. The worksheets were designed so that students would not only

learn concepts theoretically but also perform measurement activities directly through observing objects, using simple measuring tools, recording measurement results, comparing results, discussing, and drawing conclusions. This design integrates the stages of project-based learning into the worksheet activities.

The development phase involves turning the design into a student worksheet that includes the identity and instructions for use, learning objectives, guiding questions, project descriptions, tools and materials, step-by-step procedures, observation tables, discussion activities, and a section for drawing conclusions. The developed product then undergoes a validation process to assess the appropriateness of the content, the application of PjBL syntax, the clarity of the language, and the comprehensibility of the instructions. According to the research document, the LKPD validation was conducted by subject matter experts, while the pretest and posttest instruments were also validated to ensure the appropriateness of their constructs, language, and content. The validation results and recommendations from the validators served as the basis for revisions before the products were implemented with students. The subject matter expert validation yielded a suitability rate of 82.92%, while the test item validation resulted in a "very good" rating.

The implementation phase was carried out through a pilot test of the PBL-based worksheets with 18 seventh-grade students at Ayamaru Utara 1 Public Junior High School in Maybrat Regency. The pilot test was conducted over three sessions. The first session was used to introduce the activity and administer a pretest to assess the students' initial proficiency in measurement concepts. The second session was used to present the material and apply the PjBL-based worksheets through project-based activities and measurement exercises. The third session was used to administer a posttest and a student response questionnaire. During the implementation, students were guided to actively participate in the worksheet activities, work in groups, conduct observations and measurements, record results, engage in discussions, and draw conclusions.

The evaluation phase was conducted to determine the feasibility of the product, student responses, and changes in learning outcomes following the use of the worksheets. The research data consisted of qualitative data in the form of comments and suggestions from validators, as well as quantitative data in the form of validation scores, student response scores, and pretest and posttest results. Validation and response data were analyzed descriptively using percentages by comparing the scores obtained with the maximum score; the results were then interpreted based on the feasibility categories used in the study. Improvements in learning outcomes were analyzed using the mean pretest and posttest scores as well as the N-Gain calculated using the formula g = (posttest − pretest) / (maximum score − pretest). Based on the available data, the students' average pretest score was 46.11, while the average posttest score was 83.33, with an average N-Gain of 0.68909 or 68.91%. Thus, the N-Gain analysis was used to provide an overview of the improvement in learning outcomes after students used PjBL-based worksheets.

RESULTS AND DISCUSSION

Results of the Development of Project-Based Learning Student Worksheets

The development phase produced Student Worksheets (LKPD) based on Project-Based Learning (PjBL) on the topic of measurement for seventh-grade students at SMP Negeri 1 Ayamaru Utara in Maybrat Regency. The worksheets were developed based on the results of a learning needs analysis and designed to provide a more active learning experience through project-based activities. The LKPDs contain several key components, including instructions for use, learning objectives, guiding questions, project descriptions, tools and materials, procedure steps, observation tables, discussion activities, and a section for drawing conclusions. This structure is designed so that students not only acquire information about measurement concepts but also engage in activities such as observing, measuring, recording,

comparing, and interpreting measurement results directly. The integration of these activities is crucial because the nature of PjBL positions students as active participants in the project completion process, rather than merely as recipients of information. This aligns with the study by Lestari and Ilhami (2022), which shows that PjBL can provide students with opportunities to engage in learning activities that foster critical thinking skills through project-based experiences.

To provide an overview of the characteristics of the developed product, Figure 1 shows the cover of a PjBL-based worksheet on the topic of measurement. The cover includes the product's identification information, learning material, target grade level, and visual elements designed to capture students' attention at first glance.

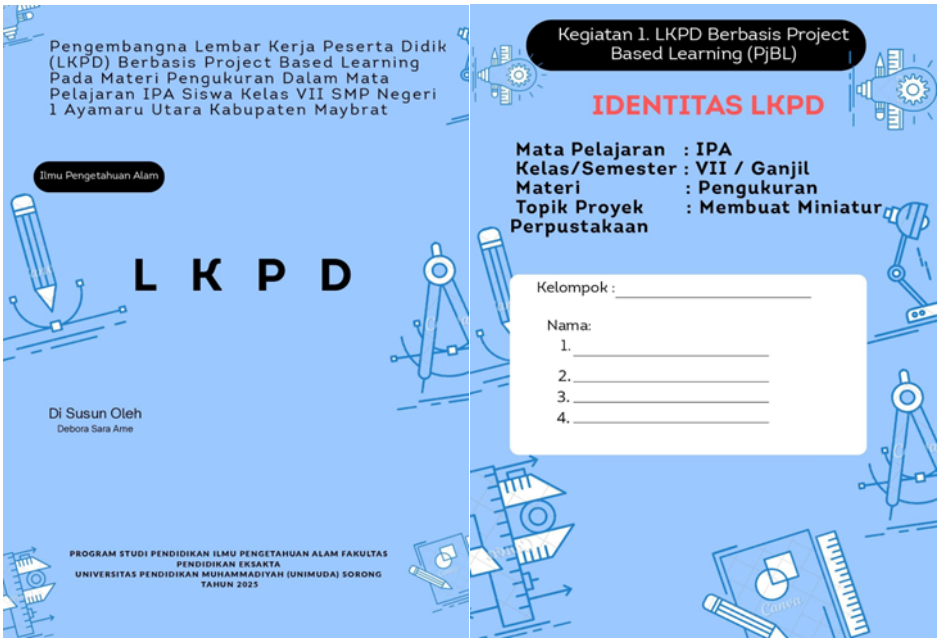

Figure 1. Cover of a Project-Based Learning (PjBL)-based worksheet on the topic of measurement

The cover design is the first element that establishes the identity of the product and creates an impression before students begin the learning activity. The use of visual elements on the cover is intended to make the worksheet more appealing and easily recognizable. However, visual appeal is not the only consideration in product development. The worksheet must also have a clear instructional structure so that students can understand the competencies to be achieved and the activities they must complete. Therefore, following the cover page, the worksheet includes the core competencies, competency achievement indicators, and learning objectives, as shown in Figure 2.

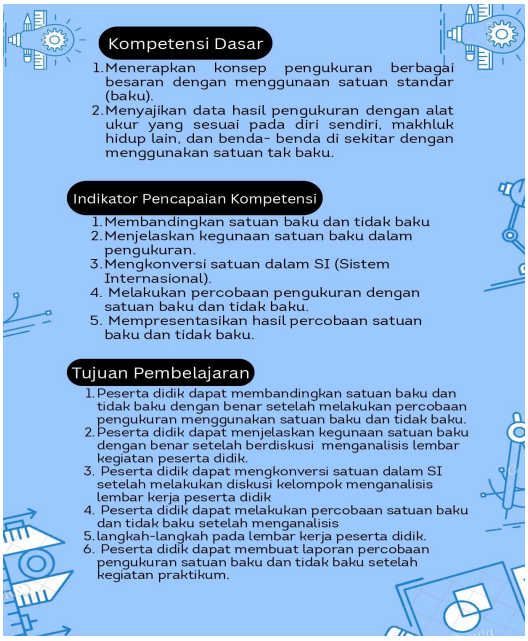

Figure 2. Core competencies, competency achievement indicators, and learning objectives in the worksheet

The inclusion of competencies, indicators, and learning objectives provides clear guidance on the skills expected of students after they complete the activities in the LKPD. These components also help link project activities to the learning outcomes to be developed. Furthermore, the core section of the LKPD is designed as assessment activities that allow students to gain hands-on learning experiences. These activities are illustrated in Figure 3, which shows a learning activity sheet from the LKPD.

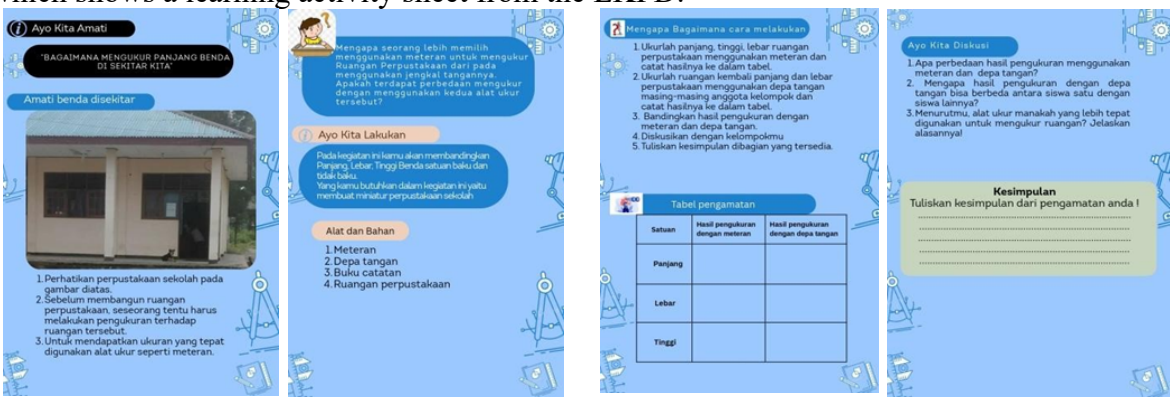

Figure 3. Project-Based Learning Assessment Activity Sheet

This activity sheet guides students to observe objects in their surroundings, use simple measuring tools such as rulers or tape measures, record measurement results, compare data, engage in discussions, and draw conclusions. Thus, the LKPD serves not only as a worksheet but also as a guide for activities that connect concepts with hands-on experiences. This series of activities provides students with the opportunity to build understanding through concrete experiences and collaborative work. These characteristics align with project-based learning, which places investigative activities and task completion at the heart of the learning process.

LKPD Validation Results

Once the product has been developed, the next step is validation to determine the suitability of the LKPD before it is implemented with students. Validation was conducted on the content, Project-Based Learning components, and grammar. The validators' assessment results showed varying levels of achievement across each aspect. To provide a more detailed

overview of these validation results, Table 1 presents the assessment percentages for each aspect.

Table 1. Validation Results of Project-Based Learning-Based LKPD by Subject Matter Experts

Assessment Aspects	Percentage	Category
Content	68.75%	Acceptable
Project-Based Learning	80.00%	Highly Acceptable
Grammar	100%	Highly Acceptable
Overall	82.92%	Highly Acceptable

Based on Table 1, the content aspect received a score of 68.75% and was categorized as "acceptable"; the Project-Based Learning aspect received 80% and was categorized as "highly acceptable"; and the grammar aspect received 100% and was categorized as "highly acceptable." Overall, the worksheet received an acceptability score of 82.92% and was categorized as "highly acceptable." These results indicate that the product possesses adequate quality in terms of content, PjBL syntax integration, and language usage. The highest percentage in the grammar aspect indicates that the instructions and descriptions in the worksheet are considered easy to understand, while the 80% score in the PjBL aspect indicates that project-based learning elements have been well integrated into the product. Meanwhile, the 68.75% score in the content aspect indicates that the substance of the material remains the area with the greatest potential for improvement.

The validation results also yielded several recommendations that served as the basis for revising the product. One of the main recommendations was the need to clarify the work steps and add time estimates for project activities. These revisions were made so that students would receive clearer guidance regarding the sequence of activities and the time allocated for completing the project. The changes to the product before and after the revisions are shown in Table 2.

Table 2. Revisions to the LKPD Based on Validator Feedback

No.	Validator Feedback	Follow-up Action
1	A schedule and time allocation should be provided to assess the use/effectiveness of the LKPD	A schedule and time allocation were added to each activity
2	The LKPD can be used with revisions	Revisions were made before the LKPD was used in the pilot test

Based on Table 2, revisions to the product were aimed at improving the clarity of procedures and the management of activity time. The addition of time allocations is important because PjBL activities consist of several stages that must be carried out sequentially. With a time breakdown, students can understand the completion targets for each activity, while teachers have a reference for managing the learning process. Thus, the validation in this study not only produced a feasibility score but also provided practical feedback used to improve the product's readiness before the implementation phase.

Validation of the Pretest and Posttest Instruments

In addition to validating the worksheet products, the instruments used to measure learning outcomes were also validated before being implemented. The validation covered the aspects of item construction, language, and content. The evaluators' assessment results showed that the instruments received very good ratings in most aspects. Details of the instrument validation results are presented in Table 3.

Table 3. Validation Results for the Pretest and Posttest Instruments

Evaluation Aspect	Percentage	Category
Item construction	100%	Very good
Language	90%	Very acceptable

Content	100%	Very good
Overall	100%	Very good

Table 3 shows that the item construction aspect scored 100%, the language aspect scored 90%, and the content aspect scored 100%, while the overall result was recorded at 100% with a "very good" category. These results indicate that the instrument has been evaluated as appropriate in terms of item construction, language use, and content suitability. Instrument validation is crucial because pretest and posttest data serve as the basis for assessing changes in students' learning outcomes after using the worksheets. With an instrument that has undergone the validation process, the interpretation of changes in scores becomes more reliable in terms of the alignment of the instrument's content with the learning objectives.

Implementation of the Worksheets and Student Learning Outcomes

After undergoing validation and revision, the worksheets were implemented with 18 seventh-grade students at SMP Negeri 1 Ayamaru Utara in Maybrat Regency. The implementation took place over three sessions, including the administration of a pretest, the delivery of instruction using PjBL-based worksheets, and the administration of a posttest and a student response questionnaire. This series of activities has already been described in the Methods section; therefore, the trial schedule table from the original manuscript should be moved to the Methods section to avoid repetition.

To determine changes in student learning outcomes, pretest and posttest scores were compared and analyzed using N-Gain. The results of the calculations based on individual student data are presented in Table 4.

Table 4. Students' Pretest, Posttest, and N-Gain Results

Indicator	Results
Number of students	18
Pre-test average	46.11
Post-test average	83.33
Average difference	37.22
Average N-Gain	0.689
N-Gain (5)	68,9%

Based on Table 4, the students' average pretest score was 46.11, which then increased to 83.33 on the posttest. Thus, there was an average increase of 37.22 points after the students participated in learning using PjBL-based worksheets. The average N-Gain value of 0.68909, or 68.91%, indicates a moderate improvement in learning achievement based on Hake's criteria used in this study. Consequently, the statement in the previous draft regarding an N-Gain of 0.73, or 73%, needs to be corrected as it does not align with the calculation results in the table.

This improvement can be attributed to the characteristics of the learning activities in the worksheets, which provide students with the opportunity to experience the measurement process firsthand. Students not only receive explanations of the concepts of length and units but are also guided to observe objects, use measuring tools, record measurement results, compare data, discuss, and draw conclusions. These activities provide concrete learning experiences so that the concept of measurement is not merely understood in the abstract. This finding is consistent with Lestari and Ilhami (2022), who demonstrated that the implementation of PjBL can foster student engagement through project-based learning experiences.

Student Responses to the Worksheets

In addition to learning outcomes, the implementation of the product is also evaluated based on student responses to the worksheets. The evaluation of these responses covers the content, language, and students' interest in the product. This data is important because a product that is sound in terms of content is not necessarily easy to use or appealing to students. Therefore, the results of student responses are used as supporting information regarding the

product's acceptance after it has been used in instruction. Details of the student response assessment results are presented in Table 5.

Table 5. Student Responses to Project-Based Learning Worksheets

Aspect	Average	Percentage	Category
Content	4.00	100%	Very high
Language	4.00	100%	Very high
Interest	4.00	100%	Very high
Overall	4.00	100%	Very high

Based on Table 5, all three aspects received an average score of 4.00 and a percentage of 100%, meaning they all fall into the "very high" category. These results indicate that students responded positively to the content, language, and level of interest in the worksheets. The high response rate regarding content suggests that the material presented was deemed appropriate for their learning needs, while the response regarding language indicates that students were able to understand the instructions and explanations. Meanwhile, the high response regarding the interest aspect indicates that project-based activities can provide a more engaging learning experience compared to instruction that is solely focused on delivering content.

These response results are also supported by the characteristics of the worksheets, which provide students with opportunities to engage in hands-on activities. Students gained experience using measuring tools, working in groups, recording data, and discussing their observations. These activities allow students to be actively engaged during the learning process, so that the worksheets are not merely viewed as a set of questions but as a guide for learning activities. Nevertheless, the response data should be interpreted as an indicator of student acceptance or perception, not as sole evidence of the product's effectiveness. Therefore, this data must be analyzed in conjunction with validation results and improvements in learning outcomes.

Product Revision and Refinement

The final stage of development in this study involved an evaluation of the validation and implementation results. Feedback from validators served as the basis for refining the product, particularly regarding the clarity of the steps and the timing of activities. Revisions were made before the worksheets were used in the pilot test to ensure that the product administered to students had undergone expert evaluation. To illustrate the relationship between validator feedback and product changes, Table 6 below can be included at the end of the Results and Discussion section.

Table 6. Product Revisions Based on Validator Feedback

No	Validator Feedback	Follow-Up Action
1	A schedule and time allocation should be provided to assess the use/effectiveness of the worksheets	A schedule and time allocation were added to each activity
2	The worksheets can be used with revisions	Revisions were made before the worksheets were used in the pilot test

Based on Table 6, the revision process served as a formative evaluation stage to ensure the LKPD was better prepared for use in instruction. The addition of a schedule and time allocation provided a clearer structure to the project activities, allowing students to follow the activity stages systematically. This process demonstrates that the product was not developed solely based on the initial design but was refined based on expert feedback before being used by end users. Thus, the research results show that the developed worksheets have excellent feasibility (82.92%), received a 100% response rate from students, and resulted in an average increase in learning achievement from 46.11 to 83.33 with an N-Gain of 0.68909 (68.91%) in the limited pilot test.

CONCLUSION

Based on the results of development and testing, the Project-Based Learning (PjBL)-based worksheets on measurement for seventh-grade students at SMP Negeri 1 Ayamaru Utara in Maybrat Regency were successfully developed using the ADDIE model through the stages of analysis, design, development, implementation, and evaluation. Expert validation results showed that the worksheets achieved a feasibility percentage of 82.92%, falling into the "highly feasible" category, indicating that the product meets the criteria for use in instruction. Implementation with 18 students showed an increase in average learning outcomes from 46.11 on the pretest to 83.33 on the posttest, with an average N-Gain of 0.68909 or 68.91%, which falls into the "moderate" category based on Hake's criteria. Furthermore, student responses to the worksheets achieved a 100% response rate, classified as "very high," indicating that the product was well-received in terms of content, language, and engagement. Thus, the PjBL-based worksheets developed are suitable for use and show positive potential in supporting the learning of measurement concepts, particularly through more active, contextual, and project-based learning activities. However, since the implementation was conducted on a limited group without a control group, future research is recommended to involve a larger number of students and a stronger experimental design to obtain more comprehensive evidence of the product's effectiveness.

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