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Development of a Student Worksheet Based on Project-Based Learning to Improve Learning Outcomes of Junior High School Students

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Abstract: This research involves the development of a Student Worksheet based on project-based learning for the solar system sub-material, focusing on improving the learning outcomes of junior high school students. The purpose of this study is to identify the level of validity, practicality, and effectiveness of the project-based learning Student Worksheet. The method employed in this research is Research and Development (R&D), utilising the ADDIE approach as the development model. This study demonstrates that project-based learning, specifically the Student Worksheet on solar system sub-materials, is deemed highly valid, with a validity value of 0.88, aimed at enhancing student learning outcomes. The practicality of the results from a student response questionnaire, with 82.24% of students agreeing, indicates that the Student Worksheet is highly practical. Effectiveness based on knowledge learning outcomes, with the calculation of n-gain from pretest and posttest, obtained an average n-gain of 0.71 with high criteria, attitude learning outcomes obtained an average of 90.67% which is categorised as very good, and learning outcomes skills obtained an average of 91% which is categorized as very good. The results of the study demonstrate that the Student Worksheet project-based learning on the solar system sub-material is feasible for use, as it meets the criteria of validity, practicality, and effectiveness in improving student learning outcomes. The implications of this research suggest that project-based learning Student worksheets can serve as an alternative, innovative teaching material that encourages active student involvement, improves critical thinking skills, and provides educators with a reference for developing learning tools that align with the demands of the Independent Curriculum and 21st-century learning.

Keywords: Learning Outcomes; Project-Based Learning; Student Worksheet.

Introduction

The Merdeka places special emphasis on implementing a learner-focused approach to learning, with the aim of developing their independence, as well as creating a meaningful and interesting learning atmosphere. The Merdeka curriculum can be supported through the application of the project-based learning model. In the independent learning curriculum, teachers are required to design learning plans that are able to attract students' interest, so that students do not feel a burden or pressure when learning [1]. According to [2] Regarding the independent learning curriculum, he argues that it is a competency-based curriculum that helps support learning recovery, implementing project-based learning to strengthen character values. One way to implement project-based learning is to provide students with guidance in the form of teaching materials.

Teaching materials play a crucial role in supporting teachers in the classroom, as they contain learning components and resources that students will use in their studies. One form of teaching material that can be utilized in learning activities is a Student Worksheet. Student Worksheet is a number of sheets that contain tasks, usually accompanied by instructions or steps to complete the tasks that students must do and is one of the tools that teachers can use to increase the involvement or activity of students in teaching and learning activities [3].

Based on observations at SMP Negeri 31 Banjarmasin, the implementation of the independent curriculum has begun at the school. However, the application of project-based learning remains challenging because teachers have not been fully utilised in using and implementing learning resources. Science learning at the school still relies heavily on textbooks and Student worksheets prepared by the teacher. However, most of the Student worksheets used are still limited to presenting material summaries and practice questions. The student worksheet used at school does not employ a project-based learning model, resulting in low student involvement and difficulty in the learning process. The Student Worksheet that is usually used seems monotonous and has not been able to optimally improve students' abilities. This condition causes students to lack enthusiasm for learning, which in turn affects their achievement of learning outcomes.

Learning outcomes refer to the implementation or expansion of potential skills in students, as evidenced by their academic achievements. This can be seen directly by educators based on their behavior in the form of mastery of knowledge, thinking skills, and motor skills. This is supported by the opinion of [4] that learning outcomes refer to the achievement of students after undergoing the learning process, which includes elements of knowledge, attitudes, and skills.

Based on the above problems, this study prepared the Student Worksheet by applying a project-based learning

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model. This model is implemented in learning, aiming to encourage the development of learner competencies in cognitive, affective, and psychomotor domains through the creation of products relevant to the subject being studied. Through this learning model, students are invited to face challenges from various real-life problems and find solutions by producing a product [5]. Project-based learning is a learning model based on constructivist theory, which suggests that knowledge is acquired through cognitive construction based on individual skills and attitudes. With real experience, learners are able to build their knowledge independently. With the project-based learning model, learners will conduct a cooperative investigation by collecting various ideas based on relevant theories. The project-based learning model has several benefits; among them, it can help learners improve their critical thinking skills by solving problems through project-based activities. Additionally, this learning model supports learners in strengthening their understanding of a problem. The implementation of project-based learning is organized according to the latest principles, so that in practice it is directed to develop learners' skills through theory, practice, and application in the context of everyday life.

The Student Worksheet in this study contains a series of learning steps used by students to complete a project on the solar system sub-material in class VII. This topic has a very abstract nature, so students often face obstacles in understanding the material presented by the teacher, which has an impact on their understanding of the concept of material that has not been maximized. The underutilization of learning media in schools is a significant contributor to the decline in learning outcomes, motivation, and interest in learning. By integrating a project-based learning model in the learning process, students can discover ideas directly. This helps learners relate science concepts to events they encounter in everyday life, encouraging an increase in their interest in learning. Solar system material in science learning at the junior high school level is one of the potential topics to be applied with a project-based learning model. Natural phenomena involving astronomical concepts can be explained more interestingly through creative projects, such as making solar system models or simulating planetary movements.

Prove that the Student Worksheet prepared applying the project-based learning model is efficient in encouraging the improvement of student learning outcomes in science subjects [6]. This is demonstrated by the fact that when a Student Worksheet based on project-based learning is used, students' learning outcomes are clearly different before and after participating in science learning. The results of research by [7] Demonstrate that the Student Worksheet developed using the project-based learning model is effective in enhancing student learning outcomes. In the material on changing the form of energy, the Student Worksheet achieved a percentage of 89.6% in the very good category, indicating that the resulting product was considered feasible and effective for use. However, some of these studies still have limitations, such as focusing on cognitive aspects without deeply integrating affective and psychomotor aspects. Furthermore, some of the developed Student Worksheets have not utilized a systematic approach in project design and have not undergone comprehensive practicality and effectiveness testing. Therefore, this study presents an update by developing a Student Worksheet based on Project Based Learning that is not only valid and practical, but also effective in improving junior high school students' learning outcomes comprehensively through project activities relevant to their experiences.

Based on the description above, the researcher plans to conduct research with the title "Development of Student Worksheet project based learning to Improve Learning Outcomes of Junior High School Students". It is hoped that this worksheet will support students in improving the achievement of learning outcomes while encouraging their motivation to learn.

Research Methods

This research employs the development method, commonly referred to as Research and Development (R&D). Development research theory focuses on the process of designing or creating a product. Development research aims to create new products or improve existing ones by presenting innovations that align with the needs of students, the school environment, and advances in science and technology. This research also plays a role in building and expanding learners' knowledge and insights [8].

The ADDIE model was applied in this development research, which comprises five stages: analysis, design, development, implementation, and evaluation. This model can be applied in various types of product development, such as learning models, strategies, methods, and teaching media and materials [9]. The stages of the ADDIE development research model are as follows.

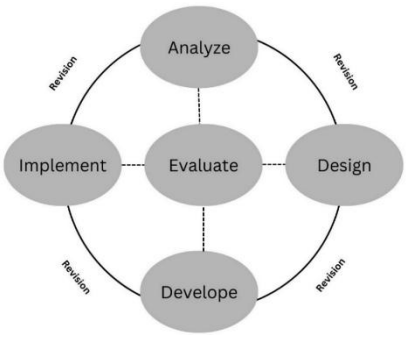

Figure 1. Stages of Development with the ADDIE Model

First, the analysis stage includes analyzing the needs and analyzing the curriculum. Second, the design stage involves developing design concepts and content, compiling the content, and creating assessment sheets. Third, development contains activities to realize the product design and conduct validation tests by experts. Fourth, at the implementation stage, the products developed are tested for use during the learning process. Fifth, the evaluation stage is carried out by analyzing and reporting data results.

The subjects in this study consisted of three lecturers from the Science Education study program and two science subject teachers who acted as validators, and involved Class VII F at SMP Negeri 31 Banjarmasin, comprising 26 students in the 2024/2025 school year. The object of this research is a Student Worksheet, based on the Student Worksheet model, designed to improve the learning outcomes of junior high school students. This research was conducted at SMP Negeri 31 Banjarmasin in February 2025.

In this study, the instruments used included Student Worksheet validation sheets, questionnaires to determine students' responses to the practicality of the student worksheet, test instruments, and observation sheets to assess attitudes and skills.

The validation sheet is prepared based on indicators of the variables used to review and improve the development of teaching materials, utilising a score list instrument in the form of a Likert scale. Table 2 presents the assessment criteria on the validation sheet.

Table 1. Likert Scale Validity

Description	Score
Very Good	4
Good	3
Fair	2
Not Good	1

The validity of this study was assessed using Aiken's V formula (1985), which is formulated as follows.

$$V = \frac{\Sigma S}{n\,(C-1)}$$

Description:
V = Aiken's index
S = r – lo
S = The total of the assessor's scores is subtracted from the lowest score in the category
r = score given by the validator
lo = lowest assessment scores (1)
C = highest assessment score (4)
n = number of validators

Furthermore, the results of the Aiken scale calculation were converted into Aiken's validity criteria, as shown in Table 2 below.

Table 2. Validity Criteria

No	Interval	Criteria
1	$V \leq 0.4$	Less Valid
2	$0.4 \leq V < 0.8$	Valid
3	$V \geq 0.8$	Very Valid

[10]

The questionnaire given to learners is presented in the form of a Likert scale. Learners are asked to mark one of the answer choices provided by giving a check mark.

Table 3. Likert Scale of Practicality

Answer Choices	Score
Strongly Agree	4
Agree	3
Disagree	2
Strongly Disagree	1

The practicality value is calculated based on the learner response questionnaire answers using the formula below.

$$\text{Practical Value} = \frac{\text{Total score obtained}}{\text{Total Score}} \text{ x } 100\%$$

The percent value of the number of answers obtained is then converted into the practicality criteria, as shown in Table 4 below.

Table 4. Practicality Criteria

No	Interval	Criteria
1	81%-100%	Very Practical
2	61%-80%	Practical
3	41%-60%	Less Practical
4	21%-40%	Not Practical
5	0%-20%	Very Not Practical

[11]

Analysis of the improvement of student learning outcomes was carried out using the N-gain (normalized gain) formula, which is formulated as follows.

$$\text{Ngain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Ideal Score} - \text{Pretest Score}}$$

The results of the N-gain calculation will then be included in the N-gain criteria to determine the level of effectiveness of the Student Worksheet, as shown in Table 5 below.

Table 5. Effectiveness Criteria

No	Interval	Criteria
1	$g < 0.3$	Low
2	$0.3 \leq g < 0.7$	Medium
3	$0.70 \leq g$	High

[12]

The calculation of the average percentage of attitude scores on each indicator and assessment aspect is carried out based on observer assessment data, using the formula from Riduwan (2020) as follows.

$$\text{Attitude score} = \frac{\text{Total score obtained}}{\text{Maximum total score}} \text{ x } 100\%$$

The average percentage of attitude scores for each indicator is then analyzed and classified into the category of students' attitudes, as shown in Table 6 below.

Table 6. Category interpretation of attitude scores

Interpretation of attitude score (%)	Category
0-20	Very Not Good
21-40	Not Good
41-60	Fairly Good
61-80	Good
81-100	Very Good

[13]

The calculation of the average percentage of skill scores on each indicator and assessment aspect is carried out based on observer assessment data, using the formula from Riduwan (2020) as follows.

$$\text{Skill Score} = \frac{\text{Total score obtained}}{\text{Maximum total score}} \text{ x } 100\%$$

The average percentage of skill scores for each indicator is then analyzed and classified into the category of students' attitudes, as shown in Table 7 below.

Table 7. Category interpretation of skill scores

Interpretation of skill score (%)	Category
0-20	Very Not Good
21-40	Not Good
41-60	Fairly Good
61-80	Good
81-100	Very Good

[13]

Results and Discussion

This study produces a student worksheet with a project-based learning model on solar system material, which has been tested at SMP Negeri 31 Banjarmasin. The ADDIE model was utilised in the development of this Student Worksheet, comprising five stages: analysis, design, development, implementation, and evaluation. Below is an explanation of each development step.

Analysis Stage

The initial stage in the analysis process involves researchers conducting a needs analysis to identify the extent of the need for teaching materials at SMP Negeri 31 Banjarmasin through preliminary observations. The results of the observation indicated that the use of teaching materials in the learning process was still not ideal, so teaching materials were needed that could support the smoothness and effectiveness of learning. Researchers also identified that obstacles to developing students' potential were caused by a low understanding of the material presented on the solar system, as well as limited teaching materials that support project-based learning. The second analysis carried out is curriculum analysis, where the curriculum used is the Merdeka Curriculum, which contains learning outcomes. In this study, the solar system submaterial was used. The learning outcomes in this material include the ability of students to elaborate on an understanding of the relative positions of the Earth, Moon, and Sun in the solar system and to understand the structure of the Earth's layers, which enables them to explain various natural phenomena in the context of disaster mitigation.

Design Stage

The next stage is to design the Student Worksheet to be developed, specifically in the form of a project-based learning Student Worksheet. The design stage begins by choosing a basic design that is in line with the criteria of the material to be included in the Student Worksheet, looking for images that support the content, and determining colors that are in line with the designed Student Worksheet. The Student Worksheet design stage begins with choosing a cover design that can attract the attention of students. The cover is designed in A4 size and contains the title of the Student Worksheet, the sub-material to be studied, the layout settings, and the name of the Student Worksheet author. Along with choosing the appropriate cover color, photos related to the solar system sub-material should be included to increase the aesthetic appeal of the design. Planning the presentation of material and the use of images related to the solar system increases the attractiveness of the Student Worksheet content design. Furthermore, designing assessment sheets for validation, questionnaires to determine student responses, test questions, and observation sheets to assess aspects of attitudes and skills.

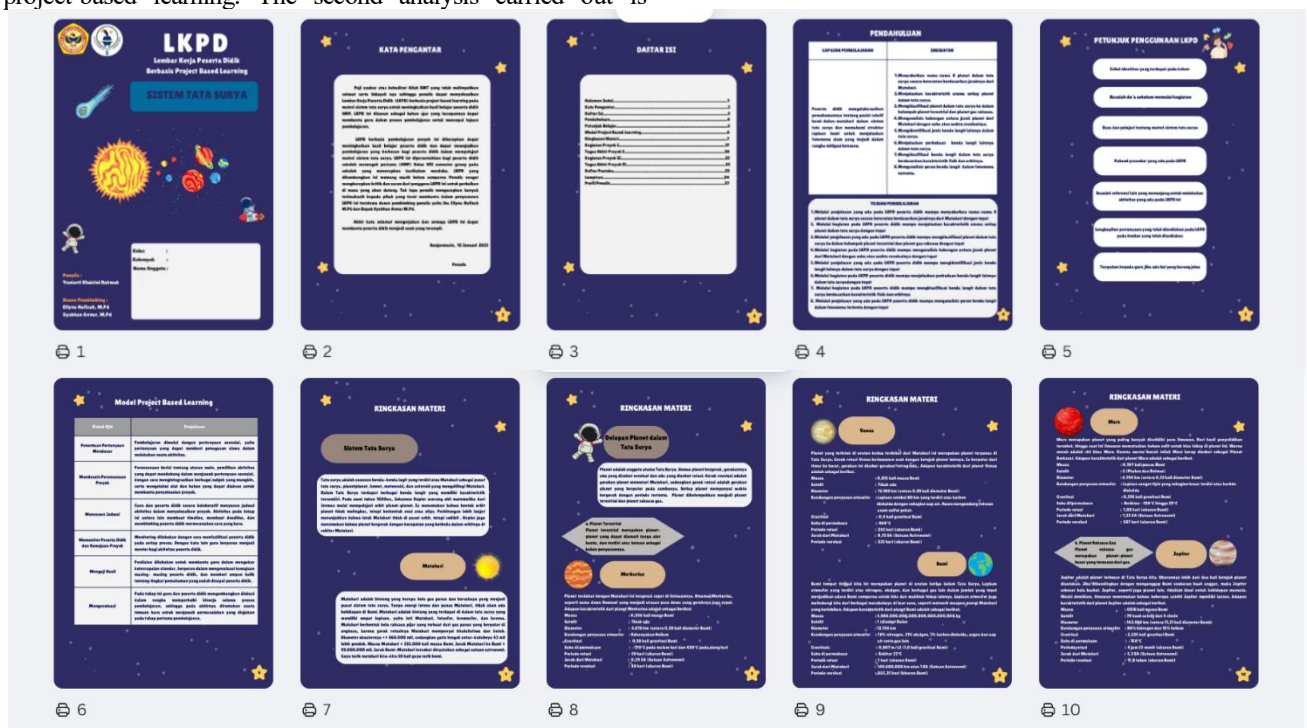

Figure 2. Design of Student Worksheet

Development Stage

In this development stage, the design of the Student Worksheet page is made using a variety of colors to make it look more attractive to students. Editing and layout arrangements on the Student Worksheet are also optimized by arranging the elements appropriately so that they look neat and attract the attention of students when reading the project-based learning Student Worksheet. Next, the Student Worksheet enters the evaluation stage, this stage aims to assess the feasibility of the Student Worksheet. Researchers used a validation sheet containing several statements, which was given to experts to

evaluate the Student Worksheet that had been designed. Five expert validators have validated this Student Worksheet, with the validity results shown in Table 8.

Table 8. Student Worksheet Validity Results

Aspect	Average V	Criteria
Content Eligibility	0.82	Very Valid
Presentation	0.89	Very Valid
Assessment language	0.91	Very Valid
Media	0.91	Very Valid
Rata-Rata	0.88	Very Valid

Based on the results of the validation by the five validators, the developed Student Worksheet achieved a validity of 0.88, meeting very valid criteria with minimal revision. The Student Worksheet validation rating scale ranges from 1 to 4. The validity assessment encompasses four key aspects: content eligibility, presentation assessment, language, and media.

The results of validity in the aspect of content eligibility as a whole receive a score of 0.82, indicating that the content eligibility of this Student Worksheet is very valid, meaning that it has been aligned with the learning outcomes and subject matter of the solar system sub-material. This is because the Student Worksheet are adjusted to the applied curriculum so that the material scope criteria are in accordance with the learning outcomes and objectives. The concepts and illustrations displayed on the Student Worksheet align with the material on the solar system and include images to support learning.

The validity results for the presentation assessment aspect yield a score of 0.89, indicating that the presentation of this Student Worksheet aligns with project-based learning activities. The assessment indicators used include presentation techniques, supporting elements, the presentation of learning materials, and the completeness of the presentation. This indicates that the presentation of the developed Student Worksheet is appropriate or attractive to users. In the research of [14] also stated that the validity status of the feasibility of presentation on the teaching materials that have been developed shows that it has been recognized as very good in the aspect of presentation techniques, has supporting components for presentation, involves students in the learning process, and has compiled a complete presentation.

The results of validity in the language aspect, with very valid criteria, yielded a validity score of 0.91 for the language aspect. Student Worksheet sentences are clear, communicative, dialogical, and interactive, and are tailored to the level of student development, as assessed by the indicators used, with a focus on conciseness and cohesiveness in the Student Worksheet. In preparing the Student Worksheet, sentences and word choices should be simple, easy to understand, and concise. New terms should be introduced first before use [15].

The results of validity in the media aspect, with very valid criteria, indicate that the validity of the language aspect received a score of 0.91, which means that the appearance of this Student Worksheet is suitable for use as teaching material. The assessment indicators covered are appearance, content, and Student Worksheet characteristics. The score is appropriate because the Student Worksheet has met the criteria for preparing a quality Student Worksheet. In the Student Worksheet, appropriate text and illustrations are used. Images (photos) that can effectively communicate messages or information from images (photos) to students as Student Worksheet users [16].

Implementation Stage

The implementation stage is the next step taken by researchers after the Student Worksheet has been declared or approved by the validator to be tested with students. A Student Worksheet based on project-based learning was tested on 26 seventh-grade students. An experiment was conducted to determine whether the Student Worksheet was practical in large group learning after improvements were made. A total of 26 students from Class VII F at SMP Negeri 31 Banjarmasin were the subjects in this experiment. Table 9 below shows the results of the Student Worksheet practicality calculation.

Table 9. Results of Student Worksheet Practicality

Assessment Aspect	Overall Score	Criteria
Ease of Use	84.62%	Very Practical
Benefits	81.01%	Very Practical
Effectiveness	79.32%	Practical
Average	82.24%	Very Practical

The developed Student Worksheet was assessed for practicality using a learner response questionnaire, which included three main aspects, namely ease of use, usefulness, and effectiveness. The questionnaire consists of 15 statements, which include 12 positive statements and 3 negative statements. A large-group test was conducted to determine the practicality of the Student Worksheet, developed for learning with large groups, involving a total of 26 students. The overall score obtained was 82.24%, based on the practical criteria listed in Table 9, which referred to the results of the learner response questionnaire analysis.

A total score of 82.24% was received, which is classified as very practical, according to Table 9. This demonstrates that the project-based Student Worksheet is very easy for learners to use. The material in the Student Worksheet is clearly organized, the instructions are easy to understand, and the language used is clear. Additionally, the Student Worksheet enhances the learning process, enabling learners to grasp the material more quickly without requiring prior direction from the teacher. The existence of illustrations in Student Worksheet, a combination of colors, and interesting text makes the content presented very challenging and interesting to solve, helps students learn on their own, even without direct instruction from the teacher, and is easily and effectively used by teachers as a supporting tool in the teaching and learning process of the solar system sub material of science learning at SMP Negeri 31 Banjarmasin. This is in line with the research of [17], the Student Worksheet, which is systematically arranged, provides students with clear work instructions, guidelines that are easy to understand, and fun activities, which also increase their active participation in learning. The Student Worksheet helps support project-based and problem-based learning by allowing learners to complete tasks in a structured and directed manner.

The test to measure learning outcomes consisted of 20 multiple-choice questions, and the test results were

calculated using N-gain to assess the effectiveness of the Student Worksheet in learning. The test subjects were 26 students from Class VII F at SMP Negeri 31 Banjarmasin. The calculation results related to knowledge are shown in Table 10.

Table 10. Knowledge Learning Outcomes

Average pretest	Average posttest	N-gain	Criteria
43,85	83.27	0.71	High

This trial involved 26 students; the results showed a high n-gain value of 0.71, with an average pretest score of 43.85 and a posttest score of 83.27. Thus, it can be concluded that the application of project-based learning, as demonstrated in the Student Worksheet, shows effectiveness in improving the knowledge learning outcomes of seventh-grade students at SMP Negeri 31 Banjarmasin. These results are supported by research by [18] which explains that the effectiveness of a teaching material is determined through an analysis of the comparison between the pretest and posttest scores of students. The difference between the two values is called gain. Based on the N-gain analysis, the average gain score of the learning test results for 26 students in Class VII F was 0.71, which is classified as high. This increase occurred due to the use of project-based learning Student Worksheets on solar system sub-materials, which had undergone the previous revision stage, in order to improve student learning outcomes. Thus, the development of a project-based learning Student Worksheet on solar system sub-materials is effective in improving student learning outcomes.

The project-based learning model places students at the centre of the learning process, and the teacher acts as a facilitator. With the help of this model, learners can enhance their problem-solving abilities and foster cognitive development. This finding is in line with research by [19] who mentioned that in project-based learning, learners act as the main subject in the learning process. Learners engage, collaborate, create and innovate during this process. This learning model also offers new experiences and insights because learners are directly involved in developing problems, determining steps, making observations, designing, and making products.

Researchers observed the learners' attitudes to determine the effectiveness of the Student Worksheet in learning, involving 26 students from class VII F at SMP Negeri 31 Banjarmasin. Data on learning outcomes related to the attitude aspect are presented in Table 11.

Table 11. Attitude Learning Outcomes

Indicator	Score	Category
Accepting (A1)	90.38%	Very good
Responding (A2)	92.79%	Very good
Appreciating (A3)	90.38%	Very good
Organizing (A4)	86.06%	Very good
Characterization by value (A5)	93.75%	Very good
Average	90.67%	Very good

Based on the data presented in 11, it is known that the attitude learning outcomes obtained an average score of 90.67%. The assessment data indicate that the average attitude of students falls in the "very good" category. It has been proven that a Student Worksheet with project-based learning can improve students' attitudes towards learning. Activities related to project-based learning, such as the Student Worksheet, which impact learning outcomes, are currently in the initial stage. At this stage, students are invited to identify problems and conduct group discussions. During this process, the attitudes of cooperation, tolerance, and mutual respect begin to form. Furthermore, at the project planning and implementation stage, learners are accustomed to being responsible for tasks that are their respective obligations, demonstrating honesty, discipline, and perseverance in completing the project within the time target. Learners show an increase in activeness, learning motivation, and a positive attitude towards the learning process. Additionally, they became more responsible, independent, and adept at collaborating well. This is in line with which statement that project-based learning models encourage students' activeness in group work activities and in completing project tasks [20-21]. Furthermore, when presenting project results, students are encouraged to develop self-confidence, remain open to feedback, and respect the opinions of others. Thus, project-based learning can be an effective solution to improve the learning outcomes of junior high school students.

Researchers conducted observations of learners' skills to determine the effectiveness of LKPD in learning, involving 26 students of class VII F SMP Negeri 31 Banjarmasin. Data on learning outcomes related to the attitude aspect are presented in Table 12.

Table 12. Skill Learning Outcomes

Indicator	Score	Catogery
Imitate (P1)	95%	Very Good
Manipulation (P2)	90%	Very Good
Precision (P3)	95%	Very Good
Articulation (P4)	90%	Very Good
Naturalization (P5)	85%	Very Good
Average	91%	Very Good

Referring to the data in Table 4.12, it can be concluded that the learning outcomes of skills obtained an average score of 91%. The assessment data indicate that the average skills of students are in the "very good" category. Student worksheets based on project-based learning have demonstrated their effectiveness in enhancing students' skills during the learning process. Activities in project-based learning, such as student worksheets, that affect the increase in skill learning outcomes include when students create products or prototypes of designed projects. This process hones fine motor skills, accuracy, and the use of specific tools or technology, depending on their field. Additionally, time management skills, teamwork, and presentation skills also develop when individuals have to present their work to teachers or classmates. Learning with a project-based learning model encourages learners to build motivation and foster cooperation and collaboration with others. Learners show the ability to work together in groups by completing tasks collectively, conveying ideas or suggestions, engaging in discussions, and sharing responsibilities. Through this collaborative activity, they can develop their motor skills while improving their social and teamwork skills. In addition, it provides learners with opportunities to gain authentic and meaningful learning experiences, as they are directly involved in creating the product and can observe its

functionality. In project-based learning, learners focus on honing individual skills, working together to solve problems, and designing and producing the final product of a joint project. The project-based learning model leads students to be able to solve problems and emphasizes contextual teaching and learning activities through various complex methods, for example, by giving students the freedom to explore and plan learning activities collaboratively, requiring projects and ending with the production of a product [22-24].

Evaluation Stage

Evaluation is the final stage in the process of developing a project-based learning Student Worksheet. In this study, researchers conducted an evaluation at each stage. At the analysis stage, researchers conducted an evaluation based on the results of the needs and curriculum analysis. This evaluation aims to ensure that the learning process runs optimally and encourages an increase in student learning outcomes, particularly in learning about the solar system. Thus, researchers designed a teaching material in the form of a student worksheet that incorporated a learning model. At the design stage, the evaluation is carried out to improve the Student Worksheet and the research instruments that have been designed, in accordance with the supervisor's suggestions and input. At the development stage, evaluation is carried out to assess whether the Student Worksheet is suitable for use and to revise it based on suggestions and input provided by the validator. The implementation stage includes an evaluation that aims to improve the project-based learning Student Worksheet, referring to the information obtained through the learner response questionnaire. At the evaluation stage, this is the final evaluation, which aims to ensure that the developed product has achieved the previously designed objectives. Based on the validation results, student responses, and test results obtained, it can be concluded that the Student Worksheet is feasible for use in the learning process.

Conclusion

The Student Worksheet, developed by applying the project-based learning model, obtained a validity score of 0.88, which is classified as very valid. In terms of practicality, this Student Worksheet is considered very practical, with a percentage of 82.24% based on the results of the students' response questionnaire to the product developed. The effectiveness of the Student Worksheet is also evident in the improvement of learning outcomes; specifically, the n-gain value of 0.71 indicates a significant increase in knowledge. Meanwhile, learning outcomes in the attitude aspect reached 90.58%, and the skill aspect amounted to 91%, both of which fell into the excellent category.

Author's Contribution

Yuniarti Khairini Rahmah: Conceived the research idea, designed the study, and developed the PjBL-based student worksheet. Ellyna Hafizah: Contributed to research design, supervised instrument development. Syubhan Annur: Supported data collection, performed validation of learning materials.

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