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Enhancing Learning Outcomes Through the Development of Project-Based Student Worksheet for Class XI MIPA Students in Science Subjects

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Abstract
This research was motivated by some students who said that physics is not fun. Students expect physics learning to be equipped with a practicum directly according to the material to be studied. To create a good interaction, creativity between students is necessary. One of them is by developing teaching materials in the form of PjBL-based LKPD for class XI MIPA students. The PjBL-based learning model actively engages students to develop their own knowledge and includes group work to create projects as an application of principles and concepts that have been acquired. This study aims to develop valid and practical PjBL-based Student Worksheets for grade XI MIPA students. The research used by researchers is Research and Development (R&D). This research procedure is an ADDIE model which consists of 5 stages, namely analysis, design, development, implementation, and evaluation, at the evaluation stage is not carried out due to time constraints. The research instruments used are validity and practicality questionnaires. Furthermore, the results obtained are analyzed to see the validity and practicality of LKPD. From the results of the study, it was found that the PjBL-based LKPD developed was categorized as very valid with a percentage of 87.13 percent and very practical with a percentage of 94.40 percent. The validity and practicality of the LKPD is illustrated from the results of validation by experts, there are four aspects of assessment, namely aspects of content feasibility, language, presentation, and media.

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1. Introduction

Education is an effort that aims to create learning situations and learning activities for students to be active and develop their abilities. Education can be done regularly which can create active learning activities for students who are active in their abilities. The purpose of national education is to create active learners. Physics learning in general still leads to educators [1]. Learners also tend to memorize notions and formulas, learning approaches are less related to natural phenomena. This results students becoming passive and less motivated, students think physics is difficult and bored so students have difficulty learning [2].

The learning progress of learners is determined by educators because educators are learning leaders, facilitators, and at the same time as learning initiatives [3]. Learning is a process that can train themselves in the process of getting new information in learning so that students are more active [4]. Some facts that have happened so far show that in educational institutions that the interest in creativity during the learning process, especially in physics subjects, is still small, generally creativity is applied to extracurricular activities. In physics learning activities, students not only memorize theories and formulas, but the formation of knowledge and understanding of students [5].

A physics learning that is expected to be carried out by actively involving students. To support physics learning activities, teaching aids are needed, namely teaching materials. In teaching materials, there are learning materials, learning methods and ways to evaluate that have been structured in an arranged manner to get a desired goal [6]. Teaching materials are learning tools that contain learning activities designed by teacher to be used during learning activities and it also can be used as a companion learning resource [7].

Based on observations through the distribution of questionnaires in class XI MIPA 4 at SMA Negeri 16 Padang, information was obtained that some students said that physics was not fun. Students also said that educators have delivered the material well but some of the students do not understand the material provided by educators, some students still do not understand the physics concepts. Students expect physics learning to be equipped with a practicum directly according to the material to be studied. Practicum can develop the ability to understand physics concepts by practicing abilities and gaining experience and skills when doing practicum. Thus, there are some learners who do not like learning physics, students still need to be trained in literacy before learning process. The response from students looks more active when they succeed in making products that are in accordance with the material. Teachers must also prepare some teaching materials that make classroom conditions interesting, so that students are not just focused to the teacher. SMAN 16 Padang using 2013 curriculum, but the school sometimes still using the various teaching methods. In learning physics, students are required to categorize critical thinking skills, including higher-order thinking skills, to understand the concepts and principles of physics [8].

Based on the description, the effort made is to use the appropriate learning model. One of the learning media that can be developed is in the form student worksheet called LKPD. The LKPD based PjBL encourage students to discuss and solve problems in making a physics material project to be studied, so that the use of PjBL-based LKPD can support teachers to face the problem of limited student absorption and educators' ability to manage learning in the classroom [9]. The advantages of LKPD include: (1) LKPD can activate students in learning activities; (2) Helping learners to discover and develop concepts; (3) Become an alternative way of presenting subject matter that emphasizes student activity; (4) and can motivate students. LKPD in the form of an activity sheet that is given directly to students to carry out real activities on the object to be studied [10]. In addition to the teaching materials used, educators need to determine learning models that are appropriate and easy to understand by students and create differences in learning activities that are more interesting to motivate students to be more competent in facing scientific advances. A learning model that can involve students more actively during learning is the PjBL learning model. This PjBL learning model is a model that focuses and involves students during problem-solving activities. PjBL has advantages, namely: (1) Increase learning motivation and ability to solve problems [11]; (2) Make students more active; (3) Can train students to collaborate; (4) Can improve students' skills to process resources; (5) Involving students to learn, then applied to the real world. PjBL with the special characteristics of designing and producing projects. This learning model can provide direct learning experiences to students through project making activities that end in the creation of a product [12]. The PjBL model can give students the freedom to think creatively and participate in developing the abilities of students [13].

The Project-Based Learning (PjBL) model actively engages learners in constructing their own knowledge and encourages group collaboration to produce a project that applies the principles or concepts they have acquired. PjBL also increases student involvement in gathering information from books or other media to solve real-world problems. This study aimed to examine the impact of the PjBL model, supported by the Student Worksheet (LKPD), on students' learning outcomes and interests, as well as to describe students' creativity during the learning process using the PjBL model.

The Project-Based Learning LKPD serves as a teaching resource that shifts the focus from the educator to the students. The presence of LKPD actively involves students in learning activities. Designed based on the PjBL approach, LKPD helps train students to collaborate and enhance their skills in creating projects that can be applied to real-world situations. In this model, students are not only performing practical tasks but are also expected to design and produce projects. This allows students to feel confident and adaptable to learning physics. The developed media targets optical tools material, enabling students to take an active role throughout the learning process. Therefore, the LKPD learning media is expected to assist students of Class XI MIPA 4 in improving their understanding of the optical equipment material.

2. Methods

This study is a survey study using comparative method as the approach. This type of research was selected due to its flexibility, which simplifies the research process, particularly with the integration of digital technology. Additionally, survey research is effective in capturing relevant conditions in real time. This study involved 467 respondents (198 male and 269 female). The respondents were selected using quota sampling from all Grade X students in a public high school Singkawang. To collect data on students SPS, the researcher used a test instrument adapted from Widia Sari [8]. The test consists of 18 multiple-choice questions, with each question representing one of the indicators SPS (observation, classification, prediction, measurement, inference, and communication).

Data collection began by providing a Google form link to physics teachers at each school, who then shared the link with their students. This approach was chosen to facilitate administration and analysis of responses from participants. Prior to distributing the test, students were informed that their responses would not directly affect their academic grades. The purpose was to encourage natural and honest responses from the students. A total of 882 tests were distributed, and 467 tests were successfully completed. The data was collected between March 5th and March 25th, 2024.

To obtain the profile of students SPS and determine whether there are differences in SPS between male and female students, a combination of quantitative descriptive analysis and comparative statistical tests is used. The descriptive analysis provides an overview of the SPS scores by assessing them based on SPS indicators and dividing them into three groups, with score (n) > 70 in high category, 30 ≤ (n) ≤ 70 is medium category, and less than 70 is low category [9]. Meanwhile, the comparative statistical tests (Mann-Whithey) evaluate whether there are significant differences in SPS performance based on gender.

3. Results and Discussion

The research has produced a profile of students SPS and its comparison based on gender, which can be observed as follows:

3.1. Students Science Process Skills

Figure 1 shows that all student SPS indicators have scores above 30, and one indicator has a score above 70. In other words, there are no indicators categorized as low, most fall into the 'medium' category. However, the communication indicator stands out with a 'high' category, making it the most mastered indicator. On the other hand, the prediction indicator is the least mastered by students. Figure 1 shows the profile of SPS possessed by students based on its indicators:

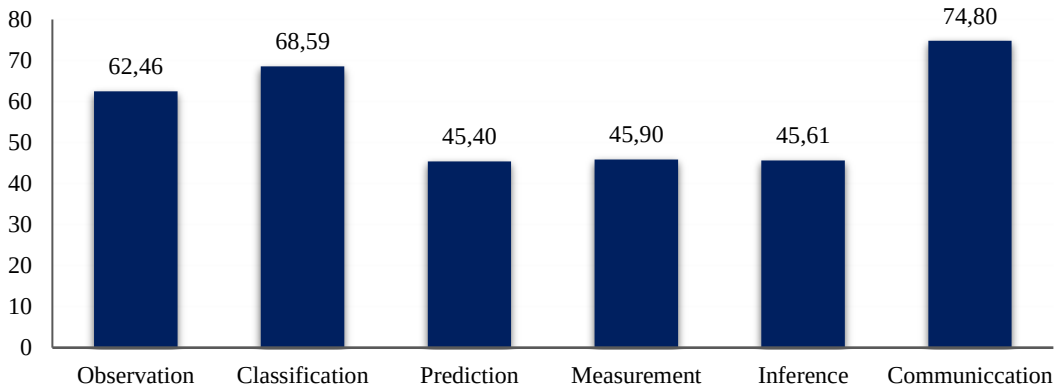

Figure 1. Profile of Students Science Process Skills

There are several factors that can influence students achievement levels in each indicator, such as: On the observation indicator, most students tend to focus on quantitative observation during their experiments and overlook qualitative observation. Quantitative and qualitative observations play different roles, quantitative observation is designed to establish standardization (using a numerical scale) and control, while qualitative observation is more naturalistic and not restricted by quantitative (numeric) categorization [10]. Based on this statement, it can be said that it is important to use both quantitative and qualitative observation because not all student experiments will yield quantitative data alone, there may be qualitative data or perhaps only qualitative data. In the classification indicator, teachers are lacking in providing assignments that train creative thinking skills.

As a result, students remain fixated on the criteria consistently used by previous teachers and do not attempt to use other criteria that allow for more creativity. This is in line with previous research on creative thinking abilities [11]-[13]. In the prediction indicator, students struggle to predict outcomes based on their observations, which are primarily quantitative data. Often, they overlook qualitative data [10], leading to difficulties in identifying patterns for prediction. As a result, most students find it challenging to envision what will happen. In the measurement indicator, students tend to focus only on quantitative measurements and lack proficiency in using qualitative measurements. Measurement is part of the SPS, involving the collection of information both quantitatively and qualitatively [14]. Based on this statement, students have not yet fully optimized their measurement skills. In the inference indicator, students lack understanding of the material taught, because students comprehension of the material is insufficient, it can lead to poorly formed conclusions [8]. Finally, in the communication indicator, students are often trained by teachers to create reports, give presentations, or engage in discussions after practical sessions under the guidance of their teachers. Through the application of the Think-Talk-Write learning model, students communication skills can be enhanced [15].

In summary, it can be said that there are no significant obstacles to students SPS, but there is room for improvement, particularly in the areas of prediction, measurement, and inference. This aligns with the findings of previous research conducted by Widia Sari [8].

3.2. Students Science Process Skills Based on Gender

Based on Figure 2, that shows that all indicators for male students fall into the ‘medium’ category, while female students have 2 indicators in the ‘high’ category. The indicator most mastered by both male and female students is communication. However, the least mastered indicators differ: for male students, it is inference, whereas for female students, it is measurement.

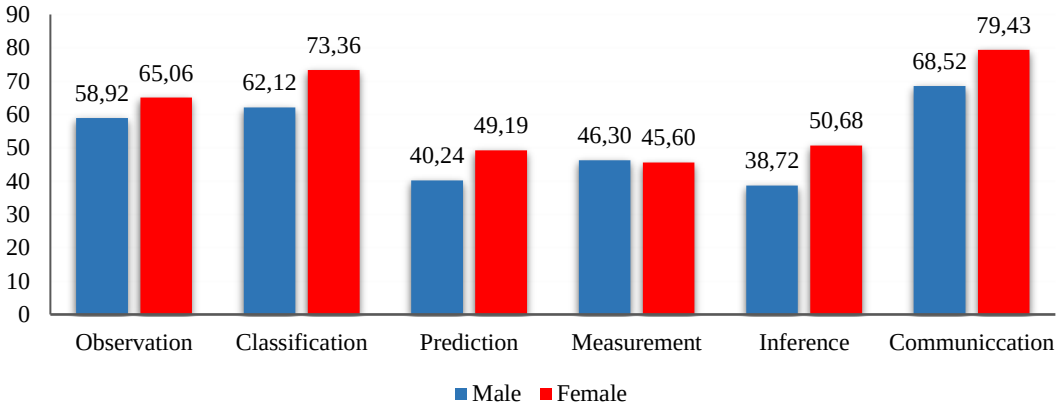

Figure 2. Profile of Students Science Process Skills Based on Gender

To further investigate whether there are differences in SPS between male and female students and examine the results of the following statistical test (Table 1).

Table 1. Data Descriptives

	Male	Female
N	198	269
Min	0	6
Max	94	100
Range	94	94
Mean	52.47	60.55
Median	55.56	61.11
Std. Deviation	22.338	21.862
Skewness	-.072	-.102
Kurtosis	-.994	-.838
Variance	498.966	477.960

Based on Table 2, it is shown that the sample size exceeds 50; therefore, the normality test used is the Kolmogorov-Smirnov test.

Table 2. Normality Test Result

	Gender	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
SPS	Male	.105	198	.000
	Female	.086	269	.000

Based on results Table 2, the Kolmogorov-Smirnov Sig. value for both male and female students SPS data is 0.000. According to the decision criteria for normality tests, when the p-value is less than 0.05, its concluded that the data are not normally distributed.

Table 3. Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Based on Mean	.563	1	465	.453
Based on Median	.514	1	465	.474
Based on Median and with adjusted df	.514	1	465.000	.474
Based on trimmed mean	.577	1	465	.448

Based on the Table 3 sig. based on mean values for the SPS variable in male and female students (which is 0.453), we can make the following conclusions: Since the Sig. value (0.453) is greater than 0.05, according to the decision criteria for homogeneity tests, we conclude that the variance of SPS scores for male and female students is equal or homogenous. Given that the normality test results indicate non-normal distribution, and the homogeneity test results suggest equal variance, the next appropriate step is to perform a non-parametric test such as the Mann-Whitney U test.

Table 4. Mann-Whitney Test Result

	SPS
Mann-Whitney U	21456.000
Wilcoxon W	41157.000
Z	-3.600
Asymp. Sig. (2-tailed)	.000

From the results of the Mann-Whitney test (Table 4), it is evident that the Asymp. Sig. (two-tailed) value is 0.000, which is smaller than the significance level of 0.05. Therefore, it can be said there are SPS difference between male and female students. Based on the comparison of scores for each SPS indicator and the results of the statistical test (Mann-Whitney), it is evident that female students outperform male students. This difference may be attributed to the fact that female students exhibit greater interest in learning compared to male students. Female students can have higher science process skills because they demonstrate higher enthusiasm and curiosity during practical activities [6]. Interestingly, this finding contrasts with research conducted by Gasila *et al*. [16] , which indicates that male students have higher average scores than female students. Some studies also suggest that male students tend to be more dominant in utilizing spatial abilities compared to their female counterparts [17], [18].

4. Conclusion

The profile of SPS among female students is higher than male students. For male students, all SPS indicators at the medium category, whereas female students have 2 indicators classified as high and 4 indicators as medium. Both male and female students share the same weaknesses in SPS, specifically in the areas of prediction, measurement, and conclusion. Almost across all indicators, female students outperform male students, except in the measurement indicator, where male students excel over female students.

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