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Increasing the Competence of Physics Teachers in Designing PjBL-Based Teaching Aids for the Implementation of the Merdeka Curriculum

Mairizwan[1*], Hidayati[1], Wahyuni Satria Dewi[1], Renol Afrizon[1], Roni Jarlis[2]

[1] Departmen of Physics Universitas Negeri Padang, Padang, Indonesia
[2] Departmen of Agroindustry Universitas Negeri Padang, Padang, Indonesia

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Corresponding Author:
Mairizwan
mairizwan@fmipa.unp.ac.id

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Abstract: A *visual aid* is an object that can be used as a support for physical science activities. Teaching aids can be designed by the teacher using readily available materials. The competence of physics teachers in Pasaman Barat Regency has not been optimal in compiling PjBL-based Physics teaching aids student worksheets. So, the facts found in the field show that the professional competence and pedagogical competence of physics teachers in Pasaman Barat Regency in physics learning are not optimal. Therefore, it is necessary to increase the competency of Physics teachers in designing PjBL-based teaching aids. This type of research is quasi-experimental research. The treatment is in the form of assistance in making teaching aids based on PjBL. Bimtek activities in the form of practical assistance increase the competency of activity participants, which in this case are Physics teachers in Pasaman Barat Regency. The increase in the competence of physics teachers in Pasaman Barat Regency in making PjBL-based physics teaching aids was 24.17%. In addition, the mentoring activities provided are effective for increasing the mastery of MGMP Physics teachers in the Pasaman Barat Regency of the PjBL model material. This activity is also helpful for teachers designing teaching aids to support Physics learning as an merdeka curriculum implementation.

Keywords: Teaching aids; PjBL; Merdeka curriculum

Introduction

Entering the era of globalization in the 21st century, the world of education must be able to prepare students with various skills following future demands. These skills include critical thinking skills, creative thinking, collaboration, and communication skills (Yu et al., 2019). These four skills are better known as the 4C skills. To achieve the goals of 21st Century education, the Ministry of Education and Culture has adapted 4C skills to develop school curricula, including the curriculum for Senior High Schools (SMA/MA). The current curriculum at the Senior High School level is the Merdeka Curriculum. The structure of the Merdeka curriculum is based on three things, namely competency-based, flexible learning and the character of Pancasila (Makarim, 2022). The Pancasila Character or Pancasila Student Profile is a guide that guides all policies and innovations in learning. Physics learning at the SMA/MA level is in two phases: Phase E in class X SMA and phase F in classes XI and XII SMA. This can be seen in the Structure and Curriculum Guidelines in Permendikbudristek No. 262/M/2022. For phase F, physics learning must allocate a project of 30% of the total lesson hours per year (Makarim, 2022).

A Merdeka curriculum demands the ability of teachers and students to have more creativity and innovation in improving the quality of learning. The innovative approach demanded in the Merdeka curriculum is in the form of project-based learning

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(PjBL), which is contextual learning with complex activities (Mudhofir et al., 2016). Learning Physics with the PjBL model can develop students' problem-solving skills critically and creatively, fostering students' collaborative spirit in finding the right solution and communicating orally and in writing. The role of the Physics teacher in PjBL is to facilitate students learning by utilizing a variety of learning media, both in simple forms and technology-based. One of the physics learning media widely used in PjBL learning is simple visual aids.

This simple teaching aid aims to bridge students' understanding of Physics concepts with real-life problems. Teaching aids can be used to convey messages to stimulate students' thoughts, feelings, concerns, interests and attention so that the learning process can take place (Anas, 2014; Suliyati et al., 2018). This teaching aid is critical for teachers to use in learning because it can train students' critical and creative thinking skills to solve physics problems. *Visual aids* are also defined as teaching aids so that the concepts taught by the teacher are easily understood by students and become a tool for achieving learning objectives (Muldiani et al., 2018; Anas, 2014). For this reason, the creativity and skills of the Physics teacher are needed to make simple visual aids that follow the characteristics of the Physics material. So, designing appropriate teaching aids can improve the quality of learning physics in class.

The initial study was conducted to determine the achievement of basic competence in Physics in the last three years through interviews with high school Physics teachers who are members of the Subject Teacher Council (MGMP) of Pasaman Barat Regency. The interviews show that the implementation of physics learning in each school still has several obstacles. First, only 50% of physics teachers made teaching aids in physics learning from 2010 to 2019. This resulted in the implementation of project activities for achieving KD-4 needing to be maximized. Second, only 63% of high school physics teachers in Pasaman Barat Regency could compile PjBL-based Physics Practicum Student Worksheets even though 75% of these teachers had applied the project-based learning (PjBL) model in physics learning. The teacher's competence is not optimal in making visual aids and compiling PjBL-based Practicum Student Worksheets. So, the facts found in the field show that the professional and pedagogical competence of physics teachers in the Pasaman Barat Regency is not optimal in supporting the implementation of the Merdeka curriculum.

Solutions to these problems have been widely discussed in several previous studies. Several studies have shown several influences on the use of visual aids and the application of the PjBL model in learning Physics. Islamiyah et al. (2018) found that there is influence of the Project-based Learning model assisted by teaching aids on students' critical thinking skills. In other studies, the learning process using simple visual aids can improve student learning outcomes in the material of effort, energy, and power (Suliyati et al., 2018; Saepuloh, 2020). Furthermore, Sari et al. (2018) states that lectures using PjBL-based teaching aids are in great demand by students and can increase student creativity. However, from the discussion of some of these studies, no one has examined how to increase the effectiveness of using physics teaching aids from the teacher's point of view. There has been no study on what activities can increase teacher competence in preparing physics teaching aids in schools.

Responding to these conditions, the researchers resolved the problems faced by Physics teachers in the Pasaman Barat Regency in supporting the implementation of the Merdeka curriculum through learning assistance activities. One of the solutions provided is mentoring activities for the Making of PjBL-Based Teaching Aids. This activity focused on providing material provision related to the making of PjBL-based teaching aids and the preparation of PjBL-based physics practicum worksheets. This activity is expected to improve the professional and pedagogic competence of physics teachers in the Pasaman Barat Regency so that they can meet the objectives of the physics subject and the demands of the applicable curriculum.

Method

This type of research is quasi-experimental research. The research design used was a pretest-posttest for one sample group (pretest-posttest group only design) (Sugiyono, 2017). In this research design, one sample group was given treatment, then the effect of this treatment on the sample group was seen. Before being given treatment, the sample group was given a pretest to determine the initial ability of the sample group. After being given the treatment, a posttest was given to determine the final ability of the sample group (Dewi et al., 2021). The treatment is in the form of assistance in making teaching aids based on PjBL. The effect of the treatment can be determined by comparing the pretest and posttest results. The research procedure consists of four stages: material debriefing, assistance in making physics teaching aids, independent activities, and evaluation monitoring.

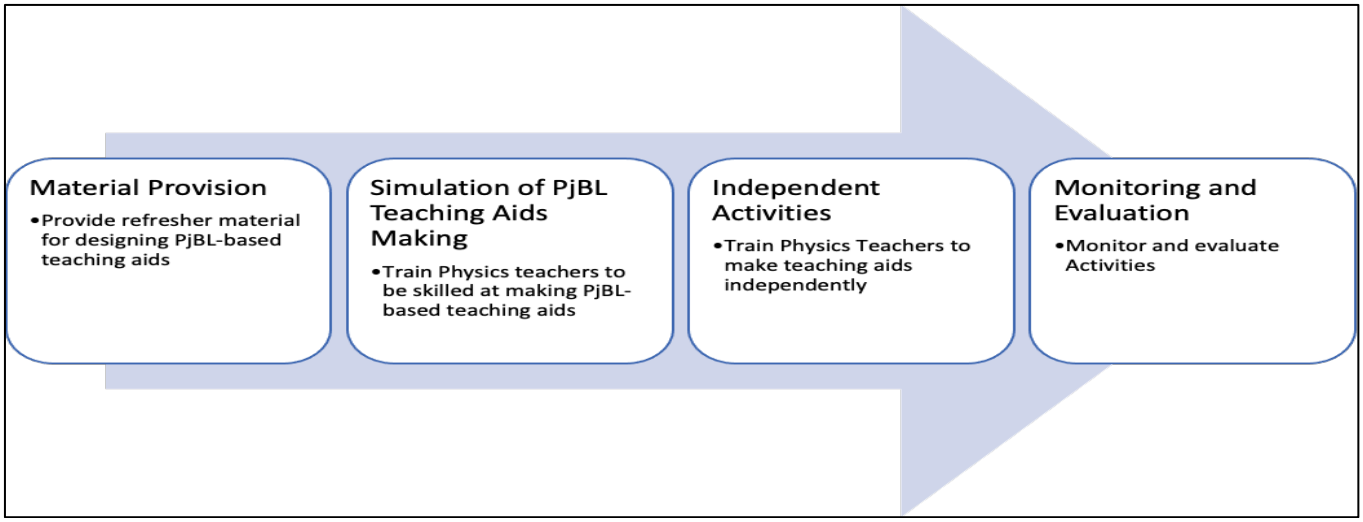

Figure 1. Research procedure

Assistance activities at the Physics Subject Teacher Deliberation (MGMP) for SMA Pasaman Barat Regency were structured and scheduled, with several stages/steps taken to solve partners' problems. The implementation of activities will be divided into four stages, as shown in Figure 1.

Provision of Materials

This material debriefing is the first stage of mentoring activities. At this stage, participants were given the material on 1) Physics learning using the PjBL model, 2) Merdeka curriculum, and 3) Preparation of PjBL-based Physics Practicum Student Worksheets (LKS). This provision aims to provide refresher material to physics teachers on designing physics lessons following the demands of the latest curriculum, namely the Merdeka curriculum. This stage stimulates physics teachers to increase motivation in teaching physics. Besides that, it can also teach physics teachers about visual aids and how to use them in learning.

Assistance in Making Physics Teaching Aids

In this second stage, the physics teacher is equipped with the skills to make simple visual aids that can be used in learning. The development of simple physics practice teaching aids can be made in two forms. First, equivalent tools are made by referring to examples of existing tools (practical tools, teaching aids, supporting tools) in the physics laboratory. For example, a simple electric bell or a Newton disc. Second, the prototype is a new tool that did not exist before, or it can be a development of an existing tool someone has made but then modified it. For example, a slide projector or a simple telescope. In addition, at this stage, the physics teacher is also assisted in making PjBL-based physics practicum worksheets.

Independent Activities

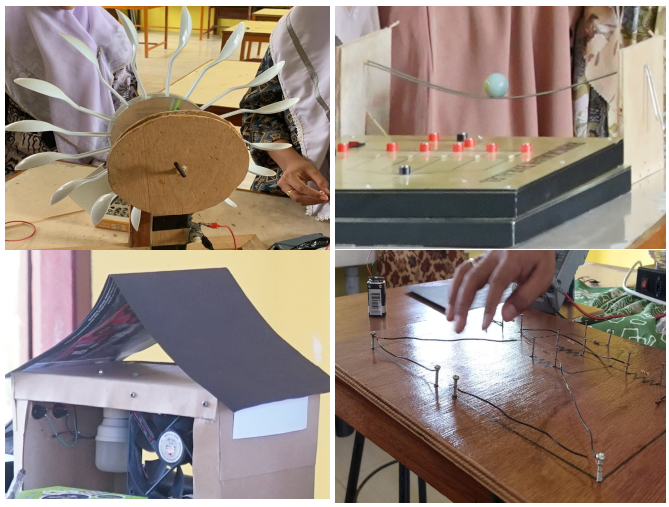

Figure 2. Product results props

In this third stage, the physics teacher performs activities independently in making simple visual aids and PjBL-based Physics practicum worksheets. Through this activity, it is expected that physics teachers can independently design and make the teaching aids needed in their learning. This independent activity provides opportunities for physics teachers in groups to design learning in class, especially practicum activities, to support the PjBL model. Independent activities produced several forms of teaching aids. Teaching aids produced in independent activities can be seen in Figure 2.

Monitoring and Evaluation

At the end of the activity, monitoring and evaluation of the physics teacher's ability to prepare lessons will be carried out, which includes the preparation of a Student Worksheet, selecting teaching aids that match the characteristics of the material, and

the use of these teaching aids in learning. In this activity, the process carried out by the teacher in making these teaching aids will be monitored and evaluated. This activity is carried out so that the teacher remains consistent in learning using simple Physics teaching aids.

The population of the study was all Physics teachers who were members of the Pasaman Barat Regency Physics MGMP. The research sample is physics teachers who fully participate in mentoring activities. This study's sample number was 18 MGMP Physics teachers in Pasaman Barat Regency. All participants in this mentoring took part in the activity five times the activity.

To see an increase in the ability of Physics teachers in the Pasaman Barat Regency to make PjBL-based teaching aids, tests were carried out before and after the mentoring activities. A research instrument was used to obtain data on improving the ability of these teachers' ability. *Research instruments* can collect data and information (D. Nuryadi, 2017; Sundayana, 2016). Research is taking measurements, so you have to use valid and good measuring instruments. The instrument used in this study is a test. This test consists of a pretest and a posttest in the form of multiple choice with equivalent questions between the pretest and posttest.

The data obtained from the mentoring activities for making these teaching aids are physics teacher mastery data in making PjBL-based teaching aids and compiling PjBL-based Physics practicum worksheets. To support the implementation of the Merdeka curriculum. Furthermore, the data obtained from this study were analyzed using descriptive statistical analysis to describe the pretest and posttest data. In this study, a normality test was used to determine the normality of the data; the homogeneity test was used to determine the similarity of the variants of the pretest and posttest data (Quraisy et al., 2021) . The Mann-Whitney test was used to determine the influence of the PjBL-based teaching aids on the competence of Physics teachers in Pasaman Barat Regency.

Result and Discussion

The effectiveness of assisting in the making of teaching aids based on PjBL is determined by a comparison between the achievement of the competence of the Physics teacher after and before the activity. The achievement of the competence of the Physics teacher related to the PjBL model and the Merdeka curriculum prior to the activity was determined from the results of the pretest. In contrast, the achievement of the competency of the physics teacher after the activity was determined from the posttest results. The results of the statistical analysis that has been carried out on the physics teacher's pretest and posttest scores can be seen in Table 1.

Table 1. Results of Statistical Analysis of Physics Teacher's Pretest and Posttest Scores in Pasaman Barat Regency

Descriptive Statistics	Value	
	Pretest	Posttest
N	18.00	18.00
Minimum	25.00	45.00
Maximum	60.00	80.00
Median	35.00	65.00
Range	35.00	35.00
Mean	39.44	63.61
Std. Deviation	12.82	10.12
Variance	164.38	102.37

From the results of descriptive statistical analysis for 18 Physics teachers who took part in the pretest and posttest, it can be explained the minimum and maximum scores, average scores, and standard deviations. The minimum and maximum pretest scores are 25 and 60, respectively, while the minimum and maximum posttest scores are 45 and 80. The mean and standard deviation values for the pretest are 39.44 and 12.82, respectively, while the average and standard deviation for the posttest are 63.61 and 10.12, respectively. The results of these descriptive statistics show that the average posttest score is higher than the average pretest score, with an increasing percentage of 24.17%.

A hypothesis test was carried out to analyze the difference between the pretest and posttest scores. To determine the type of statistical test used, prerequisite tests are first carried out as normality and homogeneity tests on pretest and posttest data (Santoso, 2014). The results of the normality test using the Shapiro-Wilk test with the help of SPSS 26 obtained data as in Table 2.

Table 2. Pretest and Posttest Data Normality Test Results

	Shapiro-Wilk			Information
	Statistic	df	Sig.	
Pretest	0.883	18	0.029	Data is not normally distributed
Posttest	0.951	18	0.442	Normal distributed data

From the Shapiro-Wilk normality test, the pretest significance value was 0.029, while for the posttest, it was 0.442. sig. Value pretest is smaller than the value of $\alpha = 0.05$, while the value of sig. posttest is greater than $\alpha = 0.05$. It means that the pretest data is not normally distributed, while the posttest data is usually distributed. So, one of the assumptions of normally distributed data is not met, namely the pretest data. The results of the data homogeneity test on the physics

teacher's pre-test and post-test scores can be seen in Table 3.

Table 3. Data Homogeneity Test Results

Levene's Statistic	F	df	Sig.	Information
2.195	39.410	34	0.148	Homogeneous Data

Based on the pretest and posttest data homogeneity test results, the significance value was 0.148. This signature value is greater than the value α = 0.05, so it can be stated that the data group has a homogeneous variance. Thus, the pretest and posttest groups come from the same variance.

Based on the results of the normality test and homogeneity test, it is known that one of the parametric test assumptions is not fulfilled. Therefore, the follow-up test is non-parametric, namely the Mann-Whitney test. The results of the analysis of the research hypothesis with the Mann-Whitney test can be seen in Table 4.

Table 4. Mann Whitney Test

	Pretest-Posttest
Mann-Whitney U	25
Wilcoxon W	196
Z	-4.359
Sig (2-tailed)	0.000

Table 4 above shows a U value of 25 and a W value of 196. When converted to a Z value, the value is -4.359. The significance value was obtained at 0.000. Where this value is smaller than α = 0.05, this analysis explains a statistically significant difference between the pre-test and post-test scores of Physics teachers in Pasaman Barat Regency. It can be concluded that assisting in manufacturing teaching aids based on PjBL can significantly improve the competence of Physics teachers in the Pasaman Barat Regency.

From the results of the research above, two things can be explained, namely: 1) the percentage increase in the competence of Physics teachers in making teaching aids based on the PjBL model is 24.17%, 2) the increasing competence of Physics teachers in making teaching aids based on the PjBL model can be said to be significant statistically with a confidence level of 95%. Physics teachers who are members of the Pasaman Barat Regency Physics MGMP who participated in training activities showed changes in knowledge competency in a better direction, with an increase of 24.17%. Before the activity, the Physics teacher did not understand well what the function of teaching aids was, how to design PjBL-based teaching aids and prepare PjBL-based physics practicum worksheets. However, after the mentoring was carried out, there was an increase in the Physics teacher's knowledge, as seen by an increase in the average pretest score to the posttest average score.

Following what Asrizal et al. (2020) state, technical guidance activities in the form of mentoring effectively increase the competency of activity participants, which in this case are Physics teachers in Pasaman Barat Regency. This activity is also beneficial for teachers in designing teaching aids to support physics learning in class according to the steps of an innovative learning model, namely Project Based Learning (Safaruddin et al., 2020). The results of this study are also consistent with Idham (2020) research conducted which states that technical guidance activities in the form of teacher competency training have an impact on increasing teacher competence. This is because the activities are structured and scheduled so that teachers can work optimally (Idham, 2020).

Conclusion

Based on the results of the research and discussion described above, it was concluded that the percentage increase in the competence of physics teachers in Pasaman Barat Regency in making PjBL-based physics teaching aids was 24.17%. In addition, the mentoring activities provided effectively increased the mastery of MGMP Physics teachers in the Pasaman Barat Regency of PjBL learning model material, making PjBL-based teaching aids and making PjBL-based physics practicum worksheets.

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