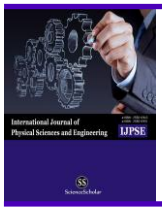

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# The Effectiveness of the Use of Portfolio Assessment by Controlling Prior Knowledge to Enhance Scientific Attitude among Senior High School Students

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**Abstract**

This study was aimed at investigating the effect of the portfolio in Physics teaching on scientific attitude by controlling prior knowledge. This study was conducted at public senior high schools in Singaraja by using the experimental method with single factor independent group design with the use of covariable. This study involved 152 Class X MIPA students of senior high schools as sample selected by multistage random sampling technique. Portfolio assessment was made by integrating it with Physics teaching. The implementation of portfolio assessment involved 4 basic elements: the presence of student's work folder, clear assessment criteria, self-assessment, and teacher and student conference. The data that were needed in this study were students' scientific attitude as the independent variable and prior knowledge as covariate variable. To obtain the data two types of instrument were used: 1) scientific attitude questionnaire that consisted of the dimensions of curiosity, respect for facts and evidence, willingness to change ideas, and critical reflection by using a Likert scale, and 2) prior knowledge test in the form of a multiple choice test using an interval scale. The data were analyzed with Analysis of Covariance (ANOCOVA) with the aid of SPSS Program 20.0 at Sig. □ = 0.05. The results of the study showed that there is a difference in scientific attitude between the students who learned Physics through portfolio assessment and those who learned Physics through conventional assessment. The result showed that portfolio assessment in Physics teaching is effective in enhancing students' scientific attitude.

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**Contents**



## 1. Introduction

The globalization era is followed by rapid development of knowledge and technology inseparable from science with its advanced position in exploring natural phenomena. Marjorie (2015: 7) states that learning science opens opportunities to apply the scientific method in developing a scientific attitude, especially in in critical reflection dimension based on scientific facts. Physics as part of science, scientifically, has thinking and understanding concepts integrated into the development of systems thinking skill and analysis. Naturally, Physics covers three entities: Physics as a process, Physics as product and scientific attitude. Hence, Physics teaching in an educational institution, especially in senior high schools should be able to educate graduates who are skillful and competent in developing mental processes to understand nature with its phenomena, to develop and apply physical concepts and to have a scientific attitude which enables them to think and act scientifically.

Students' scientific attitude needs to be developed from time to time through teaching so that the students can solve problems by applying physical concepts scientifically. Pitafi and Farooq (2012: 383) state that scientific attitude can be recognized from the action and the way of thinking based on scientific rules. Mukhopadhyay (2014: 98-100) states that scientific attitude is the characteristic of a scientist. A scientist is a person who solves problems and is in the habit of doing systematic research and validation so that new findings are obtained. It is because of the hard work of the scientists that the secrets of nature can be revealed. Hence, a scientist always has a high curiosity and always asks questions about every natural phenomenon. After that, the scientist tries to answer the questions through the scientific process.

Harlen (1991: 40) differentiates two kinds of scientific attitude: 1) attitude towards science as an asset for development, 2) an attitude toward objects and events in the scope under study as a scientific activity. In order that the students have a positive attitude toward science, they have to have a correct view of science. This can be done by developing a scientific attitude, that consists of curiosity, respect toward fact or evidence, ability to change ideas, and critical reflection.

However, it should be admitted that educational achievement in Science and especially in Physics in Indonesia is still far from expectation. The low quality of Indonesian human resources in global competition, especially in Science and Physics can be seen from the report published by Program for International Student Assessment (PISA), that is, an international systematic evaluation that is done to measure students' ability (aged 15) in reading literacy, Mathematics and Science once in every three years. The result of PISA study in 2012 places Indonesia at the 64$^{th}$ among 65 countries participating in the test. This shows that the ability of a 15$^{th}$ years old

child of Indonesia in Reading, Mathematics, and Science is still lower than children of the same age in other parts of the world.

The scope of assessment in Science literacy covers three dimensions: content, process, and context of science. The content dimension includes questions that cover a combination of Physics, Chemistry, Biology, Geography and outer space concepts. The process dimension involves the ability to use knowledge and scientific understanding, such as the students' ability to find, interpret and use evidence, to recognize scientific questions, to identify evidence, to draw a conclusion, to communicate a conclusion, and to show understanding of scientific concepts. The context dimension involves questions that cover daily life. The result of PISA study shows that the Indonesian student's scientific attitude aspects that are measurable are still low in the scope of Science literacy dimension.

This low students' scientific attitude obviously has an impact on the failure of Physics teaching process that has been conducted. There are many factors that influence the low students' scientific attitude. One of the dominant factors suspected to influence student scientific attitude is the assessment used by teachers in evaluating Physics teaching process and Physic learning achievement. In the learning cycle, assessment is one of the stages with the very important role and cannot be ignored Marhaeni (2005: 2) states that the assessment activity can at least produce two things: first, feedback to the teaching process, and secondly, information about the quality of the students' learning achievement. Furthermore, Suastra and Ristiati (2017: 25) state that assessment can be used to diagnose the strengths and weakness of the students, to observe students' progress, to determine students' ranks, and to determine the effectiveness of teaching that has been implemented by the teacher.

The assessment made in Physics teaching at school has so far used conventional assessment. Conventional assessment, in this case, is an objective test intended to know the students' learning achievement in practicum and in writing practicum reports which are done only by filling in student's worksheet. Through this assessment, one cannot know the mental activities done by the student in inventing Physic products. The use of this conventional assessment cannot record and encourage students to develop a scientific attitude.

In relation to Physics teaching, much effort has been made by the government to enhance Physics teaching quality in Indonesia. The efforts made include the provision of infrastructure and facilities (laboratories, libraries) improving teachers' quality through education and training, and improving the curriculum. In the curriculum 2013 that is now applied, there is an improvement in implementing teaching by using a scientific approach. Teaching with scientific approach is teaching that adopts a scientific procedure in developing knowledge through the scientific method. The scientific approach consists of five basic learning experiences: 1) observing, 2) questioning, 3) experimenting/collecting data, 4) associating, and 5) communicating.

The assessment model which is suitable for the teaching of scientific approach is an authentic assessment. Authentic assessment has a strong relevance for scientific approach since this kind of assessment is able to describe students learning achievement improvement, in observing, reasoning, experimenting, developing a network, etc. Authentic assessment is an assessment which is made comprehensively to assess input, process, and output of teaching which consist of attitude, knowledge, and skill. Assessment of attitude is made through observation by using a journal, self- assessment, and peer assessment. The assessment of knowledge is made through written tests, oral tests, and assignments. Assessment of skill is made through practice test project assessment and portfolio assessment.

Salvia and Ysseldike (1996: 293) define a portfolio as a collection of products used to demonstrate what a student has done, and by inference, what a person is capable of doing. Dantes, *et al* quote Paulson and Paulson who define a portfolio as a purposeful collection of student's works that exhibit the student's efforts, progress, and achievement in one or more areas. The collection must include the student's participation in selection, the criteria for selection, the criteria for judging merits and evidence of the student's self-reflection. Portfolio

assessment is an assessment of group of artifacts that show progress and is appreciated as real work in the world.

Portfolio assessment is a continuous assessment based on a collection of information that shows progress in students' ability in a certain period. Through portfolio assessment, the teacher can know the development or progress of the students' learning. For example their works in writing practicum reports. Based on this assessment, the teacher and students can do some corrections based on the requirement of the lesson.

Beside assessment, the teaching process is also influenced by internal factors in the student, such as interest, motivation, intelligence, self-concept cognitive style, prior knowledge, etc. The internal factor that is related to scientific attitude is prior knowledge. Prior knowledge is the knowledge that the student had before the teaching process in the classroom acquired in informal learning or daily experience and formal learning at school at the previous level. Hailikari (2009: 5–9) defines prior knowledge as the knowledge that consists of declarative knowledge and procedural knowledge, available before the teaching process in the classroom, can be remembered or reconstructed, relevant to the attainment of the aim of learning, composed in structured schemata, used for other learning tasks, and dynamical in nature.

In teaching, prior knowledge place an important role to achieve conceptual change. Students' prior knowledge of Physics concept to be developed by the students themselves through informal learning and formal education at a school at the previous level plays a very important role in forming scientific concepts. Prior knowledge is the basis for the teacher to start teaching process, the more intensively the teacher explores prior knowledge the easier it is for the teacher to design the teaching process.

Based on the explanation above, it can be predicted that portfolio assessment that is used in Physics teaching will influence the students' scientific attitude. Prior knowledge also contributed in determining the strengths of the student's scientific attitude. Prior knowledge is an internal factor that influences the student's scientific attitude. Prior knowledge needs to be controlled to know the pure effect of portfolio assessment in physic teaching on the student's scientific attitude.

## 2. Research Method

This study was conducted with the students of public senior high schools in Singaraja by using the experimental method with single factor independent group design with the use of co-variate. This study involved 152 students of senior high schools in class X MIPA as the sample, selected through multistage random sampling technique. The distribution of the sample of the study is presented in Table 1.

Table 1.
Distribution of Members of Experiment Group and Control Group

| No | School | Experiment Group | | Control Group | |
|---|---|---|---|---|---|
| | | Class | Number | Class | Number |
| 1 | SMA Negeri 2 Singaraja | X MIPA 1 | 35 | X MIPA 3 | 38 |
| 2 | SMA Negeri 4 Singaraja | X MIPA 7 | 40 | X MIPA 5 | 39 |
| | Total | 2 | 75 | 2 | 77 |

The experiment variable in this study was portfolio assessment. The experiment group with 75 students learned Physics with portfolio assessment, and the control group with 77 students learned Physics with the conventional assessment. Portfolio assessment in Physics teaching was an assessment of the process of writing and the product of Physics teaching task in the form of practicum reports. After treatment, data about students' scientific attitude were collected through scientific attitude questionnaire. Data about the student prior knowledge were collected before the treatment, both from the experimental group and the control group.

To measure scientific attitude variable scientific attitude questionnaire with the coefficient of reliability of 0.960 was used. The scientific attitude questionnaire consists of 41 items, with the ideal minimum score =1 and the ideal maximum score =205 so that the ideal mean score (Mi) = 123 was obtained and the ideal standard deviation (SDi) = 41 was also obtained. To measure the variable of prior knowledge, a prior knowledge test was used with the coefficient of reliability of 0.898. The prior knowledge test consists of 26 items, with the ideal minimum score =0 and the ideal maximum score =26, so that the ideal mean (Mi) =13 and the ideal standard deviation (SDi) =4.3.

Hypothesis testing used analysis of covariance (ANOCOVA) aided by SPSS program 20.0 at significance level $\alpha = 0.05$. The prerequisite testing of data analysis done before the hypothesis testing consisted of normality testing of data distribution, homogeneity testing of group variance, linearity testing, and the testing of the regression line.

## 3. Results and Analysis

The recap of the result of descriptive analysis of prior knowledge scores and scientific attitude scores are presented in Table 2.

Table 2.
Recap of the Results of Descriptive Analysis of Prior Knowledge and Scientific Attitude

| Statistic | Portfolio Assessment | | Conventional Assessment | |
|---|---|---|---|---|
| | Prior Knowledge | Scientific Attitude | Prior Knowledge | Scientific Attitude |
| Total Number of Data | 75 | 75 | 77 | 77 |
| Mean | 18.80 | 164.63 | 17.83 | 148.92 |
| Maximum Score | 25 | 186 | 24 | 185 |
| Minimum Score | 13 | 140 | 12 | 123 |
| Median | 19 | 165 | 18 | 150 |
| Mode | 17 | 170 | 19 | 150 |
| Standard Deviation | 2.68 | 9.83 | 24.70 | 2.67 |

The results of the descriptive analysis of scientific attitude in each dimension are presented in Table 3.

Table 3.
Description of Scientific Attitude Dimension

| Dimension | Portfolio Assessment | | | Conventional Assessment | | |
|---|---|---|---|---|---|---|
| | Mean | Std. Deviation | Category | Mean | Std. Deviation | Category |
| Curiosity | 42.45 | 4.26 | High | 41.82 | 4.24 | High |
| Respect for evidence | 36.32 | 4.38 | high | 36.68 | 3.73 | High |
| Willingness to change ideas | 40.49 | 5.65 | high | 34.78 | 6.14 | Average |
| critical reflection | 45.49 | 5.57 | high | 36.65 | 8.94 | Average |

The recap of the results of ANOVA and ANACOVA test are presented in Table 4.

Table 4.
The recap of the results of ANOVA and ANACOVA tests

| **Test of Difference** | | | |
|---|---|---|---|
| Effect | | F-Value | Sig. |
| Assessment | Scientific Attitude | 81.374 | < 0.001 |

| | | | |
|---|---|---|---|
| Assessment and Control of Prior Knowledge | Scientific Attitude | 77.278* | < 0.001 |

**Significance Testing of Difference**

| Effect | | Mean Difference | F-Value | Sig. |
|---|---|---|---|---|
| Assessment | Scientific Attitude | 15.705 | 81.374 | < 0.001 |
| Assessment and Control of Prior Knowledge | Scientific Attitude | 13.971** | 77.278 | < 0.001 |

* Residue F-Value ** Corrected Mean Value

Then the recap of the results of the co-variate contribution of prior knowledge to the dependent variable of scientific attitude is presented in Table 7.

Table 5.
The Recap of the Results of the Co-variate Contribution to Dependent Variable

| Regression | R | $R^2$ | $R^2$ Adjusted | F | Sig. |
|---|---|---|---|---|---|
| Prior Knowledge toward Scientific Attitude | 0.460 | 0.211 | 0.206 | 40.161 | < 0.001 |

The data of the students' scientific attitude for those who learned Physics with portfolio assessment have the minimum score =140, the maximum score =186, range =46, mean =164.63, standard deviation (SD) = 9.8.3, mode = 170, and median= 165. Based on the score classification, the scientific attitude of the students who learned Physics with portfolio assessment falls into the high category.

The data of the student's prior knowledge for those who learned Physics with conventional assessment have the minimum score =123, the maximum score =185, mean =148.92, standard deviation (SD) = 11.54, mode = 150, and median =150. Based on the score classification, the student's scientific attitude for those who learned Physics with conventional assessment falls into the low category.

The data of prior knowledge of the students who learned Physics with portfolio assessment have the minimum score=13, maximum score =25, mean=18.80, standard deviation (SD) = 2.68, mode= 17, and median = 19. Based on the score classification, the data of the student's prior knowledge for those who learned physic with portfolio assessment falls into the high category.

The data of the prior knowledge for the students who learned Physics with conventional assessment have the minimum score =12, the maximum score= 24, mean =17.83, standard deviation (SD) =2.67, mode= 9, and median=18. Based on the score classification, the data of the student's prior knowledge for those who learn physic with conventional assessment falls into the high category.

A further analysis of the description of scientific attitude in each dimension for those who learned Physics with portfolio assessment shows that all dimensions (curiosity, respect for facts for evidence, willingness to changes ideas, and critical reflection) fall into the high category. The description of scientific attitude for those who learned physics with conventional assessment in the curiosity dimension and respect for facts or evidence dimension fall into the high category, in the dimension of willingness to change ideas and critical reflection fall into the medium category.

The results of analysis of the difference in scientific attitude between the students who learned Physics with portfolio assessment and those who learned Physics with conventional assessment using analysis of covariance (ANOCOVA) aided with SPSS program 20.0 at the significance level $\alpha = 0.05$ yielded residue F-Value =77.278 and sig. < 0.001 and corrected mean difference= 13.971. This significance is below the determined significance level, and it means that there is a difference in scientific attitude between the students who learned Physics with

portfolio assessment and those who learned Physic with conventional assessment after prior knowledge was controlled.

The result of pairwise comparisons shows that the difference in the mean in scientific attitude between the group of student who learned Physics with portfolio assessment and the group of the students who learned physics with conventional assessment is 13.971, significant at sig. < 0.05. This means the scientific attitude of the students who learned Physics with portfolio assessment is significantly higher than that of those who learned Physics with the conventional assessment. The result of the study shows that the use of portfolio assessment in Physics teaching has a significant effect on the students scientific attitude after controlling prior knowledge.

The result of the study proves that Physics teaching with portfolio assessment has a positive effect on the student's scientific attitude. This positive effect is caused by the characteristics of portfolio assessment in Physics teaching which include the result of cooperation between the teacher and the students, selection process, self- assessment, and clarity of the criteria for evaluating the portfolio.

Portfolio assessment of the writing and the product of Physics teaching in the form of practicum report is very effective to develop a scientific attitude. The process for producing Physics product involves activities that follow scientific procedure or scientific process. With the requirement to write practicum reports according to the determined format, the presence of reflection and self-assessment, and the conference as feedback, all of which are evaluated by using an agreed upon rubric, so that the mental activities of the students can be identified. The scientific process done can encourage students to develop a scientific attitude which covers curiosity, respect for facts or evidence, willingness to change ideas and critical reflection. The presence of opportunities to revise the practicum report after receiving feedback and conference are very effective to develop attitude and willingness to change ideas and critical reflection. This is shown by the results that show that the attitude of the students who learned Physics with portfolio assessment in which all dimensions (curiosity, respect for fact or evidence, willingness to change ideas and critical reflection) fall into the high category. The scientific attitude of the students who learned Physics with conventional assessment in the dimensions of curiosity and respect for facts or evidence fall into the high category, in the dimensions of willingness teaching ideas and critical reflection fall into the medium category.

The results of the study support the result of the study done by Chi-Cheng Chang, Kuo-Hung Tseng, and Shi-Jer Lou (2012: 304) that in Physics teaching with portfolio assessment, there are reflection and self-assessment as well as the conference as feedback. The students tend to find more ideas or inspirations from comments given in portfolio writing and this encourages the students to revise the portfolio. The encouragement to revise portfolio is the way to make students willing to change ideas, which is one of the aspects of scientific attitude. The results also parallel to the finding in the study done by Mohammad Tawiland (2013: 1) who concludes that the implementation of portfolio based teaching model produces the ability of critical reflection better than the convention model. Similarly, Pramudya Dwi (2013) who finds that the development and implementation of authentic assessment can improve the students learning achievement which includes cognitive, psychomotor and affective aspects. The three elements that have been developing in this study are the profile of physic education students scientific ability.

In this study another variable had to be controlled, that is, prior knowledge. The variable of prior knowledge needs to be controlled because this variable is suspected to influence scientific attitude in the treatment process. The results of analysis shows that before controlling prior knowledge, F-value obtained F = 81.374 and after controlling prior knowledge, F-Residue obtained = 77.278. The decrease in this F-Value shows that in Physics teaching, prior knowledge influences students' scientific attitude.

The results of the analysis show that F-Value = 40.161 at a significance level < 0.001. This sig is smaller than the determined significance level, which means that there is a significant

correlation between students prior knowledge in learning Physics and their scientific attitude. The strength of the effect of the covariate of prior knowledge in Physics teaching on the dependent variable of students' scientific attitude yield $R^2$ adjusted = 0.206. The result of the further analysis shows that the students' prior knowledge gives 20.6% contribution to their scientific attitude. This result shows that in this study students' scientific attitude in learning Physics can 20.6% be explained by the covariate of prior knowledge.

In Physics teaching process, the effect of prior knowledge needs to be considered. Prior knowledge is knowledge processed by the students before teaching which is obtained through informal learning or daily experience and formal learning at school at the previous level. The students' prior knowledge of Physics can be in the form of inquiry process and Physics products which consists of concepts, principles, and rules of physics.

The students' prior knowledge about physics products invention will have a strong effect in the learning process in which there is a process to invent physics products. The process of inventing physics products is done through the scientific process or scientific method. The scientific process to invent physics products requires scientific attitude which includes curiosity, respect for evidence, willingness to changes ideas and critical reflection. The activity of inventing physics products which are based on their prior knowledge about this invention will help the students develop a scientific attitude.

The results of the study support Piaget's cognitive development theory that concludes that conceptual networks processed by individuals in their memory enable them to understand and combine new information. The information which fits with the existing schemata is easier to be understood and remembered than that which does not. The results of this study support the study done by Sudarma (2015) who concludes that the students with a high prior knowledge have a better scientific attitude than those with low prior knowledge.

## 4. Conclusion

a significant difference in scientific attitude between the students who learn Physics with portfolio assessment and those with conventional assessment after controlling prior knowledge, 2) Students prior knowledge in learning Physics contributes significantly (20.6%) to the student's scientific attitude. The result of a further analysis showed that the scientific attitude of students who learn Physics with portfolio assessment is higher than that of those who learn Physics with the conventional assessment. This means that portfolio assessment is effective in enhancing scientific attitude.

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