Basic Physics Learning Application Based on Value Use the Scientific Method to Improve Cognitive Abilities and Retention of College Student

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Abstract
This research aims to get an overview of the differences in the increase in cognitive abilities and retention of college students who get basic physics learning based on value use scientific methods and without use scientific methods, and get an overview of the relationship between retention and cognitive abilities of college students who get basic physics learning based on value use scientific methods. The research conducted use a quasi-experimental method with a randomised control group design pretest-posttest design. The population is all college students of the Physics Education Study Programme 2016-2017 odd semester at one of the Private Universities in Jakarta. Samples of two classes selected by cluster random sampling. The results showed that there was an increase in cognitive abilities and retention of college students in both classes. However, the magnitude of the increase in the experimental class was more significant than the control class. The normalised gain average score for cognitive abilities in the experimental class is 0.78 which meets the high criteria, and in the control class is 0.65 which meets the criteria of being. While the normalised gain average score for student retention resistance in the experimental class is 0.68 which meets the criteria of being, and the control class is 0.47 which meets the criteria of being. Based on the average difference test, at the 95% confidence level, the results of the study show that value-based basic physics learning using scientific methods can significantly improve cognitive abilities and college student retention resistance. In addition, the results of the study also showed that there was a strong and significant relationship between cognitive abilities and student retention resistance with a correlation value of 0.63.

Introduction

The era of globalisation requires the existed of quality human resources. One of the most important sectors that can improve the quality human resource is education. University is one of the most important education levels, this refers to the Law of the Republic of Indonesia Number 20 of 2003 on the National Education System.

A university also carries public trust by providing quality education through the Higher Education Quality Assurance System Programme, as stated in the Government Regulation of the Republic of Indonesia Number 19 of 2005, every Education Unit on formal and non-formal channels must carry out education quality assurance [1]. The education quality designation aims to meet or exceed the National Education Standards. Both of the competitiveness of graduates and other academic products. This of course is inseparable from the learning pro-
cess for students. One of the learning processes is for physics education students, as physics teacher candidates and researchers must able to develop students’ abilities both from the aspects of knowledge (cognitive), aspects of attitude (affective), and skills (psychomotor).

Private universities in the Jakarta area are very fast growing, therefore private universities must able to compete with other private universities and state universities to anticipate such rapid changes and challenges that are getting bigger and more complex in the world of education.

However, the results of preliminary observations for basic physics courses in several Private Universities show that achievement of competencies is not as expected. The results of preliminary observations in the realm of knowledge (cognitive) for several private universities are still low. According to some lecturers, achieving cognitive abilities is only limited to the level of remembering (C1), understanding (C2), and applying (C3), while the level of analysis (C4), evaluating (C5) and creating (C6) student achievement is still relatively low.

Besides the low achievement in the cognitive domain, student achievement for retention resistance is also still low. In fact, as a prospective teacher retention resistance must strong so that the learning objectives can achieved. According to Gagne, quoted by Dahar in an action learning there are phases associated with internal processes including the retention phase [2]. Winkel states that the retention phase is the storage of new information from short-term memory to long-term memory [3].

The low achievement of the knowledge domain (cognitive) and the weak student retention resistance thought related to the learning process that has not fully trained these abilities. Based on the results of observations, the learning process carried out more on the transfer of knowledge with the lecture method in the classroom, and problem exercises as reinforcement concepts. The process of learning basic physics is also done more with explanation of formulas. So as to make the learning process less meaningful for students. This learning process causes important concepts in physics that should invite students to think deeper to lost. Therefore, to overcome these problems a learning innovation needed that can meaningful to students and can train the cognitive domain and can strengthen student retention resistance. The innovation is by applying value-based basic physics learning using the scientific method.

The value-based basic physics learning process considered matching because it realizes integration of science and religion. This is in line with opinion of Ermawaty and Kusdiwelirawan who stated that integration of science and religion has important value to elimination the notion between religion and science are two things that cannot be united, and to prove that Religion (Islam) is not a conservative religion that does not accepting advances in science and technology, but open religion and revelation (Al-Qur’an) are sources or inspiration from all sciences [4]. This opinion is in line with statement from Usep stating that a Muslim sees the universe as the verses of Allah, therefore when observing and seeing natural phenomena, they not only try to get new findings in science, but also believe that in behind this so orderly universe there is the Supreme Creator [5]. The integration between science and religion is certainly closely related to the retention phase in the student’s internal learning process. Deese states that retention is a stage of storage of material that has studied [6]. Retention can also be interpreted as persistence of material that has learned in memory. While the scientific method is a learning method which has stages in scientific activities, namely the stages of observing, asking, reasoning, trying, and forming networks. hope through the use of scientific methods in value-based basic physics learning based on basic physics, cognitive abilities and student retention resistance will increased.

According to Anderson and Krathwohl Cognitive ability is a mental activity from the basic stage to a higher stage carried out by someone in thinking which includes aspects of remembering (C1), understanding (C2), applying (C3), analysing (C4), evaluating (C5), and creating (C6) [7]. While retention resistance is a storage of lecture material, according to Handayani, that retention phase is the storage of new information from short-term memory to long-term memory [8]. Optimal in student learning measured based on cognitive abilities, including in understanding the correct concepts to mastery of concepts. So that affects the storage of memory related to the lecture material he studied for a long time.

Based on description of the background of the problem, the purpose of this study is to get an idea of: (1) differences in the increase in cognitive abilities and retention resistance of students who get value-based basic physics learning using scientific methods and without using the scientific method, (2) the relationship between resilience retention with cognitive abilities of students who get value-based basic physics learning using the scientific method.

Methods

The method used in this study is a quasi-experimental method with a randomised control group design pretest-posttest design. This study uses two classes, one class as a control class and one class as an experimental class. The experimental
class received treatment in the form of value-based basic physics learning using the scientific method, while the control class received treatment in the form of value-based basic physics learning without using the scientific method.

The population in this research were all students of the Physics Education Study Programme 2016-2017 odd semester at one of the private universities in Jakarta. While the sample in this study were the first semester students as many as two classes selected by cluster random sampling.

The instruments used in this study are: (1) Multiple choice tests; used to measure cognitive abilities and college student retention in fluid material. Cognitive abilities developed are aspects of remembering (C1), understanding (C2), applying (C3), analysing (C4), and evaluating (C5). Tests conducted before learning (pretest) and after learning (posttest). The test instruments used have tested and analysed by validity test, reliability test, differential retention in both classes. The analysis carried out using hypothesis testing with the help of IBM SPSS Statistics 18 data processing software.

Classification of improvement characterised by the magnitude of $g$, which is a high criterion if $g \geq 0.7$; medium criteria if $0.7 \leq g \leq 0.3$; low criteria if $g < 0.3$.

After the normalised gain values of the experimental class and control class obtained, the criteria were then compared to see significance of improvement in cognitive abilities and college student retention in both classes. The analysis carried out using hypothesis testing with the help of IBM SPSS Statistics 18 data processing software. After the normalised gain values of the experimental class and control class obtained, the criteria were then compared to see significance of improvement in cognitive abilities and college student retention in both classes. The analysis carried out using hypothesis testing with the help of IBM SPSS Statistics 18 data processing software.

Data analysis continued by analysing the relationship between retention resistance and cognitive abilities of experimental class college students using correlation tests. Data processing done with the help of IBM SPSS Statistics 18. Data processing software interpretation of correlation values as follows: very strong criteria $0.8 \leq r \leq 1$; strong criteria $0.6 \leq r < 0.8$; medium criteria $0.4 \leq r < 0.6$; low criteria $0.2 \leq r < 0.4$; the criteria are very low $0 \leq r < 0.2$.

Results and Discussion

Analysis of the results of value-based basic physics learning on static fluid concepts done by comparing normalised gain values between experimental classes (value-based basic physics learning using scientific methods) with control classes (value-based basic physics learning without using scientific methods), results research shows that students' cognitive abilities for both the experimental class and the control class have increased. The average recapitulation of the pretest, post test and cognitive abilities of students between the experimental class and the control class presented in Figure 1. The normalised gain average score cognitive ability for the experimental class and control class is 0.78 (high criteria) and 0.65 (medium criteria).

Based on the results of hypothesis testing using the $t$-test obtained a signification value of 0.000 at the 95% confidence level which means that at the level of confidence 95% value-based basic physics learning using scientific methods in the experimental class can significantly improve students' cognitive abilities in static fluid lecture material compared to value-based basic physics learning without using the scientific method in the control class. Hypothesis testing done using the $t$-test because the increase in scores obtained is normally distributed and homogeneous.

![Figure 1: Average scores of pretest, posttest, and cognitive ability of experimental class (grey) and control class (light grey).](image)

The score for increasing cognitive ability in the control class is 0.65 which means that the basic physics learning process of students by integrating between religion and science can improve college students’ cognitive abilities. In the experimental class, a higher increase in score caused by the use of scientific methods in value-based physics learning.
Based on these results it can said that the steps in the scientific method also influence improvement of college students' cognitive abilities. The findings are in line with the findings expressed implicitly by Gardner that planting concepts to college students can done through college student disclosure both verbally, numerically, positivistic frameworks, thought frameworks in group life, and spiritual contemplation through a mental process of adaptation and transformation of science knowledge [10]. While the results of questionnaires filled out by college students showed that 100% of college students in the experimental class said that they were happy with the learning activities carried out.

The use of scientific methods in value-based physics learning in addition to effectively improving overall cognitive abilities is also effective in improving cognitive abilities for each aspect. In general, the use of the scientific method can further enhance every aspect of cognitive abilities, namely aspects of remembering (C1), aspects of understanding (C2), aspects of applying (C3), aspects of analyzing (C4), and aspects of evaluating (C5). Recapitulation of the normalised gain score on each cognitive aspect between the experimental class and the control class obtained shown in Figure 2.

Figure 2: Average gain scores normalised cognitive ability of college students in experimental classes (grey) and control classes (light grey) on every cognitive aspect.

Based on Figure 2, the order of increase in cognitive aspects in the experimental class from the smallest to the highest is in the aspect of analyzing (C4), aspects evaluating (C5), aspects of applying (C3), understanding (C2), and recalling aspects (C1). While the order of increase in cognitive aspects in the control class from the smallest to the highest is the aspect of evaluating (C5), aspects of remembering (C1), aspects of application (C3), aspects of analysing (C4), and aspects of understanding (C2).

The higher increase in each aspect of cognitive ability in the experimental class as an impact of the use of scientific methods, supported by the results of questionnaires filled out by students in the experimental class. The results of the questionnaire showed that of all students in the class whose learning process used scientific methods: (1) amounting to 90.07% of students said that the learning activities carried out made it easier for students to remember the concepts, (2) 84.19% of students said that the learning activities carried out made it easier for students to understand the concept, (3) 94.01% of students said that the learning activities carried out made it easier for students to apply the concepts learned, (4) 82.50% of students said that the learning activities carried out made it easier for students to analyze everyday phenomena related to the concepts learned, and (5) 85.06% of students said that the learning activities carried out made it easier for students to evaluation solutions to the concepts learned.

In addition to improving cognitive abilities, value-based basic physics learning using scientific methods can also improve student retention resistance. Recapitulation of the average student retention resistance between the experimental class and control class presented in Figure 3. Based on Figure 3 there is a difference in the increase in student retention resistance between the experimental class and the control class. Obtaining a normalised gain average score retention resistance for the experimental class and control class of 0.68 and 0.47, respectively. Obtained normalised retention gain average score in the experimental class and the control class included in the criteria. However, quantitatively, the difference in the increase in the retention score of the experimental class ranges from 0.21. These results according to the analysis of the researchers caused by the interval of giving tests...
obtained a correlation value of 0.63 with a significance level of 0.000 at the 95% confidence level, which means that retention resistance is significant associated with cognitive abilities and vice versa. Magnitude of the relationship between retention resistance and cognitive abilities characterised by a correlation value of 0.63, which means both are strongly related.

Conclusion

Based on the findings in the study, it can concluded that: (1) Value-based basic physics learning using scientific methods can significantly improve cognitive abilities and college student retention resistance compared to value-based basic physics learning without using the scientific method. (2) Retention resistance is significant related to the cognitive abilities of college students who treated with value-based basic physics learning using scientific methods with strong relationship categories. While to overcome the shortcomings of the results of the study it recommended that the use of scientific methods need to familiarised in every basic physics learning process because based on the results of the study proved to able to significantly improve student cognitive abilities and support college students in maintaining retention.

References