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Developing Physics Comprehensive Contextual Teaching Material Based on KKNI in Work and Energy for High School Students

Fitria Arifiyanti[1], Suparno[2]
Universitas Tanjungpura[1], Universitas Negeri Yogyakarta[2]
arifiyantifitria91@gmail.com[1], suparno_mipa@uny.ac.id[2]

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ABSTRACT
This research aimed to (1)produce Physics Comprehensive ContextualTeaching Material (PhyCCTM)based on KKNI which feasible in work and energy,(2)know the improvement of student's higher-order thinking skills (HOTS)by using PhyCCTM based on KKNI in work and energy, (3)know the improvement of student's scientific attitude by using PhyCCTM based on KKNI in work and energy, (4) know the effectivity of PhyCCTM based on KKNI in work and energy to improve student's HOTS and scientific attitude. The procedure of development in this research referred to the steps procedural model adapted from Borg & Gall model, which has six steps. Data collection techniques used interviews, written tests, questionnaires, and observations. Data analysis technique for the improvement in students HOTS and scientific attitude used the gain score to see its effectiveness and MANOVA to see the significance of the difference between the control class and the experimental class. The results of this research were as follows. (1) PhyCCTM based on KKNI can be reasonably used with the category of "Very Good." (2) PhyCCTM based on KKNI can improve student's higher-order thinking skills. (3) PhyCCTM based on KKNI can improve a student's scientific attitude. (4) PhyCCTM based on KKNI can improve student's higher-order thinking skills and scientific attitude.

INTRODUCTION

Fierce competition in various fields of life in the 21st century demands an increase in the quality of human resources, education quality, and its relevance to the needs of society. The improvement of education quality aims to prepare students to face competitive competition in various fields (Yulianto, Pramudya & Slamet, 2019). The improvement of education quality related to the improvement of learning quality in multiple subjects. One of the essential subjects that need to be improved is physics because it is a basic science for technological development.

Based on the results of the national examinations in West Kalimantan in 2015, the physics test scores were the lowest compared to chemistry and biology. The average score of physics was 54.69, chemistry 58.55, and biology 55.37, with a maximum score was 100 (Kemendikbud, 2015). It showed that the physics achievement of students was relatively low. The result from the research conducted by Permatasari, Wartono & Kusairi (2014) also showed that many students have difficulty in solving

HOTS physics problem about work and energy. The results of Ramos, Dolipas & Villamor (2013) research showed a relationship between Higher Order Thinking Skills (HOTS) of students and academic achievement in physics. Based on the data and the results of these studies indicated that many students who have difficulty in learning and understanding physics concepts and the ability of students to solve physics problems are still not optimal due to the weakness of HOTS.

The weakness of students HOTS in physics was proven based on the results of a preliminary survey that examined high school students HOTS in physics in West Kalimantan. The percentage of students HOTS in five schools were SMAN 7 Pontianak (50.7%), SMAN 1 Sungai Raya (55.8%), SMAN 1 Mempawah (52.3%), SMAN 3 Singkawang (51.1%), and SMAN 1 Rank (51.4%). Based on the results of a preliminary survey, students HOTS in West Kalimantan categorized in low criteria, with an average percentage of 52.26%. Therefore, research conducted with a focus on improving the students' HOTS in physics at SMAN 7 Pontianak categorized in the low category. Based on the data, real solutions in education are needed to improve students HOTS to obtain optimal physics learning outcomes.

Affective aspects also support optimal physics learning outcomes. One of the attitudes that must be developed in students in learning physics is the scientific attitude. Scientific attitude is a general assessment of someone on an object associated with science that is a facilitator and the result of learning science (Mulyasa, 2007; Sari, Sudargo, Priyandoko, 2018; Candrasekaran, 2014). Scientific attitude can help students in learning science, especially physics, so that students are motivated to study physics more deeply (Olusola, 2012). Based on the results of interviews conducted at the Physics teacher at SMAN 7 Pontianak, most students were less enthusiastic in learning. It showed the lack of a curious attitude and critical thinking of students in physics learning. Besides, the sense of responsibility and cooperation within the students is also lacking. It can be seen when students were given the task, such as group discussion. Only a few people were involved in the discussion, while other students do not dare to express their opinions. Because of this scientific attitude problem, the teacher's role is very important in developing students' scientific attitudes in physics learning. Lack of training the scientific attitude of students during the learning process causes students difficulties in learning physics, which results in low learning outcomes in physics. In addition, teaching materials used by students have not facilitated students to develop scientific attitudes that can help students learn physics.

One of the solutions to solve these problems is to develop teaching materials that can improve HOTS and the scientific attitude of students. Physics Comprehensive Contextual Teaching Material (PhyCCTM) is a teaching material that consists of the syllabus, lesson plans, teaching materials, students worksheets, and student evaluation sheets. PhyCCTM contains concepts and contextual physics material that can improve the ability of students to solve problems in the real world. In addition, PhyCCTM covers all aspects, namely cognitive, affective, and psychomotor. The cognitive aspects of PhyCCTM will be related to students' HOTS, and the affective aspects of PhyCCTM develop students' scientific attitudes. This teaching material is suitable to be used to improve students HOTS because it helps students in building their knowledge based on contextual cases presented in teaching materials so that students can solve the problems that they face in the real world. The results of research conducted by Latifah et al. (2015) and Broman & Pachmann (2014) also showed that contextual learning could increase the HOTS of students.

The PhyCCTM that was developed used the 2013 curriculum, which Indonesian National Qualification Framework (KKNI) as the basis for curriculum development. KKNI is a competency qualification selection framework that can equalize and integrate education, work training, and work experience to provide recognition of work competencies in accordance with the work structure in various sectors. KKNI implementation aims to improve the quality of human resources in all fields. KKNI consists of nine levels of qualifications. Qualification level is a level of learning achievement that is nationally agreed upon based on the results of education or training obtained through formal, non-formal, informal education or work experience (Dirjen Dikti, 2010: 18). However, there are no teaching materials that teach competencies that must be achieved at level 2 KKNI for high school education. Therefore it is necessary to develop teaching materials whose competencies are in accordance with level 2 KKNI as a guide. For high school students, all aspects contained in the PhyCCTM based on KKNI consisting of cognitive, affective, and psychomotor aspects that referred to the 2013 curriculum, which makes the KKNI as the basis for developing high school graduates' competencies in accordance with KKNI level 2 standards.

The Development of PhyCCTM based on KKNI improved students HOTS because it is a contextual teaching material so that students get physics concepts and case examples that are directly related to real life. Besides, contextual teaching materials can help students build new knowledge using the knowledge that has been obtained from the teacher to solve examples of problems in real life that are available in teaching materials. PhyCCTM can train HOTS students, such as the ability to analyze, synthesize, solve problems, make decisions, and use logic and evidence so that students are accustomed to solving problems that occur in everyday life. Cognitive aspects contained in the PhyCCTM based on KKNI are directed at increasing students HOTS. In contrast, affective aspects were directed at developing students scientific attitudes by enhancing students' physics learning outcomes through HOTS, and scientific attitudes of students, the quality of Indonesian human resources will also increase to face fierce competition in various sectors.

PhyCCTM based on KKNI, used the topic of work and energy. Solving physical problems related to work and energy requires analytical, reasoning, inference, and evaluation skills (Ding et al., 2011: 1). This ability is part of HOTS, so to study and solve the problems related to work and energy required HOTS. Based on research conducted by Istiyono (2014) regarding physics HOTS in high school students, work and energy were among the materials studied to analyze students HOTS. The results showed that the HOTS of high school students in DIY on work and energy materials was still relatively low. Therefore PhyCCTM based on KKNI, is expected to be able to improve students HOTS so that students can learn and solve physical problems related to work and energy materials. Thus the research aimed to develop PhyCCTM based on KKNI to enhance students HOTS on work and energy in XIth grade of SMAN 7 Pontianak was considered feasible and rational to do.

Based on the problems that have been described, the research conducted aimed to (1) produce a PhyCCTM based on KKNI that is feasible on work and energy in class XI IPA, (2) find out the increase in HOTS of students who take part in the learning process using a PhyCCTM based on KKNI on work materials and energy in class XI IPA, (3) find out the increase in the scientific attitude of students participating in the learning process using the PhyCCTM based on KKNI on work materials and energy in class XI IPA, (4) find out the effectiveness of the PhyCCTM based on KKNI on work and energy materials in class XI IPA to improve HOTS and scientific attitude of students, and (5) describe the effect of the use of PhyCCTM based on KKNI on the learning process to increase HOTS and scientific attitude of students.

RESEARCH METHOD

Types of Research

This type of research used in this study was research development, known as R&D (Research and Development). The development model used was adapted from the development model, according to Borg and Gall, with six stages of development. The six stages of development included the preliminary study stage, the planning stage, the stage of drafting the PhyCCTM based on KKNI product, the product validation stage, the product revision, and the testing phase and the dissemination stage.

Time and Place of Research

The study was conducted from October 2015 to April 2016. The development of the PhyCCTM based on KKNI and validation was conducted in October 2015 to January 2015. The trial was conducted in February 2016 to April 2016 at SMAN 7 Pontianak.

Research Targets/Subjects
The subjects were students of XIth Science of SMAN 7 Pontianak in the academic year 2015/2016.

Procedure
The development of the PhyCCTM based on KKNI began with library research and field surveys. Then proceed with content structure planning, core competency mapping, basic competency mapping, and concept and goal formulation. Then the PhyCCTM based on KKNI draft consisting of the syllabus, lesson plans, teaching materials, students worksheet, and student evaluation sheets was compiled. PhyCCTM based on KKNI was validated by expert lecturers and physics teachers and then revised. After that, the PhyCCTM based on KKNI was trialed at schools and revised II based on the results of limited trials. Then the PhyCCTM based on KKNI was retried on extensive trials, which resulted in revision III. Finally, valid products are produced and then disseminated through seminars or dissemination to schools.

Data, Instruments and Data Collection Techniques
The data obtained in the form of the results of the PhyCCTM based on KKNI validation and student assessment instruments, HOTS measurement test results, students 'scientific attitude questionnaires, and students' scientific attitude observations. The instrument used was the PhyCCTM based on KKNI validation instrument and the student assessment instrument, as well as the student assessment sheet, which consisted of HOTS measurement test sheets, student scientific attitude questionnaire sheets, and student scientific attitude observation sheets. Data collection techniques used interviews, written tests, questionnaires, and observations.

Data Analysis Technique
Data analysis of the validation results, the implementation of lesson plans, the results of students' questionnaire responses, and the results of observations of students' scientific attitudes were carried out by calculating the average score of these data and determining their categories. As for the analysis of the improvement in students HOTS and scientific attitude, the average score of the control class and the experimental class was calculated then the gain score was calculated to see its effectiveness. Furthermore, to see the significance of the difference between the control class and the experimental class, a MANOVA analysis was performed using SPSS.

RESULT AND DISCUSSION

Results
PhyCCTM based on KKNI in work and energy consists of syllabi, lesson plans, teaching materials, students worksheets, and student evaluation sheets. Based on the results of expert validation, namely lecturers and teachers, the PhyCCTM based on KKNI was declared eligible for use.

A. Preliminary Field Testing
Based on the results of a preliminary field testing obtained some data, namely the student response questionnaire data, the students' HOTS pretest, and posttest data, the students' scientific attitude pretest and posttest data, and the students' scientific attitude observation results. The data presented in Fig 1 shows that students responded very positively to teaching material, students' worksheets, and the learning process. The mean score of students' responses to developing teaching materials was 3.2 having very good criteria, the development students worksheet of 3.19 had very good criteria, and the average score of students' responses to the learning process was 2.87 having good criteria.

The description of students HOTS in preliminary field testing can be seen in Fig 2. Based on the results of the pretest and posttest in XIth Science 2, there was an improvement in students HOTS based on the pretest; namely, the average pretest score was 50.7, and the average posttest score was 65.9. The average gain score obtained was 0.3. In the calculation of the paired simple t-test obtained a significance of 0,000, meaning that there was a difference between the pretest and posttest scores after using the PhyCCTM based on KKNI developed. In conclusion, the use of PhyCCTM based on KKNI was able to increase students HOTS.

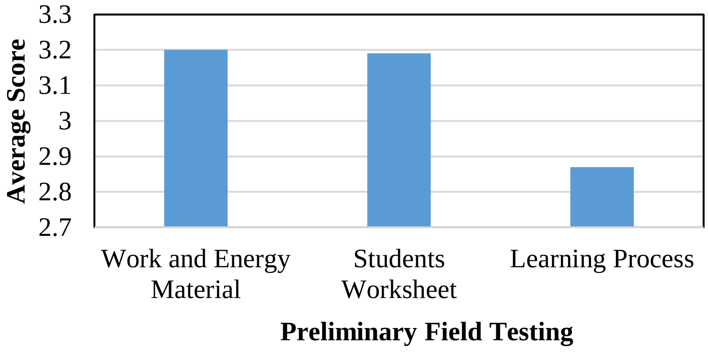

Fig 1. *Students Responses to Teaching Material, Students Worksheet, and Learning Process*

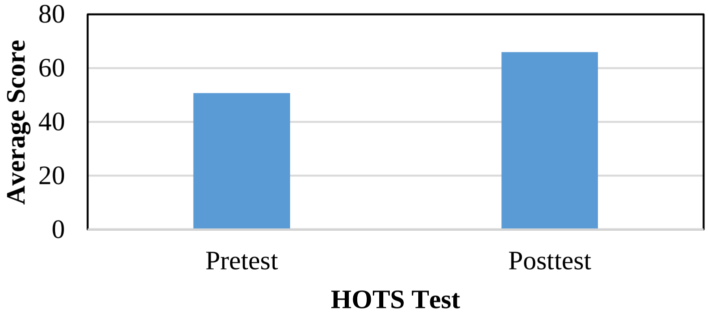

Fig 2. *HOTS Pretest and Posttest Scores in Preliminary Field Testing*

Based on the results of the students' scientific attitude questionnaire, it can be seen an increase in scientific attitude, namely the average scientific attitude pretest 69.24 and the average scientific attitude posttest 77.82. The average gain score was 0.3. In the calculation of paired simple t-test obtained a significance of 0,000, meaning that there was a difference between the pretest and posttest scores after using the PhyCCTM based on KKNI developed. The conclusion was that the use of PhyCCTM based on the KKNI developed can improve scientific attitude. A description of the scientific attitude of students in preliminary field testing can be seen in Fig 3.

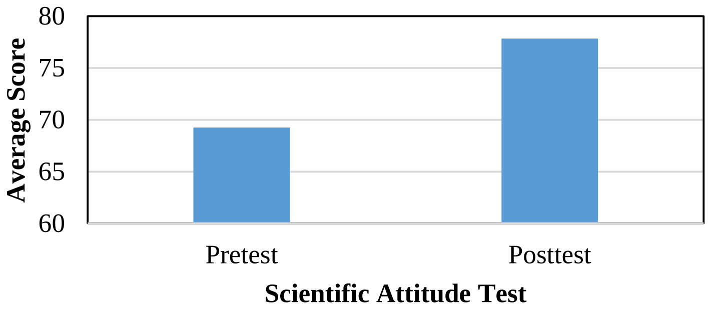

Fig 3. *Scientific Attitude Pretest and Posttest in Preliminary Field Testing*

The scientific attitude of students can also be observed by direct observation. The average score of scientific attitude in class XIth Science 2 based on observations of 70.31 is considered good.

The description of HOTS and the scientific attitude of students in the preliminary field testing can be seen in Fig 4. Based on the pretest and posttest scores in class XIth Science 2, it is known that there was an increase in the HOTS and scientific attitude of the students in control class, namely the average score of the HOTS pretest was 50.7 and the average score of the HOTS posttest was 65.9. The average score of the scientific attitude pretest was 69.24, and the mean score of the scientific attitude posttest was 77.82. The mean gain score can be seen in Fig 5. The average gain score of the HOTS score was 0.3. The mean score of the scientific attitude gain score was 0.3. In the calculation of the paired simple t-test, HOTS test obtained a significance of 0,000, meaning that there was a difference between the pretest and posttest scores after using the PhyCCTM based on KKNI developed. In conclusion, the use of the PhyCCTM based on KKNI was able to increase HOTS. In the calculation of the paired simple t-test, scientific attitude obtained a significance of 0,000, meaning that there was a difference between the pretest and posttest scores after using the PhyCCTM based on KKNI developed. In conclusion, the use of PhyCCTM based on the KKNI developed can improve scientific attitude.

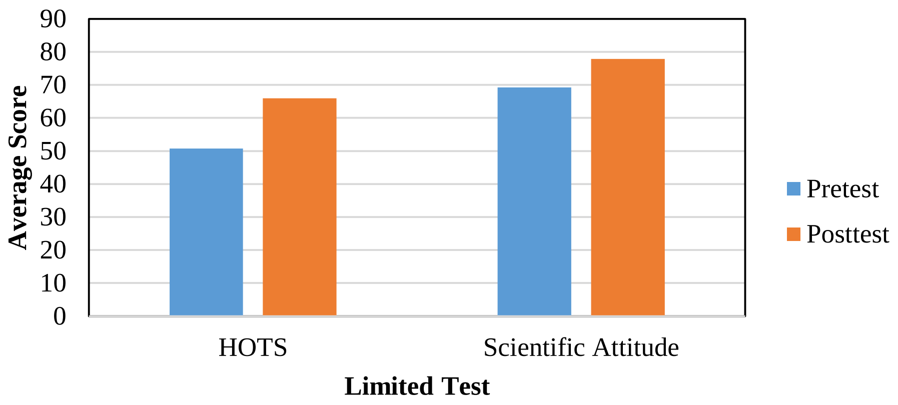

Fig 4. *The Comparison between HOTS and Scientific Attitude Pretest and Posttest Scores*

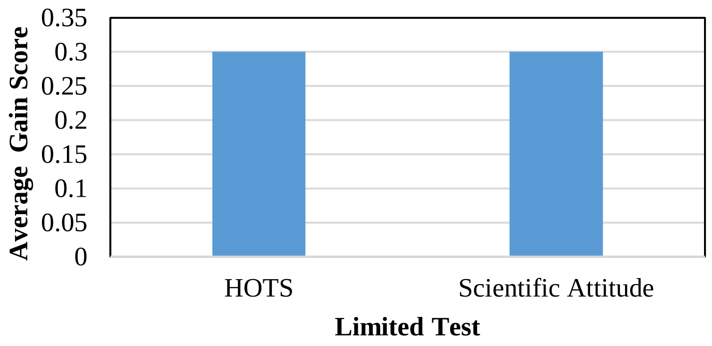

Fig 5. *The Comparison between HOTS and Scientific Attitude Average Gain Score*

Determination of the validity and reliability of HOTS questions using the Winsteps program for the Rasch model. The reliability score of the HOTS questions was 0.98, with a very good category (> 0.8). The validity scores obtained can be seen in Table 1 to determine the criteria for valid questions or cannot be seen from the score of outliers or misfits received if they meet the two MNSQ, ZSTD, or Pt Measure Corr scores. This validity and reliability prove that the quality of results/data can be trusted and valid.

Table 1. The Results of Questions Validity Analysis of HOTS Measurement

Question Number	MNSQ	ZSTD	CORR	Validity
7	2,14	3,9	0,02	Valid
11	1,61	2,6	0,12	Valid
6	1,60	3,0	0,12	Valid
10	1,16	1,0	0,36	Valid
3	1,17	1,7	0,52	Valid
9	1,01	0,1	0,25	Valid
2	0,92	-0,6	0,51	Valid
4	0,90	-1,0	0,65	Valid
1	0,92	-0,7	0,42	Valid
5	0,84	-1,7	0,53	Valid
12	0,83	-1,6	0,40	Valid
8	0,46	-5,2	0,39	Valid

B. Main Field Testing

Achievement of HOTS and students' scientific attitude was calculated using standard gain, which was the comparison between the difference between the pretest and posttest scores with the difference between the maximum score and the pretest score. The average standard gain between the control and experimental class can be seen in Fig 6.

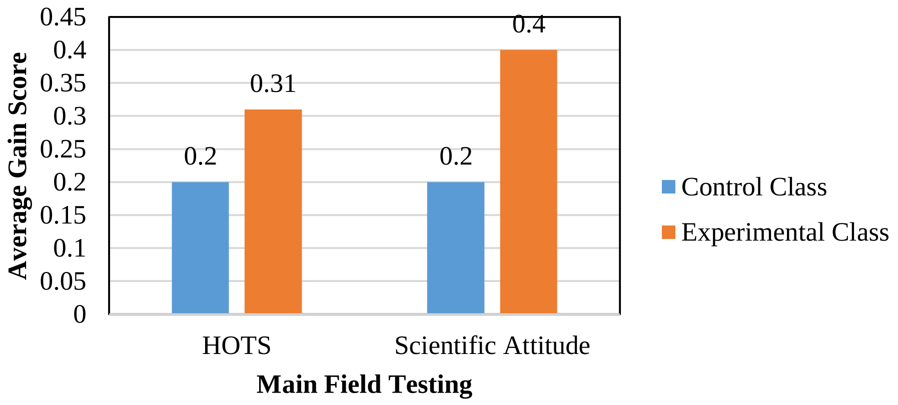

***Fig 6.** Mean HOTS Standard Gain Score and Scientific Attitude*

The data presented in Fig 6 showed that the average gain increases, the average gain of the HOTS standard of the experimental class reach 0.31 with the medium category, and the control class reaches 0.2 with the low category. The average gain of the scientific attitude standard of the experimental class reached 0.4 with the medium category, and the control class reached 0.2 with the low category.

In multivariate analysis, it can be seen in Table 2 that Sig. of F from Wilks was 0,000 < 0.05, then H0 was rejected. It can be concluded that there was a significant difference in the average HOTS (Y1) and scientific attitude (Y2) between students taught with PhyCCTM based on KKNI and students taught by teacher learning tools.

Table 2. Hypothesis Analysis Result

	Score	Sig.
Wilk' Lambda	0.147	0.000

The data presented in Fig 7 showed that students responses to teaching materials, students worksheet, and the learning process was good. The mean score of students' responses to teaching material was 2.7, the average score of students' responses to students' worksheets was 2.8, and the average score of their students' responses to the learning process was 2.72.

Fig 8 showed the results of observations of the scientific attitude of students categorized as good in the experimental class. The mean score of scientific attitude observation in the control class was 2.75 categorized as good, and the average score of scientific attitude observation in the experimental class was 2.92 categorized as good.

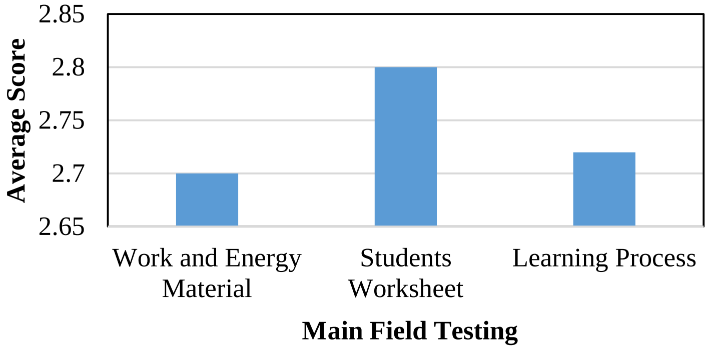

Fig 7. *Class XI Science Student Response 3 (Experimental Class)*

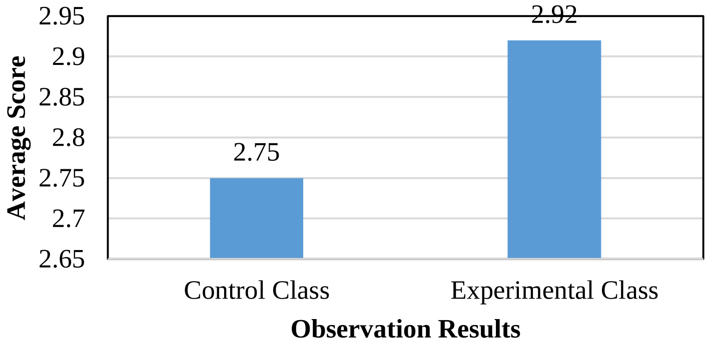

Fig 8. *Observation Results of Scientific Attitude of Main Field Testing*

Discussion

PhyCCTM based on KKNI in Work and Energy has been developed by following the modification steps of Borg & Gall. The PhyCCTM based on KKNI in this research development has undergone three revisions. In the first revision, they received some input, including from the supervisor, then got validation (from the media and material expert lecturer), as well as the physics teacher's validation at the development stage. The second revision gets input from the results of preliminary field testing and observations during learning. The third revision gets input from the results of main field testing, both students' responses and observations during the learning process. In main field testing, an evaluation was carried out both in the form of tests and non-tests to determine the effectiveness of the PhyCCTM based on KKNI in improving HOTS and scientific attitudes of students.

PhyCCTM based on KKNI in Work and Energy consists of the syllabus, lesson plans, teaching materials, students worksheet, Students HOTS Measurement Sheet, Lesson Plan Implementation Observation Sheet, Student Response Questionnaire, Scientific Attitude Questionnaire, and Scientific Attitude Observation Sheet. In order to improve students HOTS and scientific attitude, PhyCCTM based on KKNI was implemented in learning using the Contextual Teaching and Learning model, the Science, Technology, and Society approach, the question, and answer method, discussion, and experiment.

Data analysis from expert lecturer validation showed that the assessment of PhyCCTM based on KKNI on the average score on the syllabus was 3.41 categorized as very good criteria. The average score of the lesson plan was 3.58 categorized as very good. The average score on teaching material was 3.46 categorized as very good. The mean score on students worksheet 3.5 categorized in very good criteria, the mean score on the HOTS measurement sheet 3.5 categorized in very good criteria, the average score on the observation sheet of RPP 3.59 categorized in very good criteria, the average score on the sheet Student responses questionnaire 3.59 categorized in very good criteria, the mean score on the scientific attitude questionnaire sheet 3.6 categorized in a very good criterion, and the mean score on the scientific attitude observation sheet 3.45 categorized in very good criteria.

Data analysis from the validation of the Physics Teacher showed the assessment of the PhyCCTM based on KKNI. The average score of the syllabus was 3.5, categorized in very good criteria. The mean score of the lesson plan was 3.58, categorized in very good criteria. The average score of the teaching material was 3.54, categorized in very good criteria. The average score of students worksheet was 3.54 categorized in very good criteria. The average score of HOTS measurement was 3.66 categorized in criteria. The average score of the observation sheet of lesson plan implementation was 3.92 categorized in very good criteria. The average score of the Students' responses questionnaire was 3.75 categorized in very good criteria. The mean score of the scientific attitude questionnaire was 3.65 categorized in very good criteria. The average score on the scientific attitude observation was 3.7 categorized in very good criteria.

Testing in the learning process proved that students respond positively to teaching materials, students' worksheets, and the learning process. The results proved that PhyCCTM based on KKNI could improve students HOTS and scientific attitude. It is accordance with study conducted by Ardan (2016) that found out teaching material can improve students scientific attitude. To be more significantly tested with MANOVA with a significant result of 0,000, so it can be seen that there were significant effectiveness differences on the average HOTS (Y1) and scientific attitude (Y2) between students taught with PhyCCTM based on KKNI and teacher's teaching material. The PhyCCTM based on KKNI developed can improve students' HOTS and scientific attitude. It was supported by Prastowo (2011: 25-26), which stated that the function of teaching materials for students was a guide in the learning process and a competence substance that should be learned. Therefore through PhyCCTM based on KKNI, the competency substance related to HOTS and scientific attitude can be trained and developed by students to increase HOTS and scientific attitude of students. Thus the PhyCCTM based on KKNI was appropriate to use in learning physics in the work and energy while increasing HOTS and scientific attitude of students.

The advantages of PhyCCTM based on KKNI include all aspects consisting of cognitive, affective, and psychomotor aspects. The cognitive aspects of PhyCCTM based on KKNI emphasize HOTS, which includes the ability to analyze, evaluate, and create. In addition, PhyCCTM based on KKNI was contextual, making it easier for students to understand Work and Energy because of the material, examples of concepts, and practice questions on the PhyCCTM based on KKNI related to problems that occur in the students daily life. Experiments contained in students worksheets also require the students' HOTS because students designed the experiments in groups based on the purpose of the experiment and the tools and materials provided. Therefore, PhyCCTM based on KKNI was suitable to be applied to increase students' HOTS. PhyCCTM based on KKNI also emphasizes improving the scientific attitude of students through the presentation of the scientific attitude dimensions on teaching material and students worksheet. Students were expected to develop scientific attitudes and making it easier for students to understand the concepts of physics that can also increase students HOTS.

Besides, PhyCCTM based on KKNI was also based on the 2013 curriculum because it used KKNI, which was the basis for developing the 2013 curriculum so it can be an alternative for teachers in developing physics teaching materials based on 2013 curriculum. The limitations of researchers in the process of developing PhyCCTM based on KKNI were teacher's ability to manage to learn well because students who are not familiar with HOTS will tend to be confused when required to analyze, evaluate and create. The guidance from the teacher was important so that the learning process takes place smoothly and the learning time allocation in accordance with the implementation.

CONCLUSION AND SUGGESTION

Conclusion

Based on the results of the study, it can be concluded that PhyCCTM based on KKNI on work material and the energy produced was feasible to use. KKNI-based, PhyCCTM on work and energy increased students HOTS. PhyCCTM based on KKNI on work and energy also improved students scientific attitude. PhyCCTM based on KKNI on work materials and energy effectively increased students' HOTS and scientific attitude.

Suggestion

PhyCCTM based on KKNI can be further developed with different materials and levels. It also can be added to the required skills following the applicable curriculum for students. In addition, PhyCCTM based on KKNI can be used in physics learning because it was contextual so that it made it easier for students to understand physics concepts because the material, examples, and practice questions were presented based on daily activities.

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