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The Development of Physics Teaching Materials Based On Local Wisdom To Improve Students' Critical Thinking Ability

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ABSTRACT

A research and development study had been conducted to evaluate the appropriateness of local wisdom based physics teaching material in order to increase students' critical thinking skill. This study was based on 4-D development model including Define, Design, Develop, and Disseminate. Data was gathered from 30 research participants in SMK Kristen Fautmolo. Observation, interview, questionnaire and test were data collection techniques. Before applying the instruments in data field, validation was garnered from 4 physics experts with 3.75 total score in very good category which indicated the developed material's applicability in teaching and learning process. The result revealed that the local wisdom-based physics teaching material was effective to improve students' critical thinking skill with 0.80 of N-gain score (high) and 89.91% of students' responses toward learning using the material. Therefore, it could be concluded that the developed local wisdom-based physics material was appropriate to be used in physics learning and could improve student's critical thinking skill.

INTRODUCTION

Education is a process of someone's or particular group's attitude and behaviour transformation in order to be matured through teaching and training. This process can run smoothly, conducive, and interactively in teaching and learning process if it is implemented well and being ultimately supported by curriculum [1]. Primarily, the current 2013 curriculum which supports learning can make use of culture in which it is responsive toward the development of science, culture, technology and art that in result cultivates students' curiosity and skill to utilize them correctly [2].

Physics is a fundamental science as it functions as basic of science learning, materials structure, and their interaction in order to comprehend natural and human-made system. Based on the definition, physics concepts are important to be acquired but some studies reveal that secondary school students have difficulties in physics learning [3-4].

Physics learning in SMK Kristen Fautmolo was teacher-centered which caused students to mostly listen, copy, and memorize taught materials whereas in learning process, teacher emphasized more on

knowledge and rarely related the concepts with learning media available in students' surroundings. This was found in the result of interview with physics teacher and observation during physics class in the school. 60% showed that during learning process, teacher was mainly active than students and acted as main source to problem solving which made students to lack in critical thinking ability in order to solve problems, lack of comprehension, and mastered the concepts. Besides, the applied teaching device was not related to the environment and traditions of the community. The consequence was low thinking ability to master concepts which made students less critical in solving problems. Hence, teaching materials which connected physics concepts and local wisdom were needed to help students understand concepts and enhance their critical thinking competence.

Upgrading learning effectiveness could be achieved by designing learning device, defining learning method, and using teaching relevant materials to ease students in expanding their critical thinking skill to grasp concepts. Critical thinking is a success learning indicator [5]. It was meant to explore clarity by questioning all aspects related with intended information in detail to gain truth from the information and draw objective conclusion [6]. Thinking cultivation is preferred to be done by education practitioners as it maximized thinking tendency to better direction.

As facilitators, teachers bore the demand to actively designing learning process in appealing fashion for their students. An alternative of these interesting designs was to develop local wisdom-based physics teaching material. It indicated that this design could link physics concepts with experiences students had. Local wisdom is life perception and science also varied life strategies realized in local community's activities to answer problems encountered while fulfilling their life necessities [7]. Local wisdom included everything that characterized a region in form of food, customs, dances, folks or traditional rites [8]. Local wisdom also take parts as the life guidance, science and various life strategies that are manifested in the activities of local communities to answer various problems needs in community members [9].

Efforts that teachers could do to improve students' inner understanding was to relate their daily experiences or concepts existed in their minds with learning contents being discussed. This point was in accordance with the proposition [10] that students who gained knowledge through direct experiences could improve their cognitive domain easier. Learning using ethno-science approach gave learners comprehension to appreciate nature and apply science in daily life [11]. Ethno-science is the activity of transforming natural science into scientific science [12]. This type of learning would provide relevance to students concerning learning they faced with real life events. This study aimed to develop local wisdom-based physics teaching material which could improve students critical thinking ability.

METHOD

This research was conducted using research and development method that utilized the 4D development model. This model consisted of 4 development stages including define, design, develop, and disseminate.

The first stage was define in which needs analysis, core competence and basic competence analysis, students and concepts analysis were undertaken sequentially to depict fundamental concepts in the developed teaching material which would be the teaching material design's principle (1st draft). The second was design stage that covered designing components of the local wisdom-based physics teaching material including local wisdom texts and pictures, followed by questions that practise learners' critical thinking skill. The third was develop phase which aimed to produce proper local wisdom-based physics teaching material theoretically (2nd draft). This phase comprised experts' analysis and validation. The first draft was then analyzed by 3 physics lecturers and a physics teacher to obtain feedbacks as consideration source to correct the draft into second draft which was ready for a trial. The last was disseminate stage conducted in SMK Kristen Fautmolo by implementing the local wisdom-based physics teaching material in physics class to identify the subjects' critical thinking skill.

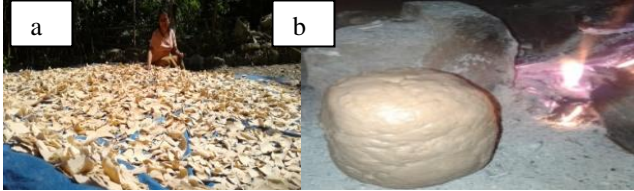


Data collection techniques were questionnaire and test whereas the instruments used to collect data were questionnaire for validation, multiple choice test items, and students' responses questionnaire toward the developed material. Data analysis technique for for the teaching material and questionnaire validity was percentage technique to diagnose the appropriateness of the applied teaching material and students' responses questionnaire. Students' critical thinking skills test items were analyzed using normality gain test [13].

RESULTS AND DISCUSSIONS

Local wisdom applied in this study was traditional sago processing from coryphaor gebang palmtree in South Middle Timor regency. The process was traditionally manual begun by cutting the trunk, cross-cutting the trunk in particular size, separating sago pith from the trunk, slicing, draining under the sun or fogging during rain, graining, sieving, washing/soaking, dryingsago starch's sludge, and sago combustion. Among the phases, sago draining, sago starch's sludge draining, and sago combustion were selected and related to calor transfer material in order to produce local wisdom-based physics teaching material on heat transfer topic.

This study was done in three times meeting under thermal conduction, convection, and radiation topic. The relationship of sago processing local wisdom and physics concepts can be seen in Table 1.

Table 1. The relationship of sago processing local wisdom and physics concepts

Sago processing stages	Physics concepts
 <p>Fig 1. (a) Sago draining, (b) Sago starch's sludge draining</p>	<p>In sago draining process under the sun and sago starch's sludge draining, thermal radiation occurred.</p>
 <p>Fig 2. Sago fogging</p>	<p>Sago draining during rainy days was done with <i>sei</i> tradition in which sagos were laid on attic (<i>pana</i>) for fogging process. This fogging process indicated thermal convection.</p>
 <p>Fig 3 . Sago combustion process</p>	<p>The mixture of sago dough was poured into mold (<i>lana</i>) to be ignited. In this stage, thermal conduction happened.</p>

The appropriateness result of local wisdom-based physics teaching material and students' responses questionnaire.

Teaching material's validation result was presented in Table 2 and 3.

Table 2. Calculation of Teaching Material's Validation

No	Assessed Aspects	Assessment Score				Average	Criteria
		Average by Validator					
		1	2	3	4		
1	Material's appropriateness	4,00	3,33	4,00	4,00	3,83	Very Good
2	Register	4,00	3,50	3,50	3,50	3,62	Very Good
3	Concept's truth	4,00	4,00	4,00	4,00	4,00	Very Good

Table 3. Calculation of Validation Teaching Material's Construction

No	Assessed Aspects	Assessment Score				Average	Criteria
		Average by Validator					
		1	2	3	4		
1	Teaching material's components completeness	3,87	3,50	3,62	3,75	3,68	Very Good
2	Register	4,00	3,50	4,00	3,75	3,81	Very Good
3	Graph components	3,00	4,00	4,00	3,33	3,58	Good

The average score was 3.75 with very good criterion based on Table 2 and 3 so the teaching material could be used without revision. Thus, in could be concluded that the developed material was appropriate to be implemented in physics learning.

Students' responses questionnaire was constructed to identify their responses toward learning using local wisdom-based physics teaching material. The developed questionnaire was then validated by physics education practitioner and experts as presented in Table 4.

Table 4. Calculation of Students' Responses Questionnaire Validation

No	Assessed Aspects	Assessment Score Average by Validator				Average	Criteria
		1	2	3	4		
		1	Instruction	4,00	4,00		
2	Learning elements scope	3,33	3,00	3,50	3,33	3,29	Good
3	Register	4,00	4,00	4,00	4,00	4,00	Very Good

Based on Table 4, the average score of all sapects was 3.76 with very good criteria. This implied that the students' responses questionnaire was applicable for the research.

Effectiveness Test of local wisdom-based physics teaching material

Students' critical thinking skill improvement was evaluated based on pretest and posttest result. Pretest was administered before learning process using local wisdom-based physics teaching material meanwhile posttest was given after learning process using local wisdom-based physics teaching material. The progress in their critical thinking skill was observed using N-gain test formula. The result implied that whole students were effectively experienced improvement to think critically on heat transfer

topic using local wisdom-based physics teaching material. This conclusion was drawn based on the improvement of 47.42 pretest score average into 89.67 posttest average score. N-gain test result produced 0.80 score or high category. The posttest result indicated that 93.33% students completed their learning and 6.67% students did not complete their learning. The percentage of students' learning completeness could be achieved by applying local wisdom-based physics teaching material. The detailed calculation of students' critical thinking skill achievement level was presented in Figure 4.

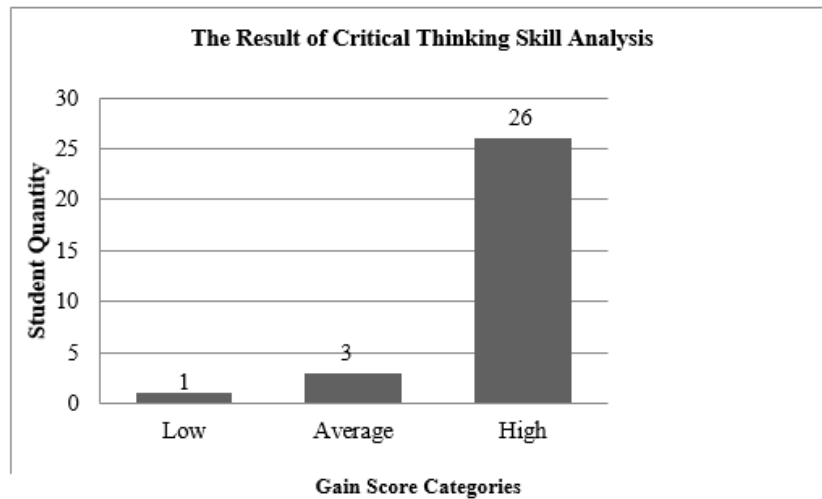


Fig 4. The Result of Critical Thinking Skill Analysis

Figure 4 displayed that 26 students accomplished high achievement category, 3 students on medium category, whereas 1 student was in low achievement category. Further, *t*-test formula was used to measure the significance of students' improvement to think critically using pretest and posttest result. The test was ran to know significant improvement of score between pretest and posttest in which the value of $t_{count} 15.19 > t_{table} 1.70$ with 0.05 level of significance. The data revealed that t_{count} was higher than t_{table} therefore a conclusion could be drawn that there was significant improvement on students' score before and after applying local wisdom-based physics teaching material.

The calculation of each critical thinking skill indicator's achievement level in detail was shown in Figure 5.

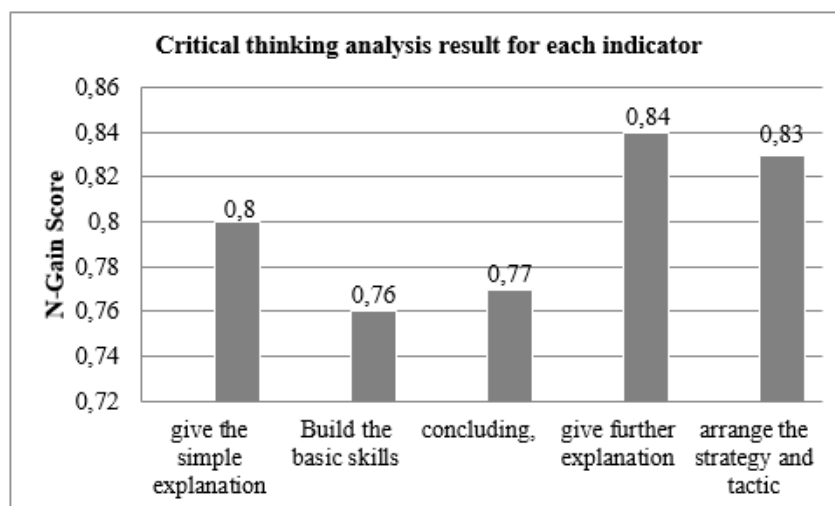


Fig 5. Analysis Result of Critical Thinking Skill Per Indicator

Figure 5 depicted that N-gain score of each indicator was in high category. Relying on the analysis result of students' improvement, it was found that the developed teaching material could improve their critical thinking ability. Physics learning by making use of local wisdom was a learning experience that enabled learners to expand their cognitive, affective, and psychomotor competence. Students were offered opportunity to discover inherited concepts and customs surrounding them by themselves and develop critical attitude in solving problems.

Learning using local wisdom-based physics teaching material encouraged students to grasp concepts and enhance their critical thinking skill in problem solving, either in the context of heat transfer topic or in their daily lives based on their local tradition. This point was in line with research result [10] and [14] that ethno-science based learning could increase students' cognitive and critical thinking ability. Local custom oriented learning could also improve students' critical thinking skill [15]. The developed teaching material was local wisdom based which meant that the teaching material did not merely present the information of heat transfer from its scientific context but also relate the theory with their cultural comprehension, in this case traditional sago processing procedure. This idea was supported by [16] that local wisdom oriented learning involved students and their life traditions actually gave more contextual impression since it was directly connected with their custom and students' personal experiences. In the developed material, there were reasoning, observing, questioning, evaluating comprehension and reviewing activities with the purpose of improving students' critical thinking skill.

Analysis Result of Students' Responses toward Local Wisdom-Based Physics Teaching Material

The detailed questionnaire's analysis result of the developed material was presented in Table 5.

Table 5. Data Result of Students' Responses

No	Student's Code	Percentage (%)	Predicate	No	Student's Code	Percentage (%)	Predicate
1.	St1	82,50	Very Positive	16.	St16	77,50	Positive
2.	St2	92,50	Very Positive	17.	St17	82,50	Very Positive
3.	St3	72,50	Positive	18.	St18	90,00	Very Positive
4.	St4	90,00	Very Positive	19.	St19	95,00	Very Positive
5.	St5	75,00	Positive	20.	St20	77,50	Positive
6.	St6	92,50	Very Positive	21.	St21	100,00	Very Positive
7.	St7	87,50	Very Positive	22.	St22	92,50	Very Positive
8.	St8	70,00	Positive	23.	St23	72,50	Positive
9.	St9	82,50	Very Positive	24.	St24	92,50	Very Positive
10.	St10	92,50	Very Positive	25.	St25	80,00	Very Positive
11.	St11	77,50	Positif	26.	St26	57,50	Quite Positive
12.	St12	75,00	Positive	27.	St27	92,50	Very Positive
13.	St13	92,50	Very Positive	28.	St28	67,50	Positive
14.	St14	80,00	Very Positive	29.	St29	95,00	Very Positive
15.	St15	100,00	Very Positive	30.	St30	82,50	Very Positive
average			89,91%		Very Positive		

Based on Table 5, it was found that the total average of students' responses percentage was 89.91%. percentaga of students who gave very positive response were 66.67%, positive 30% and quite positive 3.33%. This result also marked that the learning process provided students with positive impact in learning activity, their enthusiasm to accept each problem, their effort to find problem solution through discussion, and actively asking the teacher. These were in accordance with research result [17] that local wisdom-based science handout development gained positive response from the students.

Their perseverance and motivation to learn were implied by their effective learning time management and learning concentration. There were several possibilities underlining students' attraction toward the developed material, among each other (1) examples of an event and its process in daily life that were

related to the material, (2) systematic arrangement of sub-topics that eased students to read and comprehend material. Consequently, it could be summarized that the developed local wisdom-based physics teaching material was effective to be implemented in learning.

CONCLUSION AND SUGGESTION

Based on the result of this study, it was concluded that the developed local wisdom-based physics teaching material on heat transfer topic was valid with very good category which made it appropriate to be applied in learning process as it could improve students' critical thinking skill with 0.80 N-gain score (high) and 89.91% of students' response toward the developed material. It was recommended for further research to develop local wisdom-based physics teaching material on other topics to engage students in active learning.

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