

Construction Of Critical Thinking Skills Test Instrument Related The Concept On Sound Wave

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Abstract. This study aimed to construct test instrument of critical thinking skills of high school students related the concept on sound wave. This research using a mixed methods with sequential exploratory design, consists of: 1) a preliminary study; 2) design and review of test instruments. The form of test instruments in essay questions, consist of 18 questions that was divided into 5 indicators and 8 sub-indicators of the critical thinking skills expressed by Ennis, with questions that are qualitative and contextual. Phases of preliminary study include: a) policy studies; b) survey to the school; c) and literature studies. Phases of the design and review of test instruments consist of two steps, namely a draft design of test instruments include: a) analysis of the depth of teaching materials; b) the selection of indicators and sub-indicators of critical thinking skills; c) analysis of indicators and sub-indicators of critical thinking skills; d) implementation of indicators and sub-indicators of critical thinking skills; and e) making the descriptions about the test instrument. In the next phase of the review test instruments, consist of: a) writing about the test instrument; b) validity test by experts; and c) revision of test instruments based on the validator.

1. Introduction

The main purpose of science education is to prepare students to understand the concept and improve the skills of thinking. One form of quality thinking is critical thinking. According to Ennis (1991) critical thinking is reflective thinking that is based on reasoning that is focused on deciding what to believe or do. Someone who thinks critically reasoning is a skilled person and have a tendency to trust and act in accordance with his reasoning. People who have the critical thinking skills to be able to evaluate, discriminate, and determine whether information, ideas of others or his own mind it was right or wrong. She will also be able to find alternative solutions to the problems encountered.

Critical thinking skills was developed in learning process with the assumption that most children can achieve critical thinking and thinking skills in children is always evolving. Similarly, thinking skills can be taught and learned. Based on a literature review of the results of previous studies, some strategies/methods/learning model can be used to construct critical thinking skills of students, among others learning based problem-solving [18], cooperative learning model of STAD (*Student Teams Achievement Division*) [21], learning to use interactive multimedia/virtual simulation [20], the learning



cycle (*learning cycle*)[23] and so on. So the selection of strategies/methods/ learning model will greatly determine the success to construct critical thinking skills of students.

Efforts to assess the success of students in developing critical thinking skills must be supported by a measuring instrument that can measure such capabilities. Measurement is an important factor in education because through the measurement, teacher would be known exactly where students at one time in an activity.

Based on previous research the availability of measurement tools that can be used as guidelines in determining the level of critical thinking skills of students, especially in the subjects of physics is rarely, whereas critical thinking skills test instrument need to be developed in all the subject of physics. Previous research has developed a measuring tool critical thinking skills of students in the teaching material temperature and heat [19]. Thus, the present study teaching materials that will be developed is related to sound waves.

The learning process can construct critical thinking skills students will rely heavily on the use of strategies/methods/learning model applied by the teacher. Selection strategies/methods/model will greatly determine the final result of the increase in students' critical thinking skills. Thus, in this study applied learning models that they were problem based learning model, 5E learning cycle model, and the inquiry learning model.

Based on the above, it is necessary to develop the measurement tools of critical thinking skills related to teaching material sound waves to determine the qualification of students' critical thinking. The problems of the present study is, how to construct a critical thinking test instruments on teaching material sound waves that will be tested on high school students grade XII. The purpose of the present study is compiling test instruments critical thinking in teaching material sound waves that will be tested on high school students grade XII.

2. Experimental Method

This study used qualitative descriptive method to examine the characteristics of critical thinking skills instruments. This study tries to construct the critical thinking skills test instrument related the concept on sound waves. This study used mixed method with *sequential exploratory design*. This strategy is implemented with the aim to used the data and quantitative results to help interpreted qualitative findings. Based on the design, procedure to construct test instrument in this study was expressed by this chart below.

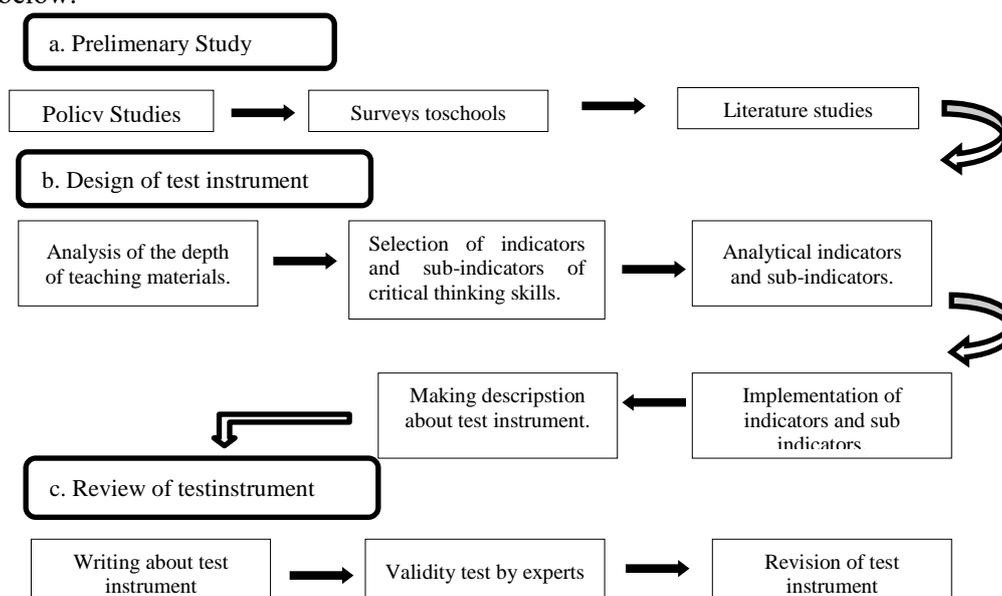


Figure 1. Procedure to construct test instrument

Critical thinking skills test instrument was written in the form of open-ended with converging pattern because it forms a comprehensive assessment and construction of indicators can capture critical thinking skills [8], [15]. This essay test would be asked to students to express their response and put forward ideas or insights that exist in their minds so as to give a describe of the level of students' critical thinking skills. The level of difficulty that will be tested was varies according to the indicators and sub-indicators of critical thinking skills.

This instrument of critical thinking skills would be tested on four public high schools in Bandung city. Three schools was used learning methods and one school was used traditional method of learning. The students who followed the test was XII grade in each school.

3. Result and Discussion

This research was conducted to obtain critical thinking skills test instruments related the concept on sound waves. Construction of this test instruments using *sequential exploratory mixed method* design consisting of three phases, preliminary studies, designing and review of test instruments. Preliminary study in this research consisted of policy studies, field surveys and literature studies. Preliminary studies conducted by the authors to determine the considered problem. Critical thinking skills including high-level thinking skills required for the flyer to the students, making it one of the learning competencies of physics in the national education curriculum[2].

Based on the results of the study[17],[13] showed that the achievement of students' critical thinking skills, included the low category. This is due to the applied physics teaching method has not stimulate and cultivate students' critical thinking skills. Learning physics tends to be teacher centered, students are not active in building their own knowledge, and does not stimulate the reasoning power and thinking of students.

This is consistent with the results of a field survey conducted by the authors at some schools at Bandung city, through interviews with teachers of physics. The result was during and after the process of learning physics, the critical thinking skills of students have never been assessed by the teacher. Most teachers assess students' mastery of concepts, using test questions which refer to the tests in the National Exam. Most teachers do not understand about critical thinking skills assessment form and procedure. In addition, teachers have not had a test instrument that assess students' critical thinking skills especially physics content. Part of the teacher was not able to develop critical thinking skills instruments due to the limited knowledge on critical thinking skills assessment.

The author conducted the selection of indicators and sub-indicators of critical thinking skills expressed by Ennis (1985) adapted to teaching materials sound waves. The result of the selection of indicators and sub-indicators of critical thinking skills along with details of the number of questions that are designed were presented in Table 1.

Table 1. Indicators and Sub Indicators Critical Thinking Skills in Research

No.	Indicators of Critical Thinking Skills	Sub Indicators of Critical Thinking Skills	Number Problem
1	Elementary clarification	Analyze the argument: identify conclusions	1
		Analyze the argument: identify the reasons	1
		Asking clarifying questions	1
		Answering questions of clarification	1
2	Basis for the decision or basic support	Assessing the credibility of the source criteria: the existing procedure	1
		Assessing the credibility of the source based on the following criteria: the ability to give a reason	1
		Assessing reports observation based on the following criteria: Note of observation	1
		Assessing reports observation based on the following criteria: Competent or the suitability of the technology.	1

3	Inference	Hypothesis explanation: claims of general causal	1
		Induction: Activities of investigation especially aspects of experimental design	1
		Induction: Provide a reasonable assumption	1
		Induction: Generalization of the chart	2
		Make a statement of values, based on: the facts	1
		Make a statement of values, based on: their alternatives.	1
		Make a statement of values: the consequences	1
4	Advanced clarification	Assessing the definition: Definition of the report	1
5	Strategies and tactics	Interacting with others: A coherent strategy	1

Indicators and sub-indicators that have been analysed in order to know meaning of relationship between indicators and sub-indicators. This phase is carried out so that the indicators and sub-indicators of critical thinking skills that are general to be more specific and concrete that can be measured. Descriptions of test questions are based on the analysis and implementation of indicators and sub-indicators of critical thinking skills. Writing test questions refer to the description of the questions that have been created. As an example of the results of test instrument design presented in this below,

Indicator : Elementary clarification

Sub Indicator: Analyze the argument by: identifying the reason that are not explicitly stated

Question :

Tora and Heru walk to school that was located in the center of city. When they arrived in front of the school, the ambulance was passed by while sirens, and from the opposite direction through the car of fire engine and sirens also rang. When the two cars passed each other in front of Tora and Heru, they heard a very loud buzzing sound and then it disappeared, and reappeared a few moments are repeated several times until the two cars apart.

Tora asked Heru, "*why is buzz happen?*". Heru responded the question by saying that they had heard the buzz caused by increased amplitude of the sound waves emanating blend of the two cars.

From the reason of Heru expressed, identify the reasons why the sound of sirens can produce a very loud buzz!

The review of test instrument is the validity of the test. Validity of test instrument was performed with requested consideration by experts. Test instruments was validated by five experts consisting of two physics education experts and three physics content experts. The results of the test instrument validation of critical thinking skills presented in Table 2.

Table 2. Results of validation by experts

Problem Test Item	Aspects ratings					Suggestions /Improvements
	Suitability indicators / sub-indicators		Use item Problem			
	Correspo nding (%)	Not available (%)	Not be Used (%)	Revision (%)	Can be Used (%)	
1	100	0	0	20	80	Add description by picture.
2	100	0	0	20	80	Repair the unit was used
3	100	0	0	0	100	-
4	80	20	0	40	60	Answer clarified
5	100	0	0	0	100	-
6	100	0	0	20	80	Answers clarified
7	100	0	0	40	60	Answer shortened
8	100	0	0	0	100	-
9	100	0	0	40	60	Add pictures
10	100	0	0	0	100	-
11	100	0	0	20	80	Clarified the question
12	100	0	0	20	80	Clarified the question
13	100	0	0	0	100	-
14	100	0	0	20	80	Add explanation of answer
15	80	20	0	40	60	Improvement questions by supporting data
16	80	20	0	0	100	-
17	80	20	0	20	80	Clarified the question
18	100	0	0	0	100	-

Conclusion:

- Validator 1: questions can be used after repair and analyzes each comment in the instrument
- Validator 2: the instrument can be used after the revision.
- Validator 3: the test instrument can be used after revision
- Validator 4: the test instrument can be used after revision the questions and answers should be equipped with a scoring rubric.
- Validator 5: need to be careful about the description conformity with questions and an answer key.

All validators provide that there was no problems that could not be used. Furthermore, the test instrument which consist of 18 items can be prepared to test and test of implementation to obtain the test instruments critical thinking skills after it was revised. The recommendation from experts is used to fix the test instrument that has been designed, so that the test instrument is really fit to be used in testing and implementation phase.

4. Conclusion

In this study, it has been prepared 18 items of critical thinking skills test instruments of high school students related concept on sound waves with five (5) indicators and eight (8) sub-indicators of critical thinking expressed by Ennis. Based on the analysis by validator that there was no problem that could

not be used, but some questions need to be improved. The test instrument will be used in testing and implementation of test instruments, after it was revised.

5. References

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