The Development of Critical Thinking Ability Instrument Based on Culturally Responsive Teaching (CRT) in Physics Subjects

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Abstract. This research is a type of development research which aims to produce a valid and reliable Culturally Responsive Teaching (CRT) based critical thinking ability test instrument. The topic studied in this research is temperature and heat. The chosen focus of Culturally Responsive Teaching (CRT) is food, drinks and traditional games typical of South Sulawesi such as Jalangkote, Pisang epe, Sarabba, Kapal otok-otok, Dangke, Kue Tori, Gundu and Gasing. The development design in this research uses the model ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The test subjects were 28 students at class XI in Senior High School 22 Makassar. Before being tested, the question instrument can be analyzed for validity and reliability. Validity results using the validity of the test items and reliability are calculated using the Cronbach's Alpha formula. The research results showed that the validity of the critical thinking ability test instrument based on Culturally Responsive Teaching (CRT) obtained 16 valid questions with a reliability level of 0.912 (perfect reliability). The critical thinking skills based on Culturally Responsive Teaching (CRT) of students at class XI in Senior High School 22 Makassar in the medium category.

Keywords: Model ADDIE, Critical Thinking Skills Based on Culturally Responsive Teaching.

1 Introduction

Education right now really determines a person's future steps and way of thinking, especially education at school which then continued to the next level. Thinking in general is an activity of the human person to determine an aim. In learning, thinking skills are very necessary to achieve the target to be achieved in the learning process because thinking skills are one aspect of improving the quality of learning to achieve learning outcomes. Conceptually, learning activities must be close to the environment [1]. The success of an education can be seen when students have been able to utilize the education they receive to meet their daily needs and in community life [2].

One of the thinking abilities needed in developing 21st Century Skills is the ability to think critically. Every individual need critical thinking skill to successfully solve problems in difficult situations. Everyone needs to analyze and evaluate their living

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conditions to make important decisions. The concept of critical thinking is a complex concept and includes complex mental and activity as well, the critical thinking process is a process that is not easy to describe. Even though critical thinking is something complex, that doesn't mean it can't be developed, especially at school. The application of the Culturally Responsive Teaching approach makes students increasingly develop and have high motivation to learn [3]. The CRT approach emphasizes the importance of respecting and understanding students' cultural diversity in the context of learning. By adapting teaching materials and methods to suit the cultural backgrounds of students, teachers can create a more inclusive and motivating learning environment. However, one of the main challenges in implementing Culturally Responsive Teaching (CRT) is teachers' lack of knowledge and understanding of students' culture.

The teacher right now tend to use ordinary learning methods, strategy, approach and model to require students to understand without developing insight into thinking that allows students to learn more actively, which of course does not direct students to develop their critical thinking abilities. Learning can be achieved through experience, learning media, environment and cognitive tactics [4]. The learning methods used in schools tend to teach students about external things without teaching students' personal and cultural environments. In fact, by teaching the culture and environment where students are, it will increase students' knowledge of their culture. Teaching like this can have an impact on the way students think. Where students will find it difficult or unable to think independently. Integration of culture into learning can improve learning outcomes when compared to conventional learning [5]. The use of learning methods that use culture can influence the level of critical thinking abilities of students. Teachers must use interesting learning methods. And provide space for students to be creative and think critically during the learning process.

One of the learning methods is the Culturally Responsive Teaching (CRT) learning method. Culturally Responsive Teaching (CRT) positions educators as mediators whose job is to mediate injustices that arise in the classroom which are caused by the diversity of backgrounds, traditions, ethnicities and differences that exist in each student. The culturally responsive learning (CRT) approach aims to enable students to better understand and appreciate the culture that is part of their identity [6]. Integrating students' cultural backgrounds aims to connect them with the learning context and increase awareness of their cultural identity [7].

In creating meaningful learning, educators can teach learning with the cultural background of students. Culturally Responsive Teaching (CRT) is a learning approach that integrates cultural diversity in students [8]. This learning approach can be a bridge that connects the knowledge possessed by teachers, students, and the community [9].

The Culturally Responsive Teaching (CRT) method is a comprehensive way to equip teachers to teach students in environments with different cultural backgrounds and improve a teacher's understanding and cultural responsiveness skills in every learning content they strive for in their learning environment. One approach that has attracted attention is Culturally Responsive Teaching (CRT), which emphasizes the importance of connecting learning to students' life experiences and culture [10]. The Culturally Responsive Teaching or CRT method places students who feel they come from a minority culture as having equal rights to have the opportunity to develop their abilities.

Through this CRT learning method, students also become more understanding of their own culture and appreciate other people's cultures.

Learning by integrating culture creating meaningful learning by linking the students' culture into the learning material. Culture is the core of the learning process, culturally responsive pedagogy is used as a connecting tool between students, teachers, schools, and communities, by adapting the learning process to the students' cultural background. This approach aims to create a relevant and meaningful learning environment, so that students feel more connected to the material, and supports closer collaboration between schools and communities. Teachers need to understand that culture greatly influences students' mindsets [11].

CRT learning offers a solution to overcome these challenges by integrating students' culture into the learning process. This approach emphasizes the importance of connecting learning materials to students' cultural experiences, so that the material taught can be easily understood [12].

The Culturally Responsive Teaching method in physics subjects can be applied if students have mutual respect for backgrounds and circumstances regardless of individual status and power in the class. For more information, CRT or the Culturally Responsive Teaching approach contains elements of learning planning which include various needs, interests and orientations in the classroom. Some learning strategies in the Culturally Responsive Teaching (CRT) approach include activities such as storytelling, group discussions, or other activities that are not only relevant to the culture of the students, but also responsive to the needs and cultural diversity that exist around the students and the people [13].

The Culturally Responsive Teaching approach is a learning method that focuses on the background and equal rights of every student to receive learning without considering different habits or cultures. This approach serves to increase student activeness in learning according to their background conditions. The CRT approach can improve students' learning outcomes because students are able to be actively involved in communicating and collaborating with their classmates.

The relationship between critical thinking skills and Culturally Responsive Teaching in physics subjects is certainly very related if we want to study it further. The problem now in studying this is the lack of instruments that can help us look deeper into this relationship. So, this is the background for conducting this research with the title "Development of Critical Thinking Ability Instrument Based on Culturally Responsive Teaching (CRT) in Physics Subjects"

2 Research Method

The type of research is research and development. The development research in question is research carried out to develop critical thinking ability instruments based on Culturally Responsive Teaching (CRT) in physics subjects. The development design in this research uses the model ADDIE (Analyze, Design, Development, Implementation, Evaluation). The development design at the ADDIE development design stage is described as follows:

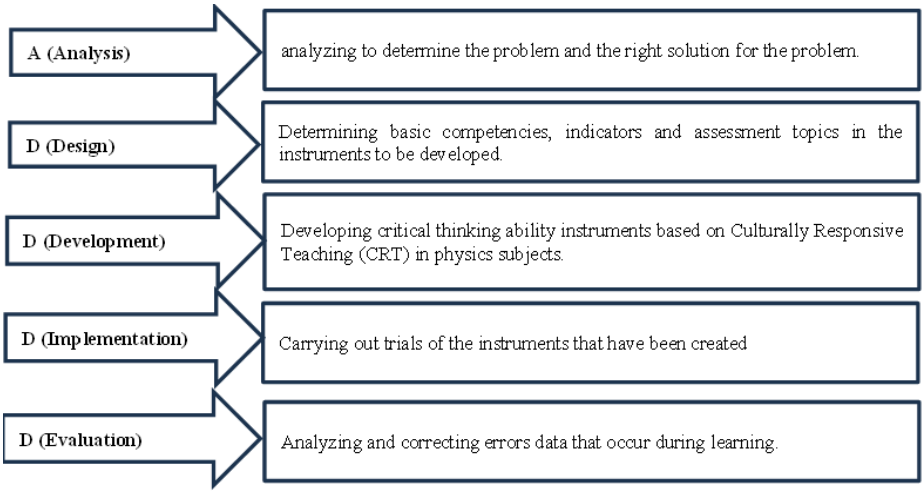

Fig 1. Instrument Development Design

This research has been done at Senior High School 22 Makassar on Pajjaiang street, Sudiang, Laikang, Biringkanaya district, Makassar City, South Sulawesi. This research has been done in the Even Semester of the 2023/2024 Academic Year, starting in March 2024 and ending in August 2024. The subjects in this research are students in class XI MIA at Senior High School 22 Makassar.

This research instruments used in this research consist of: (1) validity instruments in the form of instrument assessments assessed by two expert validators; (2) instrument practicality in the form of an assessment of whether the instrument will be used by two practitioners; and (3) effectiveness instruments in the form of student perceptions and the percentage of strengthening students' critical thinking abilities. The data analysis technique used in this research is using justification from 2 (two) experts using the Gregory analysis technique. The model is said to be valid if the results of data analysis show that the instrument being developed is in the valid category with a reliability value $(R) \geq 0.75$. An instrument is said to be practical if, according to students' perception, it is at least easy to use. The instrument that has been developed is said to be effective if according to the teacher's perception it can at least strengthen students' critical thinking abilities.

The activities have been done to analyze the perception data are: (a) counting the number of students who give positive perceptions according to the aspect being asked, then calculating the percentage; (b) determining the category for students' positive perceptions by matching the percentage results with the specified criteria; and (c) if the results of the analysis show that the students' perceptions are not yet positive, then revisions will be made to the instruments developed. The criteria set to say that students have a positive perception of their critical thinking abilities is that more than 50% of them give a positive perception of at least 70% of the aspects asked. BFPD is said to be effective if the criteria for students' positive perceptions are met and students' critical thinking abilities are strengthened.

3 Research Method

Based on the development design used, the research results include the following stages:

3.1 A The Stages of Developing Critical Thinking Ability Instruments Based on Culturally Responsive Teaching (CRT) in Physics Subjects

Analysis Stage. Based on the Core Competency to the analysis of the knowledge aspect, a number of competencies are formulated which are expected to be achieved by students in the core competency 3, namely understanding, applying and analyzing factual, conceptual, procedural and metacognitive knowledge based on their curiosity about science, technology, arts, culture and humanities with insight into humanity, nationality, statehood and civilization regarding the causes of phenomena and events, as well as applying procedural knowledge in specific fields of study according to their talents and interests to solve problems. Next, Basic Competency analysis is carried out. Basic Competencies related to the topic of temperature and heat in competency standard 3.5: Analyze the influence of heat and heat transfer which includes the thermal characteristics of a material, capacity and heat conductivity in life every day.

Design Stage. At this stage, the researcher begins to design the instrument by considering the content of the instrument that will be created later. The instrument designed must be adapted to indicators of critical thinking abilities based on Culturally Responsive Teaching (CRT) in Physics subjects.

Development Stage. The test instrument was developed into 20 essay questions, with the following details: 1) one question on the indicator of formulating the problem. 2) one question on the indicator is choosing a logical argument. 3) four questions on the indicators assess the credibility of the information source. 4) one question on the indicator assesses the results of the observation. 5) two questions on indicators make deductions. 6) one question on the indicator makes an induction. 7) Four questions on the indicators provide further clarification. 8) five questions on the indicators assess assumptions. 9) one question on choosing a logical argument.

Implementation Stage. The test instrument was tested on 28 students at class XI MIA 4 in Senior High School Makassar who had low critical thinking skills based on Culturally Responsive Teaching (CRT). A critical thinking skills test instrument based on Culturally Responsive Teaching (CRT) was developed and compiled based on the score for the correct answer to each question item which refers to the question assessment rubric that has been created. The question assessment rubric consists of points 1-5 for each question answered by students.

Evaluation Stage. At this stage, an assessment has been carried out regarding the previous stages. The instruments developed were validated and 16 valid physics instruments were produced, and 4 invalid instruments were produced. A valid instrument with the condition that rcount > rtable (0.3739) (α) 5%, (db= n-2).

Table 1. Results of Question Instrument Validity Analysis

Number	Indicator	Information
1	Formulating the problem	$r_{Count} > r_{Table}$ 1 (valid)
2, 17	Chosing the logical argument	$r_{Count} > r_{Table}$ 2, 17 (valid)
3, 12, 13, 19	Assessing the credibility of information sources	$r_{Count} > r_{Table}$ 12, 13, 19 (valid)
4	Assessing the results of observations	$r_{Count} > r_{Table}$ 4 (valid)
5, 6	Making deduction	$r_{Count} > r_{Table}$ 5, 6 (valid)
10	Making induction	$r_{Count} > r_{Table}$ 10 (valid)
7, 14, 15, 18	Making further clarification	$r_{Count} > r_{Table}$ 14, 18 (valid)
8, 9, 11, 16, 20	Assessing assumptions	$r_{Count} > r_{Table}$ 8, 9, 16, 20 (valid)

Apart from carrying out validity analysis, the reliability of the instrument developed was also calculated. Question reliability is calculated using the Cronbach's Alpha formula with the criterion that if alpha ≥ 0.90 then reliability is perfect. If alpha is between 0.70 – 0.90 then reliability is high. If alpha is 0.50 – 0.70 then reliability is moderate. If alpha < 0.50 then reliability is low. The calculated result of the reliability coefficient of the test instrument is alpha = 0.912. Based on the results of the reliability analysis, it can be concluded that the Culturally Responsive Teaching (CRT) based critical thinking ability test instrument has perfect reliability.

The form of the questions on the Culturally Responsive Teaching based critical thinking ability test instrument developed varies. Question number 1 relating to indicators for formulating problems can be shown in below:

Question Items with indicators for formulating the problem. One of the typical foods of Makassar residents is jalangkote which is fried using a certain cooking oil. It turns out that in frying using cooking oil such as mandar oil, packaged oil of a certain brand

or bokak oil (oil from coconuts) there are physics concepts that we can learn. Please make a question regarding the comparison of packaged cooking oil with Mandar cooking oil or Bokak oil in relation to physics concepts!

Solution. Questions that can be made according to the information presented in accordance with physics concepts are: Does Mandar cooking oil have a higher boiling point than packaged cooking oil? Is the viscosity level of Bokak oil higher than Mandar oil?

Question Items with indicators for selecting logical arguments. Sometimes we come across fried food sellers who fry food on the side of the road using cooking oil once, but there are also those who use cooking oil in frying up to 2-3 times or even more. Explain what quantities change in the oil used when frying food based on the physics concept of the trader's frying method!

Solution. Continuous use of oil for a long time and at high temperatures can cause cooking oil to oxidize into substances that are harmful to the body such as volatile carbonyl substances and hydroxy acids where the physical quantity that will change with continuous heating of cooking oil is the oil viscosity level.

Question Items with indicators assessing the credibility of the information. People in Enrekang who process dangke into traditional food are of the opinion that the viscosity level of dangke is closely related to the dosage of papaya fruit sap used in the dangke processing process. Is this information correct or not? Explain your reasons accompanied by accurate evidence!

Solution. The information presented is indeed true because to obtain a good level of viscosity or viscosity of dangke, a comparison is made between papaya fruit sap and the milk used with a ratio of 2 drops of papaya fruit.

Question Items with indicators assessing observation results. If we weigh food, for example pisang epe, using a 310 g Ohaus balance, one portion of pisang epe will have a mass of around 150 grams. If we weigh the bananas as the raw material for making pisang epe before pressing them with a special tool, we find that the mass of the pisang epe is around 120.57 grams and after pressing them with a special tool the mass decreases to 118.70 grams. Please write down the mass of the pisang epe before and after pressing using the correct significant figures!

Solution. Write significant figures correctly according to the rules, namely The mass of the pisang epe before pressing was 120.57 grams. The mass of the pisang epe after pressing was 118.7 grams.

Question Items with indicators for making deductions. When a child wants to play ma'gasing, which is a traditional game in Makassar, he must first wrap a rope around the neck of the top, then swing the top towards the ground or to the arena and then release the rope quickly. The child thought that the spinning top would take longer on

uneven ground than when spinning on flatter ground! Is the child's assumption correct? explain your reasons according to physics concepts about the statement!

Solution. The physics concept involved here is friction, where the friction force that occurs on the top will be opposite to the direction of rotation of the top. So, if the top rotates to the right, the friction force will rotate to the left opposite to the direction the top rotates. If the child thinks that a top will spin longer on an uneven ground surface than when it spins on a flatter ground surface, of course this opinion is wrong based on the concept of physics where a top will take longer to spin when it is on a ground surface that is flatter than the surface.

Question Items with indicators for making induction. If you know that pude wood has a density that is smaller than the density of water, then in physics terms the wood will float. Write a conclusion from the statement above! Can this type of wood be made into a Lepa-lepa boat?

Solution. If the density of pude wood is smaller than the density of water, this means that this type of wood can be made into a Lepa-lepa boat.

Excerpt of Question Items with indicators assessing assumptions. If it is known that the density of jati wood is 0.95 $g/cm3$, meranti wood 0.86 $g/cm3$ and trembesi wood 0.6 $g/cm3$. So it can be concluded that all types of wood can float and can be made into Lepa-lepa boats! Write the relationship between the statements above in physics!

Solution. All these types of wood can be made into lepa-lepa boats because the three types of wood all have a density that is smaller than the density of fresh water, namely 1 the density of the fluid in which it is located.

3.2 Critical Thinking Skills Based on Culturally Responsive Teaching (CRT)

The critical thinking ability profile based on Culturally Responsive Teaching (CRT) of students emphasizes applying scientific concepts contextually, local wisdom, and according to the demands of the times. Based on the results of the Culturally Responsive Teaching (CRT) based critical thinking ability test given to 28 students, the results can be seen in Table 2 as follows: 2 students get the very high score with interval 81-100. 7 students get the high score with interval 61-80 then 17 students get the currently score with interval 41-60. 2 students get the low score with interval 21-40 and nobody get the very low score with interval 0-20.

The results of the analysis and arguments given to students in answering questions provide an indication that science teachers should measure more students' abilities at the cognitive level which refers to high-level thinking abilities. The critical thinking skills based on Culturally Responsive Teaching (CRT) of the students who are the subjects of this research can continue to develop better, not only in Physics learning, so that the students who are the subjects of this research can get even better results later.

4 Conclusion

Based on the analysis of research data, it can be concluded that the Culturally Responsive Teaching (CRT) based critical thinking ability test instrument product developed is valid and reliable, so it can be used by teachers to determine students' critical thinking abilities, especially on the topic of temperature and heat. However, this research needs to be done further analysis regarding its effectiveness and practicality.

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