A Study of Prospective Primary School Teachers’ Alternatif Conception in Heat and Temperature

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Abstract. The aim of the study was to describe of the alternative conception of prospective primary school teachers related to concept of heat and temperature. This study uses the quantitative descriptive method. This study was conducted on 34 prospective primary school teachers at one university in Riau Province who had attended the basic concepts of science course. The university is located in the coastal area of Riau province. The instrument used to collect data is a conception test in the form of true/false choices accompanied by an explanation of the answers. Based on the choice of true/false answers and explanations given by prospective elementary school teachers, the alternative conceptions they have can be determined. The results showed that there were a number of alternative conceptions owned by prospective elementary school teacher students related to the concept of heat and temperature, where some of the alternative conceptions led to a state of misconception.

Keywords: prospective primary school teacher, alternative conception, heat and temperature

1. Introduction

One of the competencies that must be possessed by prospective teachers, including elementary teacher candidates, is professional competency which includes mastery of lesson content. Good mastery of lesson content is characterized by having a complete understanding of concepts, laws, principles and principles and free from misconceptions. Some of scientific concepts are simply too difficult for individuals to understand. This can occur for a variety of reasons, but one of the primary reasons can be that everyday experiences can provide evidence that supports incorrect assumptions.

Research on students conception, alternative conception, and science misconception has long been of interest to science educators in their pursuit of developing a scientifically literate citizenry. Fisher defined misconceptions as ideas that are at a variance with accepted view [1]. Other term have also been suggested such as alternative framework and alternative conceptions [2,3]. A number of studies have targeted common misconceptions in physics and physical science which are subject area that include concepts that can be particularly abstract for learners to understand. Compared to other areas of science, physical science concepts, such as electricity, magnetism, optic, fluid and thermodynamic are often more abstract and are difficult for students to understand. The results of studies conducted by several researchers indicate that there are still many students who have misconceptions on physical concepts involving abstract and microscopic phenomena [4, 5, 6].
Misconceptions about physical science concepts are not limited to children; they are also maintained throughout high school and into college, alerting researchers of the need to identify and challenge preservice teachers’ understandings of physical science before they enter the classroom. The results of Halloun and Hestenes’ diagnostic study found that not only did college students enter their first course in physics lacking basic physics concepts, but their “alternative misconceptions . . . are firmly in place” [7]. Their findings revealed that 47% of the students expressed a belief that under no net force, an object slows down; and 66% said that objects under a constant force move at a constant speed [8].

Lawrenz studied physical science misconceptions among elementary school teachers [9]. The results indicated that misconceptions in physical science, across a range of concepts, were prevalent among the elementary teacher sample even though the teachers had strong educational backgrounds and a favorable disposition towards science. For a question about the change in mass of an iron nail after it had rusted or combined with oxygen, the responses revealed that only 36% of the teachers believed that the mass would be greater, and 46% believed that the mass would be less as a result of rusting.

One of the science topic at graduate level that includes concepts related to abstract and microscopic physical phenomena are heat and temperature subject mater. Many previous studies have been done and found that there are still many misconceptions occurred in this concept in students at the graduate levels. This research was conducted to identify alternative conception of prospective primary school teacher related to the concept of heat and temperature after they followed traditional lectures in their university.

2. Methodology
This research was conducted using quantitative descriptive methods. The number of research subjects was 34 prospective primary school teacher consisting of 18 female and 16 male, in one of the university at Riau province. The university is located in the coastal area of Riau province. Data were collected by conception test in the form of true/false choices accompanied by explanations of answers, related to the concept of heat and temperature. This test is termed HTCTest which stands for Heat and temperature conception test. This conception test consists of four concepts, that is: temperature concept, thermal expansion concept, heat transfer concept, and change in the state of matter concept. Descriptions of HTCTest used in this study are shown in Table 1.

| Table 1. Description of HTCTest used in this study |
|---------------------------------|
| Concept | HTCTest Items |
|--------|--------------|
| Temperature | 1. An air that has a temperature of 10°C will feel twice cooler than air that has a temperature of 20°C (True or False). Explain! |
| | 2. Objects that contain more heat will always have a higher temperature than objects with less heat. (True or false)? Explain! |
| | 3. Things that rise easily in temperature when heated will more easily go down in temperature when cooled. (True or false)? Explain! |
| Thermal expansion | 4. Thermal expansion that occurs in objects made of metal when heated is due to the distance between the positive ions making up the metal material position away from each other. (True or false)? Explain! |
| Heat Transfer | 5. Metal can conduct heat by conduction because the metals have many free electrons. (True or false)? Explain! |
6. The jacket that is worn when the air feels cold can prevent the cold flowing into our body, so that our body feels warm. (True or false)? Explain!

7. The energy transferred from the sun to the earth is anergy of light. (True or false)? Explain!

| Change in the state of matter | 8. Water can boil at room temperature (25°C). (True or false)? Explain! |
|-------------------------------|---------------------------------------------------------------------|
| 9. Bubbles that form when the water boils, its contents are air. (True or false)? Explain! |

Based on the prospective teachers' answers to the questions posed at HTCTest, then a number of alternative conceptions of prospective primary school teacher can be collected regarding concepts on the topic of heat and temperature.

3. Results and Discussion

Table 1 shows the percentage of correct answers on each item heat and temperature conception test of the total answers given by 34 prospective primary school teacher.

| Item Number | Item HTCTest                                                                 | Correct Answer | Percentage Correct Responses |
|-------------|------------------------------------------------------------------------------|----------------|------------------------------|
| 1           | Air that has a temperature of 10°C will feel twice as cold as air that has a temperature of 20°C. Objects with more heat content will always have a higher temperature than objects with less heat. | False          | 35.3                         |
| 2           | Objects that rise easily in temperature when heated will more easily drop in temperature when cooled. Expansion that occurs in objects made of metal when heated is due to the distance between the positive ions making up the metal material position away from each other. | True           | 52.9                         |
| 3           | Metal can conduct heat by conduction because the metals have many free electrons. Jackets that are worn when the air feels cold can prevent the cold flowing into our bodies, so that our bodies feel warm. | True           | 38.2                         |
| 4           | The energy transferred from the sun to the earth is the anergy of light. | False          | 23.5                         |
| 5           | Water can boil at room temperature (25°C)                                   | True           | 26.5                         |
| 6           | Bubbles, which form when the water boils, contain air.                     | False          | 23.5                         |

The correct response rates ranged from 24 to 53%. Most of the prospective primary school teachers write explanations for the right or wrong answers they choose for each HTCTest item. The comparison between the percentage correct when considering only the written responses to the percentage correct based on the true/false responses is summarized in Table 2. It appears that the percentage of the
number of respondents who were correct written explanations is smaller than correct true/false responses for all HTCTest items. This shows that there are still many respondents who answer each HTCTest item by guessing and fortuitously guessing.

| Item Number | Number of Written Explanations Analyzed | Percentage Correct for Written Explanations | Percentage Correct in True/False Responses |
|-------------|----------------------------------------|---------------------------------------------|--------------------------------------------|
| 1           | 30                                     | 20.0                                        | 35.3                                       |
| 2           | 24                                     | 16.7                                        | 29.4                                       |
| 3           | 27                                     | 33.3                                        | 52.9                                       |
| 4           | 28                                     | 28.6                                        | 38.2                                       |
| 5           | 30                                     | 23.3                                        | 32.4                                       |
| 6           | 28                                     | 32.1                                        | 41.2                                       |
| 7           | 30                                     | 16.7                                        | 23.5                                       |
| 8           | 30                                     | 20.0                                        | 26.5                                       |
| 9           | 30                                     | 13.3                                        | 23.5                                       |

Based on the explanation given by each respondent who wrote an explanation of the right or wrong answer they chose for each item, an alternative conception of the prospective primary school teacher can be identified on the topic of heat and temperature. Table 3 shows the alternative conceptions of prospective primary school teacher related to concepts of heat and temperature that were successfully identified using HTCTest.

**Table 3. Item Comparison of Written Explanations to True/False Responses**

**Table 4. Alternative conception of prospective primary school teacher related to concepts of heat and temperature**

| Concept               | Alternative conception of prospective primary school teacher |
|-----------------------|---------------------------------------------------------------|
| Temperature           | 1. Temperature is the degree of heat of an object              |
|                       | 2. Temperature is a measure of the kinetic energy possessed by the constituent particles |
|                       | 3. High and low temperature of the object is affected by the heat content of the object |
|                       | 4. The feeling of heat or cold of an object when touched does not necessarily reflect the high or low temperatures of objects |
|                       | 5. High and low temperature objects are not always proportional to the amount of heat they contain |
|                       | 6. Objects that rise easily when heated will find it difficult to cool down when cooled |
| Heat Transfer         | 1. Metal can conduct heat by conduction because metal contains many free electrons |
|                       | 2. Metal can conduct heat by conduction through the propagation of vibrational kinetic energy of positive ions that make up metal |
|                       | 3. Jackets can block the cold flow to the human body |
|                       | 4. The jacket prevents heat transfer from the human body to the environment |
|                       | 5. Thick jacket-making fabric has warm properties |
6. The energy transferred from the sun to the earth is **heat energy**

7. The energy transferred from the sun to the earth is **heat and light**

8. The energy transferred from the sun to the earth is **light energy**

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**Thermal expansion**

1. The expansion of an object when it is heated occurs because the positive ions making up the objects are located away from each other.

2. The expansion of the object when it is heated occurs because the size of the positive ions making up the object becomes larger because it expands.

**Change in the state of matter**

1. Boiling water must be high in temperature

2. Water will boil only if it is heated

3. The water will boil if the temperature is 100°C or more

4. Water can boil at room temperature if the pressure is low

5. Bubbles that form when boiling water contains water vapour

6. Bubbles that form when boiling water contains O atoms and H atoms

7. Bubbles formed when the water boils, filled with air

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In Table 3 it appears that the number of alternative conceptions that have been identified for each concept on the topic of heat and temperature is as follows: 1) There were six alternative conceptions that emerged in the concept of temperature; 2) There are eight alternative conceptions that arise in the concept of heat transfer, 3) There are two alternative conceptions that arise in the concept of thermal expansion, and 4) there are seven alternative conceptions on the concept of change in the state of matter. These alternative conceptions are not in accordance with the scientific conception, so that it will resist to the process of accepting new ideas when they take part in learning activities that discuss the topic of simple electrical circuits. Based on the results of short interviews, the emergence of these alternative conceptions mostly comes from personal interpretations of the heat and temperature based phenomena that they observe and experience in everyday life.

Some researchers have also succeeded in identifying alternative conceptions that occur in students related to various physics subject matter, such as: Narjaikaew succeeded in identifying alternative conceptions related to concepts on the topic of mechanics [10], whereas Lewis and Linn succeeded in identifying alternative conceptions related to concepts on the topic of temperature and heat [11].

**4. Conclusion**

The conclusion that can be drawn from the results of the study is that only a few of prospective primary school teacher had a scientific conception related to the concepts in the heat and temperature topic. These results showed that the prospective primary school teacher have significant weaknesses in understanding the terms of fundamental knowledge of heat and temperature. This result indicates that the traditional lecture approaches cannot be relied upon to promote prospective primary school teacher in achieving scientific conception, because their lecture activities do not involve students to think, discuss and discover the physical meaning of each learned concept.
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