Identifying kindergarten children’s idea about heat and temperature concept

Qonita1*, E Syaodih1, A Suhandi1, B Maftuh2, N Hermita4, H Handayani2, R Nuraffiah1, A R Ningsih3, Y Gumala3, D Maulana3 and A Samsudin2

1Program Studi Magister Pendidikan Anak Usia Dini, Universitas Pendidikan Indonesia, Bandung, Indonesia
2Departemen Pendidikan Fisika, Universitas Pendidikan Indonesia, Bandung, Indonesia
3Departemen Pendidikan Dasar, Universitas Pendidikan Indonesia, Bandung, Indonesia
4Prodi Pendidikan Guru Sekolah Dasar, Universitas Riau, Pekanbaru, Indonesia

* Corresponding author’s email: qonita1993@student.upi.edu

Abstract. This study aim is to identifying the childrens’ idea of the heat and temperature in their daily activity. Heat and temperature is the physic concept that easily found in children daily life. Knowing children idea is important to fix misconception because they bring the concept by themselves experience. A descriptive-qualitative design with observation has been implemented to gather data from 44 (5-6 years) children in three kindergartens in Tasikmalaya. The result showed that the children in early years understanding temperature as qualitative notion that they can sense rather than qualitative notion. Some case children use the same terms to describe the different temperature. This result can give description about children’s prior idea related heat and temperature to avoid or fix the misconception in the next level education.

1. Introduction

Science education at all grade of education is aim to introduce the nature of science including physics. Thermal physics is a branch of physics that familiar in all level education no exception for young children e.g. [1-2]. From an early age child have experienced the sense of the topic. These experiences possibly arise when a new born baby senses the cold of the outside world in contrast to the warmth of the uterus e.g. [2].

Numerous children seem to have assembled many simple reasons to explain daily condition they come across involving thermal concept. Children have learned about thermal concept, by their experience, that certain things feel warm to the touch and others feel cold. Children in four and five-year-olds the notion of heat as a substance that could be found in objects was prevalent. Characteristic children aged 4-6 years are have a scope vocabulary of temperature. They always use the terms “heat” or “hot” to describe hot objects based on sensory impression e.g. [2-3]. These experiences of the terms are the relatively strength or weakness of the heat concept. It gives the strength because there is a lot of past experience upon which to build. But the weakness is, however, is that along with worthwhile first-hand acquaintance the children also carry along with them many misconceptions which must be fixed e.g. [2].
According to the view of psychology in general, concepts are belongings which exist autonomously in the environment. Concepts can consider as combinations of character. It becomes a matter of finding rules, principles, and strategies of concept attainment, which can be used to explain how children acquire concepts from the environment e.g. [3].

Heat was defined by Mak and Young e.g. [2,4] as ‘the macroscopic energy transfer by nontechnical and nonelectrical means and it is equal to the difference between the internal energy and the work done.’ Pointing to the equation of the first law of thermodynamics [5], the energy transfer described as heat supplied, $\Delta Q$, is defined

$$\Delta Q = \Delta U - \Delta W$$

$\Delta U$ is the change in internal energy and $\Delta W$ is the work done on the working system. The heat should be distinguished from the change in internal energy $\Delta U$.

Whereas, temperature was defined as the macroscopic property which expresses the condition of agitation or coordinate motion of particles, it is therefore similar to kinetic energy g. [6-7] like the picture below.

![Illustration of the motion of temperature](image)

**Figure 1. Illustration of the motion of temperature**

Figure 1 show that temperatures have two set of the identical type of molecules that are touch with each other, the set with higher kinetic energy has a higher temperature, and that net energy transfer will be from the higher temperature set to lower temperature set. The average kinetic energy of an entity is a significant element of the idea of temperature and provides some useful perception about what temperature is.

Temperature also can defining as entropy as

$$C_V = \frac{\partial E}{\partial T} = \frac{1}{4\pi^2n_s} = \pi t^2 = S_{ds}$$

Where $S_{ds}(T_{ds})$ is the temperature (entropy), $\partial E$ is change in entropy and $\partial T$ is change in internal energy [8].

The study will analyse the advance of the body of concepts which provide meaning to such terms as “hot,” “warm,” “heat,” and “temperature.” It based that the aim knowledge cannot be implicit without analysing how the the children development comes increasingly more rapidly to more objective and scientific knowledge; an endeavour will be made to associate childrens’ ideas about heat to scientific knowledge of the physics of heat.

2. Methods

This research has been projected as a minor scale investigation study with qualitative approaches for collecting and analysing data. In this research, data were composed through observations from
authentic classroom setting in three kindergartens in Tasikmalaya. The basis of data was uninterrupted straight observations of science activities in kindergarten classes to investigate children’s’ observation skill on identifying various temperature of water and how they called those water’s temperatures. Observer’s role was that of an onlooker. The recording of observations was done by video recording and by taking detailed field notes.

There was 44 children from three kindergartens have observed. The children involved in observation science activities were children in aged from 5 to 6 years. These kindergartens were chosen purposively with the criteria that they have been accredited with grade A and they agreed to participate in this study.

When engaging the kindergartens, the teachers and the headmasters were informed about the purposes of the study and the methods we were to use. The teachers agreed to join the project without any kind of pressure. The kindergarten’s headmasters were informing about the study to the children’s parents through parents meeting.

3. Result and Discussion
This study has identified children’s’ idea about heat and temperature. In the activity, teachers show children three glasses containing water at around 0°C (a combination of ice and water), around 42°C and boiling water around 70°C. Teacher asked children to observe and point which one “hot” water, “cold” water and “normal or ambient” water. Teachers also asked children to place a hand in each glass of the extreme temperatures and use words like ‘hot’ and ‘cold’ to describe them. In the next step, teachers mixed “hot” and “cold” water and this is normally described as warm water.

Figure 2. Glasses containing hot, ambient, and cold water

Figure 2 showed three glasses that containing hot, ambient, and cold water. Teachers showed those glasses to children and ask children to presume the temperature of water in the each glass. Children answer based on what come up on the glasses. They see the fog on the glass and they said that water is cold. But there are some children who described that mixture water as hot water. Data of number children who use each term is presented in Figure 2 and Figure 3.
Figure 3 and Figure 4 showed that from 44 children, majority children are 64% used term “warm” to describe the temperature of mixture water. Whereas almost half of all children are 36% used term “hot” to describe that temperature. Children take along the concept that they often learn from their environment.

The data was found from observation of teachers and children interaction when they identified the kind of water temperature. Table 1 shows children and teacher interaction data when talking about heat and temperature.
Table 1. Example interaction between children and teachers in science activity

| (a) Kindergarten A | Teacher: Which one a hot water? |
|-------------------|--------------------------------|
| Children: That one! (pointing a glass of boiling water) |
| Teacher: Which one a cold water? |
| Children: That one (pointing a glass of ice water) |
| Teacher: Which one a normal water? |
| Children : Point (pointing a glass of medium water) |

| (b) Kindergarten B | Teacher: What kind of water is this? (Show them the glass of boiled water) |
|-------------------|--------------------------------|
| Children : hot water, there is haze |
| Teacher: How about this water? (Show them the glass of medium water) |
| Children : Normal water, cold water (childrens’ answer with different term) |
| Teacher: So, what it is? (Show the glass of ice water) |
| Children: Cold water |

| (c) Kindergarten C | Teacher: (Show three glass of water that contain boiling water, ice water, and medium water) Kids, what it is? |
|-------------------|--------------------------------------------------|
| Children : Ice water, medium water, and hot water |
| (Teacher mixing the medium water with hot water) |
| Teacher: try to put your hand in each glass, and what kind of temperature is that? |
| Children 1: This is hot |
| Children 2: No, this is warm |

Table 1. Showed children described temperature with a few terms to categorize the diverse of temperatures. Different from the older children that perceive the temperature as a quantitative notion e.g. [9], young children tend perceive that temperature as a qualitative notion. When teachers presented three kind of water with the diverse temperature, children used term “hot” to describe the highest temperature, “cold” to describe lowest temperature, and “normal” or “medium” to describe the medium water temperature. They also used term “warm” to describe the temperature of mixture water. But, they have the conflict to determine the term between cold and medium. Sometime they describe medium temperature water as “cold water” when it compared by the higher temperature, but in the other hand they us “normal water” or “medium water” when it compared by lowest temperature. Those also happen when they use the term of “warmth” and “hot”. They use “warm” when it compared with the higher temperature and use “hot” when it compared with the lower temperature.

Albert e.g. [3] explain the term of “hot” have already appeared in children since an early age around two years, children have a concept of a “hot-object,” the hot object being treated as an irreducible whole and not advance analysed into an object plus a property of hotness. He was found that the matter at age four to six talk about hot objects in one of two ways: they use either very short sentences of the form “X is hot” (where X is an object) or “X make [feel] hot”.

Ericson [10] on his research revealed that children use “cold” as a notion of opposite heat. He also found that the children idea that heat and cold was a type of material like air or water which is capable of flowing into or out of objects. In line with this idea of heat, the term of warm is construed as the resultant mixture of heat and cold possessed of object.

Students that related heat conception to the condition of evaporation viewed heat as something either hot or warm, whereas the students who related temperature to the condition of evaporation thought of temperature as a degree of hotness or coldness. Such findings illustrate that although students use science terminologies such as heat or temperature, their conceptions are not scientific.
This performance indicates the reality of children conflict regarding the concept of temperature. The qualitative statement of temperature just based on personal experience, intuition, and common sense e.g. [10]. The conflict of those terms convinces the children that sight and feel is not a good way of explaining temperature. But according to Piaget, a relationship of conflict or discrepancy between two cognitive entities leads to cognitive development e.g.[11].

Although children at ages 4 to 6 do not consistently distinguish between the term “hot” and “warm,” “cold” and “medium” or “intermediate”, by the time starting at age eight, children can differentiate clearly among hot and warm and at the same time, concerning hot and warm as different instances of the same dimension. Children carry out this fundamentally by reflecting on how they take action on and respond to objects at diverse temperatures e.g. [11].

Kuhn [12] explained that is, the idea, laws, explanations state able in the terminology at the start, in language 1 (L1), cannot be articulated in terms of the terminology at the end, in language 2 (L2). Kitcher call attention that there are numerous ways for correcting the reference of any given term: definitions, descriptions, theory relative similarity to particular exemplars. Apiece theory require that for apiece term, its multiple ways of reference fixing pick out a single referent.

4. Conclusion

Young children in kindergarten learn about heat and temperature concept through sense perception experience in their daily life. Children tend to get the intuitively concept rather than scientifically defined concept. They are considered that temperature as the qualitative notion. They use a few terms categorization as “hot”, “cold”, “normal”, “warmth” or “medium” to describe temperature. But in the other hand, these terms is confusing children.

Find out that children have many misconceptions in the terms of temperature, consequently teachers should start off sensibly apply scientific terminology to express science to children. It is also necessary that teachers accurately understand children thought.

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