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An Examination of Misconception in Earth Sciences and Research into Effective Teaching Methods

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Abstract

In Japan, misconception research is conducted relatively frequently in the field of physics and chemistry, but it is not very actively pursued in the field of earth sciences. The reasons for this are thought to be related to the fact that many elementary- and middle-school science teachers in Japan major in fields other than earth sciences at university, and in turn, many university teachers who train science teachers specialize in fields other than earth sciences. Upon surveying undergraduate students on the basis of this hypothesis, we discovered that there are many misconceptions in the field of earth sciences. Misconceptions that the author is currently aware of have been revealed to arise in various units, including weather maps and wind direction, clouds, and other parts of the field of meteorology, and the distance between the sun and the planets, and light emission by meteor in the field of celestial bodies. Misconception research in the field of earth sciences leads to extremely important research for protecting citizens from meteorological disasters, such as heavy rain, typhoons, heavy snow and thunder, that occur in Japan each year and from earthquake and volcanic disasters. This study gathers information on the actual situation of students with cooperation from middle- and high-school teachers, based on case examples of misconceptions in the field of earth sciences that the author investigated of in his university classes.

Keywords: *Misconception, meteorological disasters, earthquake disasters, improvement of teaching.*

1. Introduction

Misconception, when translated directly into Japanese, is "misunderstanding, misunderstanding". Regarding misconceptions in science, Taga (2019) [7] stated, It will not be easily modified and will remain intact when you grow up. " In addition, "School-Made Misconception" which is newly occurring in science classes has been pointed out. Among them, Barke et al (2009) [2] clarified that there are some that arise from textbook figures and materials.

There are many studies in the field of physics and chemistry regarding such misconceptions. For example, if a college student gives one dry cell, one miniature bulb, and one conductor and performs the operation of “turning on the light bulb”, many students cannot turn on the light well. It uses a miniature light bulb in a socket when learning electricity in elementary and junior high school science, so it has not learned the structure of the light bulb and can not contact the conductor with the brass side of the miniature light bulb Because. Most students do the following (Figure 1) These cases are typical of the School-Made Misconception.

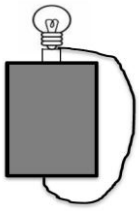

Figure 1: Connection example of wrong conductor

2. Examples of misconceptions in the meteorological field

2.1 What is a cloud?

In both elementary and junior high school textbooks, there is a statement that "clouds have water droplets and ice crystals floating", and they are also shown in the textbook diagrams. However, when asking college students, quite a few say clouds are gas. When asked why he answered, he answered, "I did an experiment to make clouds at elementary and junior high schools."

In the experimental apparatus shown in FIG. 2, a liquid crystal thermometer is contained in a plastic bottle, and a change in heat insulation can be visualized. When the air in the PET bottle is compressed, the temperature rises by 2 to 4 ° C. When the experiment is performed again with incense smoke, clouds can be reproduced in all groups. The water drop disappears when the stopper is closed and compressed immediately. Thus, it can be understood that the evaporation and condensation of the water droplets are caused by the temperature change in the PET bottle container.

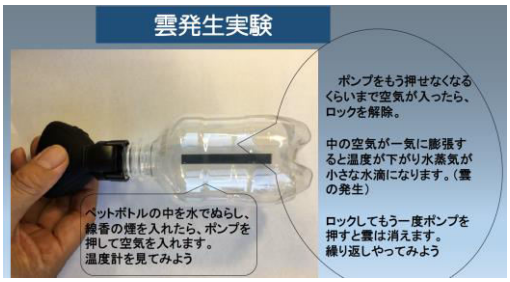

Figure 2: Cloud formation experiment. Liquid crystal thermometer in PET bottle

2.1. Cumulonimbus and thunder

If you look at Japanese textbooks, there is little to teach thunder. Although it is described that thunderstorms occur due to cumulonimbus clouds in the meteorological field, lightning disasters are rarely treated. Shigeno (2019) [6]]. "Let's make cumulonimbus clouds with milk" Aichi Prefectural General Education Center (2002 By performing the experiment [1], we can visualize the appearance of cumulonimbus from its occurrence to its disappearance.

As for lightning, the author created 10 questionnaire items from the Japan Society of Atmospheric Electrical Engineers (2001) [4], "How to Protect Yourself from Lightning-Safety Measures Q & A-Revised Version", and surveyed junior high and high school students. The following results were obtained.

・The number of responses to the questionnaire is as follows. Junior high school students 280, high school students 760, college students 67

The answer was two-choice. Here are some of them.

(1) Ten seconds after the flash, a rattling sound was heard. Still, occasionally the sun is bright and not raining. The correct answer is (B)

(A) The lightning strike is far away, so it's OK for a while. (Wrong answer: 43.5%)

(B) A dangerous situation where it is not known when a lightning strike will occur.

(2) The sky became dark and rumbling and thunder began to be heard. The correct answer is (B)

(A) It is safer to remove the metal attached to the body and keep it away from the body. It is. (Wrong answer 67.6%)

(B) Since the human body is easy to conduct current in the first place, when metal is attached and detached, almost all No change.

The level of understanding about lightning found in the questionnaire was almost the same for junior high school students, high school students, and university students.

Considering the above results, the phenomenon associated with cumulonimbus is that lightning starts before precipitation, and lightning strike (negative lightning) is the fastest stepping leader (precursor discharge) coming down from cumulonimbus and reaches the surface of the earth first. There is no indication that a lightning strike will occur in the area where the lightning strikes. The misconception that removing the metal is safer than attaching the metal is considered to be caused by the inability to understand that the human body is a good conductor.

It is hypothesized that such misconceptions are taught by adults to children, and that children become adults and then teach children. It is thought that misconceptions are also held by teachers, and When I asked the incumbent faculty for comment, it was inferred. Regarding the fact that the human body is not sufficiently recognized as a good conductor, a misconception concept that “current flows or does not flow” has arisen in electric classes in elementary and secondary education depending on whether the miniature bulb is lit or not. It is presumed that it will be lost. It is not dealt much in compulsory education that current flows in water and human body when conditions such as voltage are changed. As an experiment to eliminate this misconception, I would like to introduce a lightning experiment using a piezoelectric device and an anti-vibration bulb. (Fig. 3)

Adhere the lead from the piezoelectric device to either the bottom or brass part of the anti-vibration bulb with vinyl tape.The interior of the room is darkened, and a finger is put on the glass of the bulb, and the piezoelectric device is moved to discharge.

Figure 3: Lightning test device using vibration-resistant bulb and piezoelectric device

Then, electric discharge occurs from the filament of the bulb to the finger touching the glass. This experiment has an impact, and you can experience "the human body induces electricity". In other words, it is possible to realize that lightning is easy to strike even if a person does not wear metal because his body is a good conductor. The piezoelectric device can be easily removed from the used lighter by pulling it out with a pair of pliers. When conducting this experiment, it is better to let the students start by connecting the bulb and the piezoelectric device separately and connecting them with vinyl tape instead of connecting them. This is important for understanding the structure of the light bulb.

2.3. Weather map and wind

When the students were asked to write the wind direction on the weather chart as shown in Fig. 4, all of them entered the following wind directions.

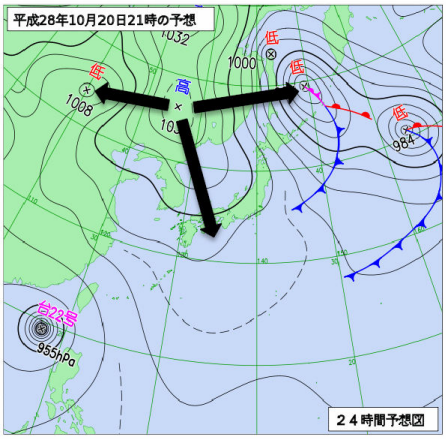

Figure 4: Wind direction written by the student on the weather map

A junior high school textbook (Keirin-kan 2011) [3] states that "where there is a difference in atmospheric pressure, the power to move the atmosphere from higher to lower pressure works." Actually, the Coriolis force due to the rotation of the earth works. "The wind blows parallel to the isobar while looking at the higher air pressure to the right (above 1 to 1.5 km or above where there is no friction with the ground surface)." Is easier to understand. .

If the wind blows from the south, the advection of the warm air, if it blows from the north, the temperature changes such as advection of the cold, and if the north-south wind hits, there will be a front line there, such as reading the wind from the weather map, knowledge will be systematic Should

be. I think these points are important for improving weather classes at the junior high school stage. Figure 5 shows what I have developed and implemented for that purpose. The weather map is sandwiched between A3 size transparent clear holders and used as a group work material. Use a blue marker pen for north winds and a red marker pen for south winds with a marker pen from above the clear holder. This material can be used as a whiteboard, and can be rewritten many times by wiping it with tissue paper.

Figure 5: Clear holder with weather map in between Teaching material for writing wind direction with marker pen

3. Examples of misconceptions in other earth science fields

An example of a celestial unit is related to the distance between celestial bodies. I understand the names of planets very well. However, about 70% of students answered, "Which is farther from Earth to the sun or from Earth to Jupiter?" The reason for this is that the whole page of the planet is shown on the facing page of the textbook, suggesting that the image is related to misconception.Meteor showers were also reported during the activity of the meteor shower, but I was shocked to see that some students thought that the stars that make up the constellation were moving.

4. Misconception Research Perspective

Misconception research cases in science are biased to fields other than earth science, where there are many researchers. In Japan, few faculty have majored in earth sciences at universities, and faculty from other majors are often teaching earth sciences. Classes are considered to be conducted according to textbooks, but systematic guidance may not have been achieved.

Under these circumstances, it is very meaningful to understand the misconceptions of university students and develop effective teaching methods while sharing information with those in charge of compulsory education and high school education. The misconceptions introduced this time are only part of what I have learned, and learning about weather such as lightning, heavy rain, and tornadoes is related to disaster prevention and mitigation, so eliminating misconceptions is a national issue.

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