Question design based on misconception related to weather disaster prevention

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In Japan, disasters caused by heavy rain often occur between June and September every year. Therefore, it is very important for school children to learn the correct knowledge about weather disasters.
A survey of students' understanding in university classes revealed a lack of understanding about weather maps.
The author analyzed how descriptions and schematic diagrams in junior high school textbooks generate misconceptions, and examined whether the content of the textbooks is designed to help students learn about weather disasters such as heavy rainfall correctly. An analysis of junior high school textbooks (from five publishers) shows that the descriptions of precipitation areas associated with extratropical cyclones and fronts are drawn only on the cold side of the front, while there are no clouds at all on the warm side of the front.
In other words, the diagrams in the places, which does not lead to the understanding thtextbook appear to be sunny at heavy rain will fall here.

1. Research Methods

1.1 Learning to read the wind from weather maps

When asked to predict what kind of wind would blow based on the weather map, and to write the wind blowing on the weather map with arrows, most of the students could not correctly fill in the wind direction.
Although the textbook states that "winds blow clockwise out from the center of an anticyclone and counterclockwise toward the anticyclone around a low pressure system," the most common answer is as shown in Figure 1.

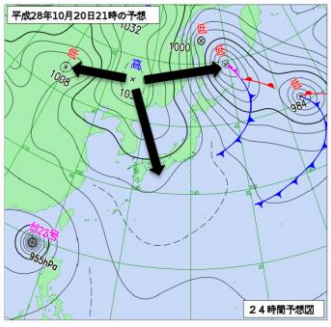

Figure 1

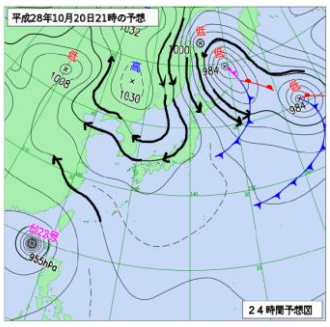

Figure 2 If we consider that the wind blows parallel to the isobar

In reality, as shown in Figure 1, the wind does not blow, but the force due to the difference in atmospheric pressure plus the Coriolis force plus the frictional force with the ground surface. Therefore, explain the following and repeat the exercise of filling in the wind direction on the weather map. In doing so, tell them two points. (1) In the Northern Hemisphere, the wind blows parallel to the isobars, with the position of the anticyclone to the right. (2) The narrower the distance between the isobars, the stronger the wind. The isobars represent the wind direction, and the wind can be considered to blow along the isobars. The wind direction is then as shown in Figure 2. In fact, at an altitude of about 1 km or more, the wind direction is almost parallel to the isobars.

1.2 Questions for thinking about weather-related disasters

To these students who had learned to "read the wind," I asked them questions that I had considered through my misconception research.
A condition in which air rises are more likely to occur is called "unstable atmospheric conditions.
"Which is heavier, dry air or moist air? Which is heavier, dry air or moist air?
In response, most of the students answered that moist air is heavier. This is one of the naive concepts, which leads to misconceptions.
If we study chemistry in high school and think in terms of molecular weight, we can understand that water vapour is lighter than nitrogen and oxygen, which are the main components of air.
When I tried this question in several university classes, almost everyone got it wrong.
So, after asking them to think about this question, I presented them with a case study as shown in Figure 3 (the forecast weather map for the July 2017 torrential rains in northern Kyushu, Japan).

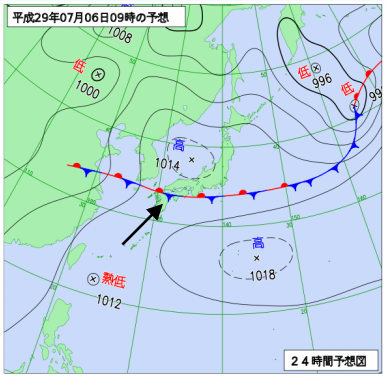

Figure 3
the forecast weather map for the July 2017 torrential rains in northern Kyushu, Japan

Direction of inflow of warm and humid air

2.Result

As a result, the students were able to better understand the situation where moist air is light, and cumulonimbus clouds develop when warm moisture inflow and dry air north of the front collide.
As in this case, students learn by asking questions based on misconceptions. It is then important to use this knowledge to learn about the causes of disasters such as heavy rain, strong winds, and lightning. When I taught college students the causes of heavy rain and other weather disasters using this method, they understood it very well

In Japan, torrential rains often occur between June and September. The design of the question presented here was devised based on the weight of moist and dry air, which most people get wrong. Using this question to learn the conditions under which disasters are likely to occur through weather maps has proven to be very effective.
As a question that can be used to study weather in junior high schools, I tell teachers about it every chance I get..

Acknowledgements
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