Do Students in Grade 10 Generate Ideas of Statistical Hypothesis Testing Spontaneously?

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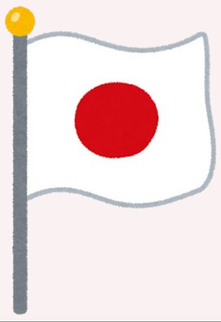

【Background】

It's essential to form a hypothesis with an expression of probability such as 'probably' or 'would'. Current research is paying attention to statistical hypothesis testing such as the Reasoning with Informal Statistical models and Modelling (RISM) proposed by Dvir & Ben-Zvi (2018). However, it has been shown to be difficult for students to understand formal hypothesis testing in previous studies (e.g., Garfield, Le, Zieffler, & Ben-Zvi, 2015).

【Aim】

We set the hypothesis that teaching and learning are possible if they are informal form. Experiencing informal statistical hypothesis testing may eliminate the difficulty of teaching and learning formal statistical hypothesis testing. Furthermore, there is a possibility that students may generate ideas of statistical hypothesis testing spontaneously. Therefore, the purpose of this study is to confirm whether ideas of statistical hypothesis testing occur spontaneously.

【Ideas of Statistical Hypothesis Testing】

1. Statistical Hypothesis Testing

Statistical hypothesis testing is the method which "aims to state the evidence in a sample against a previously defined (null) hypothesis, minimizing certain risks" (Castro-Sotos, Vanhoof, van den Noortgate, & Onghena, 2007, p. 103). For the hypothesis (alternate hypothesis) to be argues for, a hypothesis (null hypothesis) is set whose rejection provides support to the alternative hypothesis based on the inference that the observed sample can hardly be obtained under the assumption that the null hypothesis is correct.

2. Abduction

As for the definition of abduction, Peirce stated that "abduction is the process of forming an explanatory hypothesis. It is the only logical operation which introduces any new idea" (CP 5.171), and characterised the difference between deduction and induction in the logic of inference as follows: "Deduction proves that something ***must*** be; Induction shows that something ***actually is*** operative; Abduction merely suggests that something ***may be***"(CP 5.171). As an example of abduction, Peirce writes: "Fossils are found; say, remains like those of fishes, but far in the interior of the country. To explain the phenomenon, we suppose the sea once washed over this land" (CP 2.625). That is, abduction means forming a hypothesis about which facts can be true when a certain fact exists. If this fact is the data, abduction is the idea of inferring characteristics of the population from samples, which is the essence of inferential statistics.

◎ Difference between Statistical Hypothesis Testing and Abduction

The example of abduction mentioned above can be stated differently from the standpoint of statistical hypothesis testing: 'Under the assumption that there was not sea but land here in the distant past, it can be concluded that this area would have been covered by the sea in the past by rejecting the assumption based on the fact that fossils of fishes were found here.' There are two types of idea of statistical hypothesis testing: Statistical Hypothesis Testing Type with the hypothesis setting at the beginning and Abduction Type with the surprising fact (data) at the beginning.

【Method】

In educational practices for 34 students in grade 10 in a scene that inquiries the causes of global warming, we will check whether the ideas of statistical hypothesis testing occur spontaneously. Students have not yet learned statistical hypothesis testing. If the ideas of statistical hypothesis testing occur spontaneously, we will confirm whether they are Statistical Hypothesis Testing Type or Abduction Type. Also, we will check whether the description of them is explicit or implicit.

The educational practices are composed of 3 hours. In the 1st hour, students anticipated the events caused by global warming and the factors causing global warming, and watched videos on the opinions of CO2 pro and CO2 con. In the 2nd hour, then, they individually inquired the causes of global warming with the search using the computer, and summarised their opinions as a report involving the evidence. Finally, in the 3rd hour, some of the reports made in the 2nd hour were shared at the whole class, and the final explanation on the cause of global warming was summarised in the form of cause and effect diagram based on them. In this study, the objects of analysis are the descriptions in the report submitted in the 2nd hour.

【Result】

As a result of analysis, the ideas of statistical hypothesis testing were present in the descriptions of 10 out of 34 students. In addition, the result of classifying the ideas generated by these 10 students is shown in Table 1. Most of them were explicitly described. Here, specified examples of Statistical Hypothesis Testing Type and Abduction Type generated by 2 students are shown.

	Statistical Hypothesis Testing Type	Abduction Type
Explicit	2	7
Implicit	1	0

Table 1: The result of classifying the ideas of statistical hypothesis testing

Student A (who generated the idea of ***Statistical Hypothesis Testing Type***)

'Currently, the average temperature of the earth is around 14 degrees, but if there is no greenhouse gas such as water vapor, CO2, methane, and so on in the atmosphere, it will be -19 degrees'

Student B (who generated the idea of ***Abduction Type***)

'If the all energy from the sun is released from the surface, the average temperature of the earth becomes -19 degrees. However, this is not correct at present. This is because there is greenhouse gas in the atmosphere. That's why the presence of greenhouse gas raises the temperature of the earth. Therefore, the earth warms as the amount of greenhouse gas increases'

Student A	Student B
Setting the hypothesis 'There is no greenhouse gas in the atmosphere' ↓ Comparing the earth's temperature under this hypothesis with the current earth's temperature ↓ This hypothesis is rejected and the cause of the global warming is the greenhouse.	Surprising fact 'If the all energy from the sun is released from the surface, the average temperature of the earth becomes -19 degrees. However, this is not correct at present.' ↓ The effect of greenhouse gas has to be taken into account and the cause of global warming is the greenhouse.

【Conclusion】

Students in grade 10 generated the ideas of statistical hypothesis testing in the informal form spontaneously even if they have not yet learned it. In particular, a logic of abduction was constructed to set a certain hypothesis to explain some fact (data). Additionally, most of them were explicitly described, so it can be found that they consciously used the idea of statistical hypothesis testing.