Development of Concept Inventories fitting Japanese High School Physics II

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Abstract. This talk is the latter of serial presentations, and an overview of our project and method of test-data analyses will be shown in the previous one. The purpose of this study is to develop concept inventories fitting to the standard curricula for Japanese high school physics. In this talk, we will show some examples of a "trial" version of the test and discuss student's misconceptions based on student's responses to it. For example, by making an item related to sushi and improving the items of the existing concepts inventories, we made the concepts inventory in the context familiar to Japanese students.

1 Examples of Basic Physics

In this section, we will show some examples of Basic Physics' test and results of them. Basic Physics is usually taught in 10th or 11th grades in Japan. We have made a trial version of the concepts inventory fitting Basic Physics curricula (Basic Physics' test) and administered it to 1912 Japanese high school students before study Basic Physics.

Question 11 is an item related to the balance of forces and Newton's third law(the left panel of Figure. 1.). The center and left panels of Figure. 1. suggest that more than 40% of students confuse a force pair in equilibrium with action and reaction and 20% of students consider that tuna is pushing the plate through the rice. The right panel of Fig.1 suggests that such misunderstandings are commonly observed on a significant ratio of students independently of their total scores.

Since infit-t statistic of question 11 is ≥ -2 and ≤ 2, question 11 may fit the Rasch model. Moreover, since the point biserial correlation coefficient of question 11 is 0.2 or more, there is a positive correlation between the overall score and the correc rate of question 11.
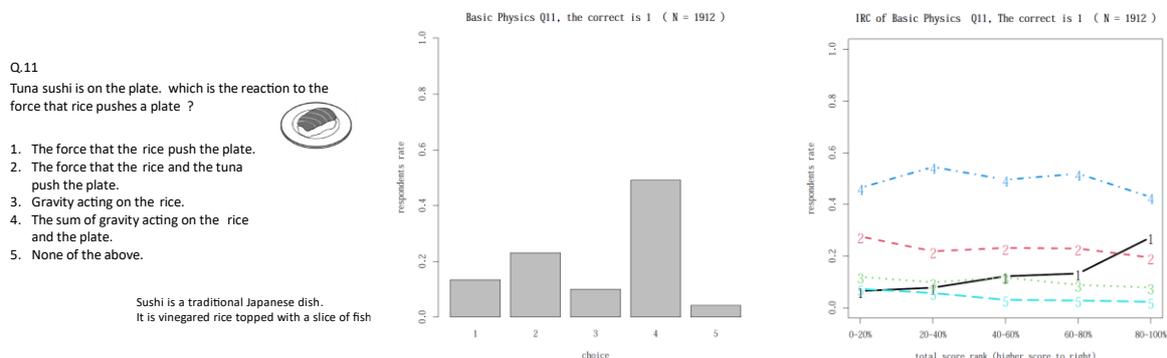

Fig. 1. Results of question 11 of the Basic Physics test. The left panel shows the question and option of question 11. The center panel shows answer rates at each choice. The right panel shows item response curves of question 11 describing respondents' rates at each total score rank.

Question 18 is an item related to a circuit (the left panel of Figure. 2.). As shown in the center panel of Fig.2, more than 20% of students believe that the electric current is consumed on a bulb. As the total score rank goes up, the less number of students choose option 1.

Since infit-t statics of question $18 \geq -2$ and ≤ 2, question 18 may fit the Rasch model. Moreover, since the point biserial correlation coefficient of question 18 is 0.2 or more, there is a positive correlation between the overall score and the correct rate of question 18.
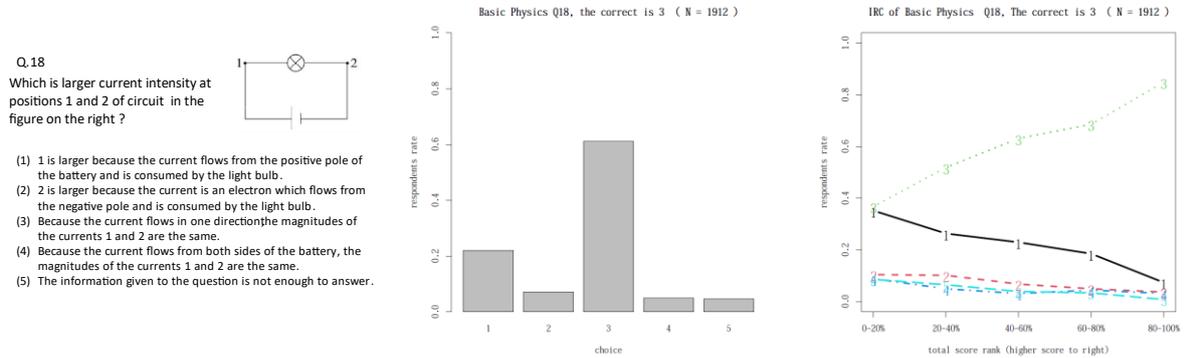

Fig. 2. Results of question 18 of the Basic Physics test. The left panel shows the question and option of question 18. The center panel shows answer rates for each option. The right panel shows item response curves describing respondents' rates at each total score rank of it.

2 Examples of Advanced Physics

In this section, we will show some examples of Advanced Physics' test and results of them. Advanced Physics is usually taught in 11th or 12th grades in Japan. We have made a trial version of the concept inventory fitting Advanced Physics curricula (Advanced Physics' test) and have administered it to 647 Japanese high school students in pretest.

Question 13 is an item related to the doppler effect and the speed of sound (the left panel of Figure. 3.). The center and left panel of Figure. 3. suggest that about 20% of students think that the speed of sound varies depending on the direction.
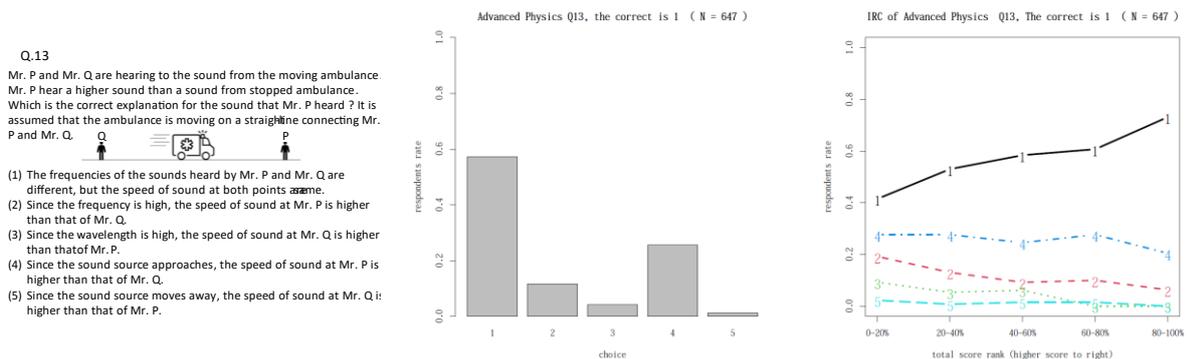

Fig. 3. Results of question 13 of the Advanced Physics test. The left panel shows the question and option of question 13. The center panel shows answer rates for each option. The right panel shows item response curves describing respondents' rate at each total score rank of it.

Since infit-t statics of question 13 is minus two or more and two or less, question 13 may fit the Rasch model. Moreover, since the point biserial correlation coefficient of question 13 is 2 or more, there is a positive correlation between the overall score and the correctness of question 13.