Mini Research: Interview and Test Score Methods
What Causes the Seasons?
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Section 1: Interviews

The two students that I interviewed did a brief but fairly good job of explaining the earth and its rotation, and identified the role of the tilt of the earth in the change in seasons. The high school sophomore that I interviewed thought that the tilt of the earth also determined the wind temperature and that the moon pulls on the axis of the earth to change its tilt. There were a two other participants in our group (interviewed by Harvel and Gebbia-Portice) that included the moon in their responses, but had misconceptions about the moon's rotation.

It was surprising to me that several students thought that the distance of the earth from the sun caused the seasons, and one thought that the longitudinal position on the earth had an impact on the seasons, meaning that she believes that all areas along the same longitudinal plane experience the same season, even if they are in the southern hemisphere.

Of the 35 students interviewed, 8 of the 17 females (about half) had misconceptions about the reason for the seasons, and 6 of the 18 males (a third of the students) expressed misconceptions. The student's grade level didn't seem to make a difference; college students had similar misconceptions to those in high school. To draw more analogies, one would have to compare the number and types of science classes that the students took, and the state/district/country in which the students were educated.

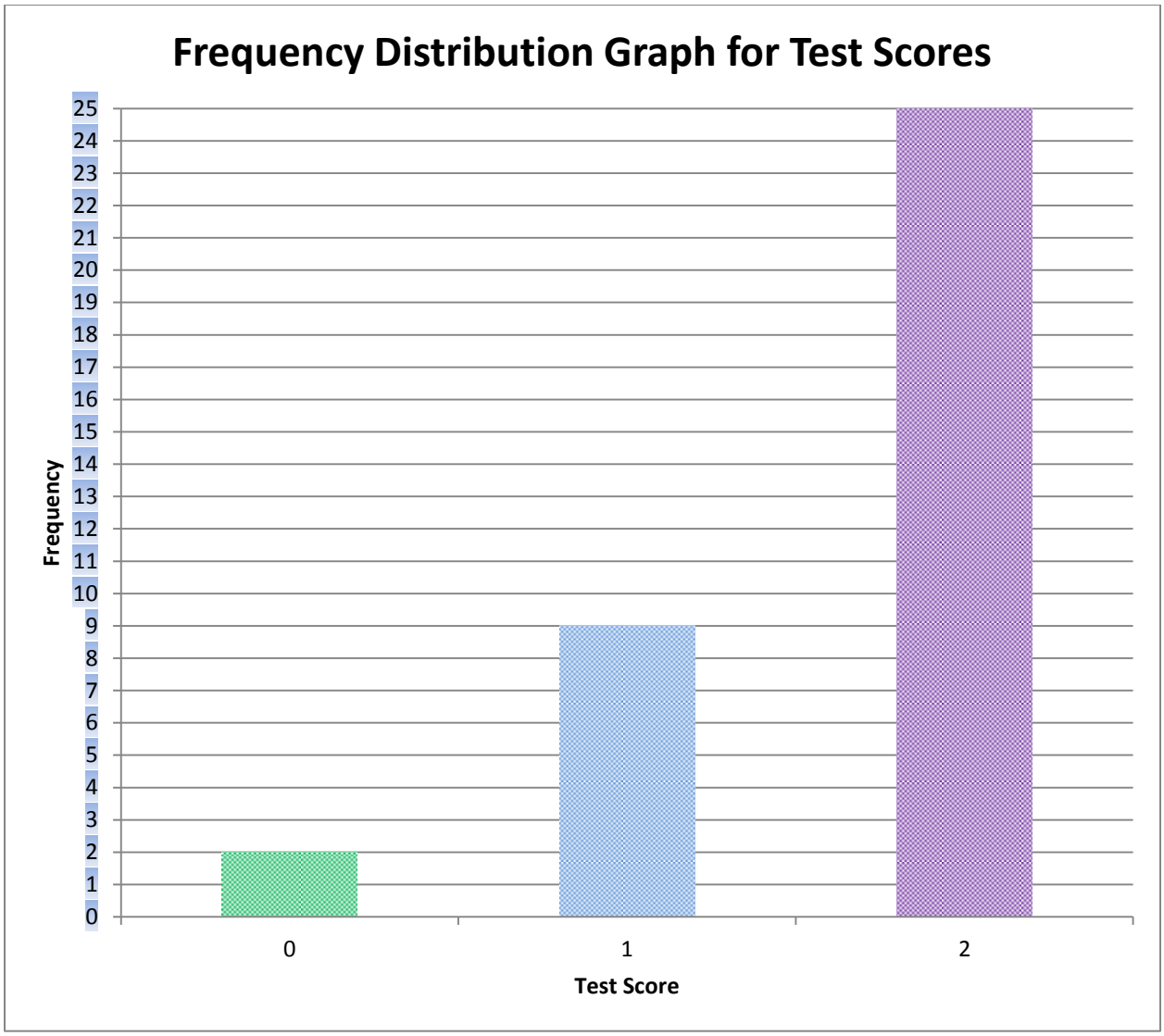
Section 2: Test Scores

Despite some misconceptions, overall the students in this group scored well on the test. There were almost three times as many that answered both questions accurately than those that answered only one correctly. Additionally, over twelve times as many answered both questions correctly than did not answer either question correctly.

When examining patterns in scoring by gender, one male and one female answered both questions incorrectly (scored 0). Of the 9 students that answered only one question correctly, 5 are male and 4 are female. A similar 50/50 split appears in those that answered both questions correctly: 13 are female, and 13 are male.

When examining patterns in scoring by age/grade level, it didn't make much difference either: a high school junior and a college senior answered both questions incorrectly. Of the 9 students that answered only one question correctly, all of them are in grades 10, 11 and 12. Students at all grade levels, high school and college age, answered both questions correctly. However, all but one of the college age students answered both questions correctly, indicating that a greater sampling or additional questions about the types of science classes might help us draw some conclusions about whether additional science classes help clear up some student misconceptions.

As the frequency distribution graph below illustrates, the slope of the graph curves dramatically, creating a concave up, increasing curve. The group average was 1.64. My participant average was 1.5, statistically slightly less than the average, but considering that there were only two questions that were represented in the scoring, the averages were similar.



Section 3: Synopsis

Although the senior in high school that I interviewed did not articulate her answers well, she understood the relationship between the tilt of the earth's axis and the seasons, and scored 100% on the test. The sophomore thought that the earth's rotations had a big impact on wind currents, and added that "The moon might have a pull on the poles to change the angles on the earth to face either from the sun or towards it. It may also change the wind currents." She scored 4 out of 5 correctly on the test.

When we look at the questions that we administered to our group, question 1 and 5 were similar, so it seems that if the student answered one of these wrong, he/she would get both wrong, and similarly, if one was answered correctly, the other one should have been as well. The two questions were:

1. When the northern hemisphere is tilted away from the sun, the weather in the southern hemisphere is:
   a. colder than that of the northern hemisphere
   b. warmer than that of the northern hemisphere
   c. the same as that of the northern hemisphere
   d. none of the above

5. When the northern hemisphere is tilted toward the sun, what season is it in the southern hemisphere?
   a. Fall
   b. Winter
   c. Summer
   d. Spring

Interestingly, the high school sophomore that I interviewed answered question 5 incorrectly but answered question 1 correctly. So although she could pick out that the temperatures in the northern hemisphere are opposite in question 1, she did not apply that same concept in question 5. Her answer to question 5 was: C. Summer.

However, question 5 could be misleading and is open to further scrutiny. When the northern hemisphere is tilted toward the sun, it is experiencing summer, or the months of June, July, and August. The southern hemisphere is also experiencing the months of June, July, and August, which could be interpreted as summer, even though the temperatures are typically cooler for the southern hemisphere, and those in the southern hemisphere consider it winter. But if one never lived in the southern hemisphere (and at age 15), how does one know that June, July, and August are considered winter? Does the word 'summer' necessarily mean warmer temperatures? (I had to look it up in the dictionary.) Regardless, this points to the need to review questions carefully, and take into account possible misinterpretations of test questions. The wording of the test question does have an impact on question validity.

When we examine scores with misconceptions, all of those who scored poorly had misconceptions, yet approximately 8 students with misconceptions did answer both questions correctly. It is possible that when asked to recall what causes seasons without any preparation, students may have forgotten or are nervous about the accuracy of their answers. Then, when they read the questions in test form, and are offered multiple choice answers, they can draw conclusions from the answers. The test questions offer the remedial help that they need to recall what they have learned in the past.