

## Analyzing Causes of Seasonal Changes Displayed by Primary Teachers at the Equator

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**Abstract:** This study was conducted to examine 10 Belizean teachers' conceptions about the causes of seasonal change. This research was conducted with an integrated method using a open ended written test and an interview which included a drawing.

There are four categories, explained by the teachers, as the causes of seasonal changes. They are; climate, rotation of the earth on its axis, revolution of the earth around the sun, and the tilting of earth's axis as it revolves. Most teachers misunderstood that the first of three categories was responsible for seasonal change.

Second, it is more effective to use the integrated method shown in this research than to use only a written test when seriously investigating the causes and understanding of seasonal change.

Third, 8 out of 10 teachers could not correctly explain the causes of seasonal change. The reasons for seasonal change seemed to be hard for the informants to understand even though it was taught in elementary, middle, high school, and college elective classes.

**Key words:** seasonal change, scientific concept, non-scientific concept, revolution of the earth, rotation of the earth, tilting of earth's axis

### I . Introduction

Students understand the change of seasons as repetitive and regular occurrence. They know from experience that flowers bloom during spring and there are long spells of rainy weather and steaming heat in the summer. Glorious tints of autumn foliage cover the mountains in fall and much of the world is buried under snow during the winter. However, there are not many students who are confident enough to answer the following questions; Then 'Why does seasonal change occur?' and 'Why is it hot during the summer and cold in the winter?' (Schneps, 1988).

The concepts of seasonal change were taught in elementary, middle, high school, and even in college elective classes. However, according to the studies conducted in Korea and outside, not only students in elementary, middle, high school, and college, but also their teachers widely share misconceptions of seasonal change that is vastly different from the scientific concepts that they were supposed to have been taught (Schneps, 1988; Schoon 1989, Sadler, 1987, Chae, 1992). For example, informants had

been randomly selected from 23 graduates of Harvard University and asked, 'Why is it hot during the summer and cold in the winter?' Only two people had correctly answered, 'It is because the Earth revolves on a tilted axis.' The rest had answered wrong, 'It is because the Earth is tilted toward the Sun in the summer and away from the Sun in the winter (Schneps, 1988).

Sadler (1987) investigated misconceptions about day and night, the positional change of the moon, and seasonal changes through interviews after having 25- 9th grade students, watch a video on the subjects. One of the biggest misconceptions is that the seasons change because the earth gets closer to the sun in summer and farther away in winter.

Schoon (1989) reported 21 misconceptions related to earth science by administering a multiple-choice questionnaire to the students in 5th grade, 8th grade, 11th grade and adults in college (1213 students). The misconceptions relevant to our research are that "The reason why summer is warmer than winter is that the distance is less between the earth and the sun in summer", "The position change of the moon

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occurs due to the shadow of the earth," etc.

Atwood & Atwood (1996) looked into misconceptions about seasonal change by using an open question survey to 49 students who were studying to become elementary school teachers. The results came back that only one of them had a scientific concept whereas the rest of them had childish conceptions.

Kim (1990) conducted a survey about the conceptions of students in 3rd and 4th grade. They responded that seasonal change is due to changes in earth's temperature.

Chae (1998) reported conceptions concerning seasonal change held by middle and high school students as follows: relative distance between the sun and the earth, the revolution of the earth around the sun, the rotation of the earth on its axis, the difference in amounts of solar radiation, the movement of the sun and the differences in atmospheric pressure. Plus, the higher the grade level, the fewer responses were given.

Ha (1999) stated that the results which came from 5th and 6th graders about the causes for the seasonal change was: the change of the distance between the sun and the earth and especially those who believed the earth's orbit is an oval, felt that way. In addition, the scientific conceptions and misconceptions emerged at a higher rate after the lesson than before.

Go (2000) explained the results from 110 students in 4th to 6th grade regarding their concepts of seasonal change. He analyzed that most of them had diverse conceptions and expressed them on the basis of empirical, intuitive and visual evidence.

Generally, the misconceptions about seasonal change might have been caused by observation and experience in life, false illustrations and readings from textbooks, misinterpretations in broadcasted media, teachers' inaccurate explanations, and regional and cultural differences (Lee & Chae, 1993). It had been investigated that one of the biggest "root" causes for the seasonal misconceptions was the use of false illustrations in text books (Schneps, 1988). If

these misconceptions can potentially develop in the students' minds prior to learning the accurate scientific concept, it interferes with students ability to correct their misunderstandings and seriously damages scientific curriculum (Champagne & Klopfer 1983).

To clarify these common seasonal misconceptions, Cosgrove & Osborne (1983) have developed a new experimental model, and since then, demonstrations using their model have been widely studied.

As mentioned above, the research related to the causes of seasonal change has been conducted in domestic and international areas. However, the research about the causes of seasonal change from students and teachers who reside in and around the equator has not been reported. This study investigates what Belize elementary school teachers visiting Korea in the name of the improvement of teaching-learning ability in elementary science field and the contribution to the internationalization, think about the causes of seasonal change. Belize is located in Central America, across the border from Mexico and Guatemala in the north and south and bordered by the Caribbean Sea on the east and west.

## II. Methods

### Informants

This study was conducted with 10 elementary school teachers from Belize which is situated in Central America and populated by about 300,000 people. They consisted of 5 males and 5 females and their careers as teachers ranged from 5 to 25 years of teaching experience. They use English as an official language. They visited the Elementary school affiliated with Jeonju National University of Education, for the purpose of improving their teaching and learning ability in the field of elementary science. The Belizean teachers also gained international experience. They were also invited to Woosuk University by the Korea International Cooperation Agency (KOICA) from July 3–July 25, 2008. They were educated in

Korean science curriculum, Korean science teaching strategies, Korean science textbooks, Korean science environments, etc by Korean professors. Researcher taught them for 8 hours about Korean science curriculum.

### Data collection

After understanding the purpose of the research, the teachers agreed to participate in the research study. A questionnaire for this research project was developed. The questionnaire had 1 item. The main question was "What do you think seasonal change is?" The method of the questionnaire consisted of having them describe the seasonal changes with both writing and drawings. The investigation on the specific conceptions for seasonal change was carried out through an interview as well. Interview questions also were related to the question "What do you think seasonal change is?" Considering that all the participants were from a foreign country, the interview was done in the way of an informal talk to provide a comfortable atmosphere. All of the participants were involved in the interview

process. The interview began with a questionnaire which was designed in advance and accompanied by an audio recording. The questionnaire and interview took 2 hours in total. The recorded interview was transcribed on the same day.

### Data analysis

The researchers extracted the main conceptions out of the responses collected through the questionnaires and the interviews. Their main conceptions were categorized and organized on the basis of non-scientific and scientific answers. After that, the researcher put forth an explanation with drawings and an interview about seasonal change. To improve the reliability, the "primary" researcher discussed the analyzed results with 2 other researchers who majored in science education and included only the results on which all three researchers agreed.

## III. Results

The summary for the causes of seasonal change in brief is as followings.

**Table 1**

*Research results for the causes of seasonal change.*

T. No.	Examples	Category	Concept
6	Tropical climate	Tropical climate	
3	The rotation of planet earth including the changes of the moon		
4	The rotation of the earth	The rotation of the earth	
5	The axis and the rotation of the earth The closer the warmer, and the farther the colder		
9	Revolution of the earth Different position of the earth	The revolution of the earth	Non-scientific conceptions
1	Rotation of the earth at a tilt Variation in 4 parts of light as the earth revolves	The revolution of the earth	
2	The revolution of the earth The earth is tilted	The rotation of the earth The axis of the earth	
8	The revolution of the earth The tilting of the earth Rotates around it's axis	⋮	
7	Tilt on earth's axis Revolution of the earth	The tilt of the earth on its axis and the revolution of the earth	Scientific conceptions
10	The tilt of the earth on its axis as it orbits the sun		

Category 1 : Tropical climate (T6)

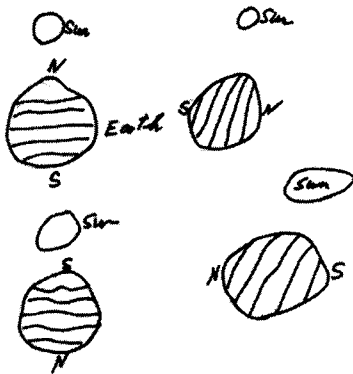


Fig. 1 T6's Drawing showing the cause of seasonal change

T6 stated that seasonal change stems from a tropical climate. However, considering figure 1 which represents seasonal changes caused by rotating the north pole of the earth clockwise 90 degrees, we can assume that T6 located the sun and earth in relation to climate. The teacher involved in this interview can assume that the top and bottom of the drawing on the right, in which the equator and sun are closest to each other, shows the hottest season.

Category 2 : The rotation of the earth(T3, T4, T5)

1) explanation with drawing

There are changes of seasons due to the rotation of planet earth like the changes of the moon.

This causes the temperature to fluctuate depending in certain areas of the world (T3).

The rotation of the earth around causes the four seasons namely spring, summer, autumn, and winter (T4).

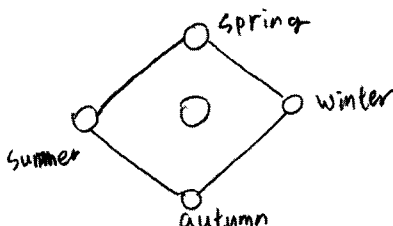


Fig. 2 T4's Drawing showing the cause of seasonal change

The rotation of the earth causes the four seasons namely spring, summer, autumn, and winter (T5).

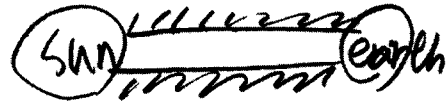


Fig. 3 T5's Drawing showing the cause of seasonal change

2) Interview

- R: What causes the change of the seasons?  
 T4: The rotation of the earth on its axis. This is spring. Here is summer, autumn and winter.  
 R: You are saying that the reason for seasonal change is the rotation?  
 T4: Yes.  
 R: What causes the changing of the seasons?  
 T5: I think what the teacher said is exactly what I was trying to say. The earth's axis and the rotation of the earth (Demonstrating the four seasons). This is winter.  
 R: Why? Can you explain more?  
 T5: It's far from the sun. There's no sun light, that's why this is winter.  
 R: You mean the cause of seasonal change is the rotation?  
 T5: Yes.

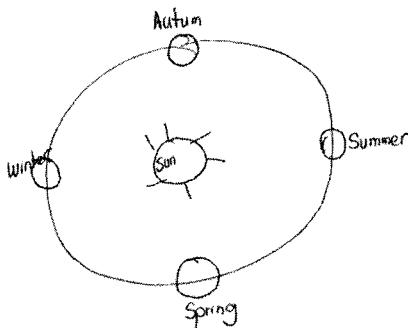
T3, T4, and T5 stated that the cause of seasonal change is the rotation of the earth on its axis, T4 explained the cause of seasonal change in relation to a different position but, Figure 2 displays the earth arranged in four different positions, a diamond shape. In this sense, T4 was not clear about the concept of the revolution of the earth around the sun or the rotation of the earth on its axis. Figure 3 of T5's drawing shows us the proximity between the earth and the sun, T5 also

didn't understand the concept of the revolution of the earth due to mentioning that it was winter because there was no sunlight. Plus, T5 meant to explain the seasons by mentioning distance.

**Category 3 : The rotation of the earth ( T9)**

**1) Explanation with drawing**

The revolution of the earth causes the four seasons of the year. As the earth revolves around the sun the seasons change due to the varying position of the earth as opposed to the sun (T9).



**Fig. 4** T9's Drawing showing the cause of seasonal change

**2) interview**

R: What causes the changing of seasons?

T9: What I remember is that the earth revolves around the sun, and during different times of the year, when it's in different positions, we have a change of season. We live near the equator so we experience routine temperatures year around but other regions have winter when they are the farthest from the sun.

R: You mean that the revolution of the earth causes the seasons to change. Is that right?

T9: Yes.

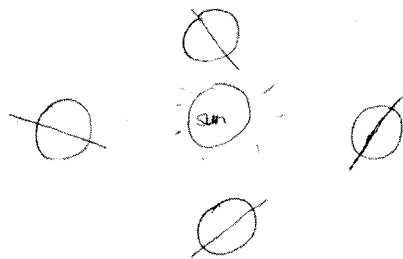
T9 stated that the cause of seasonal change was the revolution of the earth. T9 also represented the changing seasons based only on the revolution of the earth (figure 4). She also said that the parts

of the earth not near the equator have winter when they are located farthest from the sun.

**Category 4 : The revolution of the earth, The rotation of the earth, The axis of the earth (T1, T2, T8)**

**1) explanation with drawing**

*Rotation of the earth at tilt variation in amount of light as the earth revolves (T1).*

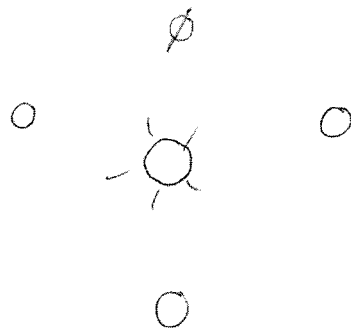


**Fig. 5** T1's Drawing showing the cause of seasonal change

*Approximately every three months as the earth moves around the sun, the seasons change. The Earth is tilted on its side and this is what varies the amount of sunlight to reach to the four different parts of the earth at different times of the year (T2).*

*The four seasons are caused by the revolution of the earth around the sun and the tilting of the earth on its axis.*

*Figure T8's drawing shows the cause of seasonal change as the earth rotates on its axis (T8).*



**Fig. 6** T2's Drawing showing the cause of seasonal change

2) Interview

R: First, can you explain your ideas?

T1: The earth goes around the sun, and the axis is tilted so it meets in different angles.

R: Can you explain that using the globe?

T1: The earth is tilted, so when it moves around the sun, the earth moves in different angles and then it causes the difference in seasons.

R: So the reason for the different seasons is the varying angle?

T1: The amount of light varies from the different angles.

R: You mean that the variation of the angle causes a difference in the amount of light to reach the earth?

T1: Yes.

R: What causes the change of seasons?

T2: I have the same idea as T1. The earth's axis is not vertical, it's tilted. As the earth revolves slowly around the sun and the axis is tilted one way, we have summer. If the axis is tilted the other way, we have winter.

R: Please show me using this globe, where is summer?

T2: I'm not sure... hmm...

R: Can you explain?

T8: Rotation and the revolution. The earth revolves around the sun, but at the same time its axis is tilted. During summer the axis is near to the sun and in the winter it's farther away.

R: You mean the change of the seasons is because of the axis changing like this(∧) and then like this(∨)?

T8: Yes. In the summer, it's closer to the sun and in the winter it's farther away and the temperatures are lower.

T1, T2 and T8 stated that the cause of seasonal change was the revolution of the earth, rotation of the earth on its axis and the axis being tilted.

Considering how T1 drew the axis of the earth as it moves around the sun, in figure 5, she doesn't understand the concepts involved in seasonal change. T2 marked only one axis of the earth in one certain season and couldn't answer the question 'where is summer?' T8 drew the revolution of the earth with the axis in one specific direction. However, she/he displayed one drawing of the axis in a certain direction which is unrelated to concept that the sun's energy differential is the basis for seasonal change. Plus, he/she explained summer and winter by mentioning the distance between the earth and the sun.

Category 5: The tilt of the earth on its axis and the revolution of the earth (T7, T10).

1) explanation with drawing

*Revolution of the earth around the sun and the tilt of earth's axis causes the different seasons (T7).*

*The changes in seasons occur due to the tilt of the earth on its axis as it orbits the sun. The earth is tilted at about 23° on its axis as it orbits the sun. Earth's surfaces are warmed unevenly on the northern (upper half) and southern (lower half).*

*As the earth revolves, the half that receives more sunlight and heat experiences warmer temperatures. This is called summer. The part that receives less sunlight experiences colder temperatures. This is called winter. The change is gradual between the two extremes of the seasons. Changing from winter to summer, there is a gradual shift. This transition time is called spring and there is a warming of temperatures (T10).*

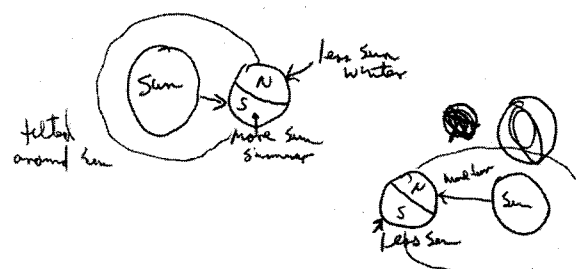


Fig. 7 T10's Drawing showing the cause of seasonal change

**2) Interview**

R: Please express your ideas.

T7: I think the tilt of the axis as the earth goes around the sun is what causes some countries to experience four seasons. This is summer and in winter the axis will be like this,

R: Where is Korea? Can you explain where the axis is during summertime in Korea?

T7: Summer, here. Winter it's here.

R: Where is it during fall?

T7: In fall will be here. Summer, winter and spring.

R: So the reason for the change in seasons is...

T7: I think it has two elements. The axis is tilted and the heat of the sun reflects off of the earth. The entire earth is not going to be heated the same because it's tilted. Up here, we will have more heat in Africa and where we are in the center of the Americas.

R: Express your own ideas please.

T10: Four seasons are basically caused by the tilt of the earth and its revolution around the sun. While it moves around the sun, there is a change gradually as it moves along. You can see that one part of the globe gets more energy as the sunlight hits it, and the other part that gets less sunlight, experiences winter and colder temperatures. Sunlight gives warmth.

When Korea is in the position where the north is receiving more sun light, it's experiencing warmer temperatures and longer daylight. This is the time when people are planting and cultivating crops. When winter comes the northern hemisphere gets less sunlight and the southern gets more. Then it's winter. As the earth moves around, the tilt makes us receive more sunlight this transition is called spring. It's a gradual change, there's no specific mark for the seasons. I think the 2nd or 3rd of March is the official mark for spring.

We are here in the southern part, near the

equator, so we don't experience many changes, we have cooler times and the sunlight is shorter. Summer, nights are shorter and the days are longer.

In short, the causes of the seasons are; the tilt of the earth, and the angle of the sun light.

T7 and T10 are the cases that explained the cause of the seasonal change in a scientific way with the degree of axis tilt and the revolution of the earth.

**IV. Conclusions**

This study examined 10 teachers, who live near the equator, for knowledge of the causes of seasonal change using writing and interviews. The results are as follows:

First, the teachers' concept level turns out to range from non-scientific conceptions to a scientific one. Overall, there are four categories the teachers used to explain the causes of seasonal change. Climate, rotation of the earth on its axis, revolution of the earth and the tilt of earth's axis as it revolves around the earth. Most teachers misunderstood the first of three categories to explain seasonal change. Especially, it was assumed that the teachers who explained the cause of seasonal change by climate might be more affected by their environment in their daily lives. They live near the equator in tropical climate and so they consider the cause of seasonal changes as climate based.

Second, the results using the integrated method were better than simply using a written test when seriously investigating the causes of seasonal change. This study released what the teachers' really thought about the causes of seasonal change while writing, drawing and explanations. If only the written test only was used, we would not have a clear picture as to the ideas of the teachers regarding seasonal change. The integrated method had been used in a previous study (Chae et al, 2003) and also it is suitable to research the understanding of the causes of

seasonal change. As a result, researchers have suggested using the integrated method in a phenomenological study.

Third, 8 out of 10 teachers couldn't correctly explain the causes of seasonal change. The causes of seasonal change seemed to be difficult for informants to explain even though it was taught in elementary, middle, high school, and college elective classes. This result was evident in the Schneps (1988), in which only two Harvard University graduate students out of 23 correctly answered questions about the causes of seasonal change. Frede (2008) suggested small group activities based on refutation modeling to overcome difficulties in understanding the concept of seasonal change to pre-service elementary teachers.

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