

ORIGINAL ARTICLE

# How Can We Improve the Lesson on Seasonal Change?

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## ABSTRACT

This study is to investigate preconception of elementary school students and Belizean elementary school teachers and to devise experiment to understand a cause of seasonal change. An open-ended questionnaire and interviews were conducted for 91 6th grade students who didn't learn seasonal change and 10 Belizean teachers to find out preconception of seasonal change and they were categorized by using inductive analysis. They thought that the Earth's rotation, the distance between the Sun and the Earth, the Earth's revolution, pollution and climate change cause seasonal change. And it found out that these misconceptions come from difficulty in awareness of space and impreciseness of textbooks and books and so on. The experiment was designed to correct inaccurate preconception and to improve lessons of seasonal change. It is to measure a meridian altitude and a length of daytime and nighttime and to compare them. This experiment can help to understand the cause of seasonal change by measuring natural phenomenons like the meridian altitude and the change of length of daytime by model.

**Key words** : season, seasonal change, earth's axis, solar altitude

## 1. Introduction

In a constructivist view, learning is accomplished not by a teacher's one-way knowledge transmission but an active process in which students construct meaning on their own. Students already have their own concept before learning and these conceptions are known as major factors which affect real teaching. It is hard to change it to a scientific concept by traditional teaching and learning methods, because their preconceptions have been internalized for a long time. So it is

necessary to understand students' preconceptions and find adequate methods which can change this situation.

The object of study in earth science is hard to experience and to conduct controlled experiments. There is a lot of research about abstract and difficult conceptions, which are hard to directly observe. Because of these reasons, teaching Earth science is difficult, and students also have difficulty in learning Earth science.

Even though seasonal change is a very important concept among science education because it is directly relevant to real life, it is one of the conceptions which

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are hard to learn for students.

For those reasons mentioned above, it is important to analyze the conceptions about the cause of seasonal change and develop a new experimental model which is appropriate.

## II. Research of study

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).

- Informants had been randomly selected of 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 position change of the moon, and seasonal change through interviews after having 25-9th grade student watch a video on the subject. One of the biggest misconceptions is that the season changes because the earth gets closer to the sun in summer and farther in winter.

- Schoon(1989) reported 21 misconceptions related to earth science by administering a multiple-choice questionnaire to students in the 5th grade, 8th grade, 11th grade and adults in college (1213 students). The misconceptions relevant to our research are "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 occurs due to the shadow of the earth." etc.

- Atwood & Atwood (1966) looked into misconceptions about seasonal change by using an open question survey to 49 students who were studying to become elementary school teachers. The result came back that only one of them had a scientific concept whereas the rest of them had childish concepts.

- Kim(1990) conducted a survey about the concepts of students in 3th and 4th grade. They responded that seasonal change is due to the 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 the amount of solar radiation, the movement of the sun and the difference in atmospheric pressure. Plus, the higher the grade level, the fewer responses were given.

- Ha(1999) stated that the results which came from 5th, 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. 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.

## III. The preconceptions about the cause of seasonal change

### 1. Korean study

One week before learning about seasonal change, this study was conducted with 91 6th grade students (male : 45, female : 46) who are in OO elementary school in a small to medium sized city. They are given

an A4 sized paper and asked to express the cause of seasonal change which they think with writing or drawing. After the research, the researcher interviewed each student. This interview is about explaining the A4 sized paper each student completed by the student.

The researchers rated the students explanations with the A4 sized papers completed by students and categorized them on the basis of non-scientific and scientific answers. In addition, they categorized the non-scientific answers again based on reason.

## 2. Belizean study

This study examined 10 Belizean elementary school teachers visiting Korea in the name of improving the teaching-learning ability in the elementary science field and the contribution to the internationalization. They consisted of 5 males and 5 females and their careers as teachers ranged from 5 to 25 years of teaching experience. After the teachers agreed to participate in the research study, they are asked to answer a questionnaire. The questionnaire has one question "What do you think seasonal change is?" and it has to be answered with both writing and drawings. And the interview was followed with a questionnaire which was

designed in advance and accompanied by an audio recording.

The researchers analyzed the questionnaire completed by Belizean teachers and the interview contents. They categorized the data on the basis of non-scientific and scientific answers. In addition, they categorized the non-scientific answers again based on reason.

## IV. Sources of misconceptions

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 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

Table 1. Research results for the causes of seasonal change Korean students think

Concept	Category	Examples	The number of example(%)
Non-scientific conceptions	The rotation of the earth	- Different amount of solar energy by the rotation of the earth	31 (34.1)
	The distance between the earth and the sun	- The closer the warmer, and the farther the colder	23 (25.3)
	The revolution of the earth	- Different amount of solar energy by the revolution of the earth	11 (12.1)
	Phenomenon	- The difference in temperature - The difference in meridian transit altitude	8 (8.8)
	The environmental pollution	- The global warming caused by environmental pollution	6 (6.6)
	Etc.	- The distance difference by the revolution of the sun - The air pressure, the sun and the moon	9 (9.9)
Scientific conceptions	The tilt of the earth on its axis and the revolution of the earth		3 (3.3)
Total amount			91 (100)

curriculum (Champagne & Klopfer 1983).

- Inability to comprehend space perceptions
- False illustrations
- False explanations in books
- Misinterpretations in broadcasted media
- Teachers' inaccurate explanations

## V. The Inquiry Experiment for Seasonal Changes

### 1. The purpose of the workshop

To investigate the causes of seasonal changes through experiments which measure the lengths of day and night and the altitude of the sun.

### 2. The synopsis of the workshop

- A. The inquiry on the causes of seasonal changes through experiments measuring the lengths of day and night. This experiment is to determine how the experiment of measuring the lengths of day and night at each position on the earth affects understanding the causes of seasonal

changes. The lengths of day and night are measured and compared, and the causes of seasonal changes are scrutinized.

- B. The inquiry on the causes of seasonal changes through experiments measuring the altitude of the sun. This experiment is to determine how experiments measuring the altitude of the sun at each position on the earth affect understanding the causes of seasonal changes. The altitudes of the sun are measured and compared, and the causes of seasonal changes are investigated.

### 3. The Inquiry Activities

- A. The inquiry on the causes of seasonal changes through experiments measuring the lengths of day and night

#### 1) Materials

A globe whose axis angle can be adjusted, a desk lamp without a shade, a round time scale, an observer piece which can stand up on the globe, a straw, a ruler, scissors, double sided tape

#### 2) The experimental method

- ① Place the globe about 40 cm away from the

Table 2. Research results for the causes of seasonal change Belizean teachers think

Concept	Category	Examples
Non-scientific conceptions	Tropical climate	- Tropical climate
	The rotation of the earth	- The rotation of planet earth including the changes of the moon - The rotation of the earth The axis and the rotation of the earth The closer the warmer, and the farther the colder
	The revolution of the earth	- Revolution of the earth Different position of the earth
	The revolution of the earth The rotation of the earth The axis of the earth • • •	- Rotation of the earth at a tilt Variation in 4 parts of light as the earth revolves - The revolution of the earth The earth is tilted - The revolution of the earth The tilting of the earth Rotates around its axis
Scientific conceptions	The tilt of the earth on its axis and the revolution of the earth	- Tilt on earth's axis Revolution of the earth - The tilt of the earth on its axis as it orbits the sun

desk lamp (Figure 1).

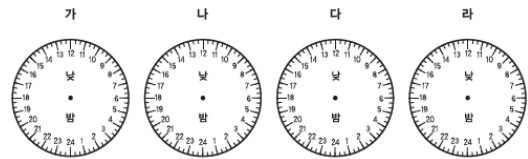
- ② Glue the round time scale (see bottom) on the North Pole so that the 12 o'clock point on the round time scale should face the lamp.
- ③ Put the observer piece (see bottom) right on Korea.
- ④ Record both the time when the sun starts to appear and the time when the sun starts to disappear while spinning the globe counter clockwise on its axis.
- ⑤ Record the lengths of day and night using the same method as above while moving the globe around the lamp little by little.

3) The results and discussion

Revolving around the sun with the earth's axis tilted

Position of the earth	Time when the sun appears	Time when the sun disappears	Comparison of the lengths of day and night	Relevant season
A				
B				
C				
D				

Color the lengths of day and night at each position with a crayon.



B. The inquiry on the causes of seasonal changes

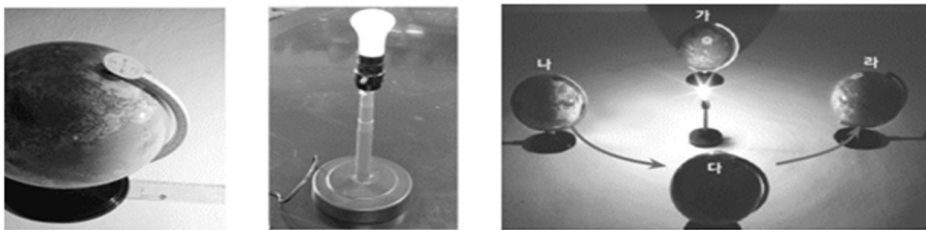


Fig. 1. The experimental method of measuring the lengths of day and night

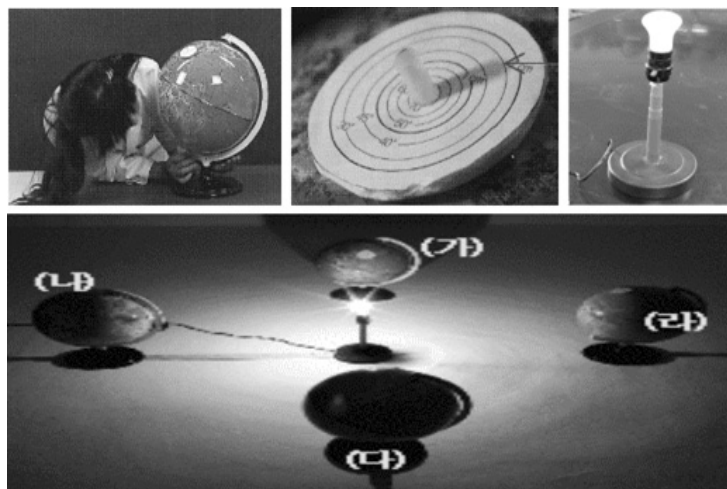


Fig. 2. The experimental method of measuring the altitude of sun

through experiments measuring the altitude of the sun

1) Materials

A globe whose axis angle can be adjusted, a desk lamp without a shade, a round time scale, a meter altitude of the sun with an observer piece which can stand up on the globe, a straw, a ruler, scissors, double sided tape

2) The experimental method

- ① Place the globe about 40 cm away from the desk lamp (Figure 2).
- ② Glue the meter altitude of the sun with the observer piece right on Korea on the globe (see bottom).
- ③ Measure the lengths of the shadow and the altitude of the sun at each position on the earth while revolving the globe around the

desk lamp little by little (see above).

- ④ Measure the lengths of the shadow and the altitude of the sun at each position on the earth while revolving the globe around the desk lamp little by little

3) The results and discussion

① Revolving around with the axis tilted

Earth Position	Solar Altitude	Shadow length	Relevant Season
A			
B			
C			
D			

- Is there any change in the altitude of the sun and shadow length?
- Can you say that season has changed?

## VI. Seasonal Change Units in the

Table 3. Content of seasonal change units

Period	Topic	Purpose
1/9	What is changed with seasons	<ul style="list-style-type: none"> <li>• To tell the differences of the four seasons after observing these scenes.</li> <li>• To gain an attitude to inquire the cause of seasonal change with curiosity and interest in it.</li> </ul>
2~3/9	What is the relationship among solar altitude, shadow length, and temperature?	<ul style="list-style-type: none"> <li>• To measure solar altitude, shadow length, and temperature during a day</li> <li>• To explain the relationship between shadow length and temperature according to solar altitude.</li> </ul>
4/9	How does the solar altitude change with seasons?	<ul style="list-style-type: none"> <li>• To compare and explain change of solar meridian altitude with seasons.</li> <li>• To draw change of solar meridian altitude per month.</li> </ul>
5/9	Why does temperature change according to seasons?	<ul style="list-style-type: none"> <li>• To find the relationship between solar meridian altitude and solar energy amounts lit on the same area.</li> <li>• To demonstrate the difference of solar energies arriving at the same area according to solar altitude through experiment.</li> </ul>
6/9	How are the sunrise and sunset time and temperature related to seasons?	<ul style="list-style-type: none"> <li>• To measure the sunrise and sunset time.</li> <li>• To understand the trend of the change of the sunrise and sunset time and of the temperature over seasons.</li> </ul>
7/9	What causes seasonal change?	<ul style="list-style-type: none"> <li>• To measure the solar altitudes with the Earth's revolution and its axis upright and tilted.</li> <li>• To explain seasonal change in terms of solar altitude.</li> </ul>
8/9	Shall we sum up what we have learned about seasonal change?	<ul style="list-style-type: none"> <li>• To tell the phenomenon and the cause of seasonal change.</li> <li>• To develop a positive attitude finding the phenomenon relating to seasonal change from everyday life.</li> </ul>
9/9	Shall we make a solar clock, called Angbuilgoo showing seasonal change?	<ul style="list-style-type: none"> <li>• To inspect the old solar clock, called Angbuilgoo, and recognize ancestor's wisdom.</li> <li>• To scrutinize several solar clocks and make a solar clock showing seasonal change.</li> </ul>

## Korean National Curriculum

The unit consists of nine periods and the main purpose is to help students understand the phenomenon and the causes of seasonal change. In order to obtain the purpose, the unit offers solar altitude and temperature, shadow change, meridian altitude of the sun, solar meridian altitude and solar energy amounts lit on the same area, the relationships between day length and temperature, and change of solar meridian altitude by axial tilt and earth's revolution.

Students can grasp the relationships between solar altitude, shadow length and temperature through activities measuring the solar altitudes, shadow lengths, and temperatures during one day. In addition, they can easily comprehend the change of the altitude of the sun over seasons through activities drawing graphs about how solar meridian altitude changes with seasons.

An experiment using thermometers and cardboard at different slopes is conducted in order to inquire the causes for temperature change over seasons. The solar energy amounts arrived in the same area can be compared with this activity. Lastly, students fathom that revolving around the Sun with a tilted axis is the cause of seasonal change through the experiment comparing the solar altitudes according to the different axial angles of the globe.

The purposes and structure of the unit are presented in the table as follows.

## VII. Discussion and conclusion

This research investigated preconceptions retained by 6th graders who hadn't learned about seasonal change and invented the experiments to help understand the causes of seasonal change.

First, students retained diverse preconceptions for the cause of seasonal change on their own before taking the class. Moreover, in many cases, a couple of preconceptions were mixed up such as earth rotation, earth revolution, the distance of the earth and the sun, Korea's position is a factor in relation with the sun,

etc. These illuminated preconceptions could be employed as basic data for adjusting preconception into scientific concepts.

Second, students' preconceptions were elucidated as being affected by everyday life experience, learning experience in class, etc. Hence, teachers might be required to take this point in account for the class plan. Especially, teachers should prepare materials or questions conflicting with students' preconceptions and consequently prompting realization by students for the class.

Third, the model of the cause of seasonal change developed by the principal researcher can be employed to measure the phenomena of seasonal change such as day and night length or solar altitude change and thereupon help appreciate the cause of seasonal change. This experiment can be applied in various cases in order to fix nonscientific preconceptions to scientific concepts.

## 국문요약

이 연구는 계절 변화에 대한 초등학생들과 벨리즈 초등교사의 선개념을 조사하고 계절 변화의 원인을 이해하는데 도움이 되는 실험을 고안한 것이다. 계절 변화에 대한 선개념을 알아보기 위해 계절 변화를 학습하지 않은 초등학교 6학년 91명의 학생과 벨리즈 초등교사 10명을 대상으로 개방형 질문지와 인터뷰를 실시하였으며, 귀납적 분석법을 이용하여 범주화하였다. 초등학생과 벨리즈 초등교사는 계절 변화의 원인을 지구의 자전, 태양과 지구 사이의 거리, 지구의 공전, 환경오염이나 기후변화 등으로 생각하고 있었다. 그리고 이러한 오개념은 공간 인식에 대한 어려움, 교과서나 교재의 부정확함 등에 기인하는 것으로 나타났다.

계절 변화에 대한 부정확한 선개념을 바로 잡고 계절 변화 수업을 개선하기 위하여 지구 자전축의 기울기에 따른 태양의 남중 고도와 낮과 밤의 길이를 측정하고, 이를 비교하는 실험을 고안하였다. 이 실험은 태양의 남중 고도와 낮의 길이 변화와 같은 자연 현상을 모형을 통해 측정할 수 있도록 하여 계절 변화의 원인을 이해하는데 도움을 줄 수 있다.

주제어 : 계절, 계절의 변화, 지구의 자전축, 태양 고도

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