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# A Study on Perception Survey of Preservice Elementary Teachers on Teaching Methods in Astronomy — A Secondary Publication

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**Abstract:** This study was conducted on 115 students from four classes of 2nd-year intensive courses at B University of Education. Preservice elementary teachers were surveyed on what teaching methods they were aware of regarding the subject of elementary science astronomy. Recognition data of 80 people from whom the questionnaire was collected were analyzed. For this study, a 5-day survey was conducted. Preservice elementary teachers complained of difficulties in teaching methods in the astronomy area of the science department. The purpose of this study was to find out what difficulties preservice elementary teachers have in teaching elementary science astronomy topics and to explore more efficient teaching methods for teaching astronomy topics. The topic of the survey was set by discussing with the preservice elementary teachers about what kind of survey to use in teaching the subject of elementary science astronomy. There are many topics for elementary science astronomy, but two questionnaires were prepared focusing on the unit on the Earth and the moon: "What does the Earth look like?" in Unit 4 (1/10) of the 3rd year, 1st semester; in Unit 2 (1/11) of the 1st semester of the 6th grade, it was set as "What does the moon look like?" The surveys candidly described how to teach the subject of astronomy to elementary school students by mobilizing all the background knowledge of preservice elementary teachers. The results of these surveys were visualized and displayed using NetMiner as a language analysis method, and the contents of the responses to the actual surveys by preservice elementary teachers were described and interpreted. Based on these results, preservice elementary teachers tried to suggest a more efficient teaching method for the subject of elementary science astronomy. In addition, basic procedures and methods for lecturing on the subject of elementary science astronomy were presented. A more efficient teaching method for teaching elementary science astronomy subjects to preservice elementary teachers was suggested.

**Keywords:** Preservice elementary teachers; Subject of astronomy; Study of cognition research; Elementary science teaching methods

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## 1. Introduction

Every year, the College of Education holds a course on teaching methods and materials research in elementary

science for preservice teachers to analyze science textbooks and design teaching and learning plans. The lecture content of this study is centered on the Earth and Space area of elementary science, and it consists of research on teaching materials and teaching methods for the topic of astronomy in elementary science. Although preservice elementary teachers are aware of the existence of astronomy in the Earth and Space domain of elementary science, they have a low level of understanding of the concept of astronomy and complain of difficulties in teaching it. It is believed that the reason for the difficulty in teaching astronomy topics is the lack of a systematic, sequential, and specialized teaching method that is appropriate to the developmental stage of elementary school students. In other words, preservice teachers lack expertise in teaching methods for elementary school students. Due to COVID-19, the education scene is currently undergoing many changes, and various teaching methods for virtual and face-to-face classes are being studied experimentally. Although many educational platforms are being developed that can provide efficient teaching methods for non-face-to-face classes, the results of learning have not been properly tested. Theoretically, the teaching method for elementary science and astronomy is efficient if it utilizes the five senses according to the developmental stage of elementary school students. However, due to the developmental stage of elementary school students, the astronomy teaching method has many limitations in understanding essential spatial perception concepts. This study aimed to discover implications for teaching methods through previous studies at home and abroad on the topic of astronomy in elementary school science. The studies on astronomy for elementary school students [1-3] were conducted on the units of "Seasonal Changes" and "Earth and Moon" in elementary school science and showed that various teaching and learning methods were effective in helping elementary school students understand the topic of astronomy. In addition, Kim and Lee [4] revealed that the use of storytelling techniques in the "Solar System and Stars" unit for elementary school students helped them acquire scientific concepts. Several studies [2,5-11] on astronomy-related topics for elementary school preservice teachers also explain that various teaching methods are applied to achieve learning effects. In particular, Lee [9] describes the use of storytelling as an effective way to learn astronomy topics. In a case study to explore the topic-specific pedagogical content knowledge (PCK) development process of elementary school teachers on the Earth's rotation, Lee and Lee [12] explain that, rather than using a specific teaching method, students should use a variety of teaching methods such as videos, role-playing, and astronomical software in classes dealing with the Earth's rotation. In addition, astronomy-related studies [13-19] describe data-based educational activities in astronomy classrooms and the use of teaching observation of lunar phase changes, and they introduce various teaching methods and show that they have been effective in learning. The results of these studies suggest that teaching astronomy-related topics to elementary school students can improve learning outcomes by understanding the characteristics of elementary school students' thinking. It is meaningful for preservice teachers who will be teaching elementary school students to analyze the topic of astronomy in elementary science and to systematically study and explore teaching and learning methods based on instructional design principles. As a result, it is expected that when preservice teachers become elementary school teachers, they will be able to use effective teaching and learning methods to teach astronomy topics in elementary science.

The purpose of this study is to investigate the preservice teachers' perceptions of teaching methods for astronomy topics and to find out the extent of differentiated perceptions of astronomy topics among preservice teachers after learning about teaching methods related to the thinking patterns of elementary school students according to their developmental stages. The following research questions were set up to derive the results of this study.

(1) What are the perceptions of preservice teachers on how to teach the topic of the "Appearance of the Earth?"

(2) What are the perceptions of preservice teachers on how to teach the topic of "Appearance of the Moon?"
(3) How do preservice teachers perceive the teaching of the topic "What is the Moon?"

# 2. Research methods

## 2.1. Research procedures

The elementary science curriculum is divided into four areas: motion and energy, matter, life, and the Earth and universe. Preservice elementary teachers complain of difficulties in teaching astronomy topics in elementary science, so we surveyed 115 students in four classes of the second-year enrichment course at B University of Education about their teaching methods for astronomy topics (**Table 1**). The results were interpreted by visualizing the survey results with NetMiner (NetMiner - Social Network Analysis Software) for 80 people who responded to the survey. In addition, the statements that responded peculiarly to the survey were presented and interpreted as examples. Based on the interpretation of the survey results, efficient teaching methods for elementary science astronomy were proposed.

**Table 1.** Number of people per advanced course

| Advanced course | Ethics | Math | Society | Music | Total |
|---|---|---|---|---|---|
| Number of people (persons) | 29 | 29 | 29 | 28 | 115 |
| Number of people collecting surveys | 20 | 18 | 21 | 21 | 80 |

## 2.2. Study period

This course started on March 2, 2023, and for the research experiment, the survey was collected from the university's LMS during the 5-day period from March 6, 2023 to March 10, 2023, when there was a lecture on "Elementary Science Materials Research."

## 2.3. Inspection tools

This study was a qualitative survey of preservice teachers to find out what areas of elementary science they find difficult to teach. The questionnaire was completed after discussing the topics that preservice teachers find difficult to teach. The questionnaire was presented to the preservice teachers in the following areas: "What does the Earth look like?" in Unit 4 (1/10) of the first semester of grade 3; "What does the moon look like?" in Unit 2 (1/11) of the first semester of grade 6. Using the background of a preservice elementary teacher, they wrote an honest description of how they would teach elementary students about the topic of astronomy.

## 2.4. Processing results

The results of the questionnaire responses of preservice elementary teachers were analyzed using the language network of NetMiner 4. Nodes and links were extracted through the method of One Mode Network analysis, Min Windows size was set to 3.0, Min Link Frequency Threshold was set to 2.0 to adjust the number of extracted nodes, and Self-Loop was removed. The minimum unit of co-occurring relationships was set to a sentence, and Degree Centrality analysis was performed using the constructed matrix. Based on the nodes appearing in the semantic clusters, the meaning of the semantic clusters was confirmed by finding the texts in which the co-occurrence of nodes occurs.

## 3. Findings and discussion

### 3.1. An analysis of preservice elementary teachers' teaching-related language about the "Appearance of the Earth" in the astronomy domain

We visualized the sentences of preservice elementary school teachers responding to the question "What is your teaching method for 'What does the Earth look like?'" and analyzed the results by focusing on the meaning of the clustering of nodes that can be identified by dimensional classification. NetMiner was used to analyze the tendency of language concentration. We wanted to understand various ideas about teaching methods by presenting a somewhat comprehensive questionnaire about how to make elementary school students understand the Earth. **Figure 1** visualizes the network of language connections using a centerline analysis.

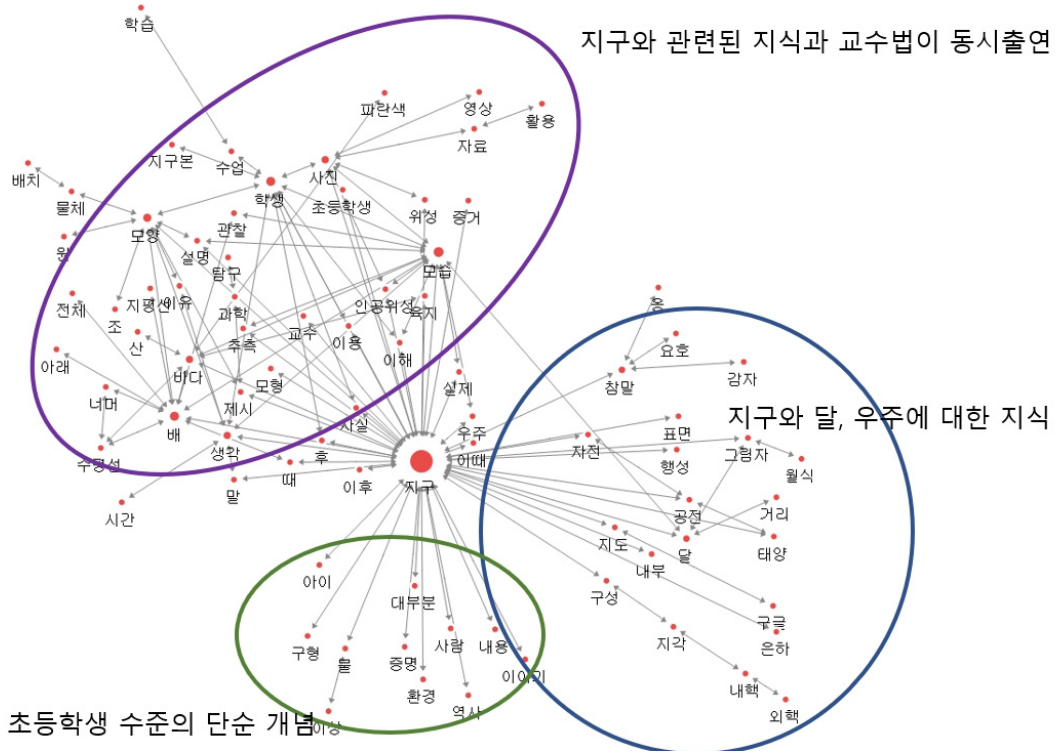


**Figure 1.** Language tendencies in the shape of the Earth

Describing the results of the analysis on how to teach about the Earth, the centrality analysis visualization of the linguistic connections to describe the Earth was divided into three main factors. The first factor can be divided into the "co-occurrence of knowledge and teaching methods related to the Earth" node, the "simple concepts at the elementary school level" node, and the nodes centered on knowledge about the Earth, the moon, and the universe.

The first factor is the simultaneous emergence of knowledge and teaching methods related to the Earth, which includes circle, model, student, photo, shape, sea, ship, etc. In the student's terminology, various connections such as shape and appearance are presented, and it is believed that elementary school students will understand the Earth quickly if they show the Earth's appearance through photographs. In the shape network, satellites, ships, and thoughts are presented in various language networks. In addition, we tried to explain that the image of a ship, which is presented in elementary school textbooks as an ocean and a ship, does not show a ship going from close to the ocean to a distant place. This node is considered to be a node that can help students

understand the shape of the Earth by analogizing the shape similar to the Earth or by describing the land in detail.

The original text of the professor's explanation for the "simultaneous emergence of knowledge and pedagogy related to the Earth" is as follows: Case 43. From our perspective, the Earth may appear to be a flat space, but evidence suggests that it is spherical. Evidence includes the existence of a horizon and the presence of solar and lunar eclipses. Elementary students are asked to develop their own ideas about the shape of the Earth, then find and prove evidence on their own, and finally draw conclusions using audio and visuals. It is explained that more than half of the Earth's surface is covered by water, and that the space that is not covered by water is made up of various landforms such as forests and mountain ranges.

The second factor is that the "simple concepts at the elementary school level" show children, people, and history, and the model shows how to explain the appearance of the Earth by analogy with spherical shape, water, and environment. In addition, the nodes that are imprinted that the Earth is a spherical body and tend to explain the appearance of the Earth in terms of environment, water, etc. are presented. Although the appearance of the Earth can be described in a variety of ways, it is interpreted that the Earth tends to be described in terms of environment, water, etc. The original text about the professor presenting a related explanation of "simple concepts at the elementary school level" looks like this: Case 22. It is bluish and round, but not a perfect sphere, with a neighborhood larger than the moon and much smaller than the sun.

The third factor is that the Earth and Moon are connected in our knowledge of the universe by spatial concepts such as rotation and revolution. It is also connected to descriptive language about the Earth's internal matter, such as composition, crust, inner core, and outer core. The original text for the professor presenting the related explanation of "Knowledge of the Earth, Moon, and Universe" is as follows: Case 65. The Earth is composed of a crust, inner and outer core, and mantle, and its internal structure is described in detail through a model of the Earth. The important elements and materials that make up the Earth's crust are explained with examples from everyday life.

To summarize the above language connections, preservice teachers are trying to approach the topics of elementary science and astronomy in various ways, especially from the perspective of spatial thinking, and the results of Kim [20] argue for the need for education on teaching and learning methods that consider spatial thinking from the teacher training stage. Hanson *et al.* [21] claim that they are confident in introducing engineering thinking habits to elementary school students, and the appearance of the Earth also seems to require the introduction of spatial and temporal thinking. Subramaniam *et al.* [22] found that preservice teachers' acquisition of science concepts is related to their teaching of students. This prior research suggests that the terms in the linguistic connections network for the shape of the Earth in this study are related to the acquisition of multiple concepts and spatial skills.

## 3.2. Analyzing the teaching-related language of preservice elementary teachers about the "Appearance of the Moon" in the astronomy domain

To describe the results of the analysis, the visualization of the centrality analysis was divided into four main factors. The factors clustered into "simple concepts at the elementary school level," "knowledge aspects related to the moon," "teaching and learning methods," and "knowledge about the relationship between the Earth and the moon." **Figure 2** shows the language tendencies in the shape of the Moon.

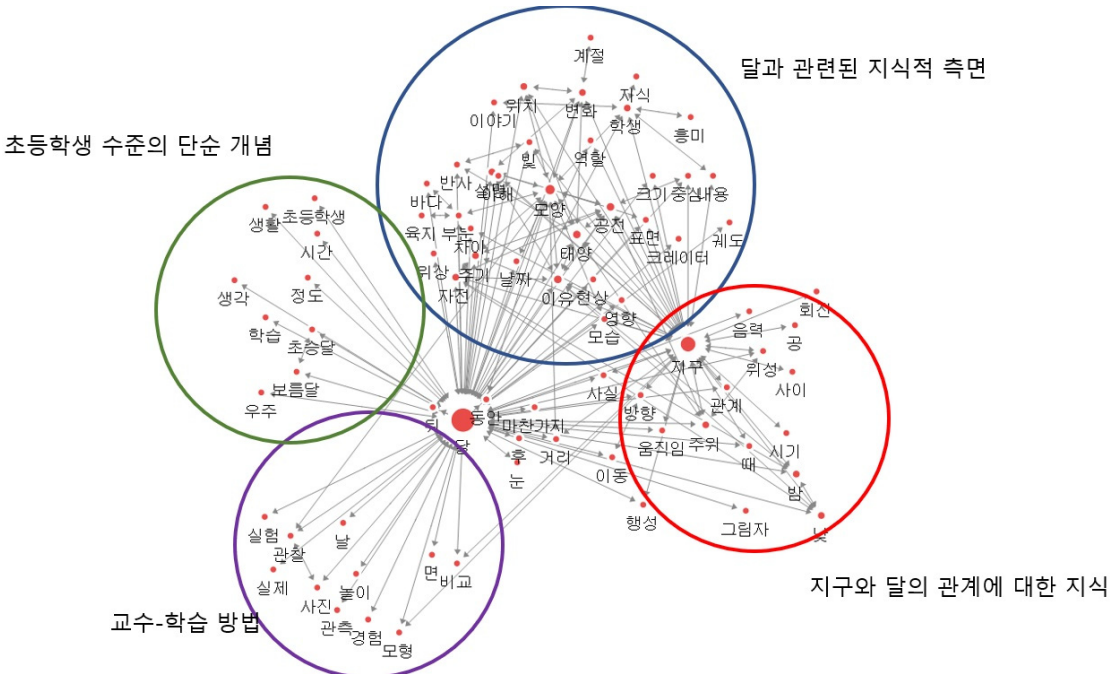


**Figure 2.** Language tendencies in the shape of the Moon

The first factor, “simple concepts at elementary school level” is composed of crescent moon, full moon, learning, life, etc. It is simply the degree to which the language is presented with empirical content about the moon. Here are some examples of texts that represent these factors: Case 13. The Earth is round. When we look out to sea, we can observe ships sailing toward the horizon. If the Earth were not round, the overall shape of the ship would have to be smaller, but if we observe the ship as it goes over the horizon, we can observe that it disappears from the bottom of the ship.

The second factor is that in the “knowledge aspects related to the moon,” the language about the shape of the moon is most centralized, presenting concepts such as sea, position, change, orbit, rotation, etc. It is mainly composed of nodes about the shape of the moon. The following is a sample text that might be representative of these factors: Case 44. We naturally think that the Earth is round, but since the children have never thought about the shape of the Earth, we want to teach them to think about it and reach their own conclusions, rather than telling them the conclusion. We want to guide their thinking by asking them why the Earth is round rather than flat, why the Earth is actually round but looks flat to the eye, what kind of shape would make it possible to travel around the world, etc.

The third factor is the “teaching and learning methods” link, which is dominated by terms that can be used in teaching methods such as experiment, observation, experience, play, and modeling. Since it is a question about teaching methods, it is connected with terms that are used in cognitive teaching and learning. The following texts are representative of these factors: Case 19. You can also teach through experiments, such as using a globe to demonstrate the phenomenon of not being able to see from the bottom as a ship travels away from the ocean. Finally, satellite images are used to summarize that the Earth is round.

The fourth factor is “knowledge of the relationship between the Earth and the Moon,” which is centered around the Earth. The connections between the lunar calendar, ball, satellite, direction, relationship, shadow, etc. tend to be centered on the word Earth. Terms related to the relationship between the Earth and the Moon are presented as connections, and knowledge of the Moon’s relationship with the Earth is presented heavily because it is thought to help understand the appearance of the Moon. The following texts are representative

of these factors: Case 55. Instead of showing students a picture of Earth or teaching them about Earth, the teacher stimulates their thinking by first asking them to say or draw what they think Earth looks like, and then asks them to explain why they think that way. Then the teacher shows them actual satellite images of Earth so they can see what it really looks like. This allows students to revise their previous knowledge by comparing what they think the Earth looks like with what it actually looks like and how it is similar and different. This comparison will make it much easier for them to understand the topic.

To summarize the above linguistic connections, the linguistic connections of words about the appearance of the moon are in line with the findings of Han *et al.* [19], which suggest a teaching method that can support students' spatial competence in the motion of the Earth and the moon. As preservice elementary teachers, the question of how to help elementary students recognize the appearance of the moon is similar to the direction of this study. In Chae's [18] study, she analyzed the activities presented in the "Earth and Moon Movement" unit and selected the Earth-Moon Movement Model as an experimental tool to effectively learn the concept, which shows how preservice teachers focus on teaching activities for elementary school students.

## 3.3. Teaching more effectively

Based on the question, "Please suggest areas and topics that you think are difficult to teach in elementary science," the lectures were given to elementary school preservice teachers in the unit of "Earth and Moon" in the astronomy section of elementary science, with topics such as "What does the Earth look like?" and "Let's learn about the moon." Elementary school students' understanding of the shape of the Earth is based on various experiences and learning, and they conventionally have the idea that the Earth is round. The shape of the Earth is already presented in various science materials, so they only remember it unconsciously, but they do not directly recognize that the Earth is a sphere. In order to present an efficient teaching method for the astronomy of elementary science, it would be good to utilize the developmental stages of elementary school students, the use of IT devices, inductive thinking, and a sequential approach. The lecture content of the astronomy of elementary science is organized based on the fact that preservice elementary teachers have five senses and inductive thinking processes that are emphasized by the Piagetian cognitive developmental stage specific manipulatives. In particular, considering the development of IT technology, elementary school students are using cell phones, game consoles, and smart devices very closely, the basic teaching design is presented as follows.

### 3.3.1. Topic: 3-1. 4(1/10). What does the Earth look like?

(1) Using Google Earth: For a sequential approach to inductive thinking, which is an elementary school student's thinking process, students use a program called Google Earth to explore the terrain around their lives and search from close to distant areas. From the main stadium of the World Cup to Gwangan Bridge (Diamond Bridge) to Namsan Tower in Seoul to Tokyo, Japan to the Great Wall of China to the Eiffel Tower in France to the Statue of Liberty in the United States to the other side of the country (the west coast of Montevideo, Uruguay), these searches are related to Burner's spiral curriculum. In the horizontal and vertical curriculum organization, the curriculum is organized from near to far depending on the grade level (in the social studies curriculum, it is organized from our town, our region, our country, our neighboring countries, and other countries in the world). Describing the phenomenon that when you see a ship approaching from a distance from the beach, you can see the top of the ship and then gradually see the whole ship.

(2) Finding the circumference of the Earth: Students use Eratosthenes' formula for measuring the size of

the Earth to find the circumference of the Earth.

Assumption: Earth is a perfect sphere, sunlight shines parallel everywhere.

Step 1: Measure the angle between the rod and the end of the shadow. The sun shines vertically on a well in Siena and at an angle of 7.2º in Alexandria.

Step 2: Measure the distance between Siena and Alexandria, Siena to Alexandria → approximately 925 km

Step 3: Find the central angle → The principle of declination. The angle of the Earth's center between Alexandria and Siena is equal to the angle of 7.2° found in step 1.

Step 4: Build a proportional formula to calculate the circumference of the Earth.

$$2\pi R : 360° = 925km : 7.2°,$$

$$2\pi R = \frac{360° \times 925km}{7.2°} \fallingdotseq 46{,}250km$$

[Source of error from the actual circumference of the Earth]

- The Earth is an ellipsoid, not a perfect sphere.
- The distance between the two cities was not measured accurately.
- The two cities are not on the same longitude.

(3) Having students use a globe to explore different parts of the globe.

(4) Traveling around the world: A DVD about traveling around the world on foot is watched.

### 3.3.2. Topic: 6-1. 2(1/11). Learn about the Moon

(1) Drawing the first and second waxing moons

When students draw the first and second waxing moons, it is made sure that the middle of the crescent moon is curved instead of straight, so that students can see the plane of the moon and not perceive it as a one-dimensional flat object. The students are then asked to draw the center of the moon as if there are mountains and valleys, and to think about why the center of the moon is not drawn as a straight line when drawing the new and old moon. The key to understanding the spherical shape of the moon is to draw a curved line through the center of the upper and lower moon, rather than a straight line, to create a sense of space in the spherical shape of the moon (**Figure 3**). As students draw the moon, they recognize the spherical shape of the moon.

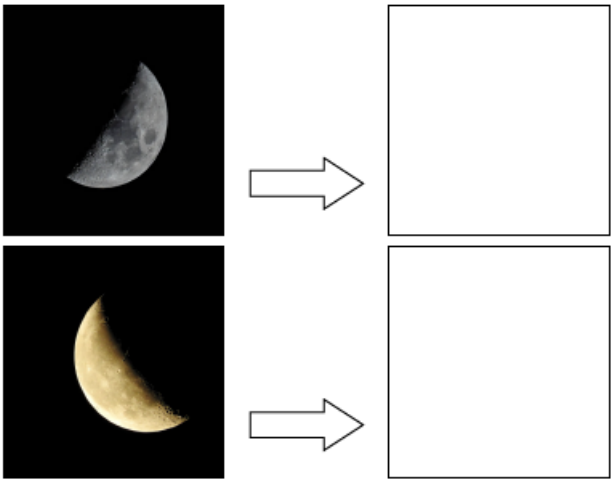

**Figure 3.** Drawing the upper and lower waxing moon

(2) Measuring the distance to the moon

If a laser beam was shot from Earth to the Moon, it would bounce off a reflector on the Moon's surface and reach Earth in 2.5 seconds. The distance from Earth to the Moon is calculated, giving the assumptions underlying the calculation.

Assumption: Light travels 300,000 kilometers in one second.

Calculate: Since the one-way time of a laser beam is 1.25 seconds, 1.25×300,000 km = 375,000 km. If the laser beam showed the time it reached the closest point to the Earth, calculate the distance to the edge of the moon, assuming it took 2.52 seconds to reach the edge of the moon.

(3) Lunar phases

The red arrow in **Figure 4** shows the moon being widely illuminated by the sun, and the basketball is compared to the moon to illustrate how the shape of the moon changes depending on where the observer (Earth) is in the Earth-Moon-Sun dynamic (**Figure 5**). This method of illustrating the moon's phases makes it very easy to understand how the moon's shape changes. Elementary school students' thinking style is based on inductive approach and sequential thinking process, and explaining the lunar phase change in one, two, three dimensions (**Figure 6**) will be easier for students to understand.

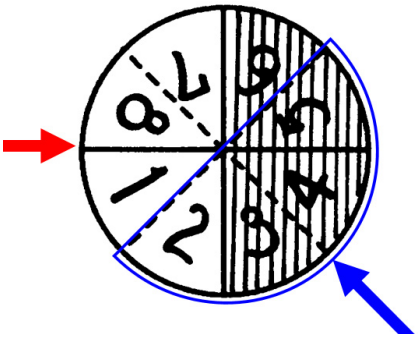

**Figure 4.** One-dimensional plane

**Figure 5.** Two-dimensional plane

**Figure 6.** Moon in 3D space

(4) Finding the most light in the relationship between the Earth, Sun, and Moon

In **Figure 7**, if look closely, one can see that the edge of the Moon is very clear in the direction the Sun is shining. In bright areas, the lunar rim is clearly visible, but on the opposite side, where the sun is shining, it is slightly darker and the surface of the lunar rim is not as smooth. These observations may help recognize the Moon's spherical shape.

**Figure 7.** The appearance of the moon in outer space

## 4. Conclusion

The purpose of this study is to investigate the perceptions of teaching methods in elementary science and astronomy as a starting point for teaching methods to preservice teachers, and to suggest effective teaching methods based on the results.

Firstly, the results of the teaching-related language analysis of preservice elementary teachers analyzed for the appearance of the Earth showed the nodes of "simultaneous appearance of knowledge and teaching methods related to the Earth" and "simple concepts at the elementary school level," and knowledge of the Earth, moon, and space as the central nodes. Secondly, the results of the teaching-related language analysis of preservice elementary teachers for the appearance of the moon showed the factors clustered into "simple concepts at the elementary school level," "knowledge aspects related to the moon," "teaching and learning methods," and "knowledge of the relationship between the Earth and the moon." Thirdly, in order to propose an efficient teaching method for the astronomical domain of elementary science, "Earth" and "Moon," the developmental stage of elementary school students, utilization of IT devices, inductive thinking, and sequential approach were taken as the basis.

## Disclosure statement

The author declares no conflict of interest.

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