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EVALUATING THE EFFECT OF FORMATIVE ASSESSMENT BASED LEARNING ON STUDENTS' UNDERSTANDING REGARDING BASIC ASTRONOMICAL CONCEPTS

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Abstract:
The aim of this study is to determine the effect of formative assessment based learning on students' conceptual understanding levels regarding basic astronomical concepts. The study was conducted in a public primary school with 24 5th graders. The study group was applied a 3 phased teaching process based on formative assessment for the duration of 4 lesson periods. The conceptual understanding levels of students were specified by using 4 formative assessment probes prior to and after the process. Findings were presented and assessed in forms of percentage and frequency together with sample student answers. Prior to the teaching process it was determined that conceptual understanding levels of students regarding basic astronomy were rather low and students had developed various misconceptions. The reason for formation of day and night *is the exchange of location of the Sun and the Moon,* the reason for lunar phases *is the Moon being a light source and radiating light from its different parts in different periods,* the reason for different seasons to emerge *is the distance change of Earth from the Sun, in terms of coming closer and moving away* were some frequently observed misconceptions. After the activities the conceptual understanding levels of students showed increase. It was, nevertheless, challenging for them to explain their correct answers. This indicates the necessity of more studies to be conducted in order to develop scientific reasoning skills of students. This study recommends teachers to use formative assessment based education, which proved to be effective in teaching basic astronomical concepts, in science classes actively.

Keywords: formative assessment, formative assessment probes, astronomy

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1. Introduction

Learning and knowledge emerge from interactive processes. According to the constructivist learning theory, current knowledge is associated with new ideas or concepts and new knowledge is created after cognitive construction (Ozar, 2015; Perkins, 1999; Yilmaz, 2009). Ignoring students' prior knowledge on the subject to be taught reduces the significance of qualitative teaching and decreases students' conceptual understanding levels (Keeley, 2008). Therefore, prior knowledge of students should be elicited at the beginning of the lesson by employing proper measurement and assessment methods and the lesson should be conducted accordingly (Metin & Birisci, 2009).

Formative assessment to manage the teaching process according to student feedbacks is essential for qualitative learning and teaching (Black & Wiliam, 1998). Curricula in many countries include formative assessment for many years now and various studies were conducted to enable teachers apply this approach more efficiently. (Black & Wiliam, 1998; Heredia, Furtak, Morrison, & Renga, 2016; Klinger, Volante, & Deluca, 2012; Rokos, Zavodska, Petr & Papacek, 2016; Grob, 2017). The New Science Curriculum emphasizes formative assessment by highlighting the importance of education activities and measurement and evaluation practices to be conducted interactively, the need for planning teaching by monitoring students and reporting feedback on their learning in order to provide significant and permanent learning (Ministry of National Education [MEB], 2017).

Formative assessment is an evaluation approach to collect comprehensive knowledge on students' conceptual understanding by employing various techniques during lesson and to adjust the lesson accordingly (Keeley, 2008). Also referred to as assessment for learning in the related literature, this approach enables the teaching process to conclude with conceptual understanding by eliciting prior knowledge at the beginning of the lesson and providing feedback on the learning of students and teaching of the teachers during the lesson (Black & Wiliam, 2018). The purpose is not to give grades but to make analyses to enhance the education process (Snowman & McCown, 2015). The fact that it uses data obtained from students to shape the teaching process separates formative assessment from other approaches. Formative assessment cannot be mentioned unless the collected data influences the way the lesson is conducted (Bulunuz & Bulunuz, 2013). This approach helps teachers to elicit misconceptions or lacking knowledge of students, to avoid unnecessary repetition or to realize the challenges they may face and to plan accordingly and to use time efficiently. Students, on the other hand, actively participate in the education process, share insights and opinions and receive feedback regarding their learning (Keeley, 2008).

International literature includes quite a lot of studies on formative assessment (Black & Wiliam, 1998, 2018; Bostrom, 2014; Eberle & Keeley, 2008; Furtak, 2012, 2017; German, 2017; Grob, Holmeier & Labudde, 2017; Keeley, 2008, 2017; Martínez-Gudapakkam, Mutch-Jones, & Hicks, 2012; Trauth-Nare & Buck, 2011). In general, these studies refer to the characteristics of formative assessment and its positive contribution to students' conceptual understanding levels and their attitude towards the lesson. According to Furtak (2012), formative assessment is a teaching approach supporting students' conceptual understanding of science concepts and is increasingly applied in science lessons. It is recommended to work on integrating formative assessment to teaching activities, to prepare guiding materials for teachers and to present them application examples (Furtak, 2017). In their research Martínez-Gudapakkam, Mutch-Jones, & Hicks (2012) discovered that formative assessment in science lesson contributed to students' conceptual understanding and that these techniques helped students to develop positive attitude towards science lessons. Trauth-Nare and Buck (2011) stated in their study with primary school students that formative assessment practices revealed the necessary methods for supporting the academic needs of students. Despite the presence of many studies proving the contribution of formative assessment to teaching processes and conceptual understanding, teachers still encounter difficulties adopting and applying these techniques in their classes (Black & Wiliam, 1998; Grob, Holmeier and Labudde 2017; Kaplan, 2015; Wylie & Heritage, 2010). As an example, Grob, Holmeier and Labudde (2017) remarked that as inquiry-based learning has become more popular these recent years, formative assessment techniques should be used in the classrooms, and focused on the difficulties teachers face applying these techniques. Teachers apparently believe in the importance of formative assessment. They, however, have challenges applying it. These challenges were examined under five categories: integrating formative assessment into teaching process, content and structure of feedbacks, student participation in feedbacks, the relationship between formative assessment and summative assessment, the required effort. The research pointed out the need of teachers for more practice opportunities in order to overcome these challenges. Regarding this issue, Page Keeley is one of the researchers leading the studies to design ready-made and efficient formative assessment probes so that teachers can elicit opinions and learning levels of students during class (Eberle & Keeley, 2008; Keeley, 2008, 2017). Moreover, she conducts studies to facilitate the integration of formative assessment into the learning process with the in-class formative assessment techniques she developed. These techniques require active participation of students and were designed as activities to make the learning process more fun for the students. The various styles these techniques were developed allow teachers apply formative assessment in their classes easily by enabling selection according to student needs and subject requirements (Keeley, 2008).

Studies on formative assessment in our country have increased in the past few years as well (Ayvacı & Candas, 2017; Bulunuz & Bulunuz, 2013, 2014, 2016, 2017; Buyukarci, 2010; Kaplan, 2015; Karaman, 2017b, 2017a; Karaman & Karaman, 2017; Kiryak, Bulunuz, & Zeybek, 2015; Metin & Birisci, 2009). These studies are predominantly aiming to introduce formative assessment probes (Bulunuz & Bulunuz, 2013, 2014) and to specify students' conceptual understanding levels about various subjects through the use of formative assessment probes (Ayvaci & Candas, 2017; Bulunuz, Bulunuz, Karagoz, & Tavsanli, 2015; Kiryak et al., 2015). In their both studies on introducing formative assessment probes, Bulunuz and Bulunuz (2013, 2014) worked with pre-service teachers and stated that they found these probes interesting and were highly motivated to answer them. Studies, in which students' conceptual understanding levels were examined by applying formative assessment probes about subjects such as Heat and Temperature (Kiryak et al., 2015), Propagation of Light (Ayvaci and Candas, 2017), showed students' lack of knowledge and misconceptions regarding these subjects. Moreover, both studies emphasized the efficiency of formative assessment probes in determining conceptual understanding levels of students. As a result of these studies, it was recommended to integrate and apply formative assessment probes to the learning process in different subjects and levels. Bulunuz, Bulunuz, Karagoz and Tavsanli (2016) determined the conceptual understanding levels of secondary school students on floating and sinking by using formative assessment probes and compared these test results of students with the results of standardized tests. The comparison revealed significant difference between the standardized science test and formative assessment probes scores. Students were able to answer the multiple choice questions correctly. It was, nonetheless, quite difficult for them to explain the answers they gave. Furthermore, according to Buyukkarci (2010) formative assessment reduces exam anxiety of students and they prefer formative assessment probes to multiple choice tests.

There are few studies in our country focusing on the effects of formative assessment used in science lessons (Bulunuz, Bulunuz and Peker, 2014; Cakmak, 2017; Sahin Topcu, 2017). Although there is some research on eliciting and enhancing conceptual understanding levels of students regarding astronomy (Aktamis, Acar, & Higde, 2018; Bozdemir, Ezberci Cevik, Candan Helvaci, & Kurnaz, 2017; Senel Coruhlu & Cepni, 2016) no studies could be found on the effects of formative assessment practices in understanding basic astronomical concepts in the fifth grade level. This study, therefore, analyzed the effects of formative assessment practices on the conceptual understanding levels of fifth graders regarding basic astronomical concepts. The study also introduced and applied kinesthetic astronomy activities based on choreographing basic astronomy events by body movements. The literature in our country does not include any research focusing on kinesthetic astronomy activities in the astronomy education field. Considering the fact that the New Science Curriculum attributes more importance to astronomy subjects and that these are determined to be the first subjects of the semester (MEB, 2017), the expectation is that this study is going to contribute to further research in terms of not only formative assessment but also astronomy education.

The research enquired the following two questions:

1) What are the conceptual understanding levels of fifth graders regarding basic astronomical concepts?
2) How does learning based on formative assessment affect fifth graders' understanding of basic astronomical concepts?

2. Material and Methods

2.1. Research Model

One-group pretest posttest design was applied. Conceptual understanding levels about astronomy concepts of students in the study group were determined by formative assessment probes prior to and after formative assessment practices. Findings were presented in terms of percentage and frequencies.

2.2. Study Group

The research was conducted with 24 students attending a public school in Yalova in spring semester of the 2017-2018 academic year. The study group was selected with proper sampling methods comprising students from the public school where the first author is employed. It was fast and convenient for the researcher to work as the sample group was close and easily accessible (Yildirim & Simsek, 2016).

2.3. Data Collection Tools

4 formative assessment probes were used designed by Keeley, Eberle and Dorsey (2008), Keeley, Eberle and Farrin (2005) and Keeley and Sneider (2012) according to formative assessment approach and about basic astronomical concepts. These probes are two-tier questions. Students were asked to choose an answer from the choices in the first tier and to scientifically explain the reason for their choice in the second tier. The formative assessment probes are presented below.

The formative assessment probe regarding the formation of day and night is given below.

A. Where Did the Sun?

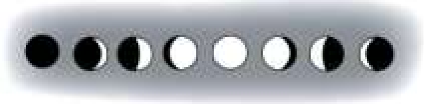
Six friends were looking up at a dark, night sky filled with stars. They wondered where the Sun was. This is what they said:

Taha: "*I think dark clouds in the sky hide the Sun at night*."
Kerim: "*I think the Sun is beneath the Earth during nighttime*."
Tuana: "*I think the Sun goes way up with the stars during the night*."
Yazan: "*I think the Sun is on the other side of the Earth during the night*."
Zeynep: "*I think the Sun is on the other side of the Moon during the night*."
Serhat: "*I think the Sun just stops shining at night*."

Which friend do you agree with and why? Explain your thinking.

The formative assessment probe regarding lunar phases is given below.

B. Going through a Phase



Mrs. Gul asked her class to share their ideas about what causes the different phases of the Moon. This is what some of her students said:
Elmas: "*The Moon lights up in different parts at different times of the month.*"
Kadir: "*The phases of the Moon change according to the season of the year*."
Hamza: "*Parts of the Moon reflect light depending on the position of the Earth in relation to the Sun and Moon.*"
Cansu: "*The Earth casts a shadow that causes a monthly pattern in how much of the Moon we can see from Earth.*"
Mucahit: "*Different planets cast a shadow on the Moon as they revolve around the Sun.*"
Ayse: "*The shadow of the Sun blocks part of the Moon each night causing a pattern of different Moon phases.*"
Eren: "*The clouds cover the parts of the Moon that we can't see*."
Naz: "*The Moon grows a little bit bigger each day until it is full and then it gets smaller again. It repeats this cycle every month*."

Which student do you agree with and why? Explain your thinking.

The formative assessment probe regarding the motion of Earth and the Sun is given below.

C. What Is Moving?

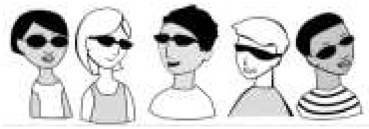
Which statement best describes the movement of the Earth and Sun? Circle the answer that best matches your thinking.

a. The Earth goes around the Sun once a day.
b. The Sun goes around the Earth once a day.
c. The Earth goes around the Sun once a day.
d. The Sun goes around the Earth once a day.

Explain your thinking.

The formative assessment probe regarding the formation of seasons is given below.

D. Summer Talk



Six friends were talking. They each had different ideas about why it is warmer in the summer than in the winter. This is what they said:
Bennu: "*It's because the winter clouds block heat from the Sun.*"
Ayca: "*It's because the Sun gives off more in the summer than in winter*."
Cemal: "*It's because Earth's tilt changes the angle of sunlight hitting Earth.*"
Ibrahim: "*It's because the Earth orbits closer to the Sun in the summer than in the winter.*"
Erkan: "*It's because on side of Earth faces the Sun and the other side faces away*."
Sude: "*It's because the Northern Hemisphere is closer to the Sun in summer than in the winter.*"
Which friend do you most agree with? --.
Describe your thinking about why it is warmer in the summer than in the winter. Provide an explanation for your answer.

Students were given one lesson period (40 minutes) to answer all questions. "Translation-back translation" method was used in the stage of translating the questions into Turkish. Each question was first translated into Turkish by the first author, and then the second author checked for typos. Finally a specialist of the field translated the questions back into English in order to prevent any meaning change/shift.

2.4. Data Analysis

In the data analysis stage the conceptual understanding levels of students prior to and after the formative assessment practices were presented in forms of percentage and frequency together with sample student answers.

For data analysis the rubric developed for two-tier question analyses by Karatas (2003) was used (Table 1). According to this rubric, student answers are analyzed in two tiers. In the first tier the answers of students for the multiple choice part are classified, in the second tier the reasons for their answers are categorized as "correct reason, partially correct reason, incorrect reason, blank". Data obtained from two tiers are then combined to conclude the test analysis. According to these criteria a student can score maximum 3 minimum 0 points for each question.

Table 1: Evaluation Criteria for Two-Tier Questions

Understanding Levels	Explanation	Evaluation Criteria	Score
Correct reason	Comprehensive answers for valid reason	Correct answer- correct reason (C.A. - C.R.)	3
Partially correct reason	Answers that do not cover all aspects of valid reason	Correct answer- partially correct reason (C.A. - P.C.R.)	2

Incorrect reason	Answers with incorrect information	Incorrect answer- correct reason (I.A. - C.R.)	2
Blank	Irrelevant, inexplicit answers or leaving blank	Correct answer- incorrect reason (C.A. - I.R.)	1
		Incorrect answer- incorrect reason (I.A. - I.R.)	0

2.5 Basic Astronomical Concepts Teaching Practice

The students were asked four formative assessment probes used as data collection tool prior to the research. The teaching implementation including formative assessment about basic astronomical concepts was the next step. After completing the process the same probes were asked the students again.

Stages of the teaching implementation are described below with the same order they were applied.

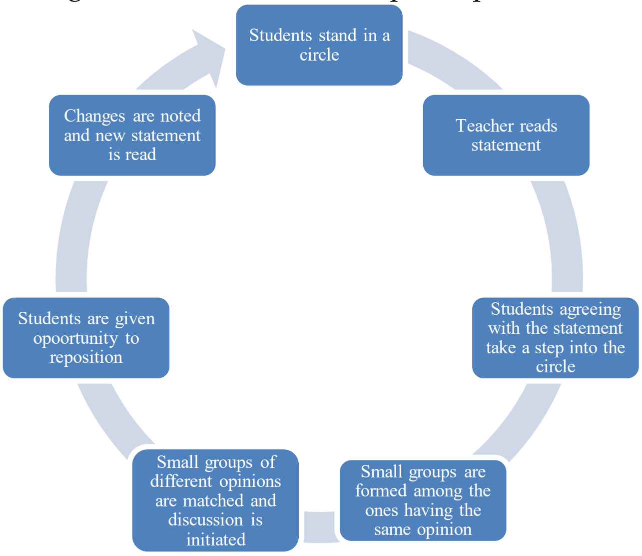
a. Video presentation regarding basic astronomical concepts.

Video clips via "eba.gov.tr" about day-night formation, lunar phases, motion of the Sun and Earth, formation of seasons were watched interactively with the students with question and answers in order to draw attention and arouse interest for a lesson period (40 minutes). Questions of students were discussed and answered in class.

b. Formative Assessment with "Agreement Circles" Technique

Agreement circles is a teaching technique based on formative assessment. A variety of teaching techniques on this issue were developed by Keeley (2008). The teacher presented some conceptually correct and incorrect interesting statements regarding the subject in order to apply the technique. Incorrect statements were meticulously selected among frequent misconceptions of students. During the implementation, students stood in a circle, facing each other. The teacher started to read the statements one by one. Students who agreed with the statement took one step inside of the circle; the ones who did not agree remained in their position. The teacher then divided the ones who agree and disagree into smaller groups, matched them up and asked them to justify their opinion regarding the statement to each other. While the small groups were in discussion, the teacher moved among them and noted down the opinions of the students. When the discussions were over, students were given the opportunity to reposition themselves. The students agreeing with the statement stood inside the circle, the ones disagreeing on the circumference; the teacher noted the changes. After note taking, a new circle was formed for the next statement and the same steps were repeated.

Figure 1: Agreement Circles Technique Implementation Diagram



Implemented according to statements about basic astronomical concepts, this technique encouraged the students to contemplate their opinions thoroughly, gave them the opportunity to develop the existing opinions and to create new and original ideas while advocating their point of view. The teacher, on the other hand, obtained information regarding their conceptual understanding levels. (For the statements used in the agreement circle technique see Appendix 1). The process was conducted in the school yard for easy implementation. It lasted for one lesson period. Photos of the technique implementation are presented below.

Figure 2: Implementation of the Agreement Circle Technique

c. Kinesthetic Astronomy

The agreement circle technique revealed the lack of knowledge and misconceptions of students regarding the motion of Earth, the Sun and the Moon, especially Earth orbiting the Sun; in order to increase their conceptual understanding levels, kinesthetic astronomy activities were conducted. Kinesthetic astronomy is a teaching technique aiming to help students to comprehend basic astronomical concepts through various drama activities and body movements that provide educational sensory experiences. At the beginning of the activity, the students are explained what the celestial object props and their body parts stand for and motions of celestial objects are choreographed accordingly. Props used in the activities need to be proportional to the sizes and distances of the celestial objects they represent (Morrow & Zawaski, 2004).

3 different activities, including the concepts of formation of day and night, lunar phases, motion of Earth, formation of seasons, were used in the teaching process. Implementation of activities continued for two periods (80 minutes). The activities are explained below with the order they were applied.

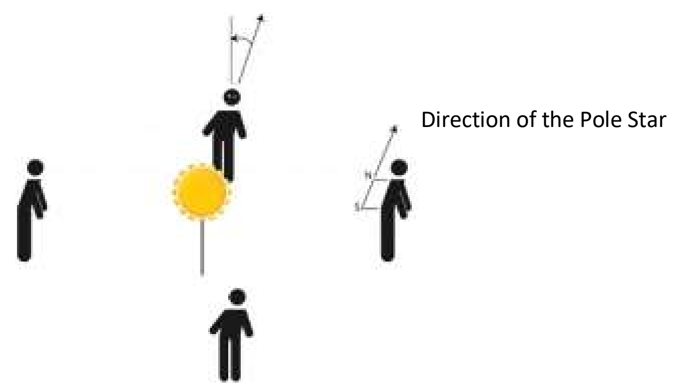
A. Activity: How do day and night form?

- An object (a balloon etc.) is selected to represent the Sun and placed in the middle of the activity field.
- 4 or 8 spots of same distance to each other are designated around the sun.
- 4-8 students are selected to represent Earth and placed on the designated spots.
- Students are explained that each of them represents Earth in various periods.
- At this stage students are asked questions regarding Earth's motions and volunteers are asked to imitate the motions for formation of a day (Students are expected to turn around their axis 360 degrees counter clockwise.).
- Students are directed questions regarding the formation of day and night (Example: The student is asked which part of him/her is day which part is night at a given position)
- Once each student is able to answer, the activity is completed by explaining how the formation of day and night is related to Earth's rotation on its own axis.

B. Activity*:* How do seasons form?

- 4 volunteers are chosen.
- Students stand in a circle with the prop representing the Sun in the middle.
- A point showing north is specified where each student stands.
- Students are told that above the waist of the four volunteers represent Earth; the heads represent the North Pole and waists the South Pole.
- Students representing Earth are asked to bend their upper body towards the specified point of north each facing the sun.
- Students are asked to rotate around themselves counter clockwise without changing their location (They always lean towards north.).

Figure 3: How do seasons form?



- Students are asked questions about the formation of seasons (Example: "How do seasons form?", "What is the difference of summer and winter?", "Which season do we experience when Earth is in this position?")
- Answers are sought with the help of the movements of students forming the circle.
- Once each student is able to answer, the activity is completed by explaining the relation of the axial tilt of Earth and its motion around the Sun to formation of seasons.

C. Activity: Lunar phases

- A light source to represent the Sun is designated first.
- Volunteers are selected.
- Students are given a pencil and a polystyrene ball and asked to insert the pencil in the center of the ball to serve as a holder.
- Students stand in a circle around the sun. They are told that the object in the middle represents the Sun, they represent Earth and the
- Polystyrene ball in their hand represents the Moon.
- Students are asked to hold the moon at arm's length.
- While the students turn around themselves, they are allowed time to explore how the Sun lights the Moon and in what phase they see it (If their own shadow covers the moon while trying to enact the full moon phase, the students can be asked to hold the moon higher.).

Figure 4: Lunar phases

- Each student is asked to position themselves where they can observe the full moon phase (Some questions are asked at this step: "How much of the moon is bright?", "How much of the moon do we observe bright when looking from Earth?").
- Students observe each lunar phase by turning around themselves counter clockwise (Students are asked questions regarding each phase: "How much of the moon is bright?", "How much of the moon do we observe bright when looking from Earth?", "What shape does the moon have looking from Earth?", "Which side of the moon is dark-bright?")
- After giving definitions regarding each phase, the activity is repeated with new volunteers.
- The activity is completed with a class debate where the students can express their opinions on lunar phases.

3. Findings

Answers given before and after formative assessment based teaching are presented below with separate frequency and percentage values for each question and sample student answers.

3.1. Findings Obtained from the First Formative Assessment Probe

Answers to the first formative assessment probe are analyzed according to the criteria given above and analysis results are presented in Table 2 with percentage and frequency values.

Table 2: Percentage and Frequency Values of the Answers the Study Group Students Gave to the Formative Assessment Probe "Where Did The Sun Go?

Categories	**Pretest**		**Posttest**	
	F	**%**	**f**	**%**
C.A.- C.R.	2	8.33	4	16.66
C.A.- P.C.R.	2	8.33	3	12.50
C.A.- I.R.	11	45.83	12	50.00
I.A.- I.R.	9	37.50	5	20.83
Total	24	100.00	24	100.00

Table 2 shows that for the first question most of the students (f=11, 45.83%) gave answers in category C.A.-I.R. prior to the formative assessment activities. Majority of the students selected the correct answer yet had difficulties to give a reason for their answer. At this step, while few students (f=2, 8.33%) answered in category C.A.-C.R., again few (f=2, 8.33%) answered in C.A.-P.C.R., and some (f=9, 37.50%) answered in I.A.-I.R. As seen in Table 2, after formative assessment activities, increase (f=4, 16.66%) in category C.A.-C.R. was observed. For example, S3 coded student answered this question prior to the activities as: "Yazan. At night the Sun moves to the other side of Earth and illuminates that part. It comes back again bringing daylight to us. This goes on like this.", in category C.A.-I.R. After the activities he moved to category C.A.-C.R. by answering: "Yazan. While orbiting the Sun, Earth rotates around itself as well. Therefore some parts get light and some parts don't. This is how day and night form.". After the activities some of the students (f=12, 50.00%) answered in category C.A.-I.R. and had still difficulty explaining their reasons, few (f=3, 12.50%) answered in C.A.-P.C.R. and other few (f=5, 20.83%) answered in I.A.-I.R. Prior to the activities, S24 coded student answered this question; "Zeynep. Because I think it is behind the Moon. It reflects its light to the Moon so that it can illuminate everywhere." in category I.A.-I.R. After the activities her answer changed to; "Yazan. If we can't see the Sun when we look up to the sky, that means that it is behind Earth." and moved to C.A.-P.C.R.

3.2. Findings Regarding the Second Formative Assessment Probe

Answers to the second formative assessment probe are analyzed according to the given criteria and analysis results are presented in Table 3 with percentage and frequency values.

Table 3: Percentage and Frequency Values of the Answers the Study Group Students Gave to the Formative Assessment Probe "Lunar Phases"

Categories	Pretest		Posttest	
	F	%	F	%
C.A.-C.R.	2	8.33	3	12.50
C.A.- P.C.R.	1	4.16	5	20.83
C.A.- I.R.	5	20.83	8	33.33
I.A.- I.R.	16	66.67	8	33.33
Total	24	100.00	24	100.00

Table 3 shows that for the second question about lunar phases most of the students (f=16, 66.67%) gave answers in category I.A.-I.R. prior to the formative assessment activities. Some of the students (f=5, 20.83%) answered in category C.A.-I.R., while few answered in categories C.A.-P.C.R. (f=1, 4.16%) and C.A.-C.R. (f=2, 8.33%). As seen in Table 3, after formative assessment activities, some increase (f=3, 12.50%) in category C.A.-C.R. was observed. S7 coded student answered this question prior to the activities as; "Hamza. The Moon radiates more light when closer to the Sun, less light when further away." in category C.A.-I.R. After the activities he moved to category C.A.-C.R. by answering: "Hamza. Someone on Earth sees the Moon in the shape the Sun lights it." After the formative assessment activities, some of the students (f=5, 20.83%) answered this question in category C.A.-P.C.R., while some (f=8, 33.33%) answered in category C.A.-I.R. and some (f=8, 33.33%) in I.A.-I.R. Prior to the activities, S22 coded student answered this question; "To Naz. It is small in the morning. Moon's parts grow when the Sun disappears." in category I.A.-I.R., whereas after the activities the answer changed to; "Hamza. When the sunlight hits the Moon, some parts get the light and some parts don't." and moved to C.A.-I.R.

3.3. Findings Regarding the Third Formative Assessment Probe

Answers to the third formative assessment probe are analyzed according to the given criteria and analysis results are presented in Table 4 with percentage and frequency values.

Table 4: Percentage and Frequency Values of the Answers the Study Group Students Gave to the Formative Assessment Probe "What Is Moving?"

Categories	Pretest		Posttest	
	f	%	f	%
C.A.-C.R.	3	12.50	3	12.50
C.A.- P.C.R.	1	4.16	7	29.17
C.A.- I.R.	4	16.67	7	29.17
I.A.- I.R.	16	66.67	7	29.17
Total	24	100.00	24	100.00

Table 4 shows that for the third question about the motions of Earth and the Sun most of the students (f=16, 66.67%) gave answers in category I.A.-I.R. prior to the formative assessment activities. Some students (f=4, 16.67%) answered in category C.A.-I.R., while few answered in categories C.A.-P.C.R. (f=1, 4.16%) and C.A.-C.R. (f=3, 12.50%). As seen in Table 4, after the formative assessment activities, category C.A.-C.R. remained the same (f=3, 12.50%), while the answers in category C.A.-P.C.R. increased (f=7, 29.17%). After the formative assessment activities, some students (f=7, 29.17%) answered in category C.A.-I.R. and some (f=7, 29.17%) in category I.A.-I.R. Before formative assessment activities, S12 coded student answered the question as "Earth receives sunlight as the Sun orbits Earth every day." without any scientific foundation in category I.A.-I.R. After formative assessment activities, the answer changed to "Earth needs 365 days to complete one circle around the Sun; so 1 year." in category C.A.-P.C.R. S20 coded student answered the same question prior to the activities as "Earth takes 1 day to turn around itself. It can't circle around that big Sun in 1 day. It takes 1 year." in category C.A.-P.C.R. while afterwards the answer changed to "The Sun is so much bigger than Earth. That's why Earth orbits the Sun. One round takes 365 days; so 1 year." in category C.A.-C.R.

3.4. Findings Regarding the Fourth Formative Assessment Probe

Answers to the fourth formative assessment probe are analyzed according to the given criteria and analysis results are presented in Table 5 with percentage and frequency values.

Table 5: Percentage and Frequency Values of the Answers the Study Group Students Gave to the Formative Assessment Question "How Do Seasons Form?"

Categories	Pretest		Posttest	
	f	%	f	%
C.A.- C.R.	-	0	5	20.83
C.A.- P.C.R.	-	0	4	16.67
C.A.- I.R.	2	8.33	13	51.17
I.A.- I.R.	22	91.67	2	8.33
Total	24	100.00	24	100.00

Table 5 shows that for the fourth question about the formation of seasons, most of the students (f=22, 91.67%) gave answers in category I.A.-I.R. prior to the formative assessment activities. The remaining students (f=2, 8.33%) answered in category C.A.-I.R. None of the students answered this question in categories C.A.-P.C.R. or C.A.-C.R. After the activities, as seen in Table 5, answers in categories C.A.-C.R. (f=5, 20.83%), C.A.-P.C.R. (f=4, 16.67%) and C.A.-I.R. (f=13, 51.17%) showed increase. At this point only a few students (f=2, 8.33%) answered this question in category I.A.-I.R. S15 coded student answered this question prior to the formative assessment activities as "To Ibrahim. Earth comes very close to the Sun in summer, moves away in winter. When it moves away, it gets cold, winter comes; when it comes closer, it gets hot, summer comes." in category I.A.-I.R., whereas afterwards it moved to category C.A.C.R. with the answer "To Cemal. As Earth orbits the Sun in a tilted position, vertical sunlight causes summer, tilted sunlight causes winter." S17 coded student answered this question before the activities as "I agree with Cemal. In winter there is less sunlight but in summer the angle of the Sun changes and it becomes hotter." in category C.A.-I.R. After the activities the answer changed to "Cemal. Seasons are formed because Earth moves in a tilted position." in category C.A.-P.C.R.

4. Discussion and Result

All findings regarding each sub-problem of the research are discussed and results are presented below.

4.1. Discussion on the first Sub-Problem

The findings regarding the question *"What are the conceptual understanding levels of fifth graders regarding basic astronomical concepts?"* ,which constitutes the first sub-problem of the research, showed that students' conceptual understanding levels regarding basic astronomical concepts are low. Prior to the formative assessment activities, most of the students answered the 4 formative assessment probes, which were used as data collection tools, in category I.A.-I.R. This finding indicates that the students did not know the basic astronomical concepts which they had experienced before and were expected to know. Moreover, answers in category C.A.-I.R. were a lot as well. Answering the question correctly but failing to explain the reason shows that students lacked necessary conceptual understanding depth. Vosniadou & Brewer (1994) and Bolat, Aydogdu, Degirmenci & Sagir (2014) stated similar results. Both studies concluded that 5th grade students' conceptual understanding levels regarding basic astronomical concepts were low. Given answers revealed that students had developed some misconceptions. Some of the frequently observed misconceptions are: the reason for night and day formation is *the exchange of location of the Sun and the Moon,* the reason for lunar phases is *the Moon being a light source and radiating light from its different parts in different periods,* the reasons for seasons to form is *the Earth coming closer to and moving away from the Sun*. In addition; *the Sun orbits Earth and the Moon grows and shrinks volumetrically in different periods* are other observed misconceptions. Literature indicates that misconceptions about day-night formation (Vosniadou & Brewer, 1994; Trumper, 2003; Frede, 2006; Bekiroglu, 2007; Bostan, 2008), lunar phases (Trumper, 2003, Frede, 2006; Bekiroglu, 2007; Bostan, 2008; Gunes, 2010), motion of Earth (Vosniadou & Brewer, 1994; Trumper, 2003; Gunes, 2010) and formation of seasons (Turk, Alemdar & Kalkan, 2012; Bostan, 2008; Trumper, 2003) are quite common among students.

4.2. Discussion on the Second Sub-Problem

The findings regarding the question *"How does learning based on formative assessment affect fifth graders' understanding of basic astronomical concepts?"* ,which constitutes the second sub-problem of the research, revealed that formative assessment practices have positive effects on students' conceptual understanding levels. Applied techniques decreased the answers in category I.A.-I.R. The increase of answers in categories C.A.-C.R., C.A.-P.C.R. and C.A.-I.R. after the activities indicates that students have reached a higher conceptual understanding level. Similar results were obtained in studies focusing on the effects of formative assessment on students' conceptual understanding levels regarding inertia, equilibrium and torque. These studies concluded that students had reached a higher conceptual understanding through formative assessment implementation (Bulunuz & Bulunuz, 2016, 2017). After the activities students mostly answered in category C.A.-I.R. and were unable to justify their answers. This can be related to students being used to multiple choice tests. (Bulunuz et al., 2015).

As a result, this study, examining 5th grade students' conceptual understanding levels regarding basic astronomical concepts, showed that students had a very low conceptual understanding level and various misconceptions prior to the learning process. A number of other studies, focusing on conceptual understanding levels of secondary school students regarding astronomy subjects, revealed that these students had difficulties in comprehending these subjects along with many misconceptions (Bolat et al., 2014; Bostan, 2008; Gundogdu, 2013; Goncu, 2013; Senel Coruhlu & Cepni, 2015; Turk, Alemdar & Kalkan, 2012; Starakis & Halkia, 2010; Trumper, 2001; Vosniadou & Brewer, 1994). Although students show high interest and motivation to astronomy subjects (Gundogdu, 2014), having difficulties in learning them is an indication of the need for improving the quality of applied teaching activities.

The research identified an increase in students' conceptual understanding levels due to the applied teaching practices. The results are in compliance with numerous studies regarding effects of formative assessment on understanding (Bulunuz, Bulunuz, 2016, 2017; Bulunuz, Bulunuz and Peker, 2014; Cakmak, 2017, Sahin Topcu, 2017; Yalaki, 2010).

Even though students' conceptual understanding levels showed increase, they had difficulties in explaining their answers; the number of students giving correct opinions in the second parts of the questions was low. This may be due to student habits. Questions in course selection exams applied by teachers and nationwide higher education placement exams focus on procedural knowledge levels rather than conceptual knowledge levels (Demircioglu and Demircioglu, 2009; Ozmen, 2005) which lead students to study accordingly and to fail developing scientific reasoning skills (Ozden, 2007). Furthermore, nationwide placement exams affect in class teaching practices of teachers. Teachers are endeavoring for their students to succeed in these crucial exams, which as a result forces them to use traditional methods (Demir and Demir, 2012).

5. Suggestions

Suggestions for teachers, researchers and authors based on the results obtained from the research are presented below.

5.1 Suggestions for teachers

- Prioritizing concept teaching and comprehension of students regarding related concepts and inter-conceptual associations in order to develop their scientific reasoning skills,
- Being aware of common student misconceptions about the subjects and planning the lessons accordingly for an efficient concept teaching,
- While planning teaching activities regarding basic astronomical concepts, using formative assessment which improves students' conceptual understanding levels and interactive feedback that reveals prior knowledge and misconceptions,
- Making use of formative assessment classroom techniques developed to use formative assessment easier and more efficiently,
- Making use of kinesthetic astronomy activities in primary and secondary schools, as they allow you to present basic astronomical concepts more easily and understandable.

5.2 Suggestions for researchers

- Conducting more research aiming to improve students' conceptual understanding levels and scientific reasoning skills,
- Making use of formative assessment probes, which are proven to be efficient in determining students' conceptual understanding levels and misconceptions, in further studies on conceptual understanding,
- Increasing sample numbers in similar research and using pretest – posttest control group design in order to obtain more general results about the effect of formative assessment on conceptual understanding of students,
- Developing more and various formative assessment probes and introducing these to teachers, as astronomy subjects gained more importance with the New Science Curriculum.

5.3 Suggestions for authors

- When planning books, preparing texts and visuals meticulously in order not to create misconceptions among students,
- Including formative assessment probes, which have proven to be effective in increasing students' conceptual understanding levels, in course books and resource books.

References

Aktamış, H., Acar, E. & Hiğde, E. (2018). Astronomiyi öğrenelim-uzayı keşfedelim kampı öğrencilerin astronomi hakkındaki kavramsal bilgilerini değiştirdi mi? [Did "Let's learn astronomy, explore the space summer camp" change the students' conceptual knowledge about astronomy?]. *Kastamonu Education Journal, 26*(2), 523-533. doi:10.24106/kefdergi.389816

Ayvacı, H. Ş., & Candaş, B. (2017). Farklı öğretim kademesindeki öğrencilerin ışığın yansıması konusunu anlama düzeyleri [Students' undertandings on light reflection from different educational level]. *Journal of Computer and Education Research*, *5*(10), 241–271.

Bekiroğlu, F. O. (2007). Effects of model-based teaching on preservice physics teachers' conceptions of the moon, moon phases and other lunar phenomena, *International Journal of Science Education, 29*(5), 55.

Black, P. J., & Wiliam, D. (2018). Classroom assessment and pedagogy, *Assessment in Education,25*(3). DOI: 10.1080/0969594X.2018.1441807

Boström, E. (2014). The impact of a teacher professional development program in formative assessment on mathematics teachers' classroom practice. *Nionde Matematikdidaktiska Forskningsseminariet(MADIF-9),38*(1), 1–11.

Bozdemir, H., Ezberci Çevik, E., Candan Helvacı, S., & Kurnaz, M. A. (2017). TGA (Tahmin Et- Gözle-Açıkla) yöntemine dayalı teleskop gözlemlerinin fen bilgisi öğretmen adaylarının bazı astronomi kavramlarını anlamalarına etkisi [The effect of telescope obsevations based on TGA (predict-observe-explain) method on preservice science teachers understanding of some astronomy concepts]. *International Journal Of Eurasia Social Sciences*, *8*(28), (CLXXXVIII-CCVI).

Bolat, A., Aydoğdu, R. Ü., Sağır, Ş. U. ve Değirmenci, S. (2014). 5. Sınıf öğrencilerinin Güneş, Dünya ve Ay kavramları hakkındaki kavram yanılgılarının tespit edilmesi [5th Grade students' misconceptions related to the subjects of "the Sun, the Earth and the Moon"]. *Journal of Research in Education and Teaching, 3*(1), 218-229.

Bostan, A. (2008). *Farklı yaş grubu öğrencilerinin astronominin bazı temel kavramlarına ilişkin düşünceleri [Different age group students' ideas about some basic astronomy concepts].* (Unpublised Master Thesis). Balıkesir Universty, Balıkesir.

Bulunuz, M., & Bulunuz, N. (2013). Fen öğretiminde biçimlendirici değerlendirme ve etkili uygulama örneklerinin tanıtılması I [Formative assessment in science teaching and demonstration of its effective implementation], *Journal of Turkish Science Education, 10*(4), 119-135.

Bulunuz, M., & Bulunuz, N. (2014). Fen öğretiminde biçimlendirici değerlendirme ve etkili uygulama örneklerinin tanıtılması II [Formative assessment in science teaching and demonstration of its effective implementation], *Yeni Türkiye Dergisi, 59, 1278-1283.*

Bulunuz, M., & Bulunuz, N. (2016). Biçimlendirici değerlendirme sorusu kullanılarak lise öğrencilerine eylemsizlikle ilgili yapılan öğretimin değerlendirilmesi [Using formative assessment probes to evaluate the teaching of inertia in a high school physics classroom]. *Journal of Inquiry Based Activities (JIBA), 6*(2), 50-62, 2016.

Bulunuz, N., & Bulunuz, M. (2017). Biçimlendirici değerlendirme uygulamalarının lise öğrencilerinin denge ve tork kavramlarını anlamalarına etkisinin değerlendirilmesi [Effect of formative assessment-based instruction on high school students' conceptual understanding of balance and toroque] . *Journal of Inquiry Based Activities (JIBA), 7(*1), 21-33, 2017.

Bulunuz, N., Bulunuz, M., Karagoz, F., & Tavsanli, O. F. (2015). Achievement Levels of Middle School Students in the Standardized Science and Technology Exam and Formative Assessment Probes: A Comparative Study. *Journal of Education in Science, Environment and Health*, *2*(1), 33. https://doi.org/10.21891/jeseh.07449.

Bulunuz, N., Bulunuz M., & Peker, H. (2014). Effects of formative assessment probes integrated in extra-curricular hands-on science: Middle school students' understanding. *Journal of Baltıc Science Education, 13*(2), 243-258.

Büyükkarcı, K. (2010). *The effect of formative assessment on learners' test anxiety and assessment preferences in EFL context.* (Unpublised Doctoral Thesis). Cukurova Universty, Adana.

Demir, S. ve Demir, A. (2012). Türkiye'de yeni lise öğretim programları: Sorunlar, beklentiler ve öneriler [New high school instructional programs in Turkey: Problems, expectations and suggestions]. *Elementary Education Online, 11*(1), 35-50, 2012

Demircioğlu, G. ve Demircioğlu, H. (2009). Kimya öğretmenlerinin sınavlarda sordukları soruların hedef davranışlar açısından değerlendirilmesi [An Evaluation of the Questions Chemistry Teachers Asked in Exams in Terms of the Target Behaviors]. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, *3*(1), 80-98.

Eberle, F., & Keeley, P. (2008). Formative Assessment Probes: A look at how probes uncover conceptual connections. *Science and Children*, (January), 50–54. Retrieved from http://digital.nsta.org/publication/index.php?i=97334&m=&l=&p=30&pre=&ver=flex

Frede, V. (2006). Pre-Service elementary teacher's conceptions about astronomy, *Advances in Space Research*, *38*, 2237–2246.

Furtak, E. M. (2012). Linking a learning progression for natural selection to teachers' enactment of formative assessment. *Journal of Research in Science Teaching*, *49*(9), 1181–1210. https://doi.org/10.1002/tea.21054

Furtak, E. M. (2017). Formative Assessment and Instructional Intervention, 1–5. Retrieved from https://www.mailman.columbia.edu/sites/default/files/legacy/Formative-Assessment-and-Instructional-Intervention.pdf

German, S. (2017). Vote discuss, revote: A formative assessment classroom technique. *Science Scope*, *41*(2), 26–29.

Göncü, Ö. (2013). *İlköğretim beşinci ve yedinci sınıf öğrencilerinin astronomi konularındaki kavram yanılgılarının tespiti [Identify the misconception in astronomy in fifth and seventh grade students].* (Unpublised Master Thesis). Mehmet Akif Ersoy University, Burdur.

Grob, R., Holmeier, M., & Labudde, P. (2017). Formative Assessment to Support Students' Competences in Inquiry-Based Science Education. *Interdisciplinary Journal of Problem-Based Learning*, *11*(2), 1–8. https://doi.org/10.7771/1541-5015.1673

Gündoğdu, T. (2014). *8. sınıf öğrencilerinin astronomi konusundaki başarı ve kavramsal anlama düzeyleri ile fen dersine yönelik tutumları arasındaki ilişkinin incelenmesi [Investigation of relationship between 8th grade students' achievement and conceptual understanding levels in astronomy and attitudes toward science course].* (Unpublised Master Thesis). Marmara Universty, İstanbul.

Güneş, G. (2010). *Öğretmen adaylarının temel astronomi konularında bilgi seviyeleri ile bilimin doğası ve astronomi öz-yeterlilikleri arasındaki ilişkinin incelenmesi [The analyze of the relation betweeen astronomy knowledge with the nature of science and the astronomy self-efficacy belief of preservice teachers].* (Unpublised Master Thesis). Çukurova Universty, Adana.

Heredia, S. C., Furtak, E. M., Morrison, D., & Renga, I. P. (2016). Science Teachers' Representations of Classroom Practice in the Process of Formative Assessment Design. *Journal of Science Teacher Education*, *27*(7), 697–716. https://doi.org/10.1007/s10972-016-9482-3

Karaman, P. (2017a). Adaptation of Teachers ' Conceptions and Practices of Formative Assessment Scale into Turkish Culture and a Structural Equation, *Intenational Electronic Journal of Elementary Education, 10*(2). https://doi.org/10.26822/iejee.2017236114

Karaman, P. (2017b). Adapting of formative assessment attitude and intention scale for pre-service teachers and a structural equation modeling, *Inonu University Journal of the Faculty of Education, 18*(3), 118-131. DOI: 10.17679/inuefd.300688

Karaman, P., & Karaman, A. (2017). Öğretmen Adaylarının Biçimlendirici Değerlendirme Uygulamalarının İncelenmesi : Eylem Araştırması Modeli [*Investigating Teacher Candidates' Use of Formative Assessment: Action Research Model], Kastamonu Educational Journal, 25*(6), 2385–2401.

Karataş, (2003). Öğrenci yanılgılarını ve anlama düzeylerini belirlemede kullanılan iki aşamalı testler, *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 1*(13), 54-69.

Keeley, P. (2008). *Science formative assessment: 75 practical strategies for linking assessment, instruction, and learning*. California: Corwin & NSTA Press.

Keeley, P. (2017). Embedding Formative Assessment into the 5E Instructional Model. *Science and Children*, 28–32.

Keeley, P., Elberle, F. & Dorsey,C. (2008). *Uncovering students ideas in science, vol 3: Another 25 formative assessment probes.* Arlington, VA: NSTA Press.

Keeley, P., Elberle, F. & Farrin, L. (2005). *Uncovering students ideas in science, vol 1: 25 formative assessment probes,* Arlington, VA: NSTA Press.

Keeley, P. & Sneider, C. (2012). *Uncovering students ideas in astronomy: 45 new formative assessment probes.* Arlington, VA: NSTA Press.

Kıryak, Z., Bulunuz, N., & Zeybek, Ö. (2015). Biçimlendirici yoklama soruları ile 7. sınıf öğrencilerinin ısı ve sıcaklık konusundaki kavramsal anlama düzeylerinin belirlenmesi [Determination of 7th Grade Students' Conceptual Understanding Levels about Heat and Temperature with Formative Assessment Probes]. Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, *9*(2), 34-60.

Klinger, D. A., Volante, L., & Deluca, C. (2012). Building teacher capacity within the evolving assessment culture in Canadian education. *Policy Futures in Education, 10*(4), 447–460. https://doi.org/10.2304/pfie.2012.10.4.447

Martínez-Gudapakkam, A., Mutch-Jones, K., & Hicks, J. (2012). Formative Assessment Practices to Support Students who Struggle in Science.: EBSCOhost, 88–94. Retrieved from http://web.a.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=1&sid=d2ea9792-e573-4611-a42d-f0a0ab1e813b%40sessionmgr4008

Metin, M., & Birişçi, S. (2009). Biçimlendirici değerlendirmenin öğretmen adaylarının bilimsel süreç becerilerini geliştirmeye etkisi ve adayların değerlendirme hakkındaki düşünceleri. *Çağdaş Eğitim Dergisi, 34*(370), 31-39.

Ministery of Education (2017). Fen bilimleri dersi öğretim programı (ilkokul ve ortaokul 3, 4, 5, 6, 7, 8. sınıflar). Ankara.

Morrow, C., & Zawaski, M. (2004). Kinesthetic astronomy. Retrieved from www.spacescience.org

Özar, M. (2013). Öğrenme öğrenende gerçekleşir: Yeni nesil eğitim uzmanı *[Learning occurs in the learner: New generation of education specialist].* Turkish Journal of Education, 2(1).

Özden, M. (2007). 2006 Öğrenci Seçme Sınavı (ÖSS) kimya sorularının kapsam ve düzey yönünden değerlendirilmesi [The Evaluation of Chemistry Questions Asked in 2006 Student Selection and Placement Tests (ÖSS) in terms of Content and Level]. *Dicle University Journal of Ziya Gokalp Education Faculty, 9*, 8492.

Özmen, H. (2005). 1990-2005 ÖSS sınavlarındaki kimya sorularının konu alanlarına ve Bloom taksonomisine göre incelenmesi, *Eurasian Journal of Educational Research (EJER), 21*, 187 – 199.

Perkins, D. (1999). The Many Faces of Constructivısm, *Educational Leadership, 57*, 3.

Rokos, L., Zavodska, R., Petr, J. & Papacek, M. (2016). Formative Assessment Methods in Biology Education: Pedagogical Study at Primary School in the Czech Republic. *Bulletin of the South Ural State University. Ser. Education. Educational Sciences, 8*(4), 94-99.

Snowman, J. & McCown, R. (2015). *Psychology applied to teaching (14th ed.).* Belmont, CA: Cengage Learning.

Starakis, J. & Halkia K. (2010). Primary school students' ideas concerning the apparent movement of the moon. *Astronomy Education Review, 9*, 010109-1. Doi: 10.3847/AER2010007.

Şahin Topçu, K. (2017). *Biçimlendirici yoklama soruları ile zenginleştirilmiş öğretimin 7. sınıf öğrencilerinin "Güneş sistemi ve ötesi: Uzay bilmecesi" ünitesindeki kavramsal anlamalarına etkisinin incelenmesi [Examining the effect of teaching the unit of "Solar system and beyond: Space riddle"enriched by the formative assessment probes on the conceptual understanding of seventh grade students].* (Unpublised Master Thesis). Uludag Universty, Bursa.

Şenel Çoruhlu, T., & Çepni, S. (2016). Zenginleştirilmiş 5E Modelinin Öğrenci Kavramsal Değişimi Üzerine Etkisi: Astronomi Örneği [Effects of The Enriched

5E Model on Students' Conceptual Change: Astronomy Sample], *Kastamonu Education Journal, 24*(4), 1785–1803.

Trauth-Nare, A., & Buck, G. (2011). Using reflective practice to incorporate formative assessment in a middle school science classroom: A participatory action research study. *Educational Action Research*, *19*(3), 379–398. https://doi.org/10.1080/09650792.2011.600639

Trumper, R. (2003). The need for change in elementary school teacher training -a cross-college age study of future teachers' conceptions of basic astronomy concepts, *Teaching and Teacher Education, 19,* 309–323.

Türk, C., Alemdar, M. ve Kalkan, H. (2012). İlköğretim öğrencilerinin mevsimler konusunu kavrama düzeylerinin saptanması. *Journal of Educational and Instructional Studies in the World, 2*(1), 2146-7463.

Vasniadou, S., & Brewer, W. F. (1994). Mental models of the day/night cycle. *Cognitive Science, 18*, 123–183.

Wylie, E. C., & Heritage, M. (2010). *Developing and deepening formative assessment practice,* Thousand Oaks, CA: Corwin Pres.

Yalaki, Y. (2010). Simple formative assessment, high learning gains in college general chemistry. *Eurasian Journal of Educational Research, 40,* 223-241.

Yıldırım, A. & Şimşek H. (Ed.) (2016). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri*, Ankara: Seçkin Publishing.

Yılmaz, M. (2009). Öğrenme ve Bilgi İlişkisi [Learning-Knowledge Relationship]. *Gazi Üniversitesi Eğitim Fakültesi Dergisi*, *29*(1), 173–190.

Appendix: Statements Used in the Agreement Circles Technique

1) The reason for lunar phases is the change of shape and size of the Moon. (Agree/Disagree)
2) The reason for observing the Moon in different shapes is the reflection of the sunlight from different parts of the Moon. (Agree/Disagree)
3) The Sun being in east in the morning, on top at noon, west in the evening proves that it orbits Earth. (Agree/Disagree)
4) Each new day forms by Earth completing one circle around the Sun. (Agree/Disagree)
5) While orbiting the Sun, if Earth comes closer to it, we experience summer; if it moves away, we experience winter. (Agree/Disagree)
6) The Sun does not radiate light at night. (Agree/Disagree)
7) While Earth is spinning around itself, the side it faces the Sun is bright, the other side is dark. (Agree/Disagree)

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