After Almost Half-Century Landing On The Moon And Still Countering Basic Astronomy Conceptions

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Abstract
The purpose of study is to investigate the fifth graders' understandings of the basic astronomy concept and, if they have, to define their misconceptions and then to determine what reason/s behind them. For this purpose, two hundred seventy fifth grade students from 6 different schools participated. Randomly selected 45 students performing under the class average and 6 teachers were interviewed to determine what reason/s behind students' misconceptions. The results of the study showed that many 5th graders have some misconceptions, such as Moon moves into the Sun's shadow, Moon only revolves around the Earth, it does not revolve around the Sun because the Moon cannot be seen in the day-light. The reasons are one of reconciling out of school experiences, such as observing the rising and setting sun, seeing stars only at night, school experiences, such as misleading diagrams and inappropriate materials, ambiguous terminology and impropriate teaching methodology used by teacher.
Keywords: Misconception, Astronomy, Science Teaching.

Introduction

Human beings' fascination with contemplating the Earth, Moon, Sun, stars and other planets has had a significant effect on the education. It was the first time that we had left the planet Earth and set foot on a different world almost half-century ago. After landing on the Moon, people started to look up the Moon and sky in wonder. This big step has led to numerous scientific discoveries that have great influence not only on humankinds' understanding of the universe but also on educational perspective. Educators started to concern much more about teaching basic astronomy concepts in K-12.

Over the past few decades there have been identified a number of commonly held misconceptions, which defined as "an idea about or an explanation for a phenomenon that is not accurately supported by accepted physical principles; a mistaken thought, idea, or notion; a misunderstanding" by American Heritage Dictionary (2011), about astronomy. In literature, there are hundreds of studies generally focused on astronomy education, status studies, achievement studies, or curriculum development studies related to the Earth's shape, the day/night cycle, the seasons, and the Earth/Sun/Moon system, in K-12. Based on the data sources in 1920s, Piaget

probably was the first researcher to study how children conceive of astronomical phenomena. He described 9 and 10 years old children's ideas about a flat Earth and the cause of day and night, and refers to previous psychologists' work on similar conceptions. He concluded in his "The child's conception of the world" book ... "America is like a lower story (sic) compared with Europe and that to reach America the Sun had to cross the sea by a tunnel which pierced what formed the floor of Europe and the roof of America" (Lelliott & Rollnick, 2009). By Yuckenberg study (1962) stated first grade students' pre-instructional knowledge about sun, moon, day-night and gravity had been extended to include many of the concepts held by adults, we could say students started to learn astronomy concepts from first grade level (cited in Lelliott & Rollnick, 2009).

After that, researchers much more focused on how we teach and/or what type of materials we use to teach easily our students. Shrigley (1971, 1972) found the handmade and commercial equipment were very effective materials to understand astronomy concepts at sixth grade students. Klopfer (1969) and Bauman (1970) showed that Elementary School Science Project astronomy materials were effective in increasing student interest in gaining knowledge about certain astronomical topics, and attitudes toward science at the fifth and sixth grade level in terms of understanding of astronomy concepts. Schivera (1972) stated that using visual review material contributes to the learning process when the visual content of the televised lesson is important to the instructional process in fifth grade students (cited in Wall, 1973).

Moreover, the developments of education in mainly in Europe and the USA leading or much more focusing on education greatly increased interest in the subject of astronomy education since 1990. This is represented by researchers, such as Baxter (1991) and Jarman and McAleese (1996) in the UK, Stahly et al. (1999) in the USA, and Trumper (2001a) in Israel, who noticed the essential astronomy topics revised in curricula in the 1990s. Commonly held astronomy misconceptions for elementary students could be gathered into 3 subjects.

Misconception about Day and Night

Children develop ideas and beliefs, which gathered directly or concretely, experienced informal learning situations many times throughout their lives before they receive formal instruction. About how *day and night* occur, many researchers, such as Klein (1982) studied with Mexican-American and Anglo-American students; Jones, Lynch, and Reesink (1987) studied with third and sixth grade students in the US; Baxter (1989) studied with 100 students, 9 to 16-year-old from five schools in the UK; Vosniadou and Brewer (1994) studied with 5- to 11-year-olds in the USA; Vosniadou & Brewer **(**1994) studied with 3 to 5 grade students in the US; Sharp (1996) studied with 10- and 11-year-olds interviewed in three schools in the UK; Fleer (1997) studied with Aboriginal children in Australia; Kikas (1998) studied with 10- and 11-year-olds in Estonia; Diakidoy, Vosniadou, & Hawks (1997) with American-Indian students; Dunlop (2000) studied with 7 to 14 years-old students in the New Zealand; Dove (2002) studied with 12-year-old students in the UK; Baloglu and Ugurlu (2005) studied with 6 grade Turkish students, found that the most commonly held misconception for the cause of the day/night cycle is that Earth revolves around the Sun. Interestingly, children held naive views in explaining why the cycle occurs, such as the Sun's moving down to the ground and hiding behind the mountains causes the change from day to night; clouds move in front of the Sun and block its light; the Sun's moving from the sky, which is located inside the hollow sphere, to outer space, which is located outside the hollow sphere; the Moon is fixed in some place of the sky where it is always night; as the Earth rotates in

an up/down direction our part of the Earth eventually comes to face the Moon in the night sky. However, the explanation of that is the Earth spins on its axis, completing a turn once every 24 hours. The side facing the Sun experiences day, while it is night on the other side.

Misconception about Earth and related Issues

The research of the Earth and related issues showed that some elementary students have widespread misconceptions about the Earth's shape. According to Nussbaum and Novak (1976) nearly all of them responded that "the earth is round". Some students thought that the earth is a "circular island that people can sail around," or that the ball-shaped earth is a "planet in the sky, where astronauts go." Many of those that understood that the earth is shaped like a ball were puzzled about why people did not fall off the bottom of the ball. These results have been confirmed and extended by a number of researchers. Mali and Howe (1979) found similar misconceptions in Nepal. Nussbaum (1979) expanded this work with 240 Israeli students in grades 4 through 8 in an attempt to generalize the earlier results. Klein (1982) addressed the comparison of Mexican American and Anglo American second-grade students had similar misunderstanding of Earth as a ball in space. Sneider and Pulos (1983) discovered a similar distribution of misconceptions among California students in grades 3 through 8 and Jones, Lynch, & Reesink (1987) looked at third-and-sixth-grade students in the US. Osborne and Freyberg (1985) investigated New Zealand children's concepts of the motion and shape of the Earth, Sun, and Moon. Lightman and Sadler (1993) found that a sample of second grade teachers expected that 95% of their students understood that the earth is shaped like a ball; whereas only 5% of the students actually understood the concept. Diakidoy, Vosniadou, and Hawks (1997) studied with native Indian-American children, Vosniadou, Skopeliti, and Ikospentaki (2004) with middle-class elementary Greek students got similar problems, which are (1) the Earth's shape is like a rectangle; (2) circular but flat like a disc; (3) a hollow sphere and that people live on flat ground inside it; (4) flattened at the top and bottom where people live; (5) Interestingly, children think there are two types of Earths, which are a flat one in which people live, and a round one that is up in the sky (Abell, George, & Martini, 2002; Barnett & Moran, 2002; Baxter, 1989; Baloglu Ugurlu, 2005; Dove, 2000; Ekiz, & Akbas, 2005; Skam, 1994; Trundle, Atwood, & Christopher, 2007; Trundle, Troland, & Pritchard, 2008).

On the other hand, researchers did not pay attention on children's ideas about the solar system as much as moon and/or day-night astronomy concept. Osborne et al. (1994) provided some information on primary children's thoughts from England. He said children have confusion about stars and planets and problematic thoughts about the scale of the solar system. Similar findings from many studies reported later by Skamp (1994), Arnold, Sarge and Worrall (1995), Sharp, Bowker and Merrick (1997), Sneider and Ohadi (1998), Dunlop (2000), Agan and Sneider (2003), Baloglu and Ugurlu (2005), Ekiz and Akbas (2005), Sharp and Kubris (2006). The most common alternative explanations about the sun are that children commonly think the Earth is the center of the galaxy or universe because people describe the sun as setting and rising; the sun moves across the sky from east to west; the Sun is directly overhead at noon; when the sun goes down, the moon comes up; the Sun does not rotate; day and night are caused by the Sun going around the Earth; the Sun is not a star and not a member of the solar system; Stars other than the Sun are closer to us than Pluto.

Misconception about Moon Phases

The research of the *moon phases* showed another misconception area of astronomy for young children. The Moon orbits around the Earth every 29.5 days. At all times, half of the Moon is lit by the Sun. The other half of the Moon facing away from the Sun is in darkness. Moon reflects light from the Sun. When the Moon is on the opposite side of the Earth from the Sun, we can see one whole side of the Moon lit up: the "Full Moon". When, on the other hand, the Moon lies between the Earth and the Sun we see no Moon for up to three nights: the "New Moon". Between these two shapes, the Moon has completed a proportion of its orbit, and a half or crescent Moon is observed. Philips (1991) worked with 5-9 grades; Broadstock (1992) with Grades 1–5; Stahly, Krockover, and Shepardson (1999) with 8- and 9-year-olds and Taylor et al. (2003) with 12- and 13-year-olds found that a majority of students held common misconceptions about the cause of moon phases which are caused by the Earth's shadow. Additional studies (Ault, 1984; Baloglu & Ugurlu, 2005; Baxter, 1989; Brunsell & Marcks, 2007; Callison & Wright, 1993; Cohen and Lucas, 1999; Dai & Capie, 1990; Dove, 2002; Ekiz and Akbas, 2005; Galili, Weizman, & Cohen, 2004; Jones, Lynch, & Reesink, 1987; Kavanagh, Agan, & Sneider, 2005; Schoon; 1992; 1999; Trumper, 2001a-b; Trundle & Troland, 2005) identified the commonalities in students' misconception of the Moon and some lunar phenomena are; (1) the Moon does not rotate on its axis; (2) the Moon is the only cause of tides on Earth; (3) the Moon is seen only at night; (4) the Moon does not revolve around the Sun; (5) apparent movement of the Moon across the sky and about the cause of moon phases is the Earth's shadow; (6) clouds cover the part of the moon that we cannot see; (7) planets cast shadows on the part of the moon that we cannot see; (8) the shadow of the sun falls on the moon, blocking our view of it; (9) the shadow of the earth falls on the moon, blocking our view; (10) the moon is always visible on clear nights and never in the daytime; (11) the moon can be closer than the clouds; (12) the moon do not move over the course of a night. It is very clear why students have misconception about the moon phases because the phases are explained in terms of the portion of illuminated side of the moon visible from the earth.

Purpose of Study

The purpose of the study is to investigate fifth graders' understandings of the basic astronomy concept and, if they have, to define their misconceptions and then to determine what reason/s behind them. The following research questions guided to analyze and interpret the students' responses.

1. What are fifth-grade students' misconceptions of the basic astronomy?
2. If the fifth-grade students have misconceptions of basic astronomy, what are these and why they have these?
3. Is there any statistically difference when comparing the results of the boy and girls scores about basic astronomy?
4. How do teachers diminish students' misconception of basic astronomy and what do they do?

Methodology

Two hundred seventy (133 female, 137 male) 5th grade students in Bornova County of İzmir were selected as the subjects of this study using cluster sampling. The population of students was clustered into three demographic areas: central, rural, and suburb Bornova County. Two schools from each areas of Bornova County were selected. One 5th grade class from each school was selected randomly for this study.

The quantitative and qualitative methods were selected for this study to investigate the nature of students' ideas about basic astronomy concept.

Through the use of quantitative methods, the questionnaire, adopted from Trumper (2000, 2001b), including 10 multiple choice (Appendix 1) and open-ended questions, as an achievement test, was applied to identify the fifth grade students' knowledge and understanding. In adaptation process of questionnaire, guidelines for cross-cultural adaptation were used. Back-translation with bilingual test of the original English instrument, content and construct validity, and inter-item correlation were done independently by experts. After this process three experts decided on Turkish version and then the questionnaire was applied. The reliability of the test was measured by calculating the KR-20 coefficient, the measure of internal consistency reliability for measures with dichotomous choices, getting an estimate of the value $\rho KR_{20} = 0.71$ showing that the test has high reliability.

The use of qualitative methods, detailed data which captured the participants' personal perspectives was collected via interview with students, scored under the class average in achievement test, to interpret why they have misconceptions of basic astronomy concept. For that purpose "why did you select this choice and briefly explain your answer?" question was asked 45 students and analyzed their narratives according to Haidar and Abraham (1991) scheme (table 1).

Table 1: Haidar and Abraham (1991) scheme

No	The criteria to classify the responses
N1	No response or no explanation
N2	No understanding: irrelevant explanations or answers such as ''I don't know'', "I have no idea'' or '' I don't understand''
N3	Misunderstanding: explanations that attempt to describe the target concept but do not match the scientific conception
N4	Partial understanding: incomplete but correct explanation
N5	Sound understanding: explanation that include all components of the science concept

Moreover, the structured interview carried out with 6 teachers to obtain information about what teachers think about that. The following interview questions guided to determine the possible reasons of students' misconceptions.

1. What is misconception?
2. Have you asked whether or not students have known something about the science subject?
3. Have you made any experiment or activities, such as informal activities, field trips etc..., regarding science concept, if you have made, what are they?,
4. How you can make sure whether or not your students learned,

5. What do you think of your students' difficulty of learning about basic astronomy concepts?

6. How do you diminish students' misconceptions and what do you do?

Results and Analysis

Results of this study have revealed that the percentages of fifth graders' achievement scores are very low that the overall correct response rate was 46.2% on basic astronomy concepts. The statistically significant difference was found when comparing the results of the boy and girls scores. Girls scored significantly better (48.8 %) than boys (43.4%) [*t*: 3.78, *p*: 0.04]. These scores are not enough to say students understood basic astronomy concepts.

If we analyze the achievement test questions; Question 1 (day-night cycle): This is the highest rate of correct answer of questions. Almost all of the students (80% male- 90% female) answered correctly, indicating that the cause of the day-night cycle is the Earth spinning on its axis. Nine percent of the students pointed out that the cause of the day-night cycle is that the Earth moves around the Sun, and another 3% indicated that the Sun's movement around the Earth is the correct answer (table 2).

Table 2: Day-night cycle

Table 2: Question 1	total	male	female
Correct	85%	80%	90%
Wrong	12%	17%	7%
Blank	3%	3%	3%

Question 2 (Moon phases): Most students (75%) answered correctly, choosing their best account for change in the Moon's phases as the Moon moving around the Earth. This is a better result than that obtained by Lightman and Sadler (1993), by Bisard *et al.* (1994), and by Trumper (2001a). However, Fourteen percent of the students believed that the Moon moves into the Sun's shadow, interestingly, 5% believed that the weather is cloudy and/or foggy, 3% believed the Earth turns faster than Moon (table 3).

Table 3: Moon phases

Table 3: Question 2	total	male	female
Correct	75%	65%	86%
Wrong	22%	29%	14%
Blank	3%	6%	-

Questions 3 and 4 (dimensions and distances): Only 33% of the students answered correctly about the distance between the Sun and the Earth. Moreover, half of them know Earth's diameter, other part of them overestimated the (35%) and could not answer it (5%) (Table 4-5).

Table 4: Distance between the Sun and the Earth

Table 4: Question 3	total	male	female
Correct	32.5%	30%	35%
Wrong	53.5%	56%	51%
Blank	134%	14%	14%

Table 5: Earth diameter

Table 5: Question 4			
Correct	%60	%60	%60
Wrong	%35	%35	%35
Blank	%5	%5	%5

Question 5 (relative distances of spatial objects from Earth): Only 16% of the students answered this question correctly, positioning the Moon as the closest object to and the stars as the farthest objects from Earth, with planet Pluto between them. Seventy-four percent of the students put Pluto behind the stars, and another 7% put the stars as the closest objects to Earth. The possible reason is that many students see the stars at most of nights, and could not realize some starts are bigger or brighter; therefore, each star have distance between them and so farther away from earth (table 6).

Table 6: Relative distances of spatial objects from Earth

Table 6: Question 5	total	male	female
Correct	%16	%17	%14
Wrong	%80	%80	%80
Blank	%4	%3	%6

Questions 6 and 7 (Moon's revolution): Most students marked the correct answer, "a month", for the Moon revolving around the Earth (75%) and correct answer, "a year", for the Moon going around the Sun (55%). Forty-nine percent of the students answered the question 6 and 7 correctly. Some of the students selected that the Moon only revolves around the Earth and not around the Sun, without understanding the meaning of a relative movement (table 7-8).

Table 7: Moon to go around the Earth

Table 7: Question 6	total	male	female
Correct	%75	%76	%74
Wrong	%21	%21	%22
Blank	%4	%3	%4

Table 8: Moon to go around the Sun

Table 8: Question 7			
Correct	%56	%57	%54
Wrong	%41	%40	%42
Blank	%3	%3	%3

Question 8 (solar eclipse): The 66% of the students thought that the Moon must be in its Full phase in order to get a total solar eclipse. Only 25% of the students answered the "Moon must be in its New phase" correctly. It is possible students' responses could be influenced by the solar eclipse, taking place on March 29, 2006, was a total eclipse of the Sun that was observed with naked-eye in Turkey (table 9).

Table 9: Solar eclipse

Table 9: Question 8	total	male	female
Correct	%25	%20	%30
Wrong	%66	%70	%62
Blank	%9	%10	%8

Question 9 (Moon's rotation): Only 13% of the students got the right answer, which is Moon rotates on its axis once a month, of Moon rotation question, "When you observe the Moon from the Earth, you always see the same side". This result is the much poorer result than Trumper's (2001a-b) study among university students (25% success) (table 10).

Table 10: Moon's rotation

Table 10: Question 9	total	male	female
Correct	%13	%11	%15
Wrong	%83	%85	%81
Blank	%4	%4	%4

Question 10 (Longest day): Only 24% of students answered correctly the longest daylight will be in December, because Australia is located in the Southern Hemisphere and receives the longest period of daylight. Most probably students confused Australia's location being either in Northern or Southern Hemisphere. They thought that Australia, like Turkey, is in Northern Hemisphere and her longest day would be in June (table 11).

Table 11: Longest day

Table 11: Question 10	total	male	female
Correct	%24	%18	%30
Wrong	%71	%75	%67
Blank	%5	%7	%3

Interview with Students

Unsuccessful students, scored under the class average in achievement test, were selected randomly to evaluate why they selected wrong answers. Many misconceptions were determined about Earth- Moon-Sun concept when interviewing with them. They were asked "why did you select this choice and briefly explain your answer?"

The analysis of student responses given to the first question, which is about the cause of day-night, showed that although 53% of the students explained correctly what cause of day-night (N5), 22% of the students have the misunderstanding (N3), 15% of the students did not response or did not make any explanation the question (N1), and 10% of the students could not explain (N2). The following excerpts taken from interviews support this misunderstanding view:

Misunderstanding 1: When the Sun goes to back side of the Earth, it is night; when come back, it is day. Because Sun goes around the Earth once a day (6 students).

Misunderstanding 2: The Moon blocks the Sun's light, because we see the moon at night (4 students).

Table 12: Misunderstanding of the Earth-Moon-Sun concept among 45 students

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
N1	7	3	11	15	2	6	2	2	7	8
N2	5	4	30	26	1	1	3	10	1	-
N3	**10**	**22**	**2**	**-**	**25**	**4**	**16**	**24**	**33**	**34**
N4	4	5	1	-	-	4	3	4	2	1
N5	24	11	1	4	17	30	21	5	2	2

The analysis of student responses of the second question about the reason for the change in the Moon's appearance showed that 49 % of the students exhibited misunderstanding of the question. The excerpts below from students' responses were categorized:

Misunderstanding 1: The Moon is smaller than the Earth and it does not turn as fast as the Earth (11 students).

Misunderstanding 2: Shadow of the Sun or the Earth may cause (7 students).

Misunderstanding 3: Cloudy weather is the reason. Because clouds cover the part of moon face (4 students).

Question 3-4 is about dimensions of the Earth and distances between the Sun and the Earth; 62% of the students declared "I do not know" or "I do not remember" answers, 29% of them could not response or give any explanation, and 6% of them have a misconception.

Misunderstanding 1: If the basketball is the Sun that would be bigger than the something representing of the Earth. As I know the earth turns around the Sun in 365 days and the Sun is 109 times bigger than the Earth. 365/109=3.34. C choice, 3.8, is very close to 3.34; thus I marked it (2 students).

The analysis of the student responses of the question 5 about revealed that 55% of the students misunderstood relative distances of spatial objects from Earth

Misunderstanding 1: Because I see moon and stars with my naked-eye but cannot see Pluto (20 students).

Misunderstanding 2: Pluto is not a planet anymore. Now it is a small satellite, I think, it is smaller and closer than Moon; therefore I selected B (5 students).

Questions 6 and 7 were planned to explore the students' understandings of Moon's revolution. The analysis of student responses of the 6th and 7th questions revealed that 9% and %36 of the students exhibited sound understanding concerning this question.

Misunderstanding 1: The Moon is smaller than the Earth and goes around the Earth in 1 day; the earth is too, because every night I see the moon (4 students).

Misunderstanding 2: I guess the Moon takes to go around the Earth and the Sun at the same amount of time, because moon does not rotate on its axis (16 students).

The findings from the question 8 related to total solar eclipse and the Moon phase indicated that 53% of students had three types of misunderstanding.

Misunderstanding 1: I selected A, because it must be a big Moon in order to close up whole sun for a total solar eclipse (13 students).

Misunderstanding 2: When the Moon is full, the Sun totally will be blocked, otherwise the other phases of moon could not block the sun (8 students).

Misunderstanding 3: When the Moon is full, the sky is lightened and we see our way clearly. Therefore, we could not need the sun light. At that time there can be a total solar eclipse (3 students).

The analysis of student responses of the question 9 about seeing the same side of the Moon showed that 73% of the students had three types of misconceptions.

Misunderstanding 1: The Moon does not rotate on its axis. And we looked at the Moon always same location. Maybe if we had opportunity to observe from different city, we could see other side of Moon (23 students).

Misunderstanding 2: The Moon rotates on its axis once a day; we see always same side of it. Besides all face of moon are same (7 students).

Misunderstanding 3: The Moon does not rotate on its axis. We cannot see other side of moon in daytime, because of daylight. But only we can see it night (3 students).

The findings from the question 10 about longest day in Australia indicated that 75% of them had misconceptions

Misunderstanding 1: The answer is June for me because the longest day is 21 June in Turkey (24 students).

Misunderstanding 1: Australia is so far away and I had heard the summer daytime is very long from Animal Planet TV and Discovery channel (10 students).

Interview with Teachers

Teachers could not define clearly the first question *what misconception is*.

- "misconception is wrong knowledge" (50%),
- "not understand science concept, (16,6%),
- "for lazy students problem, if you do not study, you do not learn" (16,6%),
- "unknown knowledge" (16,6%),

Second interview question, *have you asked whether or not students have known something about the science subject*, was asked teachers, because; according to Trumpery (2001b) "the first step in reducing students' misconceptions is to ascertain students' ideas about astronomy concepts (193)." All of the teachers asserted that we asked questions and some images regarding science concept but these questions were only given to textbook. They did not say these questions are to ascertain students' ideas about astronomy concepts.

Third interview question, *have you made any experiment or activities, such as informal activities, field trips etc..., regarding science concept, if you have made, what are they*?, was asked them, and all teachers said "yes we did experiment and/or activity (100%). However, all the pictures and experiments, which are declared, were chosen from science and technology textbook. There were some complains about models. Seven teachers said "we have a manual (not electronic) Earth-Moon-Sun model but it is broken or not working; hence, we cannot use it." As a solution they preferred to make drama activity with a few students. Nobody mentioned to use other type of sources (animations, movies, other books or magazines) for their students. Moreover only two teachers said "I have got permissions from all students' parents to go the Observatory at the University or space camp".

Fourth interview question, *how you can make sure whether or not your students learned,* is about evaluating students' understandings.

- we use alternative measurements methods, such as concept map questions, three-branched diagnostic tree question; semantic features analysis techniques, observation of students' performances, and traditional methods, such as multiple choice questions, open-ended questions (34%).
- Four teachers said we use only multiple questions for examination at end of the semester (66%).

Fifth interview question is *what do you think of your students' difficulty of learning about basic astronomy concepts*? The data showed that

- the first reason is related to materials and physical environment. The lack of materials, such as lab materials, models, and technological devices (83,3%) The inconvenient physical environment, such as small classrooms, lack of science labs and computer labs (66,4%) The inadequate libraries and astronomy centers, observatory…etc. (50%).One male teacher (working for 7 years) stated that "Although we have computers, we do not have enough and/or related software. When I found some animation or movies relating science topic, I have to face to show it to my students". Another female teacher (working for 20 years) said that "I am in 20 years in this school. We could not make school principle to repair our broken the Earth-Moon-Sun models for 6 years. Materials are very important in this topic, to change abstract knowledge to solid knowledge".
- The second reason was related to Piaget mental functioning theory. 73% of them mentioned about *the* Piaget's mental function theory, elementary students are generally in concrete operational mental stages and they can understand if they apply to actual objects or events, and not abstract tasks or concepts. Teachers declared insistently they had to use educational materials, because students had not enough opportunity for direct experience.
- The third reason was related to students' performance. They were not satisfied with students' performance in the classroom. Some of them believed students do not study enough (55%).
- The fourth reason was related to media (52%), including news, newspapers, magazines, and cartoon and science fiction movies. One female teacher (working for 7 years) said: cartoons are one of major source of misconception of astronomy. The cartoon makers generally have not thought nature and its rules. For example "The Adventures of Jimmy Neutron" cartoon. Jimmy is genius boy and makes many scientific inventions. In one episode, he and his friends found a green stone which is very valuable and important material for air-space engineering. He invented a new technological radar device and calculated how and where it came from. Then he and his friends jumped in the spaceship and went to unnamed planet without astronaut-suits and helmet. After landing the planet, they can talk and walk like in the Earth. These types of things damaged our students' minds and filled waste of knowledge up.
- The final reason was educational system problems. This reason was categorized
- Overcrowded classrooms (64%), Overloaded curriculum (73%). That was considered as an obstacle that did not encourage student-centered teaching approaches. One female teacher (working for 10 years) said: "We have to admit that we could not teach in the light of constructivist perspective for a deeper understanding of science subject." Inadequate teachers' skills (40%). Some of teachers admitted we do not know how to use technology and make a research in the Internet. One male teacher (working 14 years) said: I cannot make animation or find in the Internet. If I write any word related astronomy in Google

research engine, I could not find any Turkish animations. I do not know English. After that age I cannot learn English.

Final interview question is *how do you diminish students' misconceptions and what do you do?* Most of the teachers (82%) agreed that constructivist perspective is the solution but if we had enough time, materials and educational technology. Theoretically they know what to do but have problem with heavy curriculum to finish by the end of semester. There are many experiments and/or activities in our textbook but if we followed step by step our textbook, it is impossible to finish all topics. None of them respond clearly what they do in one lesson.

Conclusions

The results of study showed that many 5th graders possess very limited ideas about the Earth Moon-Sun. Their misconceptions, such as Moon does not turn its own axis, Moon moves into the Sun's shadow, Moon only revolves around the Earth Moon only revolves around the Earth, it does not revolve around the Sun because the Moon cannot be seen in the day-light, are paralleling with literature. There some reasons why students encounter difficulty of understanding about the Earth-Moon-Sun concepts. Common reasons are one of reconciling out of school experiences, such as observing the rising and setting sun, seeing stars only at night, school experiences, such as misleading diagrams, ambiguous terminology and impropriate teaching methodology used by teacher.

Students have ideas and beliefs about the world before they receive formal instruction at school. These ideas and beliefs are synthesized into cognitive structures which reflect the organization of their understanding based upon personal experiences. Hence, learning is a social process of making sense of experiences in terms of what is already known. According to Ausubel (1968, 18) "the most important single factor influencing learning is what the learner already knows; ascertain this and teach him accordingly." Kikas (1998), Diakidoy and Kendeou (2001), Hayes et al. (2003) studies showed that if the students' pre-conceptions and prior knowledge were wrong, it is difficult to overcome in learning process in astronomy (Frede, 2008). From this perspective, knowledge cannot be transferred in a passive way. Stahly, Krockover, and Shepardson (1999, 160) stated that "when students experience the same situation and information, they each construct divergent conceptions owing to their varied prior experiences and existing knowledge". Turkish teachers do not ask what already students know about science concept or related concepts before teaching them. They have just followed textbook.

Moreover, they declared physical deficiencies, lack of materials and overcrowded classrooms, are the biggest problem. Even over half of teachers could not define misconception. One reason of misconceptions is mismatch between science concept and students' cognitive development levels. Especially for elementary students who are in the concrete operational level of Piaget cognitive stages could not understand the abstract knowledge of science until entering the formal stage, because, teachers could not switch knowledge from abstract to solid; therefore, many students could not understand the abstract science knowledge and misconceptions (Baser, 2006; Marek, 1986), because concrete concepts can be understood only through experiences; that is, teachers should provide experimental environment for students (Comins, 1993; Turkmen & Usta, 2007). For that reason, teachers need to have technological materials, which they do not have enough. Although this is a problem, they do not feel to search to get some free 3D modeling software, animations or movies from the internet. Even most of them do not take their students to field trips, such as observatory, space camp or give assessment to observe stars or moon at night. On the other hand, they blame their students not to study enough and science education

curriculum overloaded. Interestingly, although they know the cliché solution which is constructivist perspective to diminish or eradicate the misconception of basic astronomy, they could not respond whether or not how to apply constructivist perspective in their lessons. Most probably they have deficiency of teaching models of constructivism.

Recommendation

According to literature and this study's results, teacher should start his/her lesson with open-ended question to invite students to share what their prior knowledge in order to determine specific misconceptions held by students about science subject, then design inquiry lesson plan which is the most effective approach helping to reduce misconceptions and liked by students. After that teacher can (1) design lesson with students' ideas, (2) provide an experiment or observable environment to explore the science concept, (3) lead students to make their own meaning out of the observations to explain the astronomy concept with guidance from the teacher, (4) students continue to expand the concept by conducting more activities and using additional resources for investigation, teacher make an assessment of the students' abilities and thinking habits in investigating science ideas, (5) finally they discuss the results, any questions they have, and what they learned from the activity. This type of learning perspective is to allow the students freedom to find the answers themselves and to get involved in their learning, and provides students with meaningful opportunities in which they can engage in scientific inquiry. In this perspective, teacher should integrate educational technology, such as 2D models, 3D visualization, animations, and movies (Abell, George, & Martini, 2002; Agan, & Sneider, 2003; Akerson, Flick, & Lederman, 2000; Barnett, & Moran, 2002; Dove 2000; Sharp et al.., 1999; Trumper, 2003; Vosniadou, 2003).

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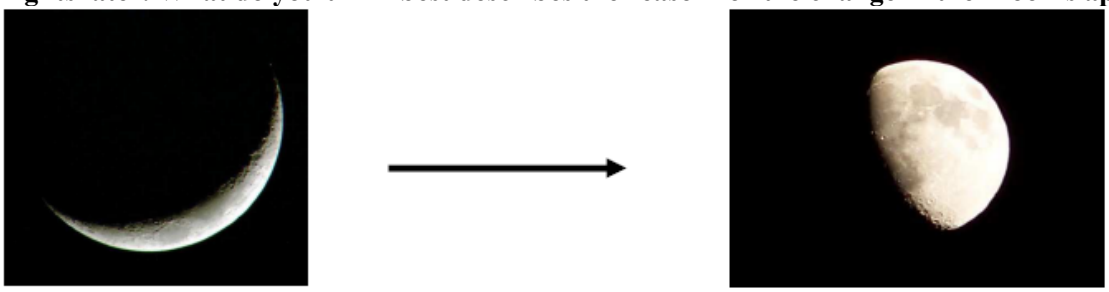
Appendix 1: Questionnaire

1. What causes night and day?
*A. The Earth spins on its axis
B. The Earth moves around the Sun
C. Clouds block out the Sun's light
D. The Earth moves into and out of the Sun's shadow
E. The Sun goes around the Earth

2. The diagrams here show how the Moon appeared one night, and then how it appeared a few nights later. What do you think best describes the reason for the change in the Moon's appearance?



One night A few night later

3. If you used a basketball to represent the Sun, about how far away would you put a scale model of the Earth?
A. 30 cm or less *B. 1.5 meters C. 3 meters D. 7.5 meters E. 30 meters

4. Give the best estimate of the Earth's diameter from among the following numbers:
A. 1,500 km *B. 15,000 km C. 150,000 km
D. 1,500,000 km E. 15,000,000 km

5. Which of the following lists shows a sequence of objects that are closest to the Earth to those that are farthest away?
A. Moon — Stars — Pluto B. Pluto — Moon — Stars C. Stars — Moon — Pluto
D. Stars — Pluto — Moon *E. Moon — Pluto — Stars

6. The Moon to go around the Earth:
A. Hour B. Day C. Week *D. Month E. Year

7. The Moon to go around the Sun:
A. Hour B. Day C. Week D. Month *E. Year

8. In order to have a total solar eclipse, the Moon must be at what phase?
A. Full *B. New C. First quarter D. Last quarter

9. When you observe the Moon from the Earth, you always see the same side. This observation implies that the Moon.
A. Does not rotate on its axis B. Rotates on its axis once a day
*C. Rotates on its axis once a month

10. When is the longest daylight period in Australia?
A. March B. June C. September *D. December

Correct answers