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Okul Öncesi Çocuklarının Yüzme Batma Kavramı ile İlgili Düşünceleri ve Sınıf İçi Etkileşimin Düşüncelerine Etkisi*

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ÖZET

Bu çalışmanın amacı, okul öncesi çocuklarının yüzme ve batma kavramlarıyla ilgili düşüncelerinin belirlenmesi ve sınıf içi etkileşimlerin bu görüşler üzerindeki etkisini incelemektir. Bu amaçla, temel ve yorumlayıcı nitel bir çalışma planlanarak çocuklarla bire bir görüşmeler yürütülmüştür. Çalışmaya, bir devlet anaokuluna devam eden toplam 20 çocuk (66-73 ay) dâhil edilmiştir. Çalışmada, beş çocuk ile ön görüşme, altı çocuk ile son görüşme yapılmıştır. Son görüşmelere katılan altı çocuktan birinin ebeveyniyle de görüşülmüştür. Veriler, deneyler sırasında yarı yapılandırılmış görüşmeler ve video kayıtları yoluyla toplanmıştır. Ses ve video kayıtlarından elde edilen veriler çözümlenerek, içerik analizi yürütülmüştür. Ön görüşmelerde, çocuklar yüzme ve batma olaylarını açıklamak için "ağır-hafif", "yumuşak-sert", "büyük-küçük", "ince-kalın" gibi kavramları kullandıkları belirlenmiştir. Son görüşmelerden elde edilen bulgularda da benzer kavramların kullanıldığı görülmüştür. Bununla birlikte, sınıf içi tartışmalar sırasında, çocuklardan ikisinin nesnelerin yüzmesi olgusunu, kaldırma kuvveti kavramıyla açıklamaya çalıştıkları gözlemlenmiş ve son görüşmelerinde de gözlemlerini kaldırma kuvveti kavramı temelinde açıklamaya devam ettikleri görülmüştür. Ön görüşmelerde belirtilmeyen "kaldırma kuvveti" kavramı, sınıf tartışmaları sırasında ortaya çıkmış, bu da aşina olan çocukların hatırlamasına yardımcı olmuştur. Bu yaş grubundaki çocuklar üzerinde yapılan daha önceki çalışmalarda yüzdürme kavramının kullanımına rastlanmamıştır.

Anahtar Sözcükler: Kaldırma kuvveti, kavram gelişimi, sınıf içi etkileşim, okul öncesi, fen eğitimi

Pre-School Children's Opinions about the Concepts of Floating and Sinking and the Effect of In-Class Interactions on Their Opinions

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ABSTRACT

The purpose of the current study is to determine pre-school children's opinions about the concepts of floating and sinking and the effect of the in class interactions on these opinions. To this end, a basic and interpretative qualitative study including one-to-one interviews with children was planned. A total of 20 children (66-73 months) attending a state pre-school were included in the study. Pre-study interviews were carried out with 5 of these children and post-study interviews were conducted with 6 of them. Parents of one of the 6 children participating in the post-study interviews were also carried out. The data were collected by means of semi-structured interviews and video recordings during the experiments. Audio and video recordings were transcribed and then subjected to content analysis. The data collected in the pre-study interviews revealed that while the children used the terms such as "heavy-light", "soft-hard", "big-small", "thin-thick" to explain the concepts of floating and sinking, the post-study interviews showed that they also used similar terms after the completion of the study. However, during the in-class discussions, two of the children were observed to try to explain the phenomenon of floating of objects through the buoyancy and these two children also continued to explain their observations on the basis of buoyancy concept in their post-study interviews. Though this concept of buoyancy was not mentioned in the pre-study interviews, it emerged during the classroom discussions, which helped the children who were familiar with it to remember. In the former studies conducted on children in this age group, the use of buoyancy concept was not encountered.

Keywords: Buoyancy, concept development, in-class interaction, pre-school, science education

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1. INTRODUCTION

Children begin interacting with their environment at birth. Children can be described as little scientists as they question everything they are curious about. They observe their environments and try to ascribe meanings to their observations. Thus, they start expressing opinions on many subjects. These opinions of children that are based on their observations may be very different than those of adults. Because, their experiences, styles of thinking, metaphors (Laçin-Şimşek, 2007), cognitive competence and the meanings they ascribe to the concepts are different than those of adults (Osborne and Freyberg, 1985; Piaget, 2005; Piaget, 2011a; Piaget, 2011b). Therefore, the meanings they ascribe to facts, events, and concepts should be well understood in order to be able to look at the world through their eyes. Children start receiving a formal education during the preschool period. The objective of this education is to impart many new skills such as psychological, cognitive and psychomotor ones to children in addition to increasing their interest in and curiosity about events around them. Thus, it is desired to make children more aware of what is going on around them. As a result, the efforts of children to ascribe meanings to facts and events increase.

Efforts of children to ascribe a meaning to everything they observe around them result in the process of concept formation. Even though they do not use the concepts as fully aware of what they mean prior to ages 7-8 (Piaget, 2011a, Piaget, 2011b), a significant development is observed in the concept formation skills of children from the age of 4 onwards (Üstün and Akman, 2003). Therefore, determination of children's first opinions about concepts is of great importance and necessity to understand concept development. When the literature on the subject of preschool period is reviewed, it is seen that studies have been carried out on various science related concepts and concept development. Concepts that children frequently encounter during their daily lives such as light (Caldero'n-Canales, 2009; Ca'zares, Floré's-Camacho and Ravanis, Christidou and Hatzinikita, 2013; Segal and Cosgrove,1993); environment (Taşkın and Şahin, 2008), living things (Backscheider, Shatz and Gelman, 1993; Bahar, Cihangir and Gözün, 2008; Zogza and Papamichael, 2000), plants (Christidou and Hatzinikita, 2006); friction force (Ravanis, Koliopoulos and Hadzigeorgiou, 2004; Ravanis, Koliopoulos and Boilevin, 2008), electricity (Salomonidou and Kakana, 2000); magnetism (Christidou, Kazela, Kakana and Valakosta, 2009; Ravanis,1994), astronomy (Saçkes, Smith and Trundle, 2016) and formation of day and night (Saçkes, 2015) have been studied. In the current study, the concepts of floating and sinking were examined.

"Floating and sinking" are among the concepts that individuals come across at early ages (Özsevgeç and Çepni, 2006) and experience during their daily lives (Hsin and Wu, 2011); therefore, they develop opinions on these concepts. First studies on the concepts of floating and sinking have been carried out in 1958 by Piaget and Inhelder (Snir, 1991). According to the results obtained from these studies, Piaget put forth that decisions can be given regarding the development levels of children by examining the meanings they ascribe to the concepts of "floating and sinking" (Driver and Easley, 1978, as cited in Özsevgeç and Çepni, 2006). In relation to the concepts of floating and sinking, it has been reported in the literature that in general children tend to think that while small and light objects float, heavy and large objects sink (Butts, Hofman and Anderson, 1993; Kallery, 2014; Tenenbaum Rappolt-Schlichtmann and Zanger, 2004; Hsin and Wu, 2011; Wiser, Smith, Asbell-Clarke, and Doubler (2009). In their study, Havu-Nuutinen (2005) attempted to explain the ways of thinking by classifying the meanings created by the children in relation to the concepts of floating and sinking. In this classification, the most remarkable aspect is that the children presented irrelevant and unscientific explanations for the concepts of floating and sinking without mentioning any physical properties. Another remarkable finding is that they presented irrelevant causes such as these concepts' being related to only the weight of the object, the shape of the material and the effect of the air. In this connection, it is argued that children have an intuitive understanding of the relationship between the mass and volume yet their opinions about this relationship is not clear. Another remarkable aspect of this classification is that the children made their explanations on the basis of different properties of volume and understood that the weight is not the only cause; thus, they explained the concepts of floating and sinking through at least two related properties. Finally, in the classification, it was determined that the children also attempted to produce evidence about the concepts of floating and sinking by comparing the weight of the object and that of the water.

The buoyancy that is closely related to floating and sinking is one of the concepts that are found to be difficult to understand by children (She, 2002). Piaget and Inhelder (1958) stated that due to their formulaic structure, the rules of floating and sinking require higher order thinking skills; thus, they cannot be fully understood or misunderstood by children (Ünal and Coştu, 2005). The existing research shows that in the teaching of this subject, difficulties are experienced at different grade levels, that the level of perception of the concepts related to the subject is low, and that there are misunderstandings and alternative concepts (Kawasaki, Herrenkohl and Yeary, 2004; Özsevgeç and Çepni, 2006; She, 2005; Ünal and Coştu, 2005).

The concepts of floating and sinking, which children encounter in their daily lives are also included in the preschool curriculum. Therefore, the current study focused on what pre-school children think about the subject and how in-class discussions affect their opinions. The reason for the investigation of the effect of in-class discussions is the fact that social interaction is highly important in learning (Vygotsky, 1986). Vygotsky sees social activities and cultural experiences as the source of thoughts (Moll, 1990) and emphasizes the importance of social environment in this regard.

A limited amount of research existed on the subject of floating and sinking in our country (Çepni and Şahin 2012; Gürdal and Macaroğlu, 1997; Kıvılcım and Öztuna-Kaplan, 2019; Özsevgeç and Çepni, 2006; Ünal and Coştu, 2005) and there is no study exploring the effect of in-class interactions on the subject. In the international literature, only one study planned to research the subject of floating and sinking in accordance with the social constructivist framework was found. In the study, Havu-Nuutinen (2005) conducted an instructional process on the subject of floating and sinking and investigated the effect of child-teacher interaction and in-class discussions. As a result of the study, it was concluded that teacher-student interaction affected conceptual change and enabled children to produce more scientific ideas. In the current study, no instructional process was carried out; only the effect of in-class peer discussions on their opinions was observed. In this regard, the current study can be seen as an original study focusing on the investigation of a state as it is without any intervention.

1.1. Statement of the Problem

Existence of problems experienced in relation to the concepts of floating and sinking in every level of education indicates that these concepts are not fully understood. Persistence of the problems related to these concepts even after a large amount of instruction has been received is worthy of investigation. Thus, it seems to be important to learn children's opinions about the concepts of floating and sinking and to elicit the meanings they assign to these concepts. In this way, the factors that hinder the correct construction of these concepts can be determined and then suitable solutions can be sought. Furthermore, effective instructional activities can be developed to overcome the obstacles because determination of children's opinions and underlying factors will assume a key role in the solution of the problems experienced. For this reason, the current study is believed to play an important role in the understanding of the concepts of floating and sinking.

1.2. Research Questions

The purpose of the current study is to determine the pre-school children's opinions about the concepts of floating and sinking and the effect of in-class interactions on these opinions. To this end, answers to the following questions were sought:

1. What kind of reasons are used by preschool children when deciding whether to float and sink an object?
2. How do their observations and in-class interactions affect the decisions made by the pre-school children?
3. After the observations, how do pre-school children explain floating and sinking of objects?

2. METHODOLOGY

The current study is a basic and interpretative qualitative study. This qualitative study is built on the question of how individuals construct reality through their interaction with their social world (Merriam, 2013). In this respect, the main focus is on how experiences affect lives and which meanings are assigned to these experiences. In the current study, it was aimed to reveal the children's opinions and the reasons underlying these opinions and attempted to elicit their opinions while making observations and experiences. Then, the changes occurring after the in-class discussions were investigated. Moreover, in order to collect in-depth data, the mother of one of the children who expressed different opinions during the in-class observations and post-study interviews were also interviewed to explore in a more detailed manner why this child thinks so. Within the context of the current study, pre-study interviews, experiments and post-study interviews were conducted.

2.1. Participants

In the current study, pre-study interviews were conducted with 66-73 months old 5 children (3 girls and 2 boys) selected among 20 children attending a state preschool as they were identified as good communicators by their preschool teacher (66-73). In this stage, the children were asked to guess whether the selected materials would float or sink.

In the second part, participation of all the 20 children who continued their education in the same class in the research was ensured. In this stage, written consents were gained from the families. This stage was video-recorded.

On the basis of his statements about buoyancy during the experiment, a boy (70 months old) was added to the five children; thus the post-study interviews were conducted with 6 children (3 girls and 3 boys) aged at 66-73 months old. The reason why post-interviews were carried out with a greater number of students than those that were included in the pre-interviews was that two students used the concept of "buoyancy" during the experiment. As one of these two students has already been included in the pre-interviews, one more student was also included in the post-interview group. Moreover, an interview was conducted with the parent of one of the children who talked about "buoyancy". The interviews were tape-recorded.

2.2. Instrument and Procedures

Data in the study were collected through semi-structured interviews and video recordings. Stages of the study were as follows:

1. First of all, research was carried out in order to decide on the materials to be used during the interviews and the experiments. A literature review was made for this purpose and information was collected about the processes used in similar studies (Havu-Nuutinen, 2005; Koliopoulos, Tantaros, Papandreou and Ravanis, 2004; She, 2002) . A list of objects used in relevant studies in literature were prepared. The objects to be used in the current study were selected from this list. When making this list, considerable attention was paid for the selected objects to be among the objects encountered by the children in their daily lives. The objects used in the current study were plastic balls of various sizes (ping pong ball, green colored basketball, star patterned balls), pencil, paper, eraser, crayons, balloon, metal marble, styrofoam, plastic fork and spoon, glass and plastic bottles, holed and non-holed stoppers.

2. Afterwards, the opinions of the teacher were also taken to determine the students to be involved in the pre-study interviews. Students with good communication skills who are open to share their opinions were selected for this purpose. The teacher was only involved in the processes of student selection for interviews and recording the videos during the experiment. Interviews were carried out with these students to learn their opinions on the concepts of floating and sinking by one of the researchers. The predetermined objects were shown during the interviews and the students were asked to guess whether these objects would float or sink when placed in water. The reasons for their guesses were asked both in the pre-interviews and post-interviews. The interview conducted with each child lasted for about 15 minutes. No explanation or guidance was provided to avoid giving any clue about which objects would float or sink. The interviews were tape-recorded for later analyses.

3. Floating-sinking experiment was carried out with the students following the completion of the pre-interviews. The experiments were carried out together with the class. Before placing the objects into the water, students were asked to guess which objects would float and sink and to provide their justification.

4. Interviews were carried out with 6 students after the completion of the experiment. It was thought that an interview would be necessary to understand how these students knew this concept and also to understand the meaning they ascribed to it. Thus, they were asked additional questions (What do you mean with the buoyancy?, Where did you learn about this term?) because no student had used this concept in the previous studies carried out on students in the same age group. Post-interviews lasted for about 15-20 minutes on average. In addition, an interview was also carried out with the parent of the student who was included in the post-interviews as he had used the expression “buoyancy”. Questions were asked to the parent on how this child might have learned this concept and what they do together.

2.3. Data Analysis

In the current study, the semi-structured interviews were tape-recorded while the experiment was video-recorded. The tape and video recordings were transcribed. The data were separately analysed by two researchers. In the analysis of the data, the children’s statements about which objects would float and which objects would sink were listed and coded. Their justifications for their guesses were elicited. Then, for each child, pre-interview and post-interview findings were compared and in-class discussions were evaluated. After completing their content analysis, the researchers came together and evaluated the data together, compared their findings and interpreted the data. The obtained findings were interpreted with the support of children’s statements.

As the current study is a qualitative study, a great care was taken to increase the reliability and consistency of the study. In order to establish the consistency, independent codings were performed and comparisons were made (Miles and Huberman, 1984). By explaining how the process was carried out, the internal validity was attempted to be enhanced. The obtained findings were supported with the statements of the children so that the reliability could be improved. Furthermore, in order to establish validity, the review technique was employed (Merriam, 2013). In this connection, how the data were collected, how the categories were developed and how the decisions were made in the review process were clearly explained. All the processes involved in the current study were explained in detail so that the current study could be easily replicated and the procedure followed in the current study was clearly defined in a detailed manner to increase reliability of the current study (Cresswell, 2014; Yin, 2003). In order to establish external validity, the role of the researchers in the interviews and experiment was explicitly defined. While presenting the statements of the children, their real names are not used. The children are renamed by the researchers. Their ages in months are written next to their names in parentheses. For instance; a 72 month old male has been named as Mehmet and shown as Mehmet (72). No corrections were made since the speech of the children was transcribed directly into writing and the parts where they remained silent were denoted as “….”. Their conversations were put down in italic. Body language and mimics were described in […]. In dialogues, the researcher was coded as “A”.

3. FINDINGS

The results obtained from the content analysis of the interviews conducted with the children and the video recordings of the experiment are given below.

3.1. Sub problem 1: What kind of reasons are used by preschool children when deciding whether to float and sink an object?

It was observed that the children most frequently used the expressions of "heavy-light" when talking about the concepts of floating and sinking during the pre-interviews. In addition, they also used expressions such as "soft-hard", "big-small", "thin-thick". The material of which the object is made, whether the object is filled or not and the shape of the object also affected their opinions. Mehmet (72) stated during the pre-interview that while "light" objects would float (balloon, star patterned small ball, ping pong ball, basketball, pencil, paper, large holed and non-holed cork stoppers, piece of wood and crayons, plastic bottle, styrofoam, plastic fork and spoon), "heavy" objects would sink (large star patterned ball, smiley patterned ball, glass bottle). Mehmet (72) evaluated being "hard" together with weight as a reason for sinking (Glass bottle, small holed and non-holed cork stoppers). Even if an object is light even though it is hard, its lightness is effective in his decision:

A: What happens when styrofoam is placed in the water?
Mehmet (72): This isn't heavy but its interior is hard [indecisive]
A: So, would it float or sink?
Mehmet (72): It floats. Light but hard but it will float.

Esra (73) stated during the pre-interview that thin and light objects (balloon, small stopper, plastic spoon and crayons) would float while large, heavy, filled, thick and hard objects (stoppers, star patterned ball, ping pong ball, glass bottle, wood, smiley patterned ball) would sink. However, it was observed that Esra (73) was not so sure of her opinions. For instance;

A: Pencil?
Esra (73): Pencil.. sinks..
A: Why?
Esra (73): Because it is thin and slightly hard
A: Why?
Esra (73): Normally thin objects do not sink but pencils may sink.
A: Why do you think so?
Esra: …… I don't know….

In addition, Esra (73) also stated that the green ball would sink even though she thinks that soft objects would float and she indicated that she had tried this by stating that "I don't know the reason but I know that it sinks". On the other hand, she said the following for eraser;

Esra (73): It will float.
A: Float. Why?
Esra (73): This part is a bit hard [points at the eraser] a bit soft [points at the paper label the eraser is wrapped in]
A: So?
Esra (73): So, perhaps this makes it float.
A: If we remove the label?
Esra (73): It will sink.
A: Why?
Esra (73): Because now it is hard everywhere.

As can be seen in this example, Esra (73) is of the opinion that soft objects will float and that hard objects will sink. If an object is hard but has soft parts, she is again of the opinion that it will float. Bahar (70) tried to explain whether an object would float or sink through references to the air they have inside during the pre-interview. Whereas she said that balloon, large star patterned ball, basketball and marble float because they have "air inside", she said that smiley patterned ball, glass bottle, piece of wood, non-holed cork stopper sink because they have no air inside. However, there were times when she indicated that the object would float even though the object has no air inside such as a pencil. It was observed that Bahar (70) got confused when more objects were involved in the process. According to her, while whether some objects float or sink depends on the air inside, whether some other objects float or sink depends on the water inside (star patterned ball, basketball, styrofoam etc.).

Yavuz (73) stated during the pre-interview that light (smiley patterned ball, ping pong ball, balloon), small (star patterned ball), thin (pencil), empty (ping pong ball) objects would float while heavy (eraser, crayons, wood, lighted ball), large (big ball, glass bottle) objects would sink. He stated that the marble would sink because it was made of glass. He explained why the styrofoam would float by saying, "it has tiny little things inside it… that is why it does not sink". For the plastic fork he said, "It will not sink… because water gets out of here [pointing at the gaps between the tips of the fork] and for the spoon he said, "it will float…water comes and flows like this [pointing at the water passing through the spoon]". Similarly, he said about the large holed stopper, "it will not sink because when you put water it passes around it, water enters here and gets out there". During the interview, Candan (66) preferred the expressions "it will stay above water" or "it will stay below water" instead of the words "float" and "sink". It could be observed that Candan (66) was aware of the effect of water with regard to floating and sinking.

A: What happens when we throw the green ball into the water?
Candan (66): it will remain above.
A: Why?
Candan (66): Hmmmm….. I don't know..
A: Think for a while.
Candan (66): it will remain above water.
A: Why?
Candan (66): Because the water makes this wavy thing and pushes it up.
A: So, do you think the waves can lift everything up?
Candan (66): No, hard things fall under water.
Similarly, Candan (66) used the expression, "water will lift it up" for balloons and plastic bottles as well. For the plastic fork, Candan said;
Candan (66): It will fall below water.
A: Why?
Candan (66): Water makes it fall down.
A: But why does it do so; it does so to some objects and not to others. Why did water make these fall down?
Candan (66): Because it cannot take the effect of the water, it falls.

While other children stated that whether objects float or sink depends on their properties, Candan (66) mentioned the effect of water. It was observed that Candan (66) tried to explain whether objects float or sink through the concepts of hardness/softness. According to her, hard objects (smiley patterned ball, ping pong ball, star patterned ball, styrofoam, pencil, wood, glass bottle, stoppers, crayons) will sink; soft objects (plastic ball, eraser) will float.

In the pre-interview, Yavuz (73) explained the concepts of floating and sinking via the terms "heavy and light". While he gave small star patterned ball, basketball, balloon, plastic ball as examples for floating objects, he listed small star patterned ball, basketball, balloon, plastic ball, pencil as examples for sinking objects. He thought that in addition to heaviness, type and shape of the object were also important in the determination whether an object to float or sink.

Mehmet (72) stated in his interpretations that the balloon would float, supporting his opinion by saying that, "Because this is rubber". Esra (73) stated that the plastic fork and spoon would float because they are "plastic". Esra (73) explained why the balloon floats by saying, "Because it has an air that is lighter than air inside…[…] I mean, we blow it with our breath, that's why it is not so heavy because we blow with our breath. Similarly, Deniz (70) stated that, "All those balloons. They fly when we let them go. Just like that "thus leading us to interpret that children try to use their little knowledge of flying balloons here.

3.2. Sub-problem 2. How do their observations and in-class interactions affect the decisions made by the pre-school children?

The experiment was carried out together with the classroom after completing the pre-interviews and the children were asked to discuss and explain which objects would float and sink. The experiment starts with the balloon:

A: What happens to the balloon when we place it in the water? Would it float or sink?
[The overall decision based on the voices from the class is that it will float]
A: Why? [One of the students raises his hand] What is your name?
Efe: Efe. Because it is heavy.
(The classroom responds as No)
Yavuz: Because it is empty inside, it is light so it will float.
A: So, any other opinions. Say your name.
Ece: I think it will float.
A: Why?
Ece: It won't sink, because it is a balloon.
Bahar: Because it has air inside.
A: Bahar says there is air inside, so, what do you say?
Deniz: Lifting force.[Points upwards with his fingers]
A: Deniz says because of lifting force. Any other ideas?
Mehmet: I agree with Deniz, I think it will float. Because it is light.
A: What was your name?
Mehmet: Mehmet.
Efe: It did float.
A: Why did it float?
Yavuz: Because there is air inside, air is light.
A:What else? What was your name?
Ece: Ece. Because, because it is filled with air.

As can be seen, the children stated that the balloon would float but put forth different reasons for it. Bahar (70) who took part in the pre-interview said that it would float because it had air inside. Throughout the experiment, Bahar made interpretations based on the existence of air. Deniz (70) who was not included in the pre-interviews mentioned the "lifting force (buoyancy)". After this expression, he tried to make the same explanation as the one given by Efe and tried to make a representation with his hands. It was observed that only Deniz (70), Mehmet (73) and Yavuz (70) used this expression during the experiment. Other children did not use such expressions. It was observed that children generally made statements that were parallel to their statements during the pre-interview. There were also cases such as the eraser example when the guesses and observations did not match:

A: Let's try the eraser.
Kaan: It will sink, because it is small.
Deniz: It will not sink because it is small.
A: Let us try.
[Children: sounds of "oo, it sank"]
A: so, why did it sink?
Kaan: Because it is small and empty inside.
Deniz: Because it could not also do the buoyancy.
Mert: Because it is hard.
A: Any other ideas?
Bahar: Because there is no air.

As can be seen in this example, Kaan guessed that it would float because it was small, he proposed the same reason after seeing that the object did in fact sink and supported his opinion by saying that the object is empty inside. In addition, the children proposed the smallness of objects as a reason for both floating and sinking. Bahar (70) again related the incident with air. Deniz (70) stated as in the other examples that the object could not do the buoyancy. It was observed throughout the experiments that the children put forth the same statements as they did during the pre-interviews but that sometimes they repeated the opinions of their friends. However, this was not observed for the expression of "buoyancy". This concept was used only by children who heard this concept before.

3.3. Sub-problem 3. After the observations, how do pre-school children explain floating and sinking of objects?

In the post-interviews conducted after the completion of observations and in-class discussions, it was seen that majority of the children repeated the statements they uttered in the pre-interviews, but when their guesses and observations did not match and some of them attempted to explain their observations on the basis of the buoyancy:

The findings obtained during the interviews carried out following the observations are as follows: Candan (66) who tried to explain whether the objects would float or sink during the pre-interview through reference to the terms "soft and hard" continued to provide explanations on the basis of the terms "soft and hard" during the post-interview as well. She explained the reason why wood sinks as follows: "because the water cannot make it light, it cannot lift it". She also made a similar explanation for the water filled glass bottle. Even though Candan (66) continued to use the expressions, "stayed above", "stayed below" instead of the concepts of floating and sinking, it was observed that she was aware of the effect of water but cannot precisely explain what this effect was.

Yavuz (73) used the terms "light-heavy", "large-small" more frequently during the pre-interview but added expressions such as "made of plastic, empty inside, air inside, has a hole" during the post-interview. It was also observed that he insisted more on the objects being empty-full during the experiments.

It was observed that the children tried to provide new explanations for their observations not matching with their guesses. For example, Esra (73) guessing that the ball with a smiling face on would sink then stated that the ball floated as it is empty inside. While she stated that light and plastic objects would float in the pre-interview, then she associated the phenomenon of floating with the object's being empty inside and its shape in the post-interview. During the interviews, children also used some expressions related to their daily life experiences. For instance Mehmet (72), "While we are doing homework from the textbook, it was floating", Yavuz (73) "I have tried it", Candan (66) "I watched it in Ayas [a cartoon]".

As was the case during the pre-interviews and the experiment stage, Bahar (70) continued to explain whether an object would float or sink depending on having air inside or not. Deniz (70) who was not present in the pre-interviews, used the expression "lifting force" (means buoyancy) during the observations. Mehmet (72) also said, "I agree with Deniz" during the observations thus supporting Deniz. It was also observed that Mehmet (72) based his explanations during the pre-interview on whether the objects are "light-heavy", he associated the floating of the balloon, green ball, styrofoam, pencil with "lifting force" and the sinking of the fork, marble, small rubber cork with "not being able to apply lifting force", "being weight" during the post-interviews. The fact that Mehmet (72) used these expressions not in the pre-interview but in the post-interview might be related

to interactions during the observation stage. It was observed that the children tried to make new explanations for observations that did not match with their guesses.

The children mentioning the buoyancy in the post-interviews were asked some follow-up questions. During the interviews, they were asked about the meaning of buoyancy and where they learned about this expression. Both students could not verbally explain the expression but lifted their hands up and tried to show how some things push objects upwards. When asked where they heard the term "buoyancy", Deniz (70) responded as, "I saw it in the cartoon, that's how I remember it". Whereas Yavuz (73) said that they made experiments with his mother and he heard it from her". We reached Yavuz (73)'s mother and made an interview. It was determined that Yavuz (73)'s mother is a science teacher.

> *A: We made an experiment with Yavuz and he explained the reason why objects float with buoyancy.*
> *Do you do such activities with Yavuz?*
> *Yavuz (73)'s mother: We make experiments together, read books and there are magazines that we follow.*
> *We read "Meraklı Minik" (Curious Kid) magazine every month.*
> *A: Yavuz said that he heard the term "buoyancy" from you, have you told him about this concept?*
> *Yavuz (73)'s mother: I do not remember if I have used that word or not, but we made some experiments about floating. Sometimes he hears us when we are talking at home about such things. Yavuz is quite interested in science and he likes making experiments*.

It was also learned during the interview that Yavuz (73)'s father is also a primary school teacher. As can be seen, Yavuz (73) conducts experiments and reads magazines together with his mother. He has some experience about the issue. Although the mother is not sure whether she mentioned the concept or not, it is seen that the children use the concept properly.

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

The topic of floating-sinking is quite complex since it includes many other concepts. One has to know about the concepts of mass, volume, density, buoyancy and to grasp the relations between them in order to understand the state of floating-sinking. It is put forth that buoyancy and related concepts can be classified as difficult (Chi, Slotta and deLeeuw, 1994) that they require a hierarchical understanding of matter as well as the process (She, 2002). Hence, it is observed that this topic is not understood sufficiently and that relations between concepts cannot be established even though it is present in many stages of education. As a result of the studies reviewed in the related literature, the "buoyancy" concept is fully understood neither in primary school nor in secondary or even high school and university levels (Özsevgeç and Çepni, 2006). That is why, it is important to determine how this concept is shaped during the period when it starts to be structured.

It was observed in the current study that the children are familiar with the concepts of floating-sinking, that they have made some experiments and thus started to produce ideas about the concepts. Butts, Hofman and Anderson (1993) and Piaget (2001) stated that children in the age group of 5-6 start using the hardness, color, weight of the material as a reason when making explanations related to the concepts of floating and sinking. It was also observed in the current study that preschool children think that light, soft, small, air filled objects will float and that heavy, hard, large, filled objects will sink. These results are in accordance with the findings by Havu-Nuutinen (2005); Hsin and Wu (2011); Koliopoulos, Tantaros, Papandreou and Ravanis (2004); Pramling and Samuelsson (2001). The shape of the object, its material, its thickness are also effective when the children decide whether an object floats or sinks. It was observed that children decide whether an object will float or sink on the basis of its properties. Only two children used the expressions, *"water lifts them up"*, Yavuz (73) and *"the lifting force of water"*, Deniz (70).

Similar to the results of a previous study by Hsin and Wu (2011), it was observed that the children focus only one certain property of the objects regarding the concepts of floating and sinking. For example, Bahar (70) mostly commented based on whether the object had air or not inside, whereas Yavuz (73) emphasized the lightness of the object. However, the children were not sure of what caused the floating or sinking. Their explanations might vary from object to object or depending on the material and shape of the object. For example, Bahar (70) stated that the marble would sink because it was filled with air and water, while she also stated that the styrofoam would float because it did not have air and water inside. Esra (73) stated during the pre-interview that the pencil would sink because it was thin and hard but then said during the post-interview that it floated because it was thin and hard. Though the children encountered many cases that did not match with their guesses while conducting the observations in the class, their initial thoughts did not change much rather they only tried to provide new explanations only by adding a new property.

Some of the children on the other hand attempted to explain whether an object would float or sink by adding some properties they had not mentioned during the pre-interviews as a result of their involvement in the classroom discussions. For example, while Yavuz (73) frequently used the terms "light-heavy", "big-small" during the pre-interview, in the post-interview, in addition to these terms, he also used the expressions "being made of plastic", "it being empty inside", "having air inside" and "having a hole". While Esra (73) stated that the pen would sink as it was thin and hard during the pre-interview, she stated that it would float as it was thin and hard. This might indicate that the in-class discussions may have affected the children's opinions because the new ideas emerging during these discussions can be used by children. However, this is only possible if the child adopts this

idea because as it was seen in the in-class discussions and post-interviews, when a concept which is not familiar to the child is uttered, he/she does not repeat it. This is clearly seen in the example of buoyancy. During the experiment, when a child used the buoyancy to explain the concepts of floating, another child supported him/her and this child frequently used this term in his/her post-interview. However, this is not true for all the children. The children adopt the terms that are meaningful to them when they are with their peers yet as in the example of buoyancy, when they encounter a term which they are not familiar with, they are not prone to adopt it. On the other hand, Mehmet (73) not having mentioned the buoyancy in the pre-interview remembered the concept when it was mentioned during the in-class discussions and then tried to use it in his explanations.

This can be considered an indication of the importance of in-class interaction and its effect on learning. Through in-class interaction, children are affected by each other and start to think differently (Havu-Nuutinen, 2005). In this way, the child comes up with his/her own interpretations through interaction and communication with others. This seems to be in compliance with the arguments proposed by Vygotsky about the effect of social interaction on learning and thinking (Jaramillo, 1996; Shepardson, 1999; Yorbik, 2006). Havu-Nuutinen (2005) also emphasized the positive effect of peer interaction on learning. While Haraldsson (2000) emphasizes the importance of reflecting the experiences lived in the preschool period by children, the language they use and the viewpoints they adopt in the development of the questions related to science, he states that this is only possible through interaction with peers (Pramling and Samuelsson, 2001). In these interactions, students can find opportunities to discuss the concepts they have and start to think scientifically.

The children using the term "buoyancy" tried to explain what buoyancy is through hand movements as they could not explain the term with their own words. In the existing research, the children in this age group have not been reported to use this term. When the children were asked where they heard the concept "buoyancy", one of them said he/she heard while watching a cartoon, and the other one said he/she heard from his/her mother while doing an experiment together. It was found out that the mother of this child is a science teacher. It can be argued that with increasing experience of any concept, children start to produce more ideas about it. At that point, it can be said that selection of the correct cartoon can have positive effects on the development of science concepts in children. On the other hand, these children can also be seen as good examples to show the importance of family interest in the concept development (Laçin-Şimşek, 2008).

The children participating in the current study were observed to generally use only a single property (mass, volume, shape etc.) while deciding whether an object floats or sinks; however, they did not mention the relationship between the concepts of floating and sinking and the buoyancy of water and density of matter/liquid. The findings obtained for this age group are normal in terms of cognitive development because in this age group children usually focus on a single property. However, Kohn (1993) proved that similar findings can also be obtained for older children and even for adults. This shows that factors related to floating and sinking should be taught more effectively. Activities should be developed and conducted for children to raise their awareness of the factors effective in the learning of the concepts of floating and sinking. For example, experiments including the different volumes of the same material and the use of the same material in different liquids. In order to collect more data about in-class interaction, long-term studies with more replications should be conducted and group works and discussions should be observed.

4.1. Limitations

In the current study, observations and experiments were conducted once. Thus, the children's process of interaction and opinion sharing were short. Long-term studies with more replications are believed to provide more data about the concept development of children. Only one of the parents of the two children mentioned about buoyancy could be reached. This is another limitation of the study.

Research and Publication Ethics Statement

The authors declare that all information in this study has been obtained and presented in accordance with academic rules and ethical conduct. Also, written consents were obtained from the parents for the implementation due to the participation of young children in the study.

Contribution Rates of Authors to the Article

The authors declare that each author made an important contribution to every stage of the study. In particular, the first author, also as corresponding author of the study, conducted the process of collecting data, interviewed with children and conducted experiments with the group. The second author constantly supported the first author in this process both made parent interview and worked in detail in the coding of the data. The two authors worked together during the analysis and reporting of the data.

Statement of Interest

The authors declare that they have no competing interests.

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