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CHANGING STUDENTS' MISCONCEPTIONS OF FLOATING AND SINKING USING HANDS-ON ACTIVITIES

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Abstract. *The aim of this study is to develop hands-on activities and to investigate their effects in changing students' misconceptions of floating and sinking. It was conducted with 28 eighth-grade students. To assess students' understanding and the effects of the instruction based on hands-on activities, a diagnostic test, Floating and Sinking Conceptual Test (FSCT), was employed in the study. It was found out that the instruction based on hands-on activities did have a significant positive effect on students' understanding of flotation concepts and rules. Moreover, the hands-on activities designed for eight problematic areas where students commonly had difficulties helped them to replace their misconceptions with the scientific ones. It is suggested that further studies should be undertaken to highlight the question 'Does the conceptual change strategy used in this study affect students' long-term memory?'*
Key words: *science education, hands-on activities, conceptual change, sinking and floating.*

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Introduction

Over the last two decades, there has been a large body of research on identifying students' understandings about various science phenomena (Driver, Squires, Rushworth and Wood-Robinson, 1999; Fleer, 1999; Osborne, 1982; Palmer, 2001; Treagust, 1988). These studies have generally agreed that students enter their classrooms with preconceptions as a result of their prior experiences, textbooks, teachers' explanations, or everyday language (Coştu and Ayas, 2005; Çalık and Ayas, 2005; Fleer, 1999; Nakhleh, 1992; Osborne, 1982; Palmer, 2001). Because students often construct their own knowledge and theories about how the natural world works, their construction of knowledge or theories may sometimes be contrary to those of scientists (Bodner, 1986; Geelan, 1995; Osborne and Wittrock, 1983). Such views or conceptions are called misconceptions, preconceptions, alternative conceptions, naive conceptions or common sense conceptions (Cerrah Özsevgeç, 2007; Driver and Erickson, 1983; Nakhleh, 1992; Treagust, 1988). A plethora of research documenting student misconceptions has also showed that they are often both pervasive and resistant to change through traditional teaching strategies (Driver and Easley, 1978; Driver and Erickson, 1983; Karamustafaoğlu, Coştu and Ayas, 2005; Köse, 2007; Ozsevgeç, 2006; Tsai, 1998, Wandersee, Mintzes, and Novak, 1994).

Theoretical Frameworks

Students' understanding of flotation

One of the areas that science education and cognitive development research have studied is flotation. Students' views on flotation were first reported by Inhelder and Piaget (1958). They have claimed that because the formulation of flotation rules requires advanced reasoning skills, it is difficult for students to understand these rules so that they had some misconceptions. Their findings were consistent with current research suggesting that young students often have difficulty in reasoning with abstract ideas, especially when they must distinguish between concrete, observable events and unobservable properties that cause them (Bliss, 1995).

Rowell and Dawson (1977a, 1977b, 1981) carried out studies related to the results of Piaget's work to help students improve their understanding of the phenomenon *'flotation'*. Not only did they use concrete examples in classes to encourage students to recognize density as the invariant ratio of the mass and volume of an object, but also logical arguments. They reported modest outcomes on students' understanding. Biddulph and Osborne (1984) investigated 7 to 14 year-olds' understanding of floating and sinking and found that students offered many unrelated factors such as mass and weight as if they determined whether an object sank or floated. Gürdal and Macaroglu (1997) investigated fifth grade students' conceptions of sinking, floating and the Archimedes principle. They found that as students did not give correct response to any test item, they were unable to construct scientific understanding about these concepts. Macaroglu and Şentürk (2001) also carried out a study to elicit fourth grade students' understanding of the flotation. They elicited that students could not identify whether a material would sink or float, because of their misconceptions about floating and sinking. In addition, there are numerous studies reporting students' misconceptions and investigating the effectiveness of alternative teaching models for flotation and related concepts (Jain, 1982; Halford, Brown, and Thompson, 1986; Hewson and Hewson, 1983; Simington, 1983; Smith, Carey, and Wiser, 1985; Smith, Snir and Grosslight, 1992; Kariotogloy, Koumaras, and Psillos, 1993; Butts, Hofman and Anderson, 1993; Kawasaki, 2004; Havu-Nuutinen, 2005). Among researchers who have investigated students' understanding of flotation, there is consensus that most of the students' difficulties about floatation stem from erroneous or incomplete ideas about underlying concepts such as volume, mass, density, force, and pressure (Halford et al., 1986; Jain, 1982; Mullet and Montcouquiol, 1988; Smith et al., 1985). This also shows that students retain their ideas in a fragmented manner (Haidar, 1997, Çalık, 2005).

Although there have been many studies on students' understanding of flotation and related concepts in the literature, they have been generally focused on children's or younger students' understanding (6 to 14). As the Archimedes principle and other related concepts are first introduced to students at the seventh grade in Turkey, one important question should be asked: Do the students still hold their earlier misconceptions even after formal instruction? Ünal and Coştu (2005) attempted to answer this question and drew out that eighth grade students still had difficulties in understanding floating and sinking as reported in the earlier studies, although they had been formally taught in seventh grade. Moreover, the results of their study showed that there were eight problematic areas such as *"effect of the mass of an object on flotation", "effect of the density of the liquid on flotation"* where students commonly had difficulties and misconceptions (Ünal and Coştu, 2005).

Hands-on activities and conceptual change

The research has indicated that traditional teaching ways or tools such as lectures and textbooks are ineffective in changing students' misconceptions with scientific ones (Champagne, Gunstone, Klopfer, 1983; Driver and Easley, 1978, Guzzetti, 2000). As a result, a growing body of research has been conducted to find alternative teaching ways to remedy students' misconceptions on various subjects. Alternative teaching ways or tools such as concept mapping, concrete activities, hands-on activities, conceptual change texts, computer-aided instruction, and so on have been exploited to achieve conceptual change and enhance students' conceptual understanding (Hewson and Hewson, 1983). Moreover, research has

ISSN 1648–3898

showed that more active, inquiry based ways of teaching bring students to a more robust understanding of physics concepts than does the traditional lecture approach (Linder and Hillhouse, 1996; Laws, 1997). In Turkey, however, although the national science education literature is full of reports including misconceptions held by students at different ages or grades about many science concepts, little attention has been given to the effective instructional activities or strategies for the remediation. Hands-on activities were preferred in this study for two significant reasons: (1) studies in which hands-on activities were used for teaching of many science concepts have generally demonstrated positive effects on students' achievement and understanding, and (2) hands-on activities including experiences with concrete materials could be considered as the best way for enhancing students understanding about abstract concepts, regarding that some students' cognitive skills may not develop in the expected time and they may not understand abstract concepts and theories as declared by Inhelder and Piaget (1958).

Hands-on activities helping students to develop conceptual understanding can be done individually, in small groups, or as a whole class. Hands-on activities present most appropriate environment for students to gain experiences by doing different instructional strategies. Through hands-on activities, students use different senses in science classes by touching, feeling, moving, observing, listening, smelling and sometimes testing materials in a controlled manner. This helps students to progress from concrete thinking levels to more complex thinking levels (Kahle and Damnjanovic, 1994; Case and Fraser, 1999; Jones et al, 2003; Bilgin, 2006). As an active learning technique, it enable students to construct scientific understanding in an entertaining learning environment (Case and Fraser, 1999; Kahle and Damnjanovic, 1994). Students can engage in the process of building their own knowledge structures from the acquired information in the activities. Moreover, hands-on activities may improve students' attitudes towards investigation, and get students to find a chance to observe links between natural phenomena and scientific facts (Jones et al., 2003; Bilgin, 2006). Also, they may retain the students' interest in science. By means of hands-on activities, students can acquire the basic skills required to carry out observations and experiments as well as the methodology of investigating a subject in a scientific manner. They may also learn to express accurately the processes involved as well as the results (Freedman, 1997; Kahle and Damnjanovic, 1994, Wenglinsky, 2000). Although their considerable advantages of hands-on activities for teaching science, few studies showed that manipulating the objects alone was not adequate to help students change their alternative conceptions towards scientific ones (Butts, Hofman and Anderson, 1993).

Since students construct new concepts or theories on prior ones in their mental backgrounds, it is important to elicit students' understanding about a phenomenon at the beginning of an instruction. Therefore, this study is based on Ünal and Coştu (2005)'s study who reported students' preconceptions about floatation. As a following work, the aim of this study is to develop hands-on activities and to investigate their effects in changing students' misconceptions of floating and sinking.

Methodology of Research

Research design

This study was the last step of an extensive effort whose aims were to identify students' misconceptions on flotation, to develop hands-on activities for remediation and to investigate the effects of this teaching strategy on students' understanding. In this effort, Ünal and Coştu (2005) determined students' understanding of flotation in depth using semi-structured interviews and a diagnostic Floating and Sinking Conceptual Test (FSCT) comprising 20 multiple-choice questions. Taking into account the results of their study, it was decided to design an instruction accompanied with hands-on activities which allow students actively construct their own understanding and find a chance to modify their misconceptions by considering their inadequacy. The science curriculum was examined to define the extent of the teaching content. Three science teachers actively took part in planning and developing process of the activities.

In the study reported here, the FSCT was administered to the students under investigation as a pre-test a week before the instruction. Firstly, seven groups each of whom consisted of four students were set in the class in which the students would be taught flotation concepts by means of hands-on activities. Then, the sample was re-taught floating and sinking rules and related concepts using hands-on activities for a three class-hour. To find out the changes on students' understanding of the floating and sinking concepts, the FSCT was re-administered to the sample as a post-test. Finally, the results obtained from the pre- and post- tests were analyzed in both qualitatively and quantitatively, so that the effectiveness of the instruction was described and reported.

Sample

This study was conducted with 28 eighth-grade students (15 girls and 13 boys) in a class of a public school which was randomly chosen in the city of Trabzon, Turkey. The ages of the participants were ranged from 14 to 16 years.

Materials and Instructional Design

Students are first introduced to the Archimedes principle, buoyancy and other related concepts in the seventh grade. These concepts are incorporated in the curriculum with the title "*All objects do not float in the water".* In this unit, students are given the rules for flotation and the Archimedes principle. Therefore, the instruction was designed in harmonies with both content and time stated in the curriculum.

At the beginning of each activity, the activity paper on which students would write down their predictions, reasons, observations and explanations, was handed out to each group and students were asked to fill in. During the instruction, the Predict-Observe-Explain teaching sequence was generally used in the activities -except for the third (related to density concept) and the eighth activities (concerned with the buoyant force)-. In this procedure, students were initially asked to predict what would happen in the given circumstances in each activity to elicit their prior conceptions. Then, they were asked to follow the steps given in the activity paper, so that they would realize and test their prior conceptions. Finally, they were asked to compare their predictions with the results deduced by the experiments. In harmonious with constructivist view and conceptual change model, before students first encountered the new concepts or flotation rules, it was provided for students to become aware that their prior ideas were insufficient in explaining the given phenomena. Challenging students' misconceptions with the experiences which were contradictory to their existing cognitive structures, students were forced to be dissatisfied with their existing concepts. Then, they were provided experiences in which the new scientific concept or rule would seem plausible, intelligible and fruitful to them.

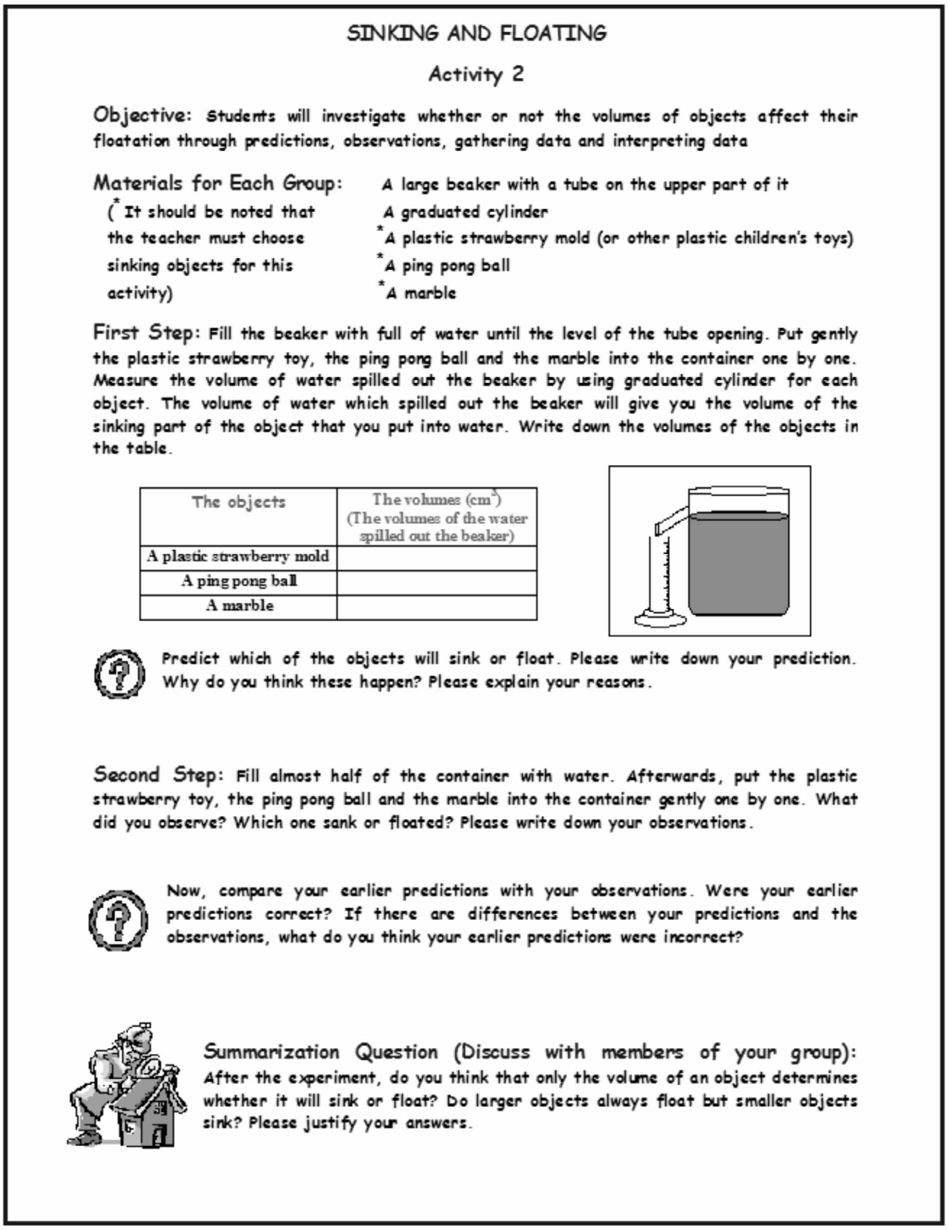
The activities used in this study are outlined in the following Table 1:

Table 1. Targeted conceptions of each activity used in the study.

Activity Number	Target Conception
Activity 1	The weight or mass of an object does not determine whether it will sink or float
Activity 2	The volume of an object does not determine whether it will sink or float
Activity 3	Description of the density concept and the effect of the density of an object on its flotation
Activity 4	Not only the density of an object but also the density of the liquid determines the flotation
Activity 5	The volume of a liquid in a container does not affect the flotation of an object
Activity 6	All objects with holes do not sink
Activity 7	The size of an object does not affect its flotation; each piece which is formed by cutting an object in different sizes will have the same position in a liquid
Activity 8	Description and calculation of buoyancy and its effect on flotation

To achieve the objectives in each activity, students were asked some questions, given directions, asked to measure some quantities, and provided a learning environment in which they could both express their ideas and listen to the others. An example of the activity papers is illustrated as follows.

ISSN 1648–3898



SINKING AND FLOATING

Activity 2

Objective: Students will investigate whether or not the volumes of objects affect their floatation through predictions, observations, gathering data and interpreting data

Materials for Each Group: (* It should be noted that the teacher must choose sinking objects for this activity)

- A large beaker with a tube on the upper part of it
- A graduated cylinder
- *A plastic strawberry mold (or other plastic children's toys)
- *A ping pong ball
- *A marble

First Step: Fill the beaker with full of water until the level of the tube opening. Put gently the plastic strawberry toy, the ping pong ball and the marble into the container one by one. Measure the volume of water spilled out the beaker by using graduated cylinder for each object. The volume of water which spilled out the beaker will give you the volume of the sinking part of the object that you put into water. Write down the volumes of the objects in the table.

The objects	The volumes (cm^3) (The volumes of the water spilled out the beaker)
A plastic strawberry mold	
A ping pong ball	
A marble	

Predict which of the objects will sink or float. Please write down your prediction. Why do you think these happen? Please explain your reasons.

Second Step: Fill almost half of the container with water. Afterwards, put the plastic strawberry toy, the ping pong ball and the marble into the container gently one by one. What did you observe? Which one sank or floated? Please write down your observations.

Now, compare your earlier predictions with your observations. Were your earlier predictions correct? If there are differences between your predictions and the observations, what do you think your earlier predictions were incorrect?

Summarization Question (Discuss with members of your group): After the experiment, do you think that only the volume of an object determines whether it will sink or float? Do larger objects always float but smaller objects sink? Please justify your answers.

Figure 1. The activity paper for the second activity concerning the effect of the volume of an object on its flotation.

Floating and Sinking Conceptual Test (FSCT)

To assess students' understanding and the effects of intervention, the diagnostic Floating and Sinking Conceptual Test (FSCT) comprising 20 multiple-choice questions was employed in this study. The test used here drew upon the work by Ünal and Coştu (2005) who also asked the three science teachers and three science educators to confirm its content validity. All of them had an agreement that the FSCT was effective in eliciting students' understanding within the related science curriculum.

Cronbach alpha-reliability coefficient was measured 0.74 for the FSCT using SPSS 10 ™. Each item with four choices includes the correct answer and three misconceptions.

Three examples of the items in the FSCT are illustrated as follows:

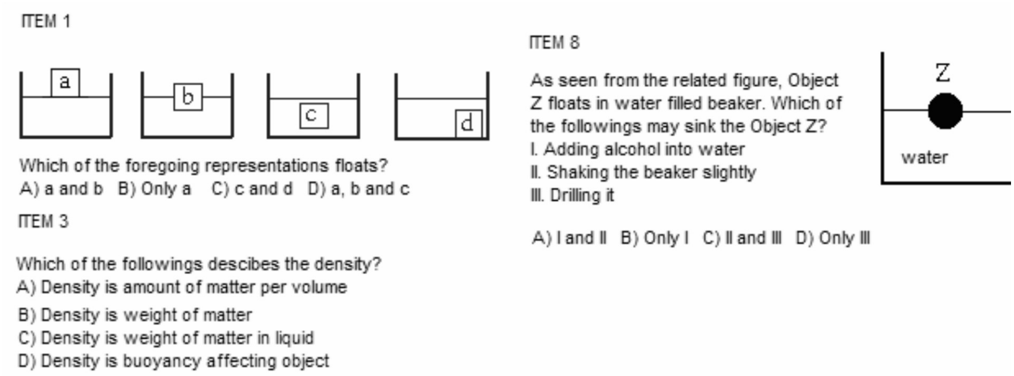


Figure 2. Some examples of the items in the FSCT.

Analysis

Students' responses to the FSCT on the pre-test were analyzed regarding both correct and incorrect responses before the instruction. The frequencies and percentages of all choices that were chosen by the students were calculated for each item. Analyses of incorrect responses selected by the students provided data on students' misconceptions about the phenomenon, so that students' misconceptions and their percentages for each item were then defined. The choices of some items included more than one misconception since a misconception was used in more than one choice of the same question. When calculating the percentage of students who had a misconception, the total of the students whose choices included that misconception was considered. Moreover, during the analyses of the responses on the pre-test, total score of each student on the pre-test was also calculated by counting five points for each correct answer for the items.

After the instruction accompanied with the hands-on activities, the FSCT was re-administered to the sample as a post-test to describe the changes on students' misconceptions on floating and sinking. Students' responses to the FSCT on the post-test were analyzed by similar manner as in case of the pre-test. The frequencies and percentages of choices given by the students as correct answers were calculated for each item. Students' misconceptions and their percentages for each item were then defined. Finally, to find out the changes in students' ideas on floating and sinking and to make audience easily understand the changes in students' misconceptions, the misconceptions and their percentages on the pre- and post-tests were presented in Table 1. Moreover, in order to make statistical comparison, *paired t-test* was utilized based on students' total points in both pre- and post-tests. The summary of the paired sample t-test is displayed in Table 2.

Results of Research

The analyses of the students' responses to SCFT showed that the majority of the students had misconceptions about floating and sinking before the instruction. The misconceptions revealed from the students' responses for each item in the pre-test were listed and the percentages of students who had these misconceptions were calculated. Detailed descriptions of these misconceptions and the possible sources of them were provided in the earlier work (see Ünal and Coştu, 2005). Because assessing the effectiveness of the instruction (comparison of students' ideas between the pre- and post-tests) is focused on the study, these misconceptions and their possible sources are not discussed in this paper again. After the instruction, the FSCT was also employed in order to

ISSN 1648–3898

determine students' understanding and their misconceptions. The percentages of students who had these misconceptions after the instruction were calculated in order to gain a measure of these changes. Table 1 shows the students' misconceptions of flotation and their percentages on the pre- and post-tests.

Table 1. Students' misconceptions of flotation and their percentages in the pre- and post- tests.

Item No	Students' Misconceptions and Difficulties	Pre-Test (%)	Post-Test (%)
1	- Objects which are hanging on in a liquid are named as sinking objects because they are covered by the liquid	11	---
2*	- Volume determines if an object will sink or float	39	---
	- Weight determines if an object will sink or float	68	---
	- The volume of the liquid determines if an object will sink or float	68	---
3	- Density is the weight of an object	11	---
	- Density is the weight of an object in a liquid	18	---
	- Density is the force that pushes an object up	25	---
4	- The density of an object hanging in a liquid is equal to that of a floating object	14	---
	- The density of an object hanging in a liquid is equal to the density of a sinking object	18	---
	- The density of a floating object is more than that of a sinking object and an object hanging in a liquid	54	4
5	- The density of an object hanging in a liquid is less than the density of the liquid	7	---
	- The buoyancy of an object which is hanging in a liquid is more than the weight of the liquid overflowing	46	4
6	- The density of an object hanging in a liquid is equal to that of a floating object	21	---
	- When two objects at the same mass are put into a liquid, the buoyancy on the object hanging in the liquid is more than that on floating object	32	11
7	- The mass of an object determines whether it will sink or float	46	4
	- When two objects of the same mass are put into a liquid, a geometrical shaped one will float, but the other having no geometrical shape will sink	18	---
8*	- When the container is shaken, the floating object will sink	14	---
	- If you make a hole through the object, it will sink	43	7
9*	- Because the volume of the liquid affects buoyancy, the volume of the sinking part of the objects in a container filled with a little liquid is more than another with more liquid	46	18
	- Because the volume of the liquid in the container is little and insufficient, the volume of the sinking part of an object is more than that in another container	39	4
10*	- The greater the floating part (out of water) of an object, the greater its buoyancy	36	11
	- When comparing buoyancies affecting three objects one of which sinks, another floats and the other hangs in a liquid, the buoyancy of the sinking object is more than the others	25	7
	- Not making the connection between the volume of sinking part of an object and its buoyancy	64	18
11	- Making wrong connections between the solvent and solute quantities of solutions and their densities	89	18
12	- Making wrong connections between the densities of different liquids and their positions in a container	43	18
13	- When the densities of the liquid changes, the buoyancy of an object changes, too	61	25
	- The volume of the sinking part of an object becomes less when a liquid which is less dense is poured into the container filled with a denser liquid	39	21
14	- When two objects, one of which is put on the top of the other, is put into the liquid one by one, the position of the object which is beneath does not change	54	7
	- When two objects, one of which is put on the top of the other, are then put into the liquid one by one, the water level in the container does not change	32	25

Item No	Students' Misconceptions and Difficulties	Pre-Test (%)	Post-Test (%)
15*	- Weight determines if an object will sink or float	46	11
	- Volume determines if an object will sink or float	57	18
16	- When the volume of a liquid in a container is increased, the volume of the sinking part of an object will decrease	18	---
	- When the volume of a liquid in a container is increased, the volume of the sinking part of an object will increase, too	21	4
	- When the volume of a liquid in a container is decreased, a floating object will sink	18	---
17	- The volume of a liquid in a container determines whether an object sinks or floats	64	4
	- Objects which have a hole will sink in the course of time because the liquid fills the hole	54	---
18	- No interpretation of the position of objects, which are tied to each other, in a liquid by considering their earlier positions in the liquid	36	7
19	- Objects which are covered by the liquid have always the same density	36	18
20*	- When a floating object is cut into two parts, the volume of the smaller sinking part will become less	50	18
	- When a floating object is cut into two parts, the bigger piece will sink or the volume of the sinking part will increase	54	18

* In some of the test items (e.g. items 2, 8, 9, 10), total percentages may not be %100 because two or more choices include the same misconception. Therefore, in grouping misconceptions and calculating their percentages, the choices of the test items were used more than once.

** The contents of the test items in the FSCT were not given in the table because they were given in the earlier work by Ünal and Coştu (2005). You could find the domains being investigated in each item in that study.

Students' responses to the test items 2, 7, 15 and 20 on the pre-test showed that most students had the misconception *'weight or mass determines whether an object sinks or floats'*. While the percentages of the students who had this misconception before the instruction were in the range of 46-68% for different items (see Table 1), only a few students retained this misconception whose percentages were in the range of 0-18% for different items after the instruction.

Another misconception *'the volume of an object determines whether it will sink or float'* appeared on the pre-test (see items 1, 2, 15 and 20). Whilst the percentages of the students who had this misconception on the pre-test were in the range of 39-57% for different items, a few students grasped this misconception whose percentages were in the range of 0-18% for different items after the instruction.

Before the instruction, the majority of the students held the misconception *'the volume of a liquid in a container determines whether an object sinks or floats'*. This misconception was revealed from the students' responses to items 2, 9, 16 and 17. Whereas the percentages of the students who possessed this misconception on the pre-test were 68%, 46%, 57% and 64% respectively, those of the students who had this misconception on the post-test were 0%, 18%, 4% and 4% respectively as well.

Students' responses to test items 3, 11, 12 and 14 on the pre-test showed that some students could not understand density concept and had some misconceptions about it. Over half of the students (54%) gave alternative descriptions for the density concept in the third question of the FSCT before the instruction. However, after the instruction all students selected the correct choice including the scientific description of density concept. In addition, some students did not consider the density of the liquid when determining whether an object would sink or float in some items (see item 8, 9 and 13). But, the percentages of the students whose choices were wrong for these items changed favorably after the instruction.

Students' responses to items 4, 6 and 19 on the pre-test indicated that they could not compare the density of different objects by regarding their positions in a liquid. For example, the most common misconception held by the students in this area was that *the density of an object hanging in a liquid is equal to that of a floating object* (14% and 21% for item 4 and 6 respectively) or *a sinking object* (18% and 36% for item 4 and 19 respectively). However, after the instruction, students did not select the choices

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including this misconception for these items except for item 19. In fact, only 18% of students still saw the same choice including this misconception as the correct answer for item 19 on the post-test.

Another results revealed from the students' responses to the test items 3, 5, 6, 9 and 10 on the pre-test was that the students lack of understanding of buoyancy. For example, almost half of the students (46%) reported that *the buoyancy of an object hanging in a liquid is more than the weight of the liquid overflowing*. In addition, some students (32%) had the misconception that *when two objects are put into a liquid, the buoyancy of the object hanging in the liquid is more than that of the floating object*. Most students gave up these misconceptions after the instruction. The percentages of the students who had these misconceptions on the post-test were 4% and 11% for the item 5 and 6 respectively.

The students' responses to test items 8 and 17 on the pre-test revealed that some students believed that *objects with holes would sink in the course of time, because the liquid filled the hole* (43% for item 8 and 54% for item 17). However, nearly all students abandoned this misconception after the instruction (except for 7% for item 8). As a matter of fact, none of the students selected the incorrect choices for item 17.

Students' responses to item 20 on the pre-test presented that some students could not identify the positions of the pieces in a liquid when a floating object was cut into parts of different size. Half of the students (50%) thought that *when a floating object was cut into two parts, the volume of the sinking part of the smaller piece would become less*. Similarly, 54% of them also reported that *the bigger piece would sink or the volume of the sinking part would increase*, *when a floating object was cut into two parts.* However, only 18% of the students possessed these misconceptions on the post-test.

To determine the changes in students' understanding about floating and sinking totally, student scores on the pre- and post- tests were statistically analyzed by means of *paired t-test*. The statistical analysis indicates that there is a significant difference between the pre- and post- test scores in favor of the post-test ($t_{(26)} = -20.503$, $p<0.05$). As can be seen from Table 2, students performed significantly higher scores in the post-test than those in the pre-test.

Table 2. The summary of the paired sample t-test.

	Subject (N)	Mean	Std. Deviation	df	t	p
Pre-test	28	45,0	13,1	26	- 20,503	.000
Post-test	28	79,8	9,0			

Discussion and Implication for Teaching

It appears that that the instruction accompanied with hands-on activities did have a significant positive effect on students' understanding of flotation concepts and rules. Regarding the results, students indicated a clear increase in understanding about flotation. Each hands-on activity has shown great impact on students' understanding in the eight problematic areas where students commonly have difficulties and misconceptions. Moreover, the instruction based on the hands-on activities for the teaching of floatation concepts helped students to replace their misconceptions with the scientific ones.

Additionally, it was evident that the activities in the instruction were surprising to the students, in a way that their ideas were confronted. Research has indicated that traditional instruction is ineffective in changing students' misconceptions to scientific ones (Champagne et al., 1983; Driver and Easley, 1978). The present study indicated that the use of hands-on activities, (1) which allows students to realize and test their prior ideas, (2) which challenges them with the experiences that are contradictory to their existing cognitive structures, and (3) forces students to be dissatisfied with their existing concepts, is an effective method in enhancing students' conceptual change. This result is in harmonies with much research proving that hands-on activities are more influential than traditional teaching approaches for conceptual change (Case and Fraser, 1999; Freedman, 1997; Kahle and Damnjanovic, 1994, Wenglinsky, 2000). Since science teachers have complained about "crowded-curriculum" (Palmer, 2003; Çalık, Ayas and Coll, 2006), this paper presents some evidence that hands-on activities are both time efficient and low-cost. Also, students may find these activities appeal to contribute the lesson actively.

The results indicate that the sample under investigation did not have a clear understanding of flotation before the instruction although they had been taught with the flotation concepts at seventh grade. If so, what could be the reason for this? Two possible reasons could be given: a) these concepts were not taught well, and (b) these concepts are not learnable by this age group. This study did not intend to discuss these possibilities, but some comments could be made. In the experiences of the researcher, science teachers are generally much dependent on textbooks. Newton (2003) maintains that if the teachers' knowledge is not enough for the concepts presented, they generally count on the information represented by textbooks. Therefore, they often have few or no laboratory activities to give students a first-hand experience with concepts. Moreover, students are rarely given an opportunity to talk about their ideas, to explore their conceptions, and to test them through discussions. As a consequence, any misconceptions held by students are seldom challenged. If these observations are consistent with the experience of the sample in this study, this might, at least in part, be the reason for their lack of understanding. It is sure that this hypothesis would be worthy to be investigated in further research. The other reason may stem from the teacher's branch. That is, up till 2000's physics, chemistry, and biology teachers and the related pure science graduates were appointed as science teachers by Ministry of National Education (MEB). Therefore, if the biology or chemistry teachers, who had bachelor degree, have not any ideas on the investigated concepts, they may surpass them superficially. Thus, it could be deserve to be further sought.

The other possibility is that these concepts are not learnable by this age group. This was discussed by many researchers in their studies (Inhelder and Piaget, 1958; Rowell and Dawson, 1977a, b; Simington, 1983). Piaget believed that formal operation thought appears between 11 and 15 years of age. Inhelder and Piaget (1958) claim that because the formulation of flotation rules requires advanced reasoning skills, it is difficult for concrete operational students to understand those rules. Their findings are consistent with the research suggesting that young students often have difficulty reasoning with abstract ideas (Bliss, 1995). This study was conducted with the eighth grade students (14-15 year-old). Although the sample in this study and that in the earlier study (Ünal and Coştu, 2005) are between 11 and 15 years-old, the transition of some students from concrete operation to formal operation could have been delayed. This delay might be account for their lack of understanding. However, contrary to these ideas, the study reported here is an attempt to teach ideas of flotation and related concepts. Also, the results pointed out that the instruction based on hands-on activities employed in this study enhanced students' understanding of these concepts and promoted conceptual change about eight problematic areas. As a consequence, it can be concluded that various materials, ways or methods introducing new concepts gradually in a meaningful and concrete way accomplished to afford students to catch these concepts adequately. However, although the results of this study are not consistent with the idea "*these concepts are not learnable by this age group*", further research into this hypothesis seems warranted.

In conclusion, some important limitations of the present study should be pointed out. One was obviously the small sample size. Because this study was conducted with the voluntary participation of a science teacher and the students in her class, this study has a shortcoming in generalizing the results. It should be noted that this is a preliminary study with a small sample size. Further studies with larger sample size should be conducted to ensure the validity of these results. The absence of a control group may be the second limitation of the study. In fact, the absence of a control group has little implication for the results of this study, because the aim of the study is to develop hands-on activities and to investigate their effects in changing students' misconceptions of floating and sinking, not to find out which group (experimental or control) is better than the other. In experimental studies, being involved in the experimental group may result in an apparent improvement. According to Trochim (2001), this issue is the main validity thread in the intervention studies. However, future research might use hands-on activities designed for the teaching of floatation in this study, and compare student outcomes with the traditional teaching of the subject in terms of achievement or attitudes in science.

In fact, the findings described here emerge a more important research question to be investigated

ISSN 1648–3898

in future studies: does the conceptual change strategy used in this study affect students' long-term memory? Since previous empirical findings have shown that students' misconceptions in science are highly resistant to change (Osborne and Cosgrove, 1983, Carey, 1986), it is possible that students may return their pre-conceptions over time (Taber, 2001; Teichert and Stacy, 2002). Therefore, a delayed test would help to highlight this question in terms of retention of related concepts.

There are a number of teaching ways or tools that are applicable in a classroom situation and that may be used for conceptual change in students' ideas such as concept mapping, concrete activities, hands-on activities, conceptual change texts, and computer-aided instruction. On the basis of the present study, it can be deduced that hands-on activities may be a powerful way to foster science learning viewed from a conceptual change perspective. If teachers demand to get their students to learn meaningfully, they need to employ various strategies or tools in their classes to enhance student understanding of problematic science concepts. A variety of learning activities which optimize student involvement in the learning process helps students to improve their performance. No one asserts that the students who are exposed to the teaching for conceptual change will immediately relinquish their preconceptions in favor of the scientists' explanations of the concepts unless they are persuaded that their preconceptions are wrong and deficient for explaining the new concepts or phenomena. Preconceptions are tenacious and may require repeated challenges in different settings and contexts to replace and rethink their newly structured knowledge. Therefore, it is necessary to develop effective teaching ways, tools or strategies and present them to the teachers for their use in science classes for teaching abstract and difficult science concepts.

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