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# An alternative method in identifying misconceptions: structured communication grid

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**Abstract**

This study aims to identify misconceptions in the understanding of 8th graders related to buoyancy and density of liquids by using structured communication grid. 107 students were administered structured communication grid technique at the end of the teaching process during the fall semester of 2010-2011 educational year in Bolu, Kocaeli and Istanbul and student misconceptions were identified. The technique presented the students with the grid representing situations such as sinking, swimming and suspending in the boxes. Students were given questions related to these situations and were asked to find correct boxes. Student answers analyzed to categorize misconceptions.

Findings showed that students had some misconceptions stated in the following expressions: "density of swimming objects is equal to the liquid", "the densities of sunken objects in the liquid are equal" and "buoyancy of sunken objects in the liquid is equal to the weight of the objects".

The results of the study showed that the structured grid technique is a method that can be used as an alternative to traditional methods in the identification of misconceptions and for meaningful learning. Additionally the study provides some suggestions related to the use of the technique in learning environments.



*Keywords:* Misconception, Structured Communication Grid

## 1. Introduction

There are many factors that affect learning and success in science education some of which are learning strategies and techniques, prior knowledge, individual differences (gender, learning styles, and cognitive styles) and attitude among others. According to the constructivism approach which is believed to explain best how learning takes shape in mind, all the factors cited above affect learning directly in educational environments. The stance that constructivist approach takes about the way learning takes place also enlightens the manner of evaluation in learning. In this context, the traditional assessment and evaluation approaches to learning based on behaviorist approaches give their place to alternative assessment and evaluation techniques appropriate for constructivist approach. Hence the effect of this serious paradigm shift in the outlook to assessment and evaluation on learning and success in classes becomes important. Assessment and evaluation is one of the most crucial elements with the educational products it creates that provide rejuvenation and sustainability for teaching programs. Recently,


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the numbers of studies that examine the effect of assessment and evaluation on success in classes have increased (Bahar & Hansel, 2000; Lawrenz et al. 2001; Ateş & Karaçam, 2008).

The effects of the changes mentioned above have also been experienced in our country and in 2004; serious modifications were undertaken in assessment and evaluation in the renewed primary school curriculums. The new curriculum is more focused on alternative assessment and evaluation approach and includes techniques that consider not only the product but the process along with it. One of these techniques is the structured grid. Structured grid is an important assessment tool in that it provides assessment of meaningful learning and manifests the shortcomings and defects in knowledge network and in misconceptions in student cognitive processing (Johnstone et. al., 2000).

### *1.1. Structured Grid and Misconceptions:*

One of the frequently studied topics in science teaching is misconceptions. There are identified student misconceptions related to many learning field and topic (solubility, electric, photosynthesis-respiration, diffusion, osmosis etc) (Chambers &Andre, 1997; Mikkila, 2001; Çalık & Ayas, 2003; Sencer & Eryılmaz, 2004; Köse & Uşak, 2006). These studies have often made use of similar type tests (multiple choice, open-ended questions, two-stage tests, interviews etc) in order to identify misconceptions. According to Çalık & Ayas (2003) although multiple tests provide us with information related to student misconceptions, they do not allow for deeper understanding of the issue. In this context it becomes more important to utilize techniques that evaluate meaningful and deeper learning and that expose the relationships among concepts in the cognitive structure. When studies in literature are reviewed, you can find studies that show structured grid technique serves that purpose (Johnstone et.al., 2000; Bahar, Öztürk & Ateş, 2002, Ateş & Karaçam, 2008). The most important feature of this technique is the ease with which it can be used for providing assessment for meaningful learning and for diagnosing the shortcomings and defects in the knowledge network and the misconceptions in student cognitive processing (Bahar, Öztürk & Ateş, 2002).

Bahar, Öztürk & Ateş (2002) identified levels of student understanding and student misconceptions regarding Newton's law of motion, work, force and energy in $10^{th}$ grade physics topics by using structured grid technique. According to the results and misconceptions in understanding the effect of force on motion. Bahar (2003) prepared a structured communication grid of 16 items in order to identify student views on vitality and questioned 1000 students in primary and secondary level students about the items on the grid. Results displayed that a substantial number of students did not know the term *dormant* and/or had misconceptions.

This study identified misconceptions of $8^{th}$ graders regarding liquid density and buoyancy by utilizing structured grid technique. There are existing studies of the study, students achieved an overall level of comprehension about the topic but had problems in the literature about liquid density and buoyancy (Unal &Coştu, 2005; Ozsevgeç& Çepni, 2006; Joung, 2009), there are not many studies that investigate related concepts and misconceptions in a wide range. In other words, in terms of buoyancy the studies have usually focused on concepts of "swimming and sinking". It is comparatively easy to determine concepts and misconceptions in a comprehensive learning field through the use of structured grid technique. Therefore, it is hoped that the present study is important to fill the gap and will provide contributions to the existing literature.

## 2. Method

*2.1.Purpose:* The aim of the study is to identify the misconception of the $8^{th}$ graders regarding liquid density and buoyancy in the context of the unit on force and motion by the use of structured grid technique.

*2.2.Procedure:* The study was implemented to a total of 107 8th graders from various school in Bolu, Kocaeli and Istanbul. In order to identify misconceptions, students were administered the structured grid developed by the researchers at the end of the unit. Five expert academicians in the field of teaching science and assessment and evaluation were consulted regarding the validity of the technique and the technique was thus finalized. Nine boxes consisting different swim and sink situations in each box were presented to students. Students were some asked questions in regards to the information in the boxes and were asked to select the boxes that sounded correct. Information in the boxes selected by students was analyzed individually and misconceptions were identified. Annex 1 provides the structured grid implemented in the study.

## 3. Findings

According to the responses gathered from 107 students, it was found that:

*1st question:* 54 students obtained the correct answers and selected the boxes 3,5 and 8. 28 students selected the boxes 1,3,6,7 and 9 in addition to boxes 3, 5, and 8 by displaying the misconception that the density of swimming objects is equal to the density of the liquid. Also, 9 students selected box 1 and stated that the density of a swimming object half sunken in the liquid is equal to the density of the liquid. 5 students selected box 5 showing misconceptions in their statements that only the density of the objects suspended in the middle of the liquid is equal to the density of the liquid.

*2nd question:* 70 students obtained the correct answers and selected the boxes 2 and 4. 18 students selected the boxes 1, 6, 7 and 9. According to these selections, students display misconceptions that the density of the swimming objects is larger than the density of the liquid. Also, 12 students selected box 8 displaying misconception that densities of suspended objects closer to bottom are larger than liquid density.

*3rd question:* 58 students obtained the correct answers and selected the boxes 1,6,7 and 9. 25 students selected the boxes 3, 5 and 8 in addition to correct boxes by displaying the misconception that the density of suspended objects is smaller than the density of the liquid. Also, 10 students selected boxes 2 and 4 displaying misconception that densities of sunken are smaller than liquid density.

*4th question:* The question requires students to order the boxes they selected (1, 6, 7, 9,) in the previous question from the smallest to the largest. While 52 students were able to do that 11 students displayed the misconception that the density of objects in the boxes are equal. Also 11 students reversed the order. 15 students ordered the boxes in a different and irrelevant manner (for example 6-7-9-1 , 1-6-7-9 , 7-1-6-9 etc).

*5th question:* 30 students obtained the correct answers and selected the boxes 1, 3, 5,6,7,8 and 9. 8 students selected the boxes 2 and 4 displaying the misconception that the buoyancy of sunken objects is equal to the weight of the object. 18 students selected boxes 3, 5 and 8 displaying misconception that only the buoyancy exerted on the suspended objects is equal to the weight of the object. 5 students selected boxes 1, 6, 7 and 9 displaying misconception that only the buoyancy exerted on the swimming objects is equal to the weight of the object. 11 students selected only box 1 displaying misconception that only the buoyancy exerted on half sunken objects is equal to the weight of the object.

*6th question:* 49 students obtained the correct answers and selected the boxes 2 and 4. 18 students selected the boxes 1, 3, 5,6,7,8 and 9 displaying the misconception that the buoyancy exerted on swimming and suspended objects is smaller than the weight of the object. Also, 4 students selected boxes 3,5 and 8 displaying misconception that only the buoyancy exerted on suspended objects is smaller than the weight of the object.

*7th question:* 42 students obtained the correct answers and selected the boxes 3, 5 and 8. 21 students selected the boxes 2 and 4 displaying the misconception that the densities of sunken objects are equal to each other. 8 students selected boxes 1,3,5,6,7,8 and 9 displaying misconception that densities of the swimming objects are equal to each other in addition to suspended objects. Also, since it was the question with the most number of blank answers (15 students), we can conclude that the students had the least information about various swimming and sinking situations.

## 4. Results and Discussion

With the radical changes in assessment and evaluation concepts in the recent years, the question of how success can be evaluated in a more meaningful and deeper manner has been the topic of discussions. Many various assessment techniques have been proposed especially in the field of teaching science and technology. Although each proposed technique has a specific nature, there is the problem of when and how to use these techniques. In this context, correct and meaningful assessment of success will only be possible through developing assessment tools in accord with the structure and nature of the related topic.

This study revealed the misconceptions of students about buoyancy and density of liquids by using structured communication grid. According to the results it is believed that structured communication grid is effective in eliciting misconceptions. There is supporting evidence in this regard in literature in studies in various learning fields (Bahar, Öztürk & Ateş, 2002; Bahar, 2003). Therefore, structured grid technique can be regarded as a technique that can be comfortably used in the identification of misconceptions especially in teaching science and technology.

Data of this study was collected at the end of the teaching process. Hence misconceptions were detected after the related topic was taught prior to the use of the technique. The existence of identified misconceptions at the end of the teaching process is a situation that calls for implementation of more effective teaching activities.

## 5. Suggestions/ Implications

Techniques that add to the cognitive structures of students, enable the identification of misconceptions and relate to meaningful learning are crucial for teachers (Bahar, Öztürk & Ateş, 2002). Learning-teaching process can only be directed through this approach and effective learning can materialize. The structured grid technique that is instrumental in this regard can be suggested to be used in different learning fields. Since the technique possesses a specific method of scoring (Annex 2) it can be used in determining success in classes in addition to identification of misconceptions. Also it can be considered for use for other classes and subjects due to the availability of placing various contents (symbols, pictures, definitions, formula etc) inside the boxes.

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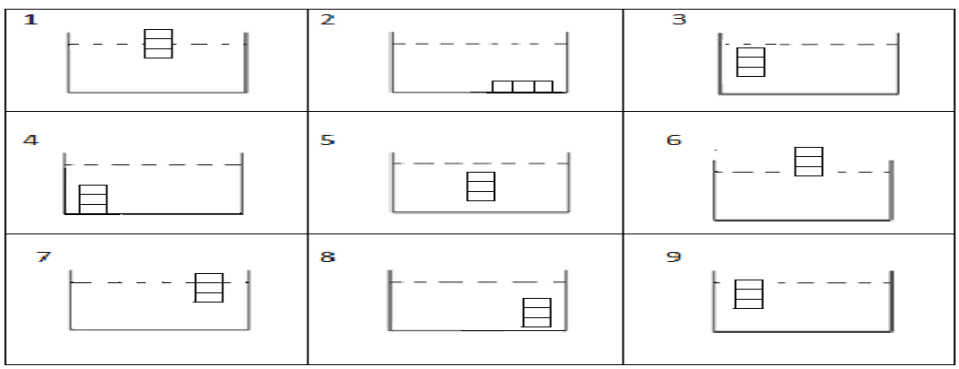
**Annex 1**

The grid below contains samples regarding various situations about buoyancy and density of liquids. Please answer the questions by using the box numbers. You can use the same box number as an answer to more than one question.




Objects are released in **the same liquid** in the above boxes. According to the box;

1) In which boxes the density of the object and liquid are the same?
2) In which boxes the density of the object is larger than the density of the liquid?
3) A. In which boxes the density of the objects in the liquid is smaller than the density of the liquid?
   B. Please order the densities for the objects from the smallest to the largest.
4) In which boxes the buoyancy exerted on objects is equal to the weight of the object?
5) In which boxes the buoyancy exerted on objects smaller than the weight of the object?
6) In which boxes density of the object is equal to the other?

**Annex 2**

(C1/ C2)- (C3/C4)

C1= Number of boxes selected correctly,
C2= total number of correct boxes,
C3= Number of boxes selected incorrectly,
C4= total number of incorrect boxes