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Mental Models of the High School Students Related To the Contraction of Matter

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ABSTRACT
The aim of this study is to reveal the mental models of the high school students related to the 'contraction of the matters'. In the study, the special case has been used as research method. The study group is composed of 107 high school students selected with the purposeful sampling. As the data of the study has been obtained from the open ended questions, it includes the description and visualization situations of the students related to the issue. The findings obtained have shown that the students have two types of mental models as initial and synthetic model related to the contraction of the matters. The results have been interpreted as that the school knowledge is not sufficient in structuring the mental models of the students in a scientific way. The usage of the training methods and techniques that will develop especially the spatial thinking and drawing characteristics in the training applications is proposed.
Key Words: *Contraction of the matter, mental models, high school students*

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INTRODUCTION

In the today's science teaching understanding, the consideration of the pre-knowledge of the students has gained importance. The researches executed in this manner have shown that the students have encountered with many abstract concepts as of the early ages and the preschool experiences have caused a number of mistakes (Nicoll, 2001; Canpolat, Pınarbaşı & Sözbilir, 2003; Koray, Akyaz & Köksal, 2007). What is meant with the mistake is the perceptions which do not coincide with the scientific knowledge. These perceptions are called with different names such as 'preconceptions', 'alternative frameworks', 'alternative ideas', 'children science', 'alternative science', or 'misconception' (e.g. Baser & Çataloglu, 2005; Petersson, 2002; Rowlands, Graham, Berry, & McWilliams, 2007) in the related literature and draw attention as a wide study area in the related literature. With this, also in some studies (e.g. İyibil & Sağlam Arslan, 2010; Kurnaz & Değermenci, 2012), the studies oriented for how the information was structured in the mind of the student were focused and the student mental models related to some fundamental science concepts were revealed.

The fundamental science concepts can be thought in two dimensions as ones encountered in the macroscopic (events which are possible to be encountered in the daily life) and microscopic (particles similar to atom, molecule and electron which are not possible to be observed directly and interactions in between them) levels. Due to the fact that especially the events realized at the microscopic level include more abstract concepts than the other, it has been revealed that the students cannot form the required relations and they cannot form a scientific structuring related to the information in their minds (Ayas & Demirbaş, 1997). For example, due to the observations related to non-contraction of the liquids and solids at the macroscopic level, most of the students think that the granular structure of the matter is continuous (Novick & Nusbaum, 1978, 1981; Brook, Briggs & Bell, 1983). According to Ayas and Özmen (2002), due to the observations related to non-contraction of the liquids and solids at the macroscopic level, the transition of a student to the knowledge that the matter is composed of particles is an important mental change. Such changes cannot be always possible even after being taught in the related courses (Novick & Nusbaum, 1978).

It has been mentioned that the mental structures formed at the early ages related to the fundamental science concepts and including alternative ideas can affect the new learning negatively (Nicoll, 2001; Coll & Treagust, 2001; Özmen & Demircioğlu, 2002). However, the only source of the non-scientific modeling that the students have is not the preschool experiences. It has been expressed that the education applications executed at the schools (Kurnaz & Sağlam Arslan, 2009, 2010) and insufficient /unqualified training materials (Cin, 2007; Kurnaz, 2012) can also cause alternative thought development. From this point of view, it is clear that to what extent the education applications related to the fundamental science concepts carry the students to the scientific structuring should be frequently questioned. It is evident that such analyses will give important clues in determination of whether the trainings given at the schools have deficiencies or not. The student mental models related to the 'contraction of the matter' which is one of the events happening at the microscopic level form the focus of this study.

METHOD

Within the content of the study, the special case study which presents the situation analyzed as it is (Yin, 2003) has been used as research method. The special case in the study is the mental models of the high school students related to the 'contraction of the matter' and the determined mental models are limited with the answers given to the questions asked.

Study Group

In the Turkish education system, the high school is composed of 4 classes. The study group in the research is composed of 107 high school students (29 of them from ninth grade, 26 of them from tenth grade, 21 of them from eleventh grade and 31 of them from twelfth grade) who are selected with the purposeful sampling method in the academic year of 2012-2013. That the high school level is not adequately analyzed yet in the studies executed related to the issue reveal the necessity of the study and the meaningfulness of the results to be achieved again from a different point of view.

Data Collecting Instrument

In revealing of the mental models, it should be started with the questions related to the objective concept oriented for the theoretical and practical information of the students (Kurnaz, 2011). This study has been limited with and executed on the basis of 2 open ended questions asked related to the students' theoretical knowledge related to the 'contraction of the matter'. The related questions are as follows:

1. What comes to your mind when contraction of matter is said? Explain it.
2. When an object is contracted, visualize the changes that will happen in the interactions between its molecules.

The first question includes the students' situations of describing the objective concept and the second question includes the students' visualization situations.

Analysis of Data

During the data analysis, primarily, the perceptions of the students related to the objective concept have been attributed as 'Correct; Partial correct; Partial correct but also including alternative ideas; Incorrect; No answer' from the answers that they have given. In the continuation, the description and visualization situations are compared and their mental models have been determined. During the mental model determination process, the mental methods proposed by Vosniadou and Brewer (1992, 1994) and which have been used as mental models for determining the mental models in some studies (e.g. İyibil & Sağlam Arslan, 2010; Kurnaz & Değermenci, 2012) have been utilized (Table 1). In the comparison of the description and visualization situations, the ones making correct and partially correct answering have been evaluated in the scientific category and the ones who have been made this have been evaluated in the synthesis model category.

Table 1. *Mental models used in the analysis process*

Mental Models	Content
Initial model	Perceptions which do not coincide with the scientific knowledge
Synthesis model	Perceptions which partially coincide or do not coincide with the scientific knowledge
Scientific model	Perceptions which coincide with the scientific knowledge

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As it can also be understood from the Table 1, the initial model reflects the perceptions which do not coincide with the school knowledge and the synthesis model reflects the perceptions which partially coincide with the school knowledge and the scientific model reflects the perceptions which coincide with the school knowledge.

Findings

The findings obtained from the study have been presented under the titles of (I) *Students' Perception Situations* and (II) *Students' Mental Models*.

I- Students' Perception Situations

The findings obtained from the answers that the students have given to the first question have been presented in the Figure 1 (C: Correct; PC: Partial correct; PCIAI: Partial correct but also including alternative ideas; I: Incorrect; N: No answer).

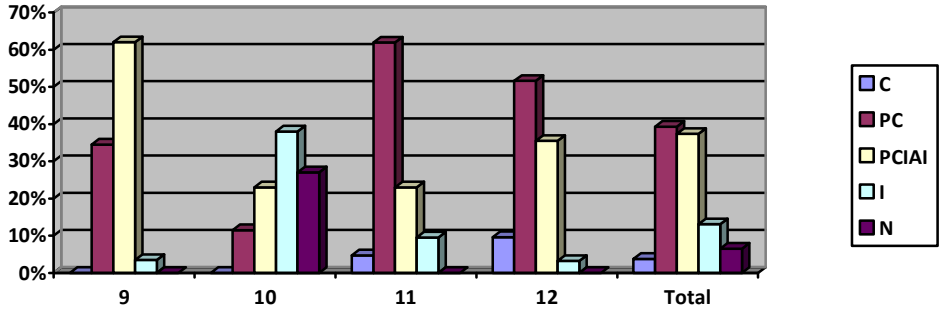

Figure 1 Success distributions of the student answers belonging to the first question

When the Figure 1 is examined, as an attention attracting finding, it has been understood that approximately 40% of all students have correct but insufficient perception related to the contraction of the matter. With this, it attracts attention that approximately 40% of them have perceptions which are correct but also include alterative ideas. When the grades are compared, 11 and 12th grade students have given correct or partially correct answers and have become more successful. 10th grade students have become the student group which gives the most wrong answers. The quotations from the answers of some students have been presented below:

"It is the event of decreasing of the space between the item's molecules/atoms and also decreasing of its volume with force applied to an item." (Correct, Student 40).

"Decreasing the item's volume by applying force on it" (Partial Correct, Student 46).

"It is the getting closer of the molecules of gas items to each other after the pressure." (Partial correct but also including alternative ideas, Student 108).

"Changing of state according to the temperature of the environment by an item by giving out heat." (Incorrect, Student 58).

The findings obtained from the answers that the students have given to the second question have been presented in the Figure 2.

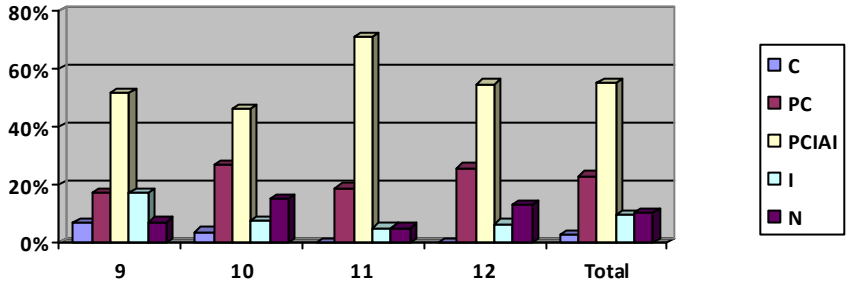

Figure 2 Success distributions of the student answers belonging to the second question

When Figure 2 is analyzed, it has been observed that more than half of all students have drawn visuals reflecting partially correct but also alternative ideas. It has been determined that approximately one fourth of them have partially correct perceptions. When the grades are

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compared, no evident success difference has been determined. The example drawings belonging to some students have been presented in the Figure 3:

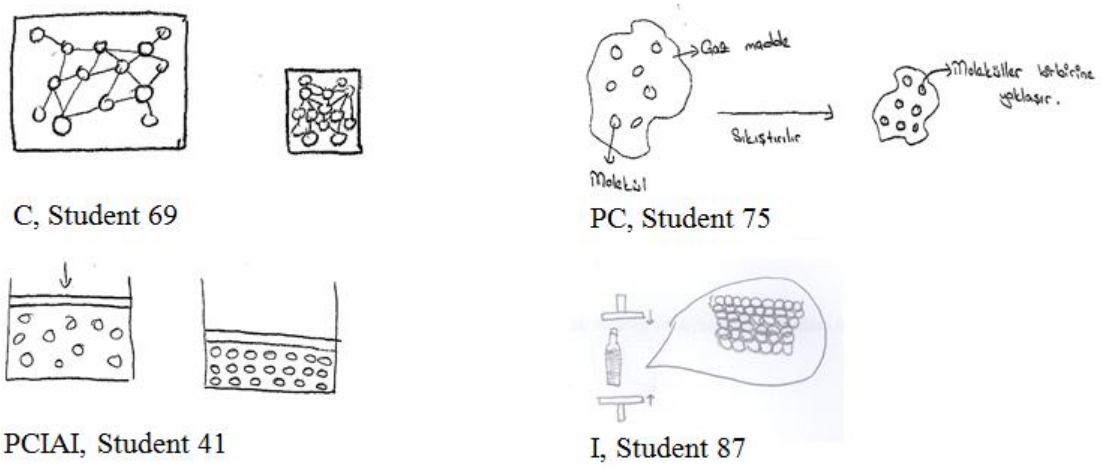

Figure 3 *Example student drawings*

II- Students' Mental Models

The student mental models revealed as a result of the comparison of the descriptive and visual answers have been given in the Figure 4.

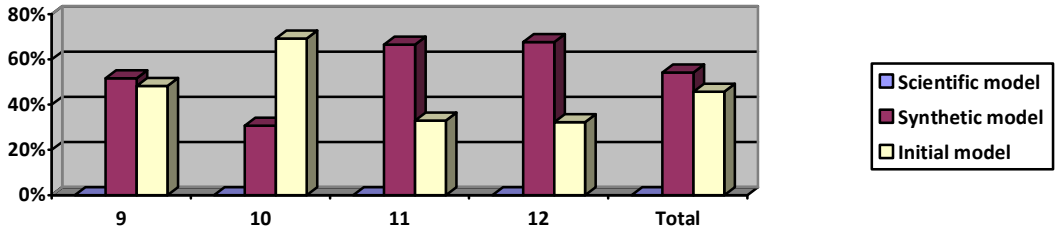

Figure 4. *Percentage distributions of student mental models*

As it has been observed in the Figure 4, none of the students has scientific model related to the contraction of the matter. The mental model that the students at the 9th, 11th and 12th grade levels have is mostly synthesis model. The mental model that the students at the 10th grade levels have is mostly initial model.

DISCUSSION AND CONCLUSION

This study has been executed with the aim of examining the mental models of the high school students related to the contraction of the matter. The obtained findings are general and are limited with the questions asked.

When the findings are examined, the situation attracting attention shows that even the perceptions of the students related to the contraction of the matter are generally scientific; they include insufficient or alternative ideas. Some students know the truth that the molecules get closer during the contraction of the matter, however they constraint this situation with the gaseous matters. This situation shows that the ones observed at the macroscopic level have not been degraded into the microscopic level. Some students express or draw that the molecules get closer to each other during the contraction process, but in the continuation they make expressions or drawings showing that there is an increase in the number of the molecules. The findings obtained coincide with the results of some studies taking place in the related literature (e.g. Ayas & Özmen, 2002; Novick & Nusbaum, 1978, 1981).

When the mental methods related to the contraction of the matter are examined, it has been understood that the students have synthesis and initialmodels. That the students mostly have synthesis model, it has made think that the information obtained before the courses intertwine with the school knowledge or the knowledge presented in the courses are not sufficient and even it

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includes alternative ideas. In fact, what is expected is that the students get the school knowledge and reach to the mental model. It is believed that the learning environments have deficiencies in the structuring of the students' mental models in a scientific way. This situation is also mentioned in other studies dealing with the different concepts (e.g. İyibil & Sağlam Arslan, 2010; Kurnaz & Değermenci, 2012).

From these results, it is proposed that the student mental models should be considered in the process of designing and application of the learning environments and for this, multidirectional presentations should be given places. In this meaning, it is proposed to use the training method and techniques that will develop especially the spatial thinking and drawing characteristics of the students in the course lecturing.

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