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**MODELS DRAW BY STUDENTS RELATED TO SOLID OBJECTS****KATI CİSİMLERLE İLGİLİ OLARAK ÖĞRENCİLER  
TARAFINDAN ÇİZİLEN MODELLER****Arş. Gör., Şenol KAYA****Arş. Gör., Refik DİLBER****Arş. Gör. İbrahim KARAMAN****Öğretmen Derya ŞİMŞEK****Atatürk Üniversitesi, Kazım Karabekir Eğitim Fak., Fizik Böl., 25240 – Erzurum****ABSTRACT**

In this study, we have investigated students' understanding able to drawing model regarding heated body. The students were presented two metal rod one of which was being heated by a heater while no action was taken for the other one. The students were then asked to draw what they thought was inside the metals rod. Then all drawings were collected, evaluated and they were grouped in accordance with similarities. We determined five type model drawing in secondary school level and two type model drawing in elementary school level. We can see that 33% of students in elementary and 30% of students in high school level were not able to draw any model. As a result, it is shown that methods of concept teaching have not been attached importance with modelling in education.

**Key words:** Modelling, physics education, modelling abilities

**ÖZET**

Bu çalışmada, öğrencilerin ısıtılan cisimlerle ilgili olarak model çizibilme anlayışları araştırıldı. Çalışmada biri, bir ısıtıcı kaynağı ile ısıtılırken diğeri üzerinde her hangi bir etki yapılmayan iki metal çubuk öğrencilerin karşısına konuldu ve metal çubukların içinde nasıl bir olayın olacağını resmini çizmeleri istendi. Daha sonra bütün çizimler toplandı ve benzerliklerine göre gruplandırıldılar. Bu gruplandırma sonucunda lise seviyesinde beş tip model çizimi yapılırken ilköğretim seviyesinde iki tip model çizildiği tespit edilmiştir. İlköğretim seviyesinde öğrencilerin %33' ü, Lise seviyesinde ise %30'u herhangi bir model çizememişlerdir. Sonuç olarak eğitimde modelleme ile öğretime yeteri kadar önem verilmediği tespit edilmiştir.

**Anahtar Kelimeler:** Model çizme, fizik eğitimi, model çizme yeteneği

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## 1. INTRODUCTION

There are many ways of gathering information about student's understanding of scientific phenomena (White and Gustone, 1992). The great majority of the methods that have mostly been used by science educators rely on students being able to talk about or write about science. Among these are the oral interviewing of students (Osborne and<sup>1</sup> Gilbert,1980), gathering students' writing responses (Leach et al. 1995), recording students' spontaneous conversations (Tunnicliffe and Reiss 1999a) and getting students to construct concept maps (Novak and Musonda 1991). Each of these approaches has its own particular advantages and disadvantages and useful distinction has been made between phenomenological and conceptually based approaches (Driver and Erickson 1983), though the choice of these labels is perhaps less than ideal.

Phenomenological approaches entail presenting students with events or systems and then asking them to make predictions and give explanations for how things happen. In these approaches, the student, to a large extent, selects the language used to communicate their knowledge and understanding. Conceptually based approaches entail presenting students with words and then asking them to perform specific tasks with them. While conceptually based approaches are value, they suffer from a fundamental limitation (Tunnicliffe and Reiss, 1999). Cox (1989) discusses some of the ways in which children can be asked to drawings.

The ways in which students use models to learn science and mathematics have interested teachers and researchers for over 30 years (Harrison and Treagust, 1998). Models are defined by their representational links to the world, suggesting that a variety or family of models can be used to capture different aspects of the phenomena of interest. (David et all, 1996).

Recent studies suggest that children perceive science largely as a passive process of observing and recording events. In their view, good scientists are those who attend acutely and make accurate and complete records of all that observe (Carey et all. 1989; Songer and Linn, 1991). Yet, accounts of the work of professional scientist paint a far different picture, one dominated by building and testing models. In this accounts, model building and testing are essential to the development of theory- models both channel observations and drive the result interpretations (Hestenes, 1992).

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Why are charts of the solar system and plant life cycles, model hearts and electric motors, models of molecules and cells, equations, graphs and computer simulations so popular in classrooms? And who would think of building a house or boat without drawing plans or making a scale model? All these models and pictures exist because imaginative people enrich their work and leisure with artistic, educational and technological devices.

Men think in terms of models (Deutsch, 1953). Modelling is a fundamental intellectual scientific activity which enables people to simplify the complexities of the world (Paton, 1996). Models are integral to thinking and working scientifically and it can be argued that science and its explanatory models are inseparable because models are science's products, methods and its major learning and teaching tools (Gilbert, 1993). Models are accessible and teachers know that students enjoy playing with them (Harrison, 1996) and that modelling is an important constructivist teaching strategy. Over the past 30 years, modelling has been researched from the philosophy of science (Black 1962, Hesse 1963), epistemology (Gilbert, 1993; Grosslight et al. 1991), explanations (Gilbert, 1998a, 1998b) and classroom practise (Hodgson, 1995; Wells et. all. 1995; Holloun 1996).

School students and some teachers think about science models in mechanical terms and believe that 'scientists know the answers' (Gilbert, 1991; Abell and Roth 1995). But models are not 'right answers', rather, they are the methods and the product of science and it is quite impossible to teach and learn science without using models. How can we describe or explain atoms, genes, chemical reactions or continental drift without using one or more models? Teachers consistently use models to explain immaterial processes like equilibrium and none- observable entities like electrons flowing in a wire (e.g. a water circuit). Can students understand the carbon cycle, blood circulation or chemical families without diagrammatic models? And what do teachers do when they see the worried looks on their students' faces in the middle of an abstract explanation? They reach for an analogy or a model and this may explain the frequent use of analogical models in science lessons.

### **1.1. Learning with Models**

Model-based reasoning does not develop over the short term. It likely unfolds over the course many years and may fail to develop at all unless it is carefully fostered and diligently practiced. To understand how model – based reasoning develops, we would need to implement and then study long-term changes in classroom practices and student learning. This study is a modest beginning to such an enterprise. In this short –term

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investigation, we explore how first –and second – grader’s conceptions about models evolved during a model-based design task; these are children considerably younger than those who have participated to date in studies of model – based reasoning (Grosslight et al.,1991; Stewart et al., 1992).

Of the models used to represent science concept, analogical models are frequently used to model macroscopic and symbolic entities (Gabel et al. 1992). Analogical models can be concrete (Keenan et al. 1980), abstract (Ogborn et al. 1996) or mixed (Keenan et al.1980). Two types analogy operate between the analogical model and the target concept: surface similarities that quickly attract students to the intended analogy and deep systematic process similarities that develop conceptual understanding. The desired concept learning almost always lies in the systematic process similarities and students usually need guidance in mapping these relationships (Gentner, 1983; Zook 1991). This partly explains Glynn’s (1991) claim that analogies are ‘two-edged swords’ students map the obvious analogy when the teacher expected them to map systematic or process analogy.

Models only act as aids to memory, explanatory tools and learning devices if they are easily understood and remembered by students. Analogical models need to be familiar, logical and owned by the students. Ownership, seems to be strongest when students generate their own analogies; however, reports of student- generated analogies are rare only Cosgrove (1995) reports success at this level. Students more easily map self-generated analogies than teacher –supplied analogies because their personal analogies are more familiar and easier to apply (Zook, 1991).

Here lies the problem: Students find it hard to generate or select appropriate analogies for a given situation and are most likely to apply an analogy to a concept when the teacher supplies the analogue even though they find mapping it difficult. This highlights the need for teachers to systematically plan model and analogy use in their lessons and recommends the use of an approach involving the Focus, Action and Reflection aspect of expert teaching (Treagust et al 1998). Focus involves pre-lesson planning where the teacher focuses on the concept’s difficulty, the students’ prior knowledge and ability, and the analogical model’s familiarity. Action deals with the in- lesson presentation of the familiar analogy or model and stresses the need for the teacher and students to co-operatively map the shared and unshared attributes. Reflection is the post-lesson evaluation of the analogy’s or model’s effectiveness and identifies qualifications necessary for subsequent lessons or modifications next time the analogy or model is used.

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## 1.2. Student Modelling Abilities

Finstere (1991) argued that students should be challenged at a level that is just beyond their current intellectual achievement. This mean, psychological terms that model – based learning should be located within the students' zones of proximal development (van der Veer and Valsiner, 1991). Vygotsky described this zone as the intellectual range bounded at the lower level by what a student can do their own and at the upper level by what they can achieve with teacher cues or peer help. This is why it is so important to socially negotiate and scaffold the meaning of difficult concepts and abstract models. Vygotsky's argument is that student intellectual growth is optimised when they are challenged to do, with help, what they cannot do on their own. Perry's (1970) model of intellectual and ethical development makes similar claims and Grosslight et al's (1991) modelling levels suggest that modelling is an intellectual skill that develops with help and experience.

Studies with very young children who have received no formal teaching about thermal physics show that they have learned, by experience, that certain things feel warm to the touch and others years –old the notion of heat as a substance that could be found objects was prevalent. Thus the link is made between heat and material from which an object is made. Later at age eight it was found that the notion of heat as something later stage of development the prevailing idea is one in which heat is treated as thought it were idea is consistent with the old Caloric theory of heat which pre- dated Rumford's work. Despite fact that these studies deal with younger children, Clough and Driver (1985) found that such concepts are held by children at least up to age 16. It would appear that ideas about thermal physics are built up by experience through childhood and remain until challenged by situations that they fail to explain. It is the role of the teacher to discover the ideas held by students and to present them with concrete examples that bring about this restructuring of the world view on the concepts of thermal physics. Clough and Driver point out that this should be done by giving the students the opportunities to explore ideas in a non- threatening atmosphere

Students tend to keep to their pre-instructional ideas about force, heat or current. Empirical research shows widespread conceptual deficits (Duit and Pfundt, 1991). Physics teaching seems to put too much emphasis on solving equations and calculating numbers without securing a qualitative understanding of the key concepts. Modelling packages can help to accentuate the concept structure of a physical domain.

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## 2. AIM AND SUBJECT OF THE RESEARCH

The purpose of this research is to analyze the students' abilities to develop any model regarding solid materials and, as a result of this, to evaluate and find out whether or not the instructors provide enough or necessary sample models during the lessons. It should be clarified that we are not considering whether the models being developed are correct or not, but the tendency that the students show to make any model.

Subject of the research is to investigate how students drawing models both before and after about heating metal rods.

### 2.1. Method

This research was carried out central area of Erzurum in Turkey with an elementary and high school students. The sample covered 171 elementary and 106 high school students. The range of age was between 13 and 14 for the elementary and 16-17 for the high school students. The schools included in the sample can be rated as average considering the quality of education level relative to others in Turkey. These students had previously been supplied with adequate knowledge about heating solids by their instructors.

Two sample metal rods, one of which was being heated while no action was taken for the other one, were put in a place that can be seen by all the students in the class. Students were not examined under formal examination conditions but told not to copy one another's work. It was asked from the students to draw the effects that were being created in their minds by thinking the states of the solids just before the heating and during the heating process. Students were given about 50 minutes to complete the drawing. After, all drawings were collected by teacher and researchers. At the end, these drawings were evaluated and grouped in accordance with the similarities. From all these drawings, we identified the students' modeling about heating solids objects.

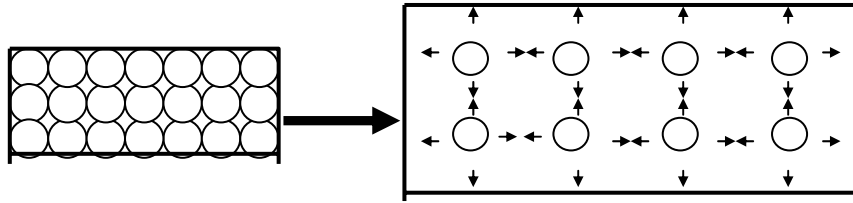
## 3. DISCUSSION

There are a lot of studies published in literature related to modelling. Two of them were published by Tunnicliffe and Reiss (1999), Harrison and Treagust (1998). For example, Harrison and Treagust studied students' understanding atoms and molecules with 11<sup>th</sup> grade chemistry students by drawing about electron cloud model of H<sub>2</sub> and ball-and-spring model for ethane etc. and Tunnicliffe and Reiss studied students' understandings about animal skeleton by drawing model with 11-16 years old students. From all

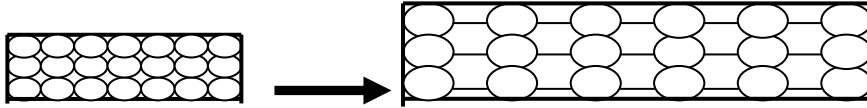
these, This study focused on children's attempts to understand the function of heated metal objects and how draw models related to these object. Most of the progress achieved by these children appears to be in coming to understand that physical models can resemble phenomena in function as well as in form.

As a result of this experiment, 5 different types of model were configured. These models are shown as following.

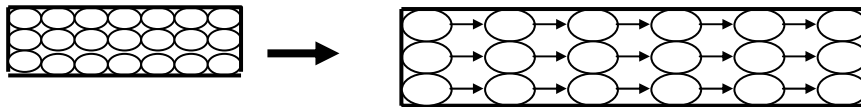
**Model 1:** All students drew this model in the sample.



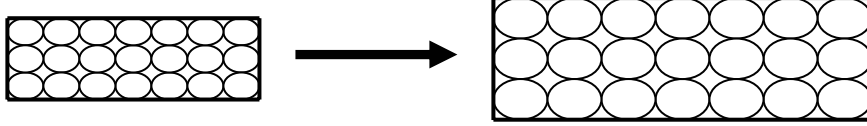
**Model 2:** This model drew by only secondary students



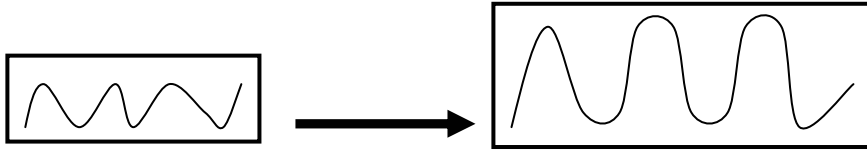
**Model 3:** All students drew this model in the sample.



**Model 4:** This model drew by only secondary students



**Model 5:** This model drew by only secondary students



We have striven to provide an objective categorization which covers all possible drawings. Clearly, the high school students not only drew more models than the elementary students but also have higher percentage for showing the ability to make a model than the elementary school students.

If we analyze the drawings made by the elementary school students, we can see that 33 % of them were not able to make any model at all. The remaining was able to draw only 2 types of model. While 30% of all elementary school students drew the model labeled model No.1 , the other 37% drew the model labeled model No.3.

On the other hand, 30 % of the high school students could not draw any model. The remaining was able to draw the model No. 2, No.4 and No. 5 as well as the model No. 1 and No. 3. While 20% of all high school students drew the model No. 1, 16%, 8%, 19% and 7% of them drew the model No.2, No. 3, No.4 and No.5 respectively. If we analyzed the all models, first model could be thought correctly in terms of physical rules that a metal rood's volume expands when it is heated. Others can be thought incorrectly. Because, as seen in the first model, atoms of the solids object are gone away from with each others to all sides. But we aren't see this in others models.



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#### 4. CONCLUSION

This research is emphasized modeling in the elementary and high school in teaching progress. The results of this research prove that a considerable amount of students, regardless of the levels, was not able to come up with any model. In elementary levels, while %67 of them drew any model, %33 of them was not able to draw any model. In high school level, while %70 of them drew any model, %30 of them was not able to draw any model. If we look at the drawing models by students, they predicted a metal rod expands while it is heated and drew their models according to this rule. On the other hands, 30 % of the high school students and %33 of the elementary students could not draw any model. This situation can not be desirable results for education that meaning of this those students haven't any idea about the subject. We may conclude that this is due to the fact that an important amount of instructors does not pay enough attention to the importance of teachings accompanied with sample models.

Model –based reasoning is central to the practice of mathematics and science. However we suspect that model-based approaches to science instruction are not widespread either at university or high school levels, and certainly not in elementary school. Yet it seems likely that school-aged children's understanding of models is constrained not primarily maturational readiness, but rather by years of participation in settings where model construction and evaluation are valued, supported and fostered.

Particularly in Physical science, one of the main reasons for the failures is that the students are fed with only theoretic knowledge and are put to memorize scientific jargons. However, in order to assure the success, it is necessary to supply these theoretic terms with related physical examples, and with the cases that explain the interactions between these terms and the everyday life as well. In this case, the instructors not only provide more comprehensible and permanent information but also give the students opportunity to improve their intelligence and intellectual talents. Moreover, the physical science courses will be more entertaining and will surely lure more interest groups among the students. Furthermore, teaching with models will bring attentive, productive and highly imaginative successful students.

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