An Example Of Model-Teaching: Crystal Lattice Structures Of Ionic Solids

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Abstract

Because of many abstract concepts in science education, especially in chemistry education, the students have difficulty in understanding and forming a picture of them in their minds (Cady, 1997). In this study, a model-teaching example was applied for understanding the crystal lattice structures of ionic solids. For this purpose, crystal lattice structures of solids models were built by the second-year chemistry students studying inorganic laboratory course in Dokuz Eylul University Faculty of Buca Education as a laboratory experiment. In construction of the models, simple materials were used like play dough and tooth sticks. At the end of the experiment, with semi-structured questions student views were taken and analyzed qualitatively and their knowledge about the subject evaluated with worksheets.

Keywords: Teaching with models, chemistry education, crystal lattice structures of ionic solids

INTRODUCTION

Crystal lattice structures of ionic solids are a subject included in chemistry education curriculum. Students’ comprehension of this subject is one of the main teaching purposes of inorganic chemistry classes. For this reason, how to teach these structures effectively and meaningfully has become a significant issue among educators.

Model – teaching, which is a highly preferred teaching method in teaching concepts like atom and molecules (Gülçiçek et al., 2003), can also be preferred in teaching crystal lattice structures of ionic solids. Model – teaching is a teaching method used with the help of the real objects’ items which are made of the same or other samples brought to the class from its natural environment. Models, as can be larger or smaller than the actual object, a substitute can be in exactly the same size and structure with the real object (Çilenti, 1985).

Model – teaching is based on imitation. For example in an atom model, atoms can be represented as taws. Imitation holds the purpose of substantially concretization of any concrete or abstract concept and meaningfully correlating them to known items. This way, it is rewarding for students both psychologically and pedagogically (Riche, 2000). Imitation also enables students to picture the concepts in their minds and give them meaning, so it works as a bridge between old and new knowledge of the subject (Yerrick et al, 2003).

The basis of model based teaching used in science education is defined as representations of basely unknown or abstract facts. Models are also based on a demonstration emphasizing the simplified important structures of the systems (Ingham and Gilbert, 1991) or a presentation demonstrating the common features of this fact and system. The main purpose of using models in education is making the teaching of the facts that are hard to teach and learn, easier by simplifying them. Students structure the experiences they gained during the learning process in their minds. And because abstract concepts are hard to comprehend, creating sample models for these concepts can prevent the miscomprehensions to be made by students (Geban et al., 1999). Also, this teaching method increases students’ motivation and facilitates their understanding (Morgil et al., 2002).

Justi and Gilbert (2002) stated in their study that model based teaching and models have a significant role in science education and they explained the reason for this statement with these three statements:
1) Students must know the meanings, limitations and nature of basic scientific terms in the field, in other words, they must learn science.

2) Students must learn the accuracy and dissemination of scientific terms in a scientific context, in other words, they must learn about science.

3) Students must be able to create, represent and test their own models, in other words, they must learn the application of science.

Today, many of science textbooks include model examples of science concepts and focused on teaching of them. So, the science teacher candidates should be familiar with these models. But they are not given this opportunity in science class in general (Van Driel and Verloop, 1999). That’s why this study is of importance for science education.

In this study, it was aimed that the students do models of basic crystal lattice structures (bcc, fcc, hcp) by using simple materials and understand the crystal lattice structures of ionic solids (unit cell models), one of the subjects of chemistry. Also, some mistakes about crystal lattice structures the student have were examined in detail.

METHOD

In this research, the answer for the question “What are the students’ views on teaching inorganic solid-state lattice models with model – teaching method in Inorganic Chemistry Laboratory classes?” was searched. In this sense, first, semi-structured interview questions were structured. The prepared draft questions were presented to learned opinion and the interview form was given its last structure after the necessary corrections are made.

In this study, model-teaching method was used in studying the crystal lattice structures (hexagonal close-packed, face-centered cubic and body-centered cubic) of ionic solids in the inorganic chemistry laboratory course. The models were made by using simple materials like play dough and tooth sticks (Figure 1). On these models, numbers of cations and anions, coordination numbers of them and their effect on the structure and vacancy types in the structure were discussed. It was assessed whether the students understood these concepts or not with the worksheets handed out after the examination. And also, student views were taken with semi-structured questions. For sample group (N=36) in the study, Dokuz Eylul University second-year chemistry students were selected.

The interview was made with 7 second-year chemistry teaching students chosen by randomization. These students were informed with a pre-interview and this way a voluntary participation was provided. Interviews were divided into 10 minute sessions in which the students were asked the questions stated in the interview form.

During the process of data analysis, descriptive analysis was used. In descriptive analysis method, data are described logically and put in writing. Later, they are rendered, cause and effect relations are determined and the results come out (Miles and Huberman, 1994; Yıldırım and Şimşek, 2000).
RESULTS AND DISCUSSION

Students seem to be affected positively from using model – teaching method in experiments (Figure 2). The reliability of the qualitative analysis were made by researchers and field experts and found to be 0.83. This result showed that the analysis was reliable in 83%.

![Figure 2: Negative views of students on model – teaching](image)

In Table 1, positive views given by students as a result of the interview, on the model – teaching experiment they made on crystal lattice structures of ionic solids. The themes showed on the table are determined and controlled after the interview with the help of learned opinion. Frequency(f) and percentage(%) figures are determined according to the total amount of views given on each theme.

**Table 1**: Student views of students on model – teaching

<table>
<thead>
<tr>
<th>Themes</th>
<th>f</th>
<th>%</th>
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<tbody>
<tr>
<td><strong>Molecule Model</strong></td>
<td></td>
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<tr>
<td>“I mean the molecule models now have a better image in my head. I found it rewarding.”</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td><strong>Experiment</strong></td>
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<tr>
<td>“The important thing here is not the simplicity or complexity of the experiment I mean I don’t think that just because we are university students we have to carry out complex experiments I mean it is not important I think it was good.”</td>
<td>33</td>
<td>65</td>
</tr>
<tr>
<td>“As we process in this experiment we gain more information about the structures that create the molecules because we produce them ourselves and it is more fun as a game. Also this way you don’t forget what you created I understood easier.”</td>
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<tr>
<td><strong>Three-dimensional thinking</strong></td>
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<tr>
<td>“There was nothing in my mind for complex molecules when I saw on the computer it started to come to my mind, after this experiment I can fully picture it in my mind. I can explain the three-dimensional figures.”</td>
<td>13</td>
<td>25</td>
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</table>

Table 1 includes the positive views gathered from the students after creating molecule model samples using play dough and frequency and percentage figures. Some negative views given by the students regarding the same themes are stated below.

Six views were gathered from students on experiment theme and some of these views are:

**Student 1**: There are boring experiments and the experiments that keep us waiting are boring. For example the experiments those require heating, to wait for something to heat up for 10-20 minutes is boring.

**Student 2**: What I can tell as inefficiency in this experiment is that we took the molecular size using play dough only approximately here.

Mistakes determined in worksheets related to Crystal Lattice Structures of Ionic Solids

According to worksheets applied after the experiment and then evaluated; students are having a hard time with coordination numbers. According to the data; there is no student to answer to coordination numbers for bcc, fcc and hcp structures in a fully correct way. As the answers given by the students are analyzed, most students stated it as 2-4-6 (3%), 8-6-4 (22%) or 4-6-8 (10%).
figures given in the parenthesis represent the in sample percentage of the students who answered it as in the examples. According to these figures; students are not taking the cation and anion numbers in the unit cell into account. In 8-6-4 example, coordination number for bcc structure is correct. Students who only know this structure’s coordination number correctly are 45% of the sample. One can say that most of the students can understand this structure.

When the students were given only the images of these structures and they were asked to guess which cell it was, about one fourth of 74% of the students turned out to know the structures correctly as names and formulas. With this result, one can say that students to see the structures three-dimensionally during the experiment is rewarding. According to the mistakes done by 26% of the students, it was assessed that for hexagonal close packed some students used statements such as “tetragonal or tetrahedral”. Also some of the students were assessed to answer to the body-centered cubic structure with statements such as “simple cubic structure” or “cube”.

Students were given the cubic structure images of CsCl and ZnS in the worksheet and when they were asked the number of cation and anions in the unit cells, the spaces that cations take place in structures and crystal lattice unit cell types of these solids, they answered for the cation and anion numbers correctly by 65%. When the answers given for the spaces are taken into account, this ratio decreases to 42%. And 19% of the students didn’t answer this question at all. And in the crystal lattice structures, 29% of the students determined the cell type of ZnS structure as hexagonal. And this shows that students are mistaken about this structure.

Considering the results of the study, it can be suggested that the experiment conducted was evaluated as positively. It was found that especially using simple materials the students applied the experiment happily and without any difficulty. And also the students expressed to a large extent that they developed their 3D thinking minds. So, it was understood that model-teaching which is a student-centered teaching method concretizes the abstract concepts and it is a considerably useful teaching method (Treagust et al., 2002).

REFERENCES


