Teaching Of The Concept Of Enthalpy Using Problem Based Learning Approach

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Abstract

The purpose of this research is to investigate the effect of the problem-based learning on students' academic achievement regarding to the concept of enthalpy, which is one of the most important in thermodynamics, and concepts of difficulty in teaching, and attitudes towards laboratory applications. The subjects were 31 third-year undergraduate students enrolled to a physical chemistry laboratory-I course in the Department of Chemistry Education in the spring semester of the 2011/12 academic year at Faculty of Education from a Turkish University. The students in groups of single and dual, every week of ten weeks for two groups participated of the same experimental study. The enthalpy concept test was administered at the beginning and the end of each pre-and post-test experimental study and repeat the test was to determine the level of reliability and durability after treatment. Statistical analysis of experimental data, paired t-test was applied in the confidence interval of 0.05. At the end of the application of problem-based teaching model, the students’ academic achievement gap between pre-test scores and post-test scores was found to be a statistical significant difference.

Keywords: problem-based learning; enthalpy; thermodynamics

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1. Introduction

A rapidly globalizing world brings to reproduce the production, distribution, use, storage, and exchange regarding the all known. This rapid process of change provides students and faculty who are ready to process information passively participate in the training system replace and the students participate actively in the learning process. This situation cause and effect relationships between events can produce knowledge they have learned to new situations by applying solutions to problems (Ozyalcin-Oskay, 2007).

Chemistry is an important field of science and students often have difficulty understanding abstract concepts, because chemistry curriculum is composed of many abstract concepts or theories it is very difficult to be understood by students (Sirhan, 2007; Taber, 2002; Zoller, 1990). For this purpose, many chemistry concepts in relation to the teaching and learning process, for example, many researches have been done on issue the mole concept, atomic structure, thermodynamics, electrochemistry, covalent bonding, ionic bonding, and gases for some decades (Gilbert & Watts, 1983; Dogar et al., 2011; Gurses et al., 2002; Ozmen & Ayas, 2003). It was reported that students prefer algorithmic learning and procedural knowledge to conceptual learning chemistry concepts (Scalise et al., 2006; Nurrenberg & Pickering, 1987).

The first law of Thermodynamics includes many energy-related concepts such as energy, heat, temperature, enthalpy, work, internal energy were carried out in the last thirty years (Loverudeet al., 2002; Tatar, 2007; Williams et al., 2010).

Some researchers have investigated the concept of enthalpy (Carson & Watson, 1999; Sozbilir, 2001 and 2004; Tatar, 2007; Thomas & Schwenz, 1998). In their researches, although the students’ information about the laws of thermodynamics has been researched, however, few researches have been explored the concept of enthalpy. In this study, the concept of enthalpy, which is the important concept of the first law of thermodynamics, was instructed by problem-based learning method, and investigated on both the effect of academic achievement and attitudes towards chemistry.

Constructivism is learning theory and based on active student learning. Students face new situations taking into consideration the concepts learned in the existing schema of the concept of activity of the mind (Bodner, 1986). Constructivism in classrooms can be applied by different teaching methods such as 5E, cooperative learning, project-based learning, and problem-based learning. Problem-based learning based on scenarios, which are in a situation with a real or realistic recognition of the problem variables, improves students’ communication skills and a learning method that allows developing a practical solution related to the problem situation (Duch et al., 2001; Savery, 2006; Sozbilir, 2004; Carson & Watson, 1999).

Problem-based learning (Thomas & Schwenz, 1998);
  i. Provides active learning,
  ii. Gives the group work skills,
  iii. Problem-solving skills improves
  iv. Science literacy increases
  v. Enhances the scientific process skills
  vi. Permanence of knowledge increases,
  vii. Increases the self-learning skills,
  viii. The critical thinking skills increases
  ix. Communication skills develops.

The aim of this paper is to investigate the effect of the problem-based learning on students’ academic achievement regarding to the concept of enthalpy, which is one of the most important in thermodynamics, and attitudes towards laboratory applications. In addition, the students’ views of problem based learning (PBL) were investigated.

2. Method

In the present study, as a research model, “one group pretest-posttest design” was used to determine the effectiveness of problem-based teaching method (Kaptan, 1998). Research group or groups without a control group
in this model are taken; Pretest is administrated to subjects before treatment. After the treatment, the subjects are tested again and the effectiveness of the method is evaluated by the difference between these two tests.

The subjects were 31 third-year undergraduate students enrolled to a physical chemistry laboratory course in the Department of Chemistry Education at Faculty of Education from a Turkish University during the spring semester.

Subject of this study is to examine teaching of the concept of enthalpy, which is one of the basic concepts of thermodynamics, by using problem-based learning model.

1. Is the students’ academic achievement levels related to the “Enthalpy” increased by problem-based learning before and after treatments?
2. After treatments, is there any difference between post-delayed test and post-test scores?
3. What are students’ attitudes towards laboratory practices?
4. Is there any misconception related using coffee-cup type calorimeter, which is the commonly used and consist of adiabatic wall between system and its environment?

The applications were carried out during spring semester as a total of ten weeks. The groups consist of two students. The same experiment was repeated in every week and the first group participated to the next group’s argumentation. In the experiment, the concept of enthalpy was discussed by using coffee-cup type calorimeter and calculations were made. An alternative enthalpy variation measurement method was asked for. Therefore, for an alternative calculation of the enthalpy value, coffee cup typed calorimeter consisting outer adiabatic cup and one diathermic beaker one within the other instead of a single cup of outer adiabatic wall was used.

2.1. Thermochemistry concept test

The test was prepared considering the literature and calculated the reliability of $\alpha = 0.85$. The test was administered to the sampling as a pre-test before the treatment and post-test after the treatment. To understand the permanence of the concept of enthalpy, the test was repeated after three weeks. The analysis of student answers was done by using paired t-test in $\alpha = 0.05$ significance level.

2.2. Attitude scale toward chemistry

The previously developed scale (Geban, Ertepınar, Yılmaz, Altın, & Sahbaz, 1994) was used to measure students’ attitudes toward chemistry as a school subject. This scale consisted of 15 items in 5-point Likert type scale. The reliability of scale was found to be 0.83. This test was given to students’ in-group after the treatment.

2.3. Scales Specific to Students’ Views of PBL

To obtain the students’ perceptions of PBL was administrated four different scales, Peer Evaluation Scale (PES), Self-Evaluation Scale (SES), Tutor’s Performance Evaluation Scale (TPES), and Students’ Evaluation of PBL Scale (SEPBLS), respectively (Gurses et al., 2004). Some of them consist of three-point-Likert type items and the scales include essay-type item for getting students ideas. These scales were done after treatment.

The obtained data was examined by using SPSS 16.0 (Statistical Package for Social Sciences).

3. Result and Discussions

It is found that there is a significant difference between pretest scores and posttest scores at the end of the application of problem-based teaching model ($t_{30} = -2.22$, $p < 0.05$ see Table 1)

<table>
<thead>
<tr>
<th></th>
<th>$\bar{X}$</th>
<th>S</th>
<th>sd</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>31</td>
<td>45.45</td>
<td>21.57</td>
<td>-2.22</td>
<td>.033</td>
</tr>
<tr>
<td>Posttest</td>
<td>31</td>
<td>57.59</td>
<td>25.68</td>
<td></td>
<td></td>
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</tbody>
</table>
After a three-week period, in order to investigate the permanence of the knowledge, the last test was repeated and the results are shown in Table 2.

| Table 2. Post-delayed test results |
|---|---|---|---|---|
| N | X | S | sd | t | p |
| Posttest | 31 | 57.59 | 25.68 | 30 | .742 | .464 |
| Post-Delayed test | 31 | 61.27 | 23.69 | |

After the implementation of the test, there was no any difference between the posttest and post-delayed test scores ($t_{30} = 0.742$, $p > 0.05$). This implies that the permanence of the knowledge is not changed a statistically significant difference.

### 3.1. Students’ views of PBL

According to students’ views on the method used, most students have had positive thoughts about the particular period and aspect of problem based learning to learn the very simplicity and stated that solved a problem. However, they were reported partially self-competence.

Aspects of their own attitudes and behaviors of students in the learning process, students’ self-confidence and research skills and group working skills prompted, especially Vygosky’ stated that “the students aware of their arrival in blind spots” and with it also reported an increase in the scientific process skills.

Group studies were examined students’ behaviors and attitudes towards the group, including increased adherence to the positive development of communication and a positive commitment to learning to occur improved and the group formation process has been made very important contributions according to students.

Students views on teachers during problem-based learning process is examined that they have a positive attitudes. They say, “Teacher carried out a willingness to work, used the method effectively, students’ interested increased and provided positive contributions for each teams.”

At the end of the application are examined students’ attitudes towards chemistry and chemistry to increase significantly with a very important place in their lives, and learning that laboratory applications, requests, and especially the more eagerly participated in discussing the negative attitudes expressed decreased and scientific issues.

In addition, the students’ misconceptions related to the concept of the enthalpy were revealed as bellows. The misconceptions consist with the literature (Sozbilir, 2001; Carson & Watson, 1999; Yalcinkaya et al., 2009).

i. Heat exchange.
ii. The heat capacity.
iii. The difference between the energy changes.
iv. Change of internal energy.
v. The stored energy within a substance.
vi. One of the reaction heats.

### 4. Conclusions

From this study, it can be summarized as follows:

- PBL students have high scores after the treatments.
- PBL helped students to improve their science process skills.
- Students’ have positive perceptions not only attitudes towards the chemistry but also problem based learning. The results consistent with the literature (Gurses et al., 2007; Tatar & Oktay, 2008).
- Students recognized the difference between enthalpy and enthalpy change and also a common assumption related coffee cup calorimeter, which is assumed as system and environment, is one within the other.

### References


