Developing worksheet based on science process skills: Factors affecting solubility

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Contents

Abstract

The purpose of this study is to develop a worksheet about the factors affecting solubility, which could be useful for the prospective science teachers (PST) to remind and regain their science process skills (SPS). The pilot study of the WS was carried out with 32 first grade PST during the 2007-2008 academic year in the education department at Giresun University, Turkey. Action research methodology was used in this study. Thoughts from experts were received during the development of the worksheet. The study had some limitations in providing concrete evidence as to how the WS based on SPS effects the PST SPS, since the paper is a suggestion. For this reason, to investigate its effectiveness in a comparative manner, further research should be undertaken.

Keywords: Teacher Training, Science Process Skills (SPS), Worksheet, General Chemistry Laboratory

Introduction

Worldwide society is quickly improving and increasing because new ideas are continuously being tested at research institutions or elsewhere. It is impossible for students to grasp all information in any academic discipline. Therefore, teaching how to reach information, instead of teaching all that is known, is common in current educational systems (Ayas, 1995; Varış, 1996; Demirel, 1998; Mallinson & Mallison, 1998).

In our country, the science and technology curriculum aims to educate individuals who are aware of science concepts and principles affecting their life and also conscious of individual and social responsibilities. This goal is within Turkish National Education's main aims, which was restructured in 2004. When the new science and technology program is examined, it is possible to see that "educating all students to be scientifically literate regardless of their individual differences" is among the most important aims of education. Scientific literacy is defined as developing individuals' abilities of investigating, questioning, critical thinking, problem solving, decision making, life-long learning, and acquiring a set of abilities, attitude and understanding of science to sustain individuals' curiosity about their environment and the world (MNE, 2006). Educating scientifically literate individuals, however, is possible not through passing knowledge onto individuals, but through teaching them and enabling them to reach scientific knowledge. In this respect, the place of science process skills is prominent and important to teaching ways of reaching knowledge. The students need the process skills both when doing scientific investigations and during their learning process (Harlen, 2000; Taconis, Ferguson-Hessler & Broekkamp, 2000). For these reasons, students should be informed about the importance of SPS.

Science process skills are (SPS) defined as the adaptation of the skills used by scientists for composing knowledge, thinking of problems and making conclusions. As a society, the goals is for each individual to be scientifically literate (MNE, 2006; Temiz, 2007). Çepni et al. (1997) also defined SPS as facilitating basic activities in regards to learning science, gaining research method and techniques, helping students to be active and to make learning permanent. SPS are classified as basic (observation, testing, classification, relating number with space, and recording data), causal (prediction, determination of variables, and drawing a conclusion) and experimental (making a hypothesis, modeling, doing the experiment, changing and testing the variables, and making a decision) (Ayas et al., 2007; Kanlı & Yağbasan, 2008; http://www.tufts.edu/as/wright_center/products/sci_olympiad/pslsl_training_hammond.pdf).

SPS ensures that students have the meaningful learning experience. SPS has a great influence on science education because they help students to develop higher mental skills, such as critical thinking, making decision and problem solving (Lee, Hairston, Thames, Lawrence & Herron, 2002; Tan & Temiz, 2003; Arslan & Tertemiz, 2004; Koray, Köksal, Özdemir & Presley, 2007).

Many researchers have investigated studies related to SPS in science education (Lazarowitz & Huppert, 1993; Brotherton & Preece, 1995; Harlen, 1999; Beaumont-Walters & Soyibo, 2001; Huppert, Michal, Lazarowitz, 2002; Tan & Temiz, 2003; Harrell & Bailer, 2004; Saat, 2004; Monhardt & Monhardt, 2006). Some recent studies indicated that the laboratory practices had great influence to increase students SPS (Aydoğdu, 2003; Tatar, Korkmaz & Şaşmaz Ören,

2007; Kanlı & Yağbasan, 2008). What attracts the researchers' attention is the small number of studies carried out on the SPS of teachers and prospective teachers (Farsakoğlu, et all, 2008; Karslı, Şahin & Ayas, 2009). In their study, Farsakoğlu and others (2008) determined that senior prospective teachers explaining SPS theoretically had difficulties when transferring the theoretical knowledge into the practical applications and confused it with concepts like Bloom's Taxonomy and Piaget's Formal Operation Stages. Considering that teachers are the main source in educating individuals, it is inevitable that there is a need for current teachers and prospective teachers to possess SPS.

SPS are used in real life as well as in science. Students are required to explain how real life events occur. SPS involves creativity and critical thinking along with scientific thinking. It is known that those who can think creatively and critically are an important factor in the development of a country. Aktamış and Ergin (2007), aimed to determine the relationship between SPS and scientific creativity, and they found a meaningful correlation between the two. Therefore, it is possible to say that SPS can be thought as a measurement of creativity in making scientific discoveries and contributing to countries' development. In order to scientifically educate creative individuals, it is necessary to improve students' SPS. Teachers play an important role for teaching SPS to students through arranging learning activities, determining the development of students' SPS and teaching how to reach scientific information (Ash, 1993; Harlen, 1999; Bağcı Kılıç, 2003; Arslan & Tertemiz, 2004). PST should be encouraged to design activities aiming to improve their students' SPS development in the future.

The aim of this study is to develop a worksheet based on science process skills about factors affecting solubility in chemistry laboratory practices. In order to have effective results from laboratory practices, students should benefit from using worksheets. The worksheets are developed to meet needs in the learning environment and also used for different purposes according to researchers' needs or aims (Kurt 2002, Gönen & Akgün, 2005; Ünal & Ergin, 2006). WSs are also used for teaching science concepts (Coştu, Karataş & Ayas, 2003; Çalık, 2006; Ünal & Ergin, 2006). Some researchers benefit from worksheets improvement of the high and elementary school students' SPS (Saka, Akdeniz & Enginar, 2002; Dökme & Ozansoy, 2004; Aktamış & Ergin, 2007; Kanlı & Yağbasan, 2008). But WSs were not developed in order to be aware of and improve student teachers' SPS.

Methodology

This research study was carried during the academic year of 2007-2008 at the department of education, Giresun University, Turkey. Action research methodology was used in this study. Action research methodology is defined as studies made by researchers in order to solve problems (Cohen & Manion, 1989; Çepni, 2007). During laboratory sessions, researchers identified those PST that had difficulty in chemistry laboratories when transferring the SPS into practice. Action research methodology is defined as studies made by researchers in order to solve problems (Cohen & Manion, 1989; Çepni, 2007). A worksheet based on SPS, which could be useful for PST to support their awareness and knowledge of SPS, was developed about factors effecting solubility. While the worksheet was developed, these next steps were taken:

1. A topic was determined for preparing the worksheet.

2. Which SPS could be gained from the worksheet were confirmed.

3. A draft of the worksheet was prepared.

4. Experts' input was solicited and received for consideration.

5. The worksheet was revised according to experts' recommendations.

6. The worksheet was applied as a pilot study to PST.

Pilot Study: A pilot study was carried out with 32 first grades PST. Four groups, consisting of 5 PST and two groups of 6 PST, were formed. The PST first encounter SPS when they take the science teaching laboratory application – I lesson. Related information about SPS, such as identifying and controlling variables, formulating and testing hypotheses, operational describing, experimenting, and commenting variables were explained to the PST in the pilot study about 50 minutes before the worksheet was applied. Worksheets were handed out to each PST who completed the worksheet according to the following steps. Application of the pilot study took 90 minutes.

1.1. Worksheet Discription

The worksheet was composed of four parts, which are defined in details below:

First, a cartoon character captures students' attention. This cartoon character gives students information about the subject. The application starts with an inquiry:

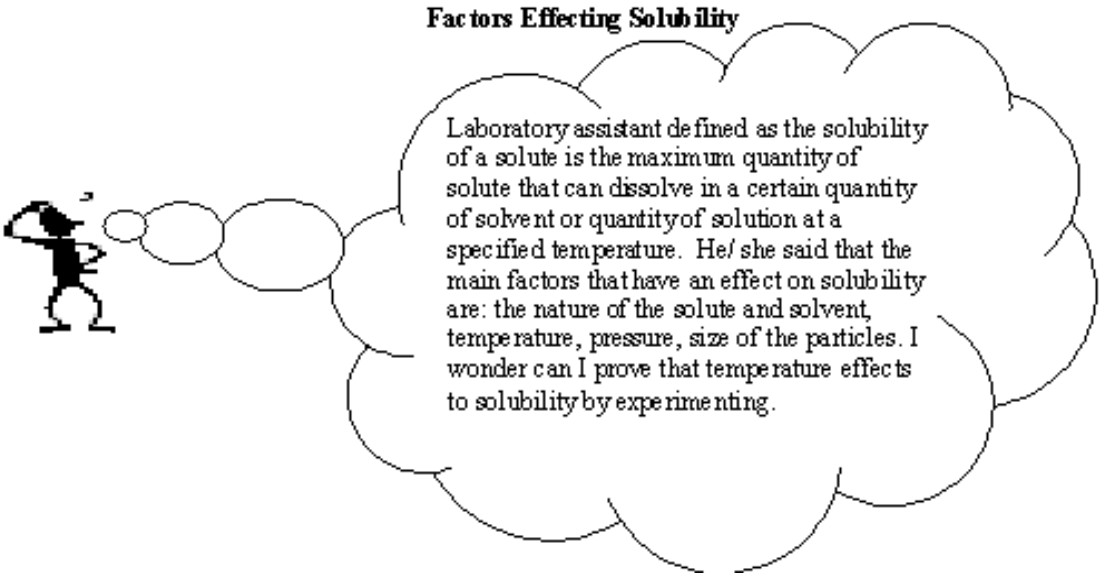

Figure I. The first part of the worksheet

In the second part of the worksheet, laboratory equipment and chemicals, that PST should know, are given. PST should write the names of certain equipment and draw pictures others whose names are given. Questions, such as designing an experiment and associating science with daily life, are also asked to gain SPS like predicting, drawing a conclusion, and planning of experiment.

Equipments:
Experiment tube, beaker, thermometer, scale, nuke funnel, tap, glass bar, clamp, graduate, amyant, heater, distilled water, $CuSO_4$. $5H_2O$, H_3BO_3, $(NH_4)_2SO_4$, K_2CrO_4, KNO_3, NaCl.
Fill in the blanks below the name of the experiment equipments on the pictures.





....

1. How can you desing an experiment which explaines the relationship between the solubility and temperature?

. . . . . .
.....
.....

2. Can you give examples about the effects of temperature on solubility?

. . . . . .
.....

.....

Figure II. The second part of the worksheet

I**n the third part of the worksheet**, activities for PST include formulating hypotheses about the experiment, identifying variables, designing the experiment by using variables, observing the experiment, saving and making a data table, and drawing a graph by using data, interpreting the graphs, and comparing formulated hypotheses and results of the experiment.

It is aimed at SPT to bring in SPS, such as observing, measuring, using relationships, predicting a conclusion, communicating, identifying and controlling variables, formulating and testing hypotheses, experimenting, and drawing and interpreting the graph in this part of the worksheet.

1. **To test 'temperature effects to solubility':**

Make a hypothesis: ……
. . . . . .
……

Write depended variable:
……

Write independed variables:
……

Write controlling variables:
……

4. Please write experimental details bu using variables defined in the experiment, which give information about how you carried out the experiment

5. Please write observations and provide data collected in the experiment

……
. . . . . .
……

6. Please draw a table by using data collected in the experiment

7. Please draw a graph by using the data from the table

8. Make comments on your graph and compare your comments with the original hypothesis and results in the experiment

. . . . . .
……

Figure III. The third part of the work sheet

In the fourth part of the worksheet, there are questions related to daily life and basic ideas about experiments.

1. To test 'temperature effects to solubility':

Make a hypothesis: .....
. . . . . .
.....

9. Answer these questions

a) When you shake the coke, it is froth. I wonder whether this is related with experiment. Please write your thoughts below.

. . . . . .
.....
. . . . . .
.....
. . . . . .
.....

b) What is the reason for a fish to live in the deeper parts of the sea?

. . . . . .
.....

c) Please write what you think about the WS. Please make clear statements and write down if you want to add something else

.....

Figure IV. The fourth part of the worksheet

Implications for Effectiveness of Worksheets based on SPS and Research

To teach factors affecting solubility and allowing PST to gain SPS, a worksheet based on SPS is illustrated here. However, the study has some limitations in providing concrete evidence of how it effects PST' SPS, since the paper is merely a suggestion. For this reason, to investigate its effectiveness in a comparative manner, further research should be undertaken. It is believed that only one worksheet was not enough to gain SPS. For this reason, worksheets based on SPS about variety topics should be developed for laboratory activities in physics, chemistry, and biology and the effectiveness of worksheets should be investigated. Parts of this worksheet may be changed to meet the needs of sample.

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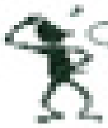
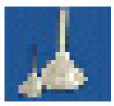
Appendix: Worksheet based on Science Process Skills

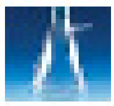
Çözünürlüğe Sıcaklığın Etkisi

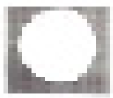


Öğretim elemanı, çözünürlüğü belli bir sıcaklıkta 100 gr çözücüde çözünebilen maksimum madde miktarı olarak tanımlamıştır. Maddelerin çözünürlüğünü; madde cinsi, sıcaklık, basınç, ortak iyon ve yabancı iyon değişkenlerinin etkilediğini söylemiştir.
Acaba sıcaklığın çözünürlüğü etkilediğini bir deney yaparak ispatlayabilir miyim?

Deney için gerekli malzemeler ve kimyasallar :
Deney tüpü, beher, termometre, terazi, bunsen yakıcı, tüp, spor, kıskaç, mezür, amyant tel, süzgeç, saf su, $CuSO_4 \cdot 5H_2O$, H_3BO_3, $(NH_4)_2SO_4$, K_2CrO_4, KNO_3, NaCl
Aşağıda resimleri verilen deney malzemelerinin isimlerini verilen boşluklara yazınız.







1. Siz nasıl bir deney tasarlayarak sıcaklığın çözünürlüğü etkilediğini ispatlayırsınız?

2. Günlük hayatta sıcaklığın çözünürlüğü etkilediğini gösteren örnekler verebilir misiniz?

3. Bir maddenin çözünürlüğünün belirlenmesi ve sıcaklıkla nasıl değiştiğini belirlemek amacıyla yapılan bu deneyle ilgili olarak;

Hipotezinizi kurunuz:

Bağımlı değişken: Çözünürlük

Bağımsız değişken: Sıcaklık

Kontrol edilen değişkenler:

4. Değişkenlerden faydalanarak deneyin yapılışını yazınız:

5. Deneyde neler gözlemlediğinizi ve elde ettiğiniz verileri kaydediniz:
Sıcaklık arttıkça KNO_3 çözünürlüğü arttı. Sıcaklık azaldıkça KNO_3 çözünürlüğü azaldı. 90°C maddenin tamamı çözündü. 68°C 3 birim, 58°C 5 birim 54 °C 7 birim 50°C 8 birim, çökelme olmuştur.

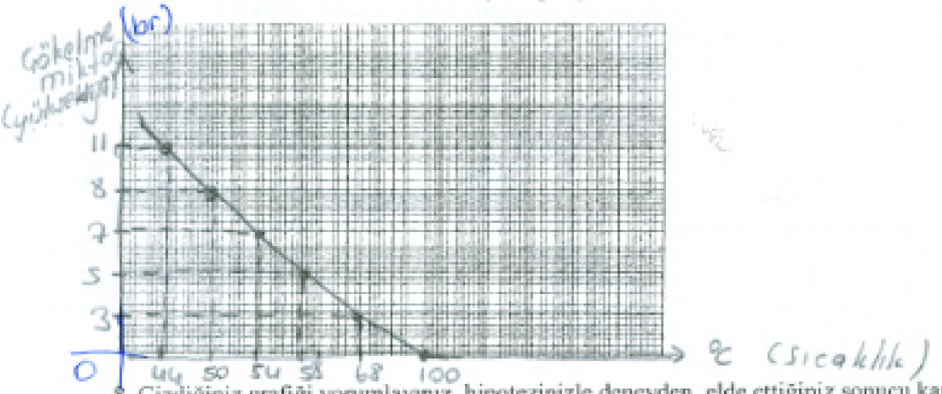
6. Elde ettiğiniz verileri tablolaştırınız:

Sıcaklık °C	Çökme miktarı
68	3 birim
58	5 birim
54	7 birim
50	8 birim
44	11 birim

Tablo adı eksik

Sıcaklık °C	Çökme miktarı
100°C	—

7. Tablodaki verileri kullanarak deneyle ilgili grafik çiziniz:



8. Çizdiğiniz grafiği yorumlayınız, hipotezinizle deneyden elde ettiğiniz sonucu karşılaştırınız:
Sıcaklık arttıkça çökme miktarı azalır dolayısıyla çözünürlük artar. Sıcaklık azaldığında çökme miktarı artar. Bu deney sonucunda hipotezimizi deneyi desteklediği gözlenmiştir.

9. Değerlendirme soruları

a) Kolanın çalkalanması ile köpürmesinin sebebini nasıl açıklarsınız? Bu sonucun yaptığınız deneyle bir ilişkisi var mıdır? Açıklayınız.
Gazlarda sıcaklık arttıkça çözünürlük azalır. Çalkalandığı zaman moleküller birbirine daha hızlı olur ve sıcaklığı artar. Sıcaklığı arttığı için çözünürlük azalır. Kolanın içerisinde bulunan gazlar kabarcık oluşturur.

b) Balıkların daha çok denizin dibinde bulunmalarının sebebi nedir? Açıklayınız.
Gazlar düşük sıcaklıkta daha iyi çözünürler. Denizin derinliklerinde sıcaklık azalır. Balıklarda oksijenli solunum yaptığı için dipte...

c) Bu deney kılavuzu hakkında düşüncelerinizi yazınız. Eklenmesini istediğiniz veya beğenmediğiniz bölüm varsa belirtiniz.
Bence gayet güzel bir çalışmadır. Günlük hayattaki olaylarla yaptığımız deney arasında ilişki kurabilmek çok güzel.