JOURNAL OF EDUCATIONAL AND INSTRUCTIONAL STUDIES
IN THE WORLD
February, March, April 2013, Volume: 3 Issue: 1 Article: 25
ISSN: 2146-7463

KNOWLEDGE LEVEL OF TEACHER CANDIDATES ABOUT ELEMENTS AND COMPOUNDS IN DAILY LIFE

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Abstract
One of the factors that make learnt things permanent is connecting them with daily life. We can possess information about substances that we use in daily life with the help of chemistry. In this respect, elements and compounds from daily life are transferred to students via chemistry courses. The meaningfulness of knowledge is significant for teacher candidates due to their occupation. In this study, it is aimed to research 3 different universities' education faculty students' opinions about such elements and compounds. In data gathering, an instrument consisted of two parts developed by the researchers was utilized. In the first part, the explanations of elements; in the second part, the explanations of compounds from daily life were provided and the participants were asked to identify their symbols/formulas with their names. Data gained was analyzed with the help of SPSS 16.0 package. The findings were evaluated relating with the literature.

Key words: elements, compounds, chemistry, daily life.

INTRODUCTION

The science of chemistry mainly focuses on matter and its inferences with other substances (Erten, 2009: 1). As one of the aims of science education is to develop scientifically literate people, chemical education does not only intend to transfer the scientific knowledge from teacher to students, but also allows students make meaningful knowledge by relating what has been learnt theoretically to daily life issues. The related objectives of chemistry education in terms of chemistry – technology – society - environment remarked by Turkish National Ministry of Education (Milli Eğitim Bakanlığı [MEB], 2007) can be stated by the following: (i) to be able to realize the application of chemistry on social and economic areas (ii) to be able to utilize what has been learnt in the solution of chemical problems and physical situations. Hence, the extension of knowledge and application of it on everyday situations is significant for learning at this respect.

However, the literature reports a number of problems showing that students lack this ability. Yadigaroğlu and Demircioğlu (2012) reported that chemistry teacher candidates had difficulty to connect their chemistry knowledge to daily life. Yiğit, Devecioğlu and Ayvacı (2002) found out that elementary 8^{th} grade students possessed difficulty to connect their scientific knowledge to daily life issues. Özmen (2003) investigated the level of chemistry teaching students' acid-base knowledge about relating it to daily life. The results indicated that teacher candidates could not relate their knowledge on acids-bases sufficiently to daily life events.

To measure attitudes towards everyday chemistry, Koçak and Önen (2012) developed a reliable and valid scale for secondary school students. The scale involved five sub-scales: (1) antipathy (2) chemistry and daily life (3) significance (4) experiment and daily life (5) awareness. The administration of the scale on three different types of high schools (Anatolian, general and occupational high schools) yielded that general high school students showed more interest on daily life chemistry issues than Anatolian high school and occupational high school students.

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Although chemistry is reported to be abstract and difficult to understand by the students (Osborne and Collins, 2001; De Vos, Bulte and Pilot, 2002; Gilbert, Justi, Van Driel, De Jong and Treagust, 2004) it would be made more interesting to the students by the teachers with the help of correlating it to daily life and paying attention to the language used in the course to eliminate the communication problem between the science of chemistry and everyday life (Koçak and Önen, 2012). Treagust, Chittleborough and Mamiala (2003) highlight the role of teacher about school chemistry. Additionally, the literature presents several studies which regard enhancing students' chemistry knowledge at this respect. Çoştu (2008) showed that Predict-Discuss-Explain-Observe-Discuss-Explain Method helped students better in making sense of everyday situations in terms of chemistry. Also, Çoştu, Ünal and Ayas (2007) proved that students who were instructed with group discussions on daily life events were significantly more successful than those who were instructed traditionally. Additionally, Göçmençelebi and Özkan (2011) determined that 6^{th} graders who owned computers and read scientific publications related their knowledge to daily life more than those who did not. As can be seen, there are things that can be done by the teachers and by the students themselves to facilitate the use of chemistry knowledge in daily life.

On the other hand, having knowledge about periodic table constitutes an important part of chemistry knowledge because it introduces the elements and thus provides a language for chemistry. Those elements are shown with letters and they may combine together to form different compounds in related numbers and ratios (Erten, 2009: 26-27). Those compounds and elements are pure substances and during chemistry courses, a number of substances, pure or mixtures are encountered by the students. Those substances become more meaningful when their functions and properties are fully comprehended by the students. Otherwise, they are complicated formulas, strange letters or difficult names to pronounce. Hence, correct sensations of the functions and properties of chemical substances – elements and compounds from daily life are significant for teacher candidates. A science teacher candidate who will work in elementary schools should be informed about their range of use, functions, symbols or formulas and naming of such substances.

Problem

In this study, it is aimed to investigate science teacher candidates' knowledge level related to a number of pure substances in everyday life which are various elements and compounds in chemistry. In this paper, it was researched whether the participants could write the symbols / formulas of the provided elements and compounds correctly and whether they could write their names after they were given the explanations related to their uses, functions or other characteristics. Also, the effects of different universities and grade levels on students' responses were investigated and compared.

METHOD

Study Design

A survey study was carried out to answer study questions. Survey studies intended to determine the opinions or interests, abilities, attitudes etc. of the participants related to a phenomenon or issue and it is conducted with a relatively large sample (Büyüköztürk, Çakmak, Akgün, Karadeniz and Demirel, 2010: 231).

Study Group

A total of 220 students studying at 3 different Turkish governmental universities, education faculty elementary science education departments, year 3 (n=111) and year 4 (n=109) students were included in the study. The names of the universities were not provided in the text in order not to judge them among. Instead, they were coded as *Uni A, Uni B* and *Uni C*. 68.6 % of the participants (n= 151) were female whereas 31.4 % of them (n= 69) were male. More detailed demographic frequency distributions of the participants are provided in Table 1.

Table 1: Distribution of the Participants with respect to Their University, Gender and Grade Level

	Year 3		Year 4		
University	*Female*	*Male*	*Female*	*Male*	Total
Uni A	27	12	18	20	77
Uni B	23	12	27	8	70
Uni C	30	7	26	10	73
Total	80	31	71	38	220

The sample was selected via purposive sampling method which allows gathering data from information rich cases in depth (Büyüköztürk et al., 2010: 89).

Research Instrument

An instrument which consisted of 2 parts developed by the researchers was utilized in order to collect data. In the first part of the instrument, explanations of 10 different compounds frequently used in daily life were provided to the participants. They were asked to write those compounds' names and their formulas. Those compounds were given as follows:

(1) Baking powder
(2) Vinegar
(3) Vitriol
(4) Peroxide
(5) Table salt
(6) Sugar
(7) Sand
(8) Quicklime
(9) Gas causing stove poisoning
(10) Gas causing firedamp explosion

In the second part, similar to the previous part of the research instrument, a number of elements' explanations were given to the students and they were asked to write their names and symbols. And those elements were asked as follows:

(1) An element which has three allotropes namely coal, diamond and graphite
(2) An element which is frequently used as fuel in nuclear reactors
(3) An element which is found in the valuable jewelry
(4) The matter of the string inside the electric bulbs
(5) The matter used by the dentists in teeth filling or used in thermometers
(6) The matter used in saturation of the margarines
(7) A matter used in laboratory materials such as electrodes, wires or in surgery and prosthesis
(8) Colorless, odorless gas used in air balloons

Administration and Data Analysis

The instrument was administered to the participants by the researchers in three different universities and it was highlighted that collected data would be used for only scientific purposes, not for any grading purposes for the students and the participation is on voluntary.

Collected data were firstly analyzed qualitatively. They were coded as correct (C), incorrect (IC) and no response (NR) for both parts of the each question (formula/symbol & name) according to the key prepared by the researchers. Next, the coding were written to an excel file and then transferred to SPSS 16.0 package. Descriptive statistics of the responses for each question were obtained and presented in the form of tables by relating the findings to the grade level and university factor.

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RESULTS

Findings related to the Compounds from Daily Life

Analyses of the data obtained from all participants for the first part of the research instrument are present in Table 2. The explanations of the compounds as asked to the participants in the research instrument are showed in this table. So, Table 2 indicates the frequency and percentage distributions of students' responses for both the formula and the name of the compound.

Table 2: Distribution of the Participants for Writing the Formulas and the Names of Compounds

Compounds	Formula n (%)			Name n (%)		
	C	IC	NR	C	IC	NR
Baking powder	49 (22.3)	49 (22.3)	122 (55.5)	52 (23.6)	42 (19.1)	126 (57.3)
Vinegar	66 (30.0)	10 (4.5)	144 (65.5)	64 (29.1)	9 (4.1)	147 (66.8)
Vitriol	51 (23.2)	17 (7.7)	152 (69.1)	54 (24.5)	11 (5.0)	155 (70.5)
Peroxide	56 (25.5)	32 (14.5)	132 (60.0)	35 (15.9)	16 (7.3)	169 (76.8)
Table salt	198 (90.0)	6 (2.7)	16 (7.3)	187 (85.0)	7 (3.2)	26 (11.8)
Sugar	182 (82.7)	16 (7.3)	22 (10.0)	140 (63.6)	1 (0.5)	79 (35.9)
Sand	36 (16.4)	4 (1.8)	180 (81.8)	30 (13.6)	4 (1.8)	186 (84.5)
Quicklime	26 (11.8)	37 (16.8)	157 (71.4)	25 (11.4)	30 (13.6)	165 (75.0)
Gas causing stove poisoning	194 (88.2)	13 (5.9)	13 (5.9)	190 (86.4)	10 (4.5)	20 (9.1)
Gas causing firedamp explosion	77 (35.0)	12 (5.5)	131 (59.5)	85 (38.6)	4 (1.8)	131 (59.5)

According to Table 2, it is obvious that the students who do not respond to the question are disturbingly numerous except three compounds: table salt (NaCl; sodium chloride), sugar ($C_6H_{12}O_6$; glucose) and stove poisoning gas (CO; carbon monoxide). The participants mostly seem to be successful at writing the correct form of formula and the correct names of the compounds; NaCl, $C_6H_{12}0_6$ and CO. Those compounds are surely most frequently encountered ones in everyday life and more than 82.0 % of the participants are successful at this respect. When the names of those three compounds are compared to their formulas, the frequency of students who write their correct names tends to decrease.

On the other hand, the least correctly written formulas are found to belong to baking powder ($NaHCO_3$), sand (SiO_2) and quicklime (CaO). The reason for incorrect responses obtained from $NaHCO_3$ can be due to be confusing it with $NaCO_3$ as can be seen among student responses. In addition, the reason of not giving response for the formula and name of sand might be the opinion that sand is a mixture hence it has no formula. On the other hand, incorrect answers for the formula of sand include selenium and silicon. Similarly, the formula of quicklime is found to be confused with $CaCO_3$ which is slaked lime. Accordingly, the least correctly written compound names are found to belong to peroxide (hydrogen peroxide), quicklime (calcium oxide) and sand (silicon dioxide).

Examples for incorrect student responses for the formulas of other compounds are CO_3 for $NaHCO_3$; C_2H_5OH for CH_3COOH; HNO for HNO_3; H_2O_4, OH, H_2O for H_2O_2; I_2 for NaCl; $C_8H_7O_6$ for $C_6H_{12}O_6$; C_2H_4, SO_2 for CO and CH_3, NH_4 for CH_4. As can be seen from student responses, the students generally have difficulty to form the formula

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with the correct number of elements. However; when different number of elements come together, they form different compounds in chemistry. Hence, this finding constitutes a problem for teacher candidates.

Generally, the percentages of students who write correct formulas are close to the percentage of students who write correct names but this difference becomes clearer for the compounds peroxide and sugar. The compounds whose formula cannot be written also cannot be named by the students.

Figure 1 and Figure 2 depicts the change in students' correct responses for writing the compounds' formulas and names with respect to grade level in the form of line graphs.

Figure 1: Distribution of the Correct Formulas' Percentages with Grade Level

Percent (%)

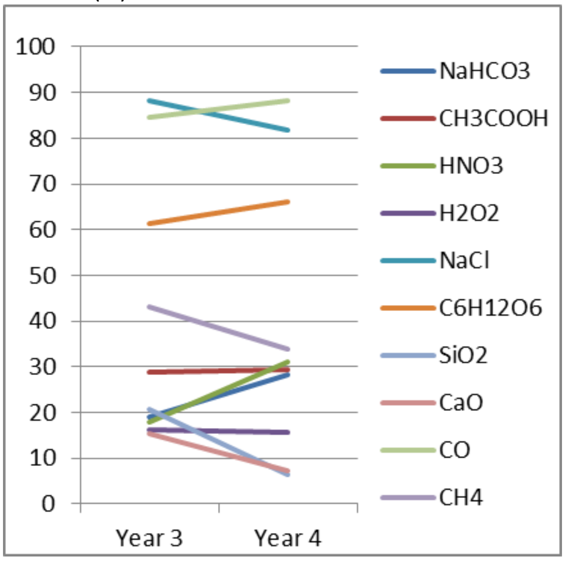
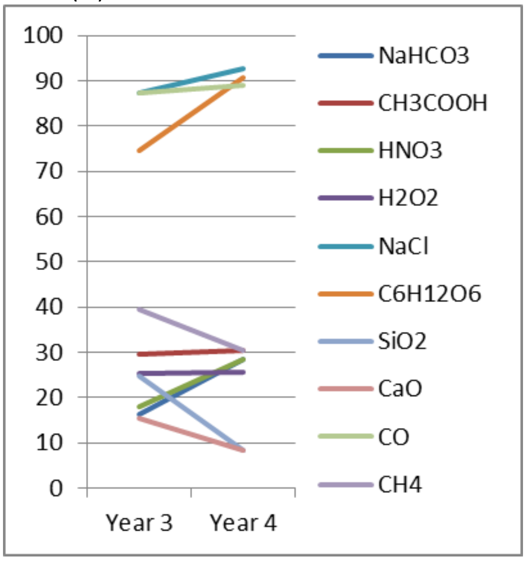


Figure 2: Distribution of the Correct Compound Names' Percentages with Grade Level

Percent (%)



As can be seen in Figure 1 and 2, there are strict falls and decreases in correct answers in several cases when passed from 3rd year to 4th year. However; it is interesting that the number of rises and decreases in both the naming and writing the formula of the compounds is about equal. In fact, it is expected that students become more successful in another words it is expected that the percentage of correct responses rises from 3rd to 4th year. Problems in conceptualization of that knowledge and relating it to daily life might cause this outcome.

Figure 3 and Figure 4 shows the percentages of students' correct responses related to the compounds respect to universities in the form of bar graphs.

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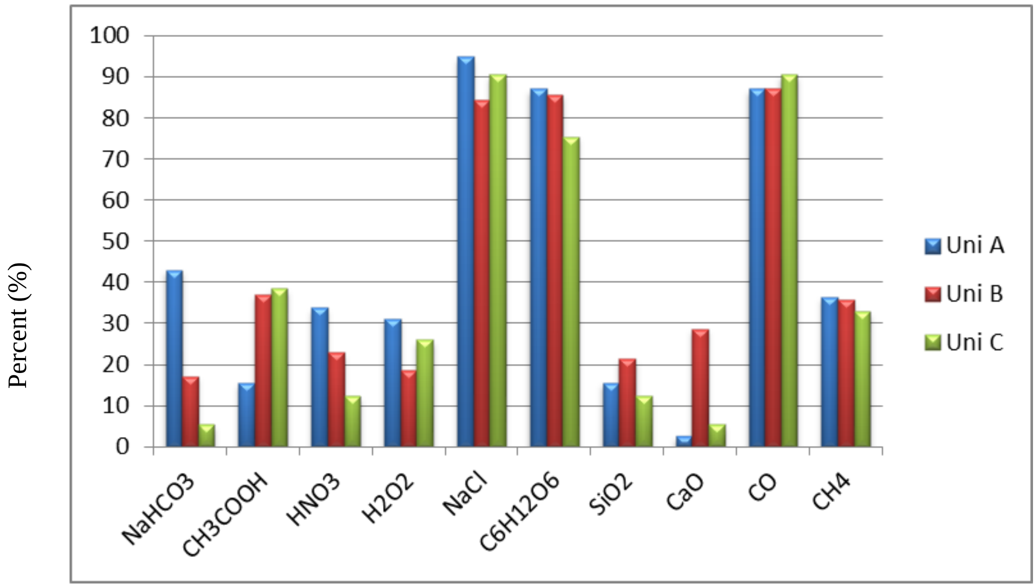
Figure 3: Distribution of the Correct Formulas' Percentages with University Type



According to Figure 3, the responses from all three universities are close to each other for writing the formula of table salt, sugar, gas causing stove poisoning and gas causing firedamp. As can be seen from the figure, distinctions become clearer as in the case of baking powder and quicklime. University A is more successful for writing the formula of baking powder whereas university B is more successful at writing the formula of quicklime.

Figure 4: Distribution of the Correct Compound Names' Percentages with University Type

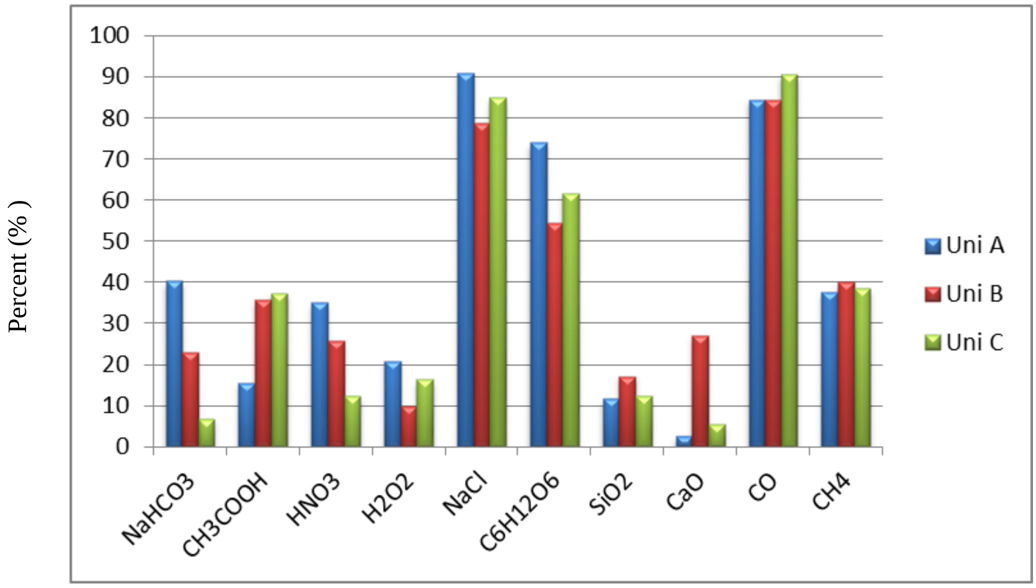


Figure 4 demonstrates the distribution of correct responses for naming of the compounds regarding university factor. Findings related to naming are very parallel to the findings of formula writing.

Findings related to the Elements from Daily Life

Analyses of the data obtained from all participants for the second part of the research instrument are present in Table 3. The results were similarly analyzed for both the symbol and the name of the elements explained to the participants. In Table 3, to use the space efficiently, the names of the elements were displayed instead of their explanations as provided in the research instrument.

Table 3: Distribution of the Participants for Writing the Symbols and the Names of Elements

Elements	Symbol n (%)			Name n (%)		
	C	IC	NR	C	IC	NR
Carbon	171 (77.7)	9 (4.1)	40 (18.2)	171 (77.7)	10 (4.5)	39 (17.7)
Uranium	98 (44.5)	46 (20.9)	76 (34.5)	99 (45.0)	45 (20.5)	76 (34.5)
Gold	134 (60.9)	24 (10.9)	62 (28.2)	138 (62.7)	45 (20.5)	37 (16.8)
Tungsten	0 (0)	107 (48.6)	113 (51.4)	15 (6.8)	103 (46.8)	102 (46.4)
Mercury	130 (59.1)	14 (6.4)	76 (34.5)	134 (60.9)	15 (6.8)	71 (32.3)
Hydrogen	105 (47.7)	12 (5.5)	103 (46.8)	105 (47.7)	13 (5.9)	102 (46.4)
Platinum	42 (19.1)	36 (16.4)	142 (64.5)	43 (19.5)	40 (18.2)	137 (62.3)
Helium	191 (86.8)	9 (4.1)	20 (9.1)	191 (86.8)	7 (3.2)	22 (10.0)

Table 3 shows that students mostly become more successful for writing the symbol and the name of the following elements: gas used in air balloons (He, helium); an element which has three allotropes – coal, diamond and graphite (C, carbon), a valuable metal used in jewelry (Au, gold).

As can be seen, participants who did not respond to the question constitute a significant proportion in the study group especially for the elements tungsten, hydrogen and platinum. It can be concluded that students do not possess enough information about functions of several elements. It is an interesting result that no participant could write the correct symbol for the metal of the string in the electric bulbs (W, Tungsten). Incorrect responses for the symbol of this element were found to indicate Tu for Tungsten. Also, incorrect responses involve suggesting aluminum or copper for the answer of the question. The highest percentage for not responding for platinum may again stem from insufficient knowledge about the function of this element despite its wide range of use as indicated in the explanation part of the question.

Examples for incorrect student responses for the symbols of elements are as follows: Pb, O_2, O_3 for C; B, Ur for U; Al for Au; Cu, Al for W; Zn for Hg; C for H; Al, Cu, K, Ag for Pt and CO_2, H_2 for He. The students write the names of the symbols correctly however; they failed to provide the correct element's symbol for the questions. For example, they state a number of metals' names and symbols for the matter used in surgery, electrodes and catalyzes such as copper, aluminum, potassium and silver which are all scientifically incorrect responses for that explanation.

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Figure 5 and Figure 6 depicts the change in students' correct responses for writing the elements' symbols and names with respect to grade level in the form of line graphs.

Figure 5: Distribution of the Correct Symbols' Percentages with Grade

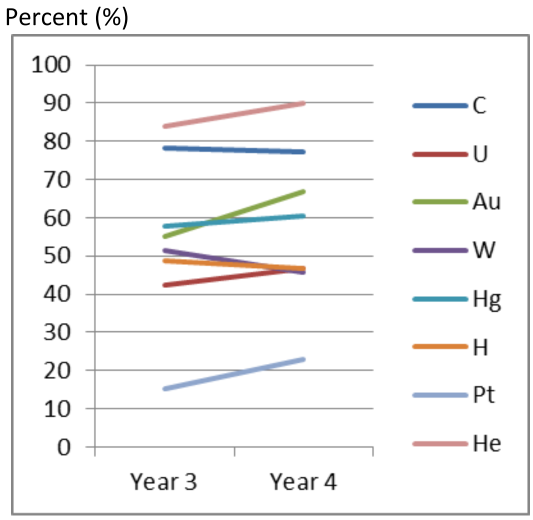
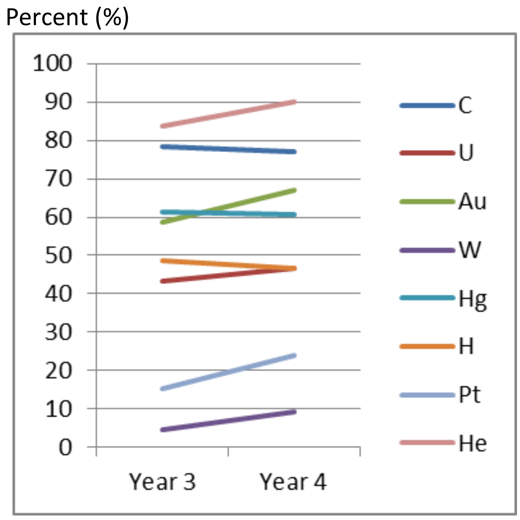


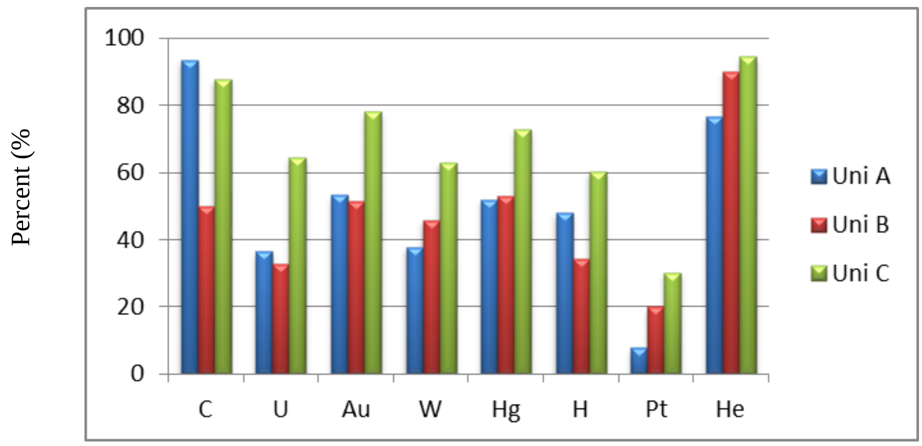
Figure 6: Distribution of the Correct Element Names' Percentages with Grade Level



As can be seen in the figures, there is a decrease in the correct responses of the symbols of hydrogen and tungsten when passed to year 4 from year 3. It is disappointing that although hydrogen is the first element of the periodical table and the first element taught to the students in the school, the correct answers tend to decrease. Similar to the previous outcomes, it might stem from the difficulty to provide the correct element's name to the explanation. The decrease for tungsten can be explained as stated earlier. On the other hand, the percentages of correct answers for platinum tend to rise. Perhaps, elective courses about chemistry might become effective on increasing students' daily life chemistry knowledge at this respect.

Figure 7 and Figure 8 shows the percentages of students' correct responses related to the elements as mentioned above with respect to universities in the form of bar graphs.

Figure 7: Distribution of the Correct Symbols' Percentages with University Type



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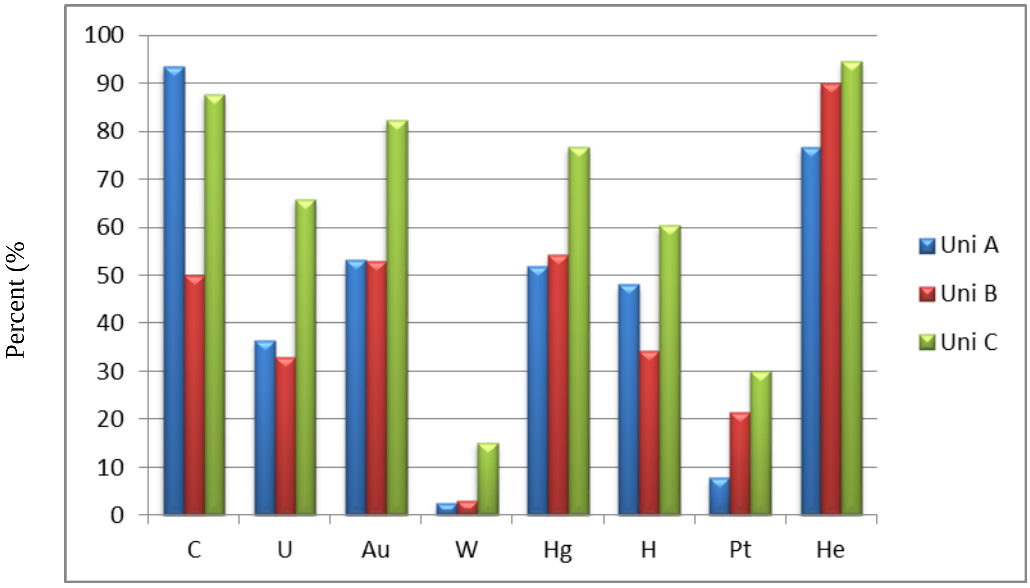
ISSN: 2146-7463

According to Figure 7, university C is more successful in most cases for providing the correct symbols for the elements than the other two universities.

Figure 8: Distribution of the Correct Compound Names' Percentages with University Type



The findings from correct naming of the elements are consistent with writing the correct symbols of the elements as demonstrated in Figure 8. Again, university C is more successful than the others at this respect.

DISCUSSION AND CONCLUSION

To summarize the study results, it is seen that science teacher candidates do not hold sufficient knowledge related to daily life chemicals. They have difficulty in writing correct symbols, formulas and naming as can be understood from not responded answers although this topic stays in Turkish 9th grade chemistry curriculum introduced by MEB (2007). Insufficient knowledge level detected in participants is similar with what has been found in the previous research although conducted with different grade level students (Özmen, 2003; Yiğit, Devecioğlu and Ayvacı, 2005; Yadigaroğlu and Demircioğlu, 2012). Besides leaving questions as being not responded, a number of compounds were seen to be confused in writing their formula such as methane, baking powder and quicklime as well as very simple everyday compounds – table salt. This is a problem detected by the study.

When the results are evaluated in terms of elements and compounds, it can be concluded that there are differences regarding their relative frequencies. Generally the students are better at the responses related to the elements except the element – tungsten than they are at compounds. This may stem from the simplicity of the symbols of the elements when compared to more complex form of the formulas of the compounds. Thus, students may learn elements more easily and relate them to daily life more. However; this is not only related to simplicity of the symbols of the elements and complexity of the compounds. Students' inconvenience to supply correct substance is more effective on not responded items. It is approved by the fact that the percentages of incorrect responses are all less than those of not responded.

On the other hand, university factor seems effective on both writing formulas/symbols as well as their naming as can be observed from the percentages in the bar graph except the compounds – NaCl, $C_6H_{12}O_6$, CO and CH_4. Grade level factor is more effective on compounds' names and formulas because the slopes of the lines related to elements are smaller than the ones of compounds which mean that responses related to elements are more stable when passed to year 4 from year 3. There are more sharp changes in the lines related to compounds which mean several significant decreases or increases. Unfortunately, those falls indicate that students could not remember the correct formulas despite being in their final year in university.

To enhance students' chemistry knowledge at this respect, developing a reading habit of scientific magazines might become helpful also for teacher candidates (Göçmençelebi & Özkan, 2011). Thus, their knowledge might stay permanently without forgetting them. Also, making chemistry more interesting by the teachers can motivate students towards learning. At this respect, the usage of storylines in chemistry teaching is indicated to provide meaningful learning for students (Demircioğlu, Demircioğlu & Ayas, 2006).

WJEIS's Note: This article was presented at 4th International Conference on New Trends in Education and Their Implications - ICONTE, 25-27 April, 2013, Antalya-Turkey and was selected for publication for Volume 3 Number 1 of IJONTE 2013 by WCEIS Scientific Committee.

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