OPEN ACCESS
EURASIA Journal of Mathematics Science and Technology Education
ISSN: 1305-8223 (online) 1305-8215 (print)
2017 13(6):2539-2552
DOI: 10.12973/eurasia.2017.01239a

Pupils' Attitudes toward Chemistry in Two Types of Czech Schools

Milan Kubiatko
Univerzitna 1, 01026 Zilina, Slovakia

Kristyna Balatova
Univerzitna 1, 01026 Zilina, Slovakia

Jana Fancovicova
Trnava University

Pavol Prokop
Trnava University

Received 14 December 2016 ▪ Revised 27 January 2017 ▪ Accepted 31 March 2017

ABSTRACT

Chemistry is a school subject that is not viewed favorably among pupils. Before we can improve pupils' attitudes toward chemistry, it is important to find out the problem as to why the attitudes are relatively negative. The research was focused on Czech lower secondary and secondary grammar school pupils' attitudes to the subject of chemistry. Also, the difference between groups of variables (gender and grade) was examined. The sample size contained 931 Czech lower secondary and secondary grammar school pupils. The research tool was a questionnaire with 25 Likert type items. By the use of factor analysis, the items were distributed into four categories: 1) Popularity and difficulty of chemistry, 2) The relevance of chemistry, 3) Chemical aids and laboratory experiments, 4) The future life and chemistry. The overall score indicated neutral/slightly positive pupils' attitude toward chemistry. Girls received a lower score in comparison with boys in all grades, except the 1st grade, in secondary grammar schools. The opposite situation was among lower secondary school pupils, where girls achieved a slightly higher attitude score. It is possible to say that negative attitudes toward chemistry are also among lower secondary and secondary grammar school pupils, so it is needed to try to improve attitudes toward chemistry from the early age of pupils. The recommendations for the pedagogical practice are suggested in the conclusion.

Keywords: attitudes toward chemistry, lower secondary school pupils, secondary grammar school pupils, quantitative approach, questionnaire.

Correspondence: Milan Kubiatko, *University of Zilina, Faculty of Humanities, Department of Pedagogical Studies, Univerzitna 1, 01026 Zilina, Slovakia*. Telephone: +421 41513 6364.
Email: mkubiatko@gmail.com

State of the literature

- Learners with more positive attitudes toward chemistry achieved significantly better achievement in comparison with learners with negative attitudes toward this subject.
- Boys and younger pupils have got more positive attitudes toward chemistry in comparison with girls and older students.
- The most using method for the detection of attitudes toward chemistry is a questionnaire.

Contribution of this paper to the literature

- Pupils have got neutral / slightly positive attitudes toward chemistry, what is different situation as many researchers presented.
- Secondary grammar school girls achieved higher score in comparison with boys.
- Pupils do not see connection of chemistry with their future life.

INTRODUCTION

It is possible to say that chemistry is on the bottom of the ranking table in terms of subjects offered in lower secondary and secondary grammar school pupils. On a rough scale, chemistry has a reputation for being a complicated and boring science due to it abstract nature. But from many sides, chemistry's reputation is undeserved. There are many things visible by the human eye, which are connected with chemistry. For example, it is possible to connect chemistry with cooking. Chemistry explains how food changes as you cook it, how it rots, how to preserve food, how your body uses the food you eat, and how ingredients interact to make food. The other field is medicine. Pupils can understand how vitamins, supplements, and drugs can help or harm them. Part of the importance of chemistry lies in developing and testing new medical treatments and medicines. Also, there are many other processes based on chemistry such as fireworks and explosions. So, teachers have got many possibilities how to make the teaching process of chemistry more attractive and interesting for pupils.

Pupils' attitudes toward science subjects are an important research area, particularly because of a mutual relation between pupils' and students' attitudes and achievement (Weinburgh, 1995). Chemistry is not a different case. This mutual relation was confirmed by various research studies, for example from Cheung (2009), Kan and Akbas (2006), Salta and Tzougraki (2004), Xu, Villafane and Lewis (2013), who stated that there are significant correlations between achievement and attitudes toward chemistry. Learners with more positive attitudes toward chemistry achieved significantly better achievement in comparison with learners with negative attitudes toward this subject.

THEORETICAL BACKGROUND

In the forefront of the analysis of factors, which influence attitudes are necessary informed why chemistry (along with other natural science subjects) is important for pupils. For example, Sears and Kessen (1964) stated that the major role of chemistry education is

arousing children's interest in science subjects and the sense of delight from teaching science. A significant decrease of interest in chemistry started in the 1980s and remains to this day. For example, Prokop, Prokop & Tunnicliffe (2007) showed that only 1 % of 941 children from Slovak elementary schools reported that chemistry was their favorite subject. Notably, no other school subject received lower scores than chemistry in their research. One reason could be that chemistry is abstract for many students and they have problems understanding it and finding any value for their future life and career. Some researchers indicated that without understanding chemistry concepts it is very hard to make chemistry closer to students (Acar, Turkmen & Bilgin, 2015).

There is a relatively high amount of research focused on the problem of pupils' attitudes toward chemistry. Some studies have focused on the description of attitudes by the use of questionnaires with Likert type items or use of semantic differential. From older research works, Menis (1983) detected attitudes level in Israeli lower secondary school pupils. Attitudes were first compared in general and then in four dimensions: interest in chemistry, application of chemistry, importance of chemistry and the enjoyment of chemistry. Menis discovered that boys had a positive perception of chemistry. Further, he focused on the influence of gender and age on attitudes toward chemistry and he found the interest in chemistry to be positively correlated with the age of pupils. Next, student attitudes toward chemistry were examined by Dhindsa & Chung (1999). This work was focused on perception of chemistry by pupils in four dimensions (enjoyment, motivation, fear and chemistry importance). More positive perceptions of chemistry were found in girls compared with boys. Constituent of this study is to research how attitudes toward chemistry influence pupils' favorite subjects, which has never been studied and accessible references have never been detected. Salta & Tzougraki (2004) have contributed mostly on this research topic. Greek high school pupils, who need chemistry in their follow-up study, achieved significantly more positive scores compared with pupils, who preferred humanities and technical subjects. Kan & Akbas (2006) focused on the difference between Turkish boys and girls, next between grades (from first to third grade) and on influential attitudes to success rate in this subject, too. The results indicated a positive perception of chemistry by boys. From this study's point of view, pupils in the second grade achieved more positive attitudes than pupils in first and third grades. This study indicated that pupils with positive attitudes had better study results. Cheung (2009) put emphasis on the influence of gender and grade on high school students in Hong Kong. The research tool was a scaled questionnaire and this scale was divided into four dimensions – evaluation of chemical lessons, evaluation of laboratory practise, tendency toward learning chemistry and evaluation of chemistry by pupils with respect to its difficulty and importance. A significant effect was found in the first two dimensions and attitudes were more positive by boys compared to girls. Korbanoglu & Akin (2012) found a negative relationship between attitudes to chemistry and chemistry anxiety. In some recent studies it is possible to find some suggestions, such as how to make the teaching process more interesting for pupils. Can & Boz (2012) examined the effect of pupils' grades and found that the youngest pupils (16 years old) achieved more positive attitudes toward chemistry in comparison with older respondents. For example, Erdem (2012) examined the influence of project-based learning on pupils' attitudes toward chemistry. Barchok, Too & Ngeno (2013) examined the influence of collaborative concept

mapping on attitudes toward chemistry. The effect of problem-based learning was described in the study of Tuson and Senucak (2013). Olakanmi (2015) examined the effect of web-based computer simulation on pupils' attitudes toward chemistry. Nearly all studies confirmed the positive influence of enriched learning environments on the attitudes toward chemistry. Other methodological studies have been conducted. For example, Bauer (2008) created and adapted the semantic differential to measure attitudes toward chemistry. Many researchers would also like to improve attitudes toward chemistry through different programs and courses activities for pupils (e.g. O'Dwyer & Childs, 2014; Richter-Egger et al., 2010).

PURPOSE OF THE STUDY

The research regarding attitudes toward chemistry was done in many countries all over the world. However, the area of central Europe, mainly Slovakia and Czech Republic, is lowly represented. This was one of the reasons was to conduct this research study in the Czech Republic. Another reason was to examine how students' attitudes have the power to predict future behaviors like school subjects and career preferences. Attitudes are a potential for predicting future preferences, especially if there is a direct interaction between participants and the attitude object (i.e. objects related to attitude like science lessons). Attitude plays an important role in determining individual reaction to a particular entity. Attitudes shape human behavior. For example, a positive attitude leads toward a favorable response and a negative attitude leads toward an unfavorable response. Based of these facts it is possible to say the following: (a) how students could behave in the future in relationship toward chemistry, (b) how they could use chemistry in their future life, and (c) if any of students could work in the field of chemistry.

The main aim of the research was to examine students' attitudes toward chemistry. Next, this study examined the differences between gender and grade level.

METHOD

General Research Characteristics

In order to determine students' attitudes toward chemistry, the research was designed in which participants were invited to fill out a Likert-type questionnaire. The quantitative approach was used with respect to its main principles (Steckler et al., 1992). The data were gathered and analyzed through the research process to determine students' attitudes toward chemistry. The data were analysed by descriptive methods and inferential and multidimensional statistics. The data analysis was conducted in three ways: a) to determine reliability of the research tool; b) by the use of factor analysis to determine validity of the research tool and to identify the dimensions of questionnaire; c) to determine the attitudes of respondents toward chemistry and to find out the differences between gender and grade level of students. The research was conducted during spring 2014 semester.

Respondents

The sample size included lower secondary and secondary grammar school pupils (n = 931) (see table 1). The sample included students from schools where the principals were willing to

allow this research to be conducted among pupils. The sample size is appropriate for the statistical analyses presented in the methods and results part of the text (Bartlett, Kotrlik, & Higgins, 2001; MacCallum et al., 1999). According to Cumming (1990), if the sample size is appropriate, then the results from non-probability and probability sampling would be similar because of higher probability that our data produced similar results as data from the probability sampling would produce. Girls accounted for 60.47 % of the sample size (n = 536). The chemistry class was taught in the last two years (8th and 9th grade) at lower secondary school as a compulsory subject. The pupils from these two grades were chosen for this research, and their age was 13/14 and 14/15 years. Chemistry is a compulsory subject in the first three grades of secondary grammar schools (1., 2., 3.), the respondents from these grades were chosen as the participants for this research study, and their age ranged from 15 to 18 years. Respondents were divided into two groups based on their favorite school subjects: the first group were those respondents who had one science subject (biology, chemistry or physics) as their favourite (n = 289), and the second group were those who responded favourably to subjects other than science (n = 642).

Research Tool

The questionnaire included 25 total items measured on a 5-point Likert type scale as a research tool. The items were adapted from a similar questionnaire investigating attitudes towards biology (Prokop, Prokop, & Tunnicliffe, 2007).

The questionnaire was divided into two parts: the first part included 25 attitudes items, and the second part comprised of demographic items (gender, age, grade, favorite subject). By the use of factor analysis, the items were distributed into four categories: 1) Popularity and difficulty of chemistry; 2) The relevance of chemistry; 3) Chemical aids and laboratory experiments and 4) The future life and chemistry. The attitudes items contained both positively and negatively worded statements. The total number of positive items was 15, and these items were coded in a statistical processing software as follows: totally disagree – 1; slightly disagree – 2; neutral – 3; slightly agree – 4; totally agree – 5. The negatively worded items were reverse coded. General scores demonstrated students´ attitudes toward chemistry – a low score meant relatively negative attitudes, and a high score relatively meant positive

Table 1. The basic demographic variables of the sample size

	Total number of respondents	Boys	Girls	Grade					Favorite subject	
				8.	9.	1.	2.	3.	Science	Other than science
Lower secondary school	379	170	209	236	143	-	-	-	100	279
Secondary grammar school	552	198	354	-	-	145	113	294	189	363

attitudes.

Because the research tool was validated in a previous research study (Prokop, Prokop & Tunnicliffe 2007), chemistry teachers checked if the research tool was appropriate for both lower secondary and secondary grammar school pupils. All items were comprehensible according to the teachers. The results from the factor analysis could support construct validity (see chapter Factor analysis). The construct validity was also assured by the comparison of two groups – pupils with favourite science subjects (science majors) and pupils with other favourite subjects other than science (non-science majors). The science majors achieved a higher score ($x = 3.6$; $SE = 0.04$) in comparison with non-science major students ($x = 3.18$; $SE = 0.02$). The difference was statistically significant ($F = 105.61$; $p < 0.001$; $df = 1$). This similar approach is possible to find in the Coll, Dalgety and Salter (2002) study.

Factor Analysis

The data was analyzed using a factor analysis with Varimax rotation. Prior to the factor analysis, Kaiser-Meyer-Olkin and Bartlett's sphericity test were performed to determine the adequacy of the sample and to check whether or not the data fitted for factor analysis. Kaiser-Meyer-Olkin ratio should be above 0.50 (Temel, Sen & Yilmaz 2015). The KMO value of 0.89 showed that the data set was appropriate for a factor analysis and the value of Bartlett's test of sphericity was $\chi^2 = 3564.74$ ($p < 0.001$) that indicated a high level of correlation was evident between the variables.

Items were divided into four dimensions (see table 2): 1. Popularity and difficulty of chemistry (3 items), 2. The relevance of chemistry (4 items), 3. Chemical aids and laboratory experiments (9 items) and 4. The future life and chemistry (3 items). These dimensions explained 40.92 % of total variance, and the most variance was explained by the first dimension (21.99 %). The critical value for inclusion of an item to a dimension was 0.40. The reliability of the scale was determined by Cronbach's alpha coefficient, which had an acceptable value ($\alpha = 0.79$) (Cronbach 1951).

Data Analysis

The mean score indicated the attitudes toward chemistry. The mean score for the entire questionnaire and the four dimensions were the dependent variables and the categorical variables (gender and grade) were the independent variables. From the descriptive statistics, the mean score and standard error (SE) was used. The standard error of the mean estimates the variability between samples whereas the standard deviation measures the variability within a single sample. This study used the standard error of the mean to determine how precisely the mean of the sample estimates the population mean. Lower values of the standard error of the mean indicate more precise estimates of the population mean (Streiner 1996). The differences between groups of independent variables were determined by using an analysis of the variance (ANOVA).

Table 2. Results of factor analysis

I. Popularity and difficulty of chemistry				
4. Chemistry lessons are demanding for me.	**0.70**	0.04	0.33	0.08
16. I have to concentrate more when I understand chemistry curriculum.	**0.78**	-0.07	-0.05	0.00
25. I suppose that chemistry is one of the easier teaching subjects.	**0.67**	-0.02	0.23	0.06
II. The relevance of chemistry				
9. Progress in chemistry improves our life.	0.14	**0.72**	0.10	-0.11
11. Chemical knowledge can help us by solving problems with the environment.	0.07	**0.73**	0.16	0.03
17. Nature is an integral part of human life.	-0.15	**0.62**	0.11	0.00
23. I think that the processes occurring in nature are interesting.	0.06	**0.64**	0.16	0.19
III. Chemical aids and laboratory experiments	0.34	0.11	**0.57**	0.26
1. I like chemistry more than other subjects.				
5. I expand my knowledge and skills by chemical laboratory exercises.	0.00	0.32	**0.58**	0.11
8. Chemistry lessons are boring.	0.16	0.06	**0.71**	0.13
10. Lectures in chemistry are interesting.	0.14	0.15	**0.74**	0.03
14. Chemical aids, used in chemistry lessons, are interesting for me.	-0.07	0.25	**0.52**	0.24
15. I suppose that chemistry is not important compared with other teaching subjects.	0.33	0.22	**0.46**	0.36
20. I do not like chemistry lessons.	0.43	0.09	**0.66**	0.25
22. We use a lot of chemical aids on chemistry lessons.	0.06	0.02	**0.47**	-0.05
24. Chemical experiments are very interesting.	-0.11	0.38	**0.56**	0.08
IV. The future life and chemistry				
13. Chemistry knowledge is not important for my future life.	0.06	-0.09	0.11	**0.75**
18. When I finish my studies I would work in the field of science.	0.23	0.30	0.15	**0.62**
19. Chemical knowledge is not necessary for daily life.	0.30	0.22	0.12	**0.42**
Eigenvalue	5.50	2.11	1.41	1.21
% of variance	21.99	8.46	5.62	4.85

Numbers of items are identical with item numbers in questionnaire.

Table 2. *Contiuned.*

Deleted items				
2. We do not use teaching aids on chemistry lessons.	-0.15	-0.01	0.09	0.11
3. Chemistry and nature are strange for me.	-0.10	0.08	0.02	0.38
6. I would like chemistry lessons frequently.	0.25	0.08	0.17	0.14
7. Knowledge of chemistry is important for understanding other teaching subjects.	0.06	-0.05	-0.03	0.16
12. Chemistry is interesting for me because of our chemistry teacher.	-0.16	-0.25	0.32	-0.19
21. I do not like our chemistry teacher.	0.11	-0.04	0.34	-0.25

Numbers of items are identical with item numbers in questionnaire.

RESULTS

Mean score was 3.30 (SE = 0.02), which showed slightly positive attitudes toward chemistry. From a detailed perspective, it was apparent that students saw the relevance of chemistry and they perceived chemical aids and laboratory experiments as positive (see Figure 1). These two dimensions are connected to each other. The teachers were probably using chemical aids and realized chemical experiments on topics, which were connected with the real life of students. Pupils maybe understood the role of chemistry in the nature, environment and also in the life of students. The other way could be the presentation of the abstract things, which is typical for chemistry. The pupils could see, that chemistry is not a boring subject and it could have an effect on relatively high scores in these dimensions. The significant relationship between these two dimensions was supported by The Pearson

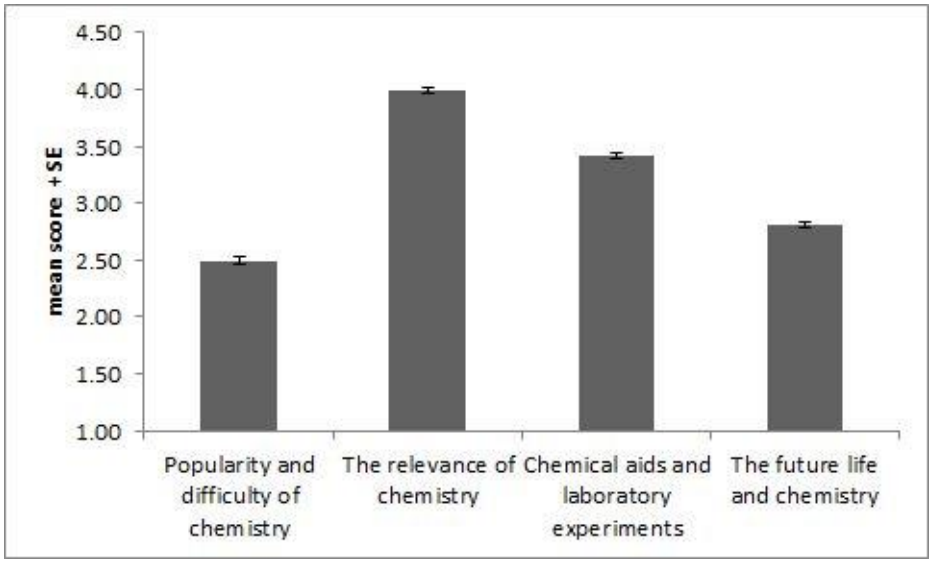

Figure 1. Mean score of dimensions

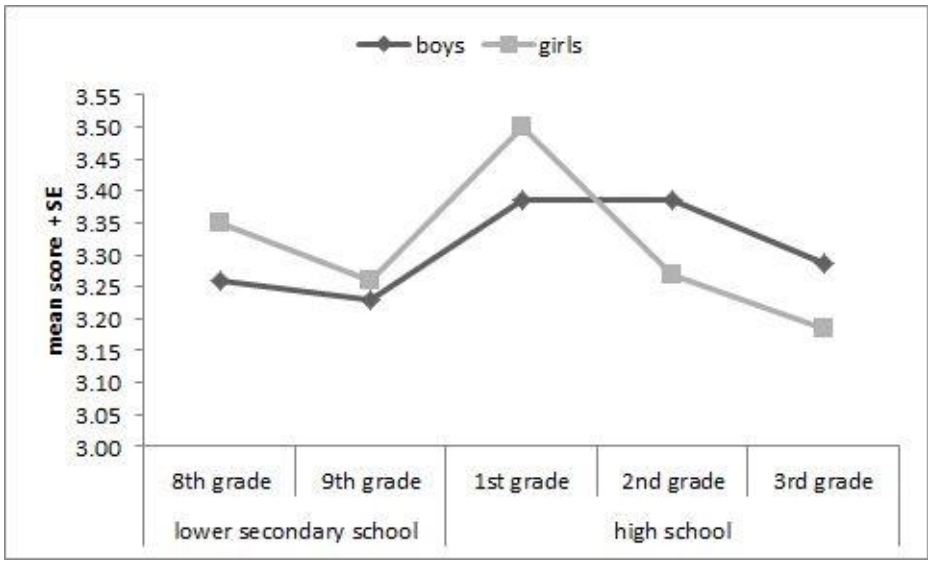

Figure 2. Mean score with respect to gender and grade

product moment ($r = 0.42$; $p < 0.05$). Dimension "Popularity and difficulty of chemistry" achieved negative score and the last dimension "The future life and chemistry" was perceived neutral. Pupils were perceiving chemistry as a relevant subject, but they did not see themselves working in the field of chemistry in their future life. Also, the popularity of this subject achieved a neutral score, maybe this is due to theoretical knowledge, which are presented to students during chemistry class.

The influence of the categorical variables (gender and grade level) were not significant ($F = 1.14$; $p = 0.34$). Figure 2 displays the highest score achieved by boys and girls from the first grade of secondary grammar schools. Girls achieved the lowest score in the 3rd grade of secondary grammar schools. Boys achieved the lowest score in 9th grade of lower secondary schools. It is also possible to see that girls had more positive attitudes toward chemistry in all grades of lower secondary schools and at the beginning (1st grade) of secondary grammar schools. In the next grades the boys had more positive attitudes toward chemistry. The highest difference between boys and girls was in the last two grades of secondary grammar schools.

Table 3 shows the mean values for boys and girls in each grade based on the four dimensions. Both genders, achieved the highest score (the most positive attitudes toward chemistry) in the dimension 2 (Relevance of chemistry) (table 3). In this dimension, the results indicated a statistically significant difference ($F = 2.50$; $p < 0.05$). In this dimension, girls achieved a higher score in comparison with boys in all grades except the last (3rd) grade, where boys had got more positive attitudes. This similar situation was evident in the third dimension (Chemical aids and laboratory experiments). The boys achieved a higher score in comparison with girls in the last two grades (2nd and 3rd grade of secondary grammar schools). In the last two dimensions, the scores from pupils were relatively low, which means their attitudes ranged from neutral to slightly negative.

Table 3. Mean score for boys and girls in grades for the dimensions

	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
	Dimension 1		Dimension 2		Dimension 3		Dimension 4	
8th grade	2.64	2.56	3.93	3.65	3.53	3.52	2.75	2.65
9th grade	2.42	2.78	3.85	3.72	3.46	3.37	2.72	2.63
1st grade	2.58	2.62	4.20	3.98	3.68	3.58	2.95	2.78
2nd grade	2.31	2.77	4.10	4.04	3.36	3.48	2.85	2.84
3rd grade	2.24	2.50	4.12	4.24	3.18	3.25	2.91	2.90
F	2.19		2.50*		0.66		0.36	

* $p < 0.05$

DISCUSSION

This research study examined pupils' attitudes toward chemistry, and the differences between boys and girls and among grades. The mean score on attitudes toward chemistry by pupils was slightly positive. This result was different from the results from other studies. For example, Salta and Tzougraki (2004) stated that pupils' attitudes toward chemistry were neutral. Similar results to our findings were found in studies by Bennett et al. (2001) and Cheung (2009), as both studies found that pupils had slightly positive attitudes toward chemistry. The results, in more detail, from this study show that pupils saw the relevance of chemistry and the chemical experiments and the use of chemical aids caused these positive attitudes.

We also found that, between these two dimensions, there was a statistically significant relationship. This result could be due to the effect of the chemical experiments pupils observed in class as the reason why chemistry is significant for people. The similar finding aligns with previous studies. For example, Kurbanoglu and Akim (2010) found that the chemical experiments were influencing the pupils' attitudes toward chemistry in positive way. It seems, the chemical experiments and adequate using of chemical aids could influence pupils' perceptions of chemistry. However, chemistry was difficult for pupils, and pupils did not see the connection between their future life and chemistry. These two dimensions decreased the level of attitudes toward chemistry. This fact could be caused by the curriculum in Czech schools (not only in Czech Republic, it is also valid for the other countries of Central Europe, because the chemistry curriculum is similar). The chemistry curriculum is focused on the facts, have not considered the connection between chemistry with the real life. Perhaps the problem is time, as a small number of teaching hours are dedicated to chemistry subjects in lower secondary schools. Chemistry topics are taught rapidly and, as a result, teachers do not have the time and/or the space in class to motivate

pupils to learn chemistry, which could lead to an increase in pupils' attitudes toward chemistry.

The effect of gender and grade was insignificant on the attitudes toward chemistry; only on one dimension regarding the relevance of chemistry was the effect statistically significant. It is possible that, in lower secondary school, girls had more positive attitudes in comparison with boys. This finding aligned with older studies (e.g. Hofstein et al., 1977), but this difference aligned with recent research studies as well (e.g. Heng & Karpudewan, 2015). Also in the beginning of secondary grammar school, girls achieved higher scores, but the 2nd and 3rd grade boys had more positive attitudes toward chemistry. The higher score for boys was found in studies from Cheung (2009) or Ozden (2008), and the different effect found in Hofstein and Mamlok-Naaman (2011). When examining differences between boys and girls, future studies should consider the regional/living factors that could affect these results. As Linn and Hyde (1989) stated, the differences in attitudes, achievement, etc. are in many cases caused by the regional situation, so the gender differences are not general, but specific. Perhaps the reason girls in lower secondary schools had more positive attitudes toward chemistry are that the style of teaching and achievement is more appropriate for girls in comparison with boys. The rapid nature of teaching chemistry, due to limited hours of instruction, probably caused pupils to memorize the facts instead of making real world connections with chemistry, and this learning strategy could be more suitable for girls. The reduced number of hours to teach chemistry could have lead to a reduction of the number of experimental hours and it could have caused the boys to respond lower to the items from the attitudes toward chemistry. The information about better perception of chemistry, when the laboratory experiments were using was possible to find in the study of Jones, Howe and Rua (2000) or Tsai (1999). As it was possible to see, when pupils moved from lower secondary school to secondary grammar schools, their attitudes toward chemistry was increasing, which was not in concordance with other studies (Can, 2012; George, 2006). On the other side, Heng and Karpudewan (2015) found similar results as was detected in our research. In the first grade of secondary grammar school group was identified as having the highest score. Perhaps the different style of teaching and the different structure of the class could have influenced the results. In the secondary grammar schools in the Czech Republic, pupils are more successful in terms of school achievement, and they want to continue in their studies after high school by attending a university. So, there is the presumption that the attitudes toward chemistry (and also other subjects) were more positive among pupils. Also, the character of teaching hours is different in the Czech Republic. There is a higher dotation of chemistry, and teachers have the resources to present to students, not only the facts, but also the interesting aspects of chemistry and the implications it has to real life. In the last two grades of secondary grammar schools, the attitudes toward chemistry were lower in comparison with the first grade, and the boys had more positive attitudes in comparison with girls. This was probably caused by the decision of pupils about their future career and they were choosing the subjects, which were connected with their other life. In regard to the difference between boys and girls, it is possible that the teaching and learning are becoming more boy-friendly in order to improve boys attitude towards chemistry in comparison with the first grade. This statement aligns in the Heng and Karpudewan (2015) study.

CONCLUSIONS

The results of the study showed chemistry to be a relatively unpopular subject. However, it was found that attitudes toward Chemistry are influencing students in a positive way by the use of chemical aids and chemical experiments. If chemistry teachers show experiments demonstrating chemistry concepts, at least they could increase the attention of students and by these types of learning activities, teachers could influence their attitudes toward chemistry. These ideas are possible to read in some studies, which were focused on the influence of experiment demonstration on the learners' attitudes toward chemistry (e.g. Basheer et al., 2017). Likewise, focusing chemistry on everyday life (combination of practise, e.g. methods of separating mixtures and production of ethanol, metal processing to things of daily requirement, medicines and drugs and so on) influences positive perception of chemistry. The next opportunity to change attitudes toward chemistry could lead in the application of informal education (primarily with methods of observation and experiments) and education with constituent of cooperative, explorer and problem. Also the implementation of some forms of learning like project and problem based learning could change the perception of chemistry among pupils (e.g. Sababha et al., 2016). The results of our study caused some suggestions; a longitudinal study that follows the same students over all grades in lower secondary and secondary grammar schools to study changes in their attitude toward chemistry is recommended. Further research is needed to ascertain the reason behind gender differences across the grade levels in students' attitude towards chemistry as school subject.

ACKNOWLEDGEMENT

We thank David Des Armier, who kindly improved the English for this article.

REFERENCES

Acar, O., Turkmen, L., & Bilgin, A. (2015). Examination of gender differences on cognitive and motivational factors that influence 8th graders' science achievement in Turkey. *Eurasia Journal of Mathematics, Science & Technology Education*, 11(5), 1027-1040.

Barchok, K. H., Too, J. K., & Ngeno, K. J. (2013). Effect of collaborative concept mapping teaching strategy on students' attitudes towards chemistry in selected secondary schools in Kenya. *Asian Journal of Social Sciences & Humanities*, 2(2), 530-540.

Bartlett, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). Organizational research: Determining appropriate sample size in survey research. *Information Technology, Learning, and Performance Journal*, 19(1), 43-50.

Basheer, A., Hugerat, M., Kortam, N., & Hofstein, A. (2017). The effectiveness of teachers' use of demonstrations for enhancing students' understanding of and attitudes to learning the oxidation-reduction concept. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(3), 555-570.

Bauer, C. F. (2008). Attitude toward chemistry: A semantic differential instrument for assessing curriculum impacts. *Journal of Chemical Education*, 85(10), 1440-1445.

Bennett, J., Rollnick, M., Green, G., & White, M. (2001). The development and use of an instrument to assess students' attitude to the study of chemistry. *International Journal of Science Education*, 23(8), 833-845.

Can, H. B., & Boz, Y. (2012). A cross-age study on high school students' attitudes toward chemistry. *International Journal on New Trends in Education and Their Implications*, 3(3), 82-89.

Cheung, D. (2009). Students' attitudes toward chemistry lessons: The interaction effect between grade level and gender. *Research in Science Education*, 39(1), 75-91.

Coll, R. K., Dalgety, J., & Salter, D. (2002). The development of the chemistry attitudes and experience questionnaire (CAEQ). *Chemistry Education Research and Practice in Europe*, 3(1), 19-32.

Cronbach, L. J. (1951) Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3), 297-334.

Cumming, R. G. (1990). Is probability sampling always better? A comparison of results from a quota and a probability sample survey. *Community Health Studies*, 14(2), 132-137.

Dhindsa, H. S., & Chung, G. (2003). Attitudes and achievement of Bruneian science students. *Society & Animals*, 3(1), 17-24.

Erdem, E. (2012). Examination of the effects of project based learning approach on students' attitudes towards chemistry and test anxiety. *World Applied Sciences Journal*, 17(6), 764-769.

George, R. (2006). A cross-domain analysis of change in students' attitudes towards science and attitudes about the utility of science. *International Journal of Science Education*, 28(6), 571-589.

Heng, C. K., & Karpudewan, M. (2015). The interaction effects of gender and grade level on secondary school students' attitude towards learning chemistry. *Eurasia Journal of Mathematics, Science & Technology Education*, 11(4), 889-898.

Hilbink, C., & Barke, H. D. (2000). An idea of science: Attitudes towards chemistry and chemical education expressed by artistic paintings. *Chemistry Education: Research and Practice in Europe*, 1(3), 365-374.

Hofstein, A., Ben-Zvi, R., Samuel, D., & Tamir, P. (1977). Attitudes of Israeli high-school students toward chemistry and physics: A comparative study. *Science Education*, 61(2), 259-268.

Hofstein, A., & Mamlok-Naaman, R. (2011). High-School students' attitudes toward and interest in learning chemistry. *Education Quimica*, 22(2), 90-102.

Jones, M. G., Howe, A., & Rua, M. J. (2000). Gender differences in students' experiences, interests and attitudes toward science and scientists. *Science Education*, 84(2), 180-192.

Kan, A., & Akbas, A. (2006). Affective factors that influence chemistry achievement (attitude and self-efficacy) and the power of these factors to predict chemistry achievement-I. *Journal of Turkish Science Education*, 3(1), 76-85.

Kurbanoglu, N. I., & Akim, A. (2010). The relationships between university students' chemistry laboratory anxiety, attitudes, and self-efficacy beliefs. *Australian Journal of Teacher Education*, 38(8), 48-59.

Kurbanoglu, N. I., & Akim, A. (2012). The relationships between university students' organic chemistry anxiety, chemistry attitudes, and self-efficacy: a structural equation model. *Journal of Baltic Science Education*, 11(4), 347-356.

Linn, M. C., & Hyde, J. S. (1989). Gender, mathematics, and science. *Educational Researcher*, 18(8), 17-27.

MacCallum, R. C., Widaman, K. W., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, 4(1), 84-99.

Menis, J. (1989). Attitudes towards school, chemistry and science among upper secondary chemistry students in the United States. *Research in Science & Technological Education*, 7(2), 183-190.

O'Dwyer, A., & Childs, P. (2014). Organic chemistry in action! Developing an intervention program for introductory organic chemistry to improve learners' understanding, interest, and attitudes. *Journal of Chemical Education*, 91(2), 987-993.

Olakanmi, E. E. (2015). The effects of a web-based computer simulation on students' conceptual understanding of rate of reaction and attitude towards chemistry. *Journal of Baltic Science Education*, 14(5), 627-640.

Ozden, M. (2008). An investigation of some factors affecting attitudes toward chemistry in university education. *Essays in Education*, Special Edition, 90-99.

Papanastasiou, C., & Papanastasiou, E. C. (2004). Major influences on attitudes toward science. *Educational Research and Evaluation*, 10(9), 239-257.

Prokop, P., Prokop, M., & Tunnicliffe, S. D. (2007). Is biology boring? Student attitudes toward biology. *Journal of Biological Education*, 42(1), 36-39.

Richter-Egger, D. L., Hagen, J. P., Laquer, F. C., Grandgenett, N. F., & Shuster, R. D. (2010). Improving student attitudes about science by integrating research into the introductory chemistry laboratory: Interdisciplinary drinking water analysis. *Journal of Chemical Education*, 87(8), 862-868.

Sababha, B. H., Alqudah, Y. A., Abualbasal, A., & AlQaralleh, E. A. (2016). Project-based learning to enhance teaching embedded systems. *Eurasia Journal of Mathematics, Science & Technology Education*, 12(9), 2575-2585.

Salta, K., & Tzougraki, C. (2004). Attitudes toward chemistry among 11th grade students in high schools in Greece. *Science Education*, 88(4), 535-547.

Sears, P. B., & Kessen, W. (1964). Statement of purposes and objectives of science education in school. *Journal of Research in Science Teaching*, 2(1), 3-6.

Shannon, A. G., Sleet, R. J., & Stern, W. (1982). School students' attitudes to science subjects. *Australian Science Teachers Journal*, 28(1), 77-82.

Steckler, A., McLeroy, K. R., Goodman, R. M., Bird, S. T., & McCormick, L. (1992). Toward integrating qualitative and quantitative methods: An introduction. *Health Education Quarterly*, 19(1), 1-8.

Streiner, D. L. (1996). Maintaining standards: Differences between the standard deviation and standard error, and when to use each. *Canadian Journal of Psychiatry*, 41(8) 498-502.

Temel, S., Sen, S., & Yilmaz, A. (2015). Validity and reliability analysis for chemistry self-concept inventory. *Journal of Baltic Science Education*, 14(5), 599-606.

Tosun, C., & Senocak, E. (2013). The effects of problem-based learning on metacognitive awareness and attitudes toward chemistry of prospective teachers with different academic backgrounds. *Australian Journal of Teacher Education*, 38(3), 61-73.

Tsai, C.-C. (1999). "Laboratory exercises help me memorize the scientific truths": A study of eighth graders' scientific epistemological views and learning in laboratory activities. *Science Education*, 83(6), 654-674.

Xu, X., Villafane, S. M., & Lewis, J. E. (2013). College students' attitudes toward chemistry, conceptual knowledge and achievement: structural equation model analysis. *Chemistry Education Research and Practice,* 14(2), 188-200.