ALTERATION OF STUDENTS' INTEREST IN SCIENCE TOPICS IN LATVIA: 2003 – 2008

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Abstract

A number of researches confirm that students' interest in science both in Lower and Upper secondary school has a tendency to decrease. Various international comparative studies such as OECD PISA, TIMSS and ROSE reveal comparatively low achievements of students in Latvia. To analyze the causes behind such a situation it is important to carry out longitudinal studies. The analysis of the results obtained during ROSE studies in 2003 - 2008 show that, through the five year period, the most popular and unpopular science topics basically have remained the same, and there are no significant differences in the distribution of ranks. Changes in the mean value are also not statistically significant, though absolute values have a tendency to decrease. One of the most unpopular topics is "Atoms and molecules", which is the ground topic in the chemistry course.
The results confirm that the differences between mean values marked by girls and boys have slightly diminished, which testifies that the Latvian cohort of students both in Lower and Upper Secondary school has become more homogenous.
Key words: *comparative study, interest, ROSE project, science topics.*

Introduction

Different researches in Latvia as well as worldwide confirm, that students interest in science both in Lower secondary school and Upper secondary school has a tendency to decrease (Schmidt, 2000; Bartuseviča, 2006; Lamanauskas & Vilkonis, 2007). Although science education in Latvia during recent years has been designated as a national priority, still students do not wish to acquire science subjects.

Various international comparative studies such as OECD PISA[1] (Kangro,2007), TIMSS[2] (Geske, 2005), and ROSE[3] (Gedrovics, 2005) show a comparatively low Latvian students` interest in learning science. For example, students' achievements in OECD PISA international re-

[1] OECD - Organisation for Economic Co-operation and Development
[2] TIMSS - Trends in International Mathematics and Science Studies
[3] The Relevance of Science Education

search statistically are significantly below the level of the OECD countries, in various fields of science, rating from 25 to 34 out of 57 countries (OECD, 2007). Also the analysis of the international ROSE project results (obtained 2003 and 2008) has revealed that overall 15-years-old Latvian students have grown less enthusiastic about science subjects at school. Consequently the number of students regarding science subjects, in particular - chemistry and physics, as difficult has increased (Gedrovics, 2010). Science is one of the most important components in education. Further attitude of a new generation to environment and nature in general is based largely on the quality of chemistry education. It is important to clear up the students' opinion to make the studying process adequate to the needs, abilities and interest of modern student. Statement that interest enables the acquirement is commonly known fact (Lipman, 2003), though following question stays topical – is the role of the interest in studying process overestimated? Dahlbom M. has proven that students` interest towards science subjects even during long period of time stays unaffected (Dahlbom, 1988).

By changing the preconditions of learning chemistry, it would become possible to change the tendency of students' interest and there would follow the changes of the attitude towards science. This is why the basic task was posed for the long-lasting finding to compare the students` interest in different phenomena and science education problems by researching the aspects of science topics in which students are interested for improving chemistry learning.

Therefore we have drawn the following research questions:

What kind of topics Latvian students are interested to learn in science and especially in chemistry?

What changes have been observed during the last few years?

Methodology of Research

General Background

The research was based on the International comparative project ROSE (Schreiner & Sjøberg, 2004). The first cycle was carried out in 2003, and it involved students at the age of 15 (grade 9) from 39 schools (Gedrovics & Praulite, 2007). The next stage was organized in late autumn 2007/early 2008, which comply with the methodology of the project – one class from at least than 25 schools in a country and about 25 students from each class. The 25 schools were selected from those 39 which were involved in the project ROSE 2003.

Respondents

Totally 1065 students from grade 9 participated in the first cycle in 2003. There were involved 325 students from grade 9, as well as 420 students for comparison from grades 8-12 took part in the pilot research in 2008, totally 746 respondents from 25 schools of Latvia.

Instrumentation

The questionnaire included 108 questions of the closed type, where a respondent should give answers using the 4 categories of the Likert scale ($1 \leq M \leq 4$), it means that each respondent should choose from the four answers provided (Schreiner & Sjøberg, 2004) indicating the one that most precisely reflects their opinion. Though the instrumentation of the project ROSE does not allow ascertaining unequivocally, why students have chosen or declined one or another offered topic. This is the reason why in early 2007 a pilot research was carried out by involving students from Lower secondary school and Upper secondary school at 20 schools in Latvia. We were able to include students from other grades, not only grade 9, on the basis of previously

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published results proving that the questionnaire of the project ROSE is very well suited for use with other age groups, too (Gedrovics & Platonova, 2005). Since the concept of the project ROSE, unlike TIMSS or OECD PISA, is based on the research of students' attitude, not largely on the evaluation of their knowledge. Moreover for this pilot research, unlike the basic version of the ROSE, all respondents were asked to evaluate the importance of every suggested topic learning science according to Likert scale (*not important; of little importance; rather important; very important*), and supplement their answers with a brief explanation of their choice in free form.

Data Processing

The data processing was obtained by using the methods of statistical analysis (t-test, Kolmogorov-Smirnov test) of the SPSS program (version 17.01).

Results of Research

By analyzing the topics related to different science subjects, the pilot research of early 2007 as well as the repeated ROSE study (2008) both have confirmed the following. Grade 9 students' common interest in chemistry topics displays the tendency to decrease, though a slight increase is obvious regarding at least two the offered topics, namely *Chemicals, their properties and how do they react* and *Atoms and molecules*. However, neither issue attracts the majority of respondents ($M_{aver} < 2.50$). Statistically significant differences between the results from years 2003 and 2007 are observable only in the girls' cohort, which proves that boys' and girls' interests have grown relatively similar (mainly due to the fact that boys are losing interest in such "boys' themes" as *How the atom bomb functions* and *Explosive chemicals*.

Looking at students' from other grades and their interest to learn one or another chemistry topic, it was established that, irrespective of differences in mean values ($1 \leq M_{aver} \leq 4$), students' from different grades display a similar level of interesting the offered topics for example the issue *Atoms and molecules* is marked as one of the least-interesting in all grades from 8 to 12 ($M_{aver}<2.50$), while he issue *Chemicals, their properties and how they react* in secondary school grades (10-12) of in general is rated as interesting ($M_{aver}>2.50$).

Table 1. Respondents' reasoning for their choice of chemistry topics.
(% from the amount of respondents)

Answer category	Explanation abut the choice of an answer	Grades				
		8	9	10	11	12
1	Do not like, do not need, disgusting	8.7	4.3	4.2	3.5	1.6
2	Not interested, because already familiar; boring; complicated; hard	29.0	31.9	27.7	19.5	15.6
3	Interested, because do not know yet; can be useful; must know	18.8	26.7	29.4	13.3	31.1
4	Interested, because familiar; interesting; want to know; very absorbing; like chemistry	7.2	6.0	10.9	7.1	7.4
No answers		36.2	31.0	27.7	56.6	44.3
Total amount of respondents		69	116	119	113	122

Students from all grades (8-12) rated also such topics as *Deadly poisons and what do they do to the human body*, *The ozone layer and how it may be affected by humans, What can be done to ensure clean air and safe drinking water* as most interesting, but as the most important topic related to chemistry students from all grades indicated *How alcohol and tobacco might affect the body* and *How different narcotics might affect the body*. While the mean values characterizing students' wish to acquire respective topics still prove existing interest in general (M_{aver}>2.50), they so show decreasing interest in the period between 2003 and 2007. So students have greater interest in topics that are connected with practical life rather than the questions related to theory.

By evaluating students' reasoning behind their choices (Table 1), it was established that it is hard for a great part of respondents (more than half in Upper Secondary level) to phrase the explanation of their choice. This is why the existing numbers should be considered as approximate in Table 1, though they reveal a very interesting distribution of answers. For example, until grade 10 on average every third student has indicated dislike of, needlessness and complexity of the chemistry topics and expressed difficulty to learn chemistry. However an almost similar number of students of the same age indicate usefulness, interest in and curiosity about the chemistry topics, which in general proves that the eyes of students (grades 8-10) chemistry topics are still quite popular. In grades 11-12 the number of students that do not explain their choice of answer increases, while interest in chemistry topics decreases. Partly this could be explained with the upcoming graduation from secondary school; fewer students consider science as an interesting choice for their future career.

Table 2. The ranking [R] of most popular topics in science.

Explanation		2003[1]			2008			p
		M_{aver}	S.D.	R	M_{aver}	S.D.	R	
E42	Phenomena that scientists still cannot explain	3.34	0.932	**1**	3.18	1.014	**4**	**
C08	The possibility of life outside earth	3.30	0.944	**2**	3.12	0.988	**7**	**
C13	Why do we dream while we are sleeping, and what our dreams may mean	3.29	0.926	**3**	3.38	0.862	**1**	*
A34	How does it feel to be weightless in space	3.27	0.932	**4**	3.20	0.960	**3**	n.s.
A40	How to exercise to keep our body fit and strong	3.27	0.900	**5**	3.20	0.933	**2**	n.s.
A23	How meteors, comets or asteroids may cause disasters on earth	3.23	0.926	**6**	3.04	0.990	**9**	***
C15	Thought transference, mind-reading, sixth sense, intuition, etc.	3.19	1.017	**7**	3.13	1.036	**6**	n.s.
C10	Unsolved mysteries in outer space	3.14	1.045	**8**	2.92	1.074	24	***
A22	Black holes, supernovas and other spectacular objects in outer space	3.09	1.049	**9**	2.99	1.059	15	n.s.
E08	Cancer, what do we know and how can we treat it	3.09	0.963	**10**	3.06	0.991	**8**	n.s.
C11	Life and death and the human soul	3.06	1.021	12	3.16	0.992	**5**	n.s.
A30	How does the atom bomb function	2.91	1.073	29	3.03	1.075	**10**	*

[1] Data from (Gedrovics, 2006)
$1 \leq M_{aver} \leq 4$, R - ranking, * $p<0.05$ ** $p<0.01$ *** $p<0.001$, $\alpha = 0.95$
n.s. non significant differences 2003-2008

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The comparison of the results from years 2003 and 2008 show, that both the most popular topics (Table 2) and most unpopular science topics (Table 3) during five year period basically have remained the same. In addition, there are no obvious significant differences in the distribution of ranks. The changes in the mean value are not statistically significant, though absolute values have a tendency to decrease.

It is evident that such important topics as *Chemicals, their properties and how they react*, *Atoms and molecules*, which are the basic topics in chemistry, are the ones most unpopular, as well as the topic *How is crude oil converted to other materials, like plastics and textiles*, which just like the previously mentioned themes are at the bottom of the rank (Table 3). research in 2008 the change of students' scientific interest in biology, physics and chemistry was evaluated by appraising the common mean value in biology, physics and chemistry topic groups, respectively. These results are summarized in Table 4 and they prove that the absolute M values for boys have a tendency to decrease, while the M values for girls rather have the tendency to increase. Therefore we can consider that during the five years (2003 - 2008) girl's attitude to science statistically has become far less positive than in the case of boys, and 15-year-olds have grown more homogenous in their opinions about school science subjects.

Table 3. The ranking [R] of most non-popular topics in science.

Explanation		2003			2008			p
		M_{aver}	S.D.	R	M_{aver}	S.D.	R	
A03	The inside of the earth	2.23	0.902	97	2.09	0.895	**101**	**
E37	Famous scientists and their lives	2.15	1.038	**99**	2.11	1.021	**100**	n.s.
A02	**Chemicals, their properties and how they react**	2.12	0.996	**100**	2.12	0.952	**99**	n.s.
E25	Plants in my area	2.09	0.959	**101**	2.04	0.905	**104**	n.s.
A47	How do petrol and diesel engines work	2.09	1.080	**102**	2.19	1.075	96	n.s.
E19	Organic and ecological farming without use of pesticides and artificial fertilizers	2.09	1.038	**103**	2.08	0.960	**103**	n.s.
E33	Benefits and possible hazards of modern methods of farming	2.05	0.964	**104**	2.03	0.930	**105**	n.s.
C01	**How is crude oil converted to other materials, like plastics and textiles**	1.96	1.004	**105**	2.08	0.991	**102**	*
A15	How plants grow and reproduce	1.88	0.872	**106**	1.81	0.858	**107**	n.s.
A17	**Atoms and molecules**	1.83	0.937	**107**	1.82	0.890	**106**	n.s.
E01	Symmetries and patterns in leaves and flowers	1.54	0.777	**108**	1.56	0.784	**108**	*

$1 \leq M_{aver} \leq 4$, R ranking, * $p<0.05$ ** $p<0.01$ *** $p<0.001$; $\alpha = 0.95$
n.s. non significant differences 2003 – 2008

In general, the differences in mean values for different groups of topics in years 2003 and 2008 are not statistically significant ($p>0.05$), and therefore it can be stated, that in the period of five years no relevant changes in students' scientific interests have taken place, although regarding separate questions there is obvious statistically significant decrease of interest (Table 4).

Table 4. Average means values of students' scientific interest.

Groups of topics	Mean value, 2003			Mean value, 2008		
	Total	Girls	Boys	Total	Girls	Boys
Total	2.64	2.65	2.63	2.61	2.64	2.58
Chemistry	2.42	2.26	2.64	2.45	2.32	2.58
Physics	2.65	2.56	2.78	2.62	2.54	2.71
Biology	2.66	2.74	2.53	2.63	2.74	2.50

By changing the preconditions of learning science it would become possible to change the tendency in students' interests, and there would follow changes in attitude towards science. The methodology of teaching is relatively easy to be changed. This is why the development of new methodological approaches in future, by researching how to improve chemistry learning process with an aim to promote students` scientific interest, was posed as the basic task.

Discussion

International research ROSE, which was launched in Latvia in 2003, indicates that students' interest in science, including chemistry, in Latvian schools displays a common tendency to decrease. Although, in this research mainly the regular students' attitude towards science in general is analyzed, focusing also on their choice future career, the questionnaire contains also questions about chemistry and topics related to chemistry, e.g. *Atoms and molecules*, *Chemicals, their properties and how they react*, *Detergents, soaps and how they work* etc. (Možeika, Cedere & Gedrovics, 2007). The analysis of the ROSE project results obtained in Latvia prove that 15- year-olds in Latvia find the more or less are pseudoscientific and/ or mysterious topics (for example (*The possibility of life outside earth*, *Unsolved mysteries in outer space* etc.) most interesting.

Among the top ten (from totally 108 offered, Table 2) most popular topics students have ticked, there are also some issues related to human health (*How to exercise to keep your body fit and strong*, *Cancer, what do we know and how can we treat it* etc.). Although, students indicate that they would like to learn also such issues, which either just partly relate to science or generally are considered pseudoscientific, like *Why do we dream while we are sleeping, and what our dreams may mean*, *Astrology and horoscopes, and whether planets can affect human beings*. Several questions are equally interesting for both boys and girls, though statistically significant differences are observed, regarding questions about health and the previously mentioned pseudoscientific topics (Gedrovics, 2006; Gedrovics & Praulite, 2007). It is obvious that among the ten most unpopular topics are such items as *Chemicals, their properties and how they react* (rating 102 out of totally 108 topics) and *Atoms and molecules* (rating 107 out of totally 108 topics), besides there is no statistically significant difference between students from schools in cities and small rural places, also there is no difference in gender context (Gedrovics & Praulite, 2007).

There are always two kinds of participants in the learning and teaching process– students and teachers, and the efficiency of this process depends from consensus between both of them within teaching and learning aims. If we compare teachers' observations in Latvia and other countries then it should be mentioned that Swedish science teachers have indicated *Atoms and molecules* as the most important theme (M_{aver}=3.56) from the same 108 topics offered in project ROSE, and added that it should be learned by students – in opposition of Swedish

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students who ranked this theme as the 98th (girls) and 73rd (boys). The other chemistry related topic *Chemicals, their properties and how they react* is viewed as important by teachers (rank 14; M_{aver}=2.99), while for Swedish students it ranks as the 87th (girls) and 66th (boys) (Oscarsson, et al., 2009).

Chemistry teachers in Latvia, during a similar research, have ranked neither of these two topics among the 10 most important ones (Gedrovics et al., 2007): Latvian chemistry teachers consider that the most important themes, which should be acquired in grade 9 are *How different narcotics might affect the body* (M_{aver}=3.92), *How alcohol and tobacco might affect the body* (M_{aver}=3.85) and *What can be done to ensure clean air and safe drinking water* (3.85). Students in Latvia ranked the respective themes as the17th (M_{aver}=3.02), 20th (M_{aver}=2.99) and 43rd (M_{aver}=2.77) in year 2003 (Gedrovics, 2006), and as the 23rd (M_{aver}=2.94), 12th (M_{aver}=3.00) and 47th (M_{aver}=2.70) in year 2008. An interesting difference, which could be explained by the fact that in foreign countries learning is generally related to every day life, but for teachers and learners in Latvia it is something relatively new.

The fact that students do not want to learn about atoms and molecules is understandable – they tend to avoid excessive theory; however, they have admitted that learning chemistry in the context is more interesting and useful. It was observed within the other research project too (Gedrovics, Cedere, & Mozeika, 2009), and such observations confirm that there are relatively big differences what the students and their teachers accept as important themes for science education/ learning. Such situation requests to change teaching methods, which alloy to understand necessity and importance of corresponding themes in science education.

The answers obtained from Latvian students in ROSE-2003 do not differ significantly from those in Germany and Austria (Elster, 2007), in Czech Republic (Bilek, Radkova, & Gedrovics, 2006), as well as from other European countries in general (Schreiner, 2006). The repeated ROSE-project in Czech Republic and Poland, organized January-February 2008, reveals, that there are some differences between Latvian and Czech/ Polish results (Gedrovics et al., 2008). Though the observed differences are not diametrically opposed; they only point, that due to various teaching traditions, methodological approaches etc. relatively small differences occur. However, they are not sufficiently remarkable to indicate at important changes in students' interest in science topics. M. Dahlbom has proven that Swedish students' attitude towards separate science subjects even during a long period of time stays unaffected. The results of the research confirm that the students` interest to learn different science topics depends on various generalized factors, which are now similar in many countries. M. Dahlbom also highlights that students' developmental psychological features, the content of the subject and methodology of teaching, as well as social-psychological and other environmental factors affect the *tendencies in students' attitude* to science (Dahlbom, 1988).

For science teachers it is important to know students' today's interests as well as understand the possible changes in this field, therefore it helps to develop new teaching methods to promote students' learning achievements as an indicator of efficiency of science education.

Conclusion

In general students' scientific interest in different grades, during five years period (2003 - 2008) has not relevantly changed. The comparison of the results shows that the most popular and unpopular science topics have basically remained the same. Students' interest is comparatively higher in such themes which are presently topical and affect every individual in the world (personal health, problems in nature). The interest in chemistry problems is lower comparing with that in physics and biology, as well as in science in general.

During the five years some differences can be observed in the context of gender: girls' interest to learn science has had a slightly tendency to increase compared to boys. On the whole,

15-years-old students have become more homogenous in their opinions about learning science at school.

There are some important differences regarding what Latvian students and their teachers consider as most interesting (students) and important (teachers) science themes to learn. Although it seems that it is impossible to have absolute conformity of opinions for both groups, there needs to be more agreement in order to achieve better results in the science teaching/ learning process.

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