JOURNAL OF BALTIC SCIENCE EDUCATION

ISSN 1648-3898

COGNITIVE INTEREST: PROBLEMS AND SOLUTIONS IN THE ACQUISITION OF SCIENCE AND MATHEMATICS IN SCHOOLS OF LATVIA

Dagnija Cēdere,
Inese Jurgena,
Ineta Helmane,
Inta Tiltiņa-Kapele,
Gunita Praulīte

Abstract. *Cognitive interest is a vital learning motive for the successful learning process. Nowadays students' interest about science and mathematics are decreasing. The aim of the study is to explore the cognitive interest of Grade 9 students in science and mathematics. Students were surveyed and it helped to explore the respondents' cognitive activity and the cognitive interest regarding the understanding of causal relations, research activity and the solution of practical problems. The level of cognitive interests on the three level scales is average for the whole sample of respondents. The survey shows that students do not possess explicit cognitive activity; learning happens rather passively, without initiative; however, they have rather pronounced interest to explore and solve problems connected with the real life. Some implications for teachers on how to increase learners' cognitive interest are provided in the conclusion.*

Key words: *cognitive interest, learning process, science and mathematics.*

Dagnija Cēdere, Inese Jurgena, Ineta Helmane, Inta Tiltiņa-Kapele, Gunita Praulīte
Riga Teacher Training and Educational Management Academy, Latvia

Introduction

Science and technology education (STE) along with art and pragmatic education is the area of education that today experiences fast and continuous change in order to satisfy the topical needs of today's life. In other words, changes in our life are closely connected with respective changes in education, because educational activities of any person as well as the society as a whole mean specially organized gaining of life experience (knowledge, values, skills) for life (cognition, consideration, behaviour) (Broks, 2014).

One of the essential factors hindering the growth of the society's well-being is students' insufficient science literacy. The lack of knowledge and skills in science and mathematics today can be considered a threat to the modern science and technologies - driven economy (European Commission, 2012). Students' low level of knowledge and skills in science and mathematics is a resinous problem also in the economic development of Latvia.

During the last decade all European countries have reformed the education contents (Science Education in Europe, 2011), because science taught traditionally at school does not provoke interest in students about nature mainly because they do not see the link between the science with their own life and interests (Aikenhead, 2005). The experience of other countries shows that students' little or decreasing interest in science is partly defined by the fact that science is taught as if remotely, including content-wise invaluable facts that are unrelated to students' own experience (Aikenhead, 2005; Osborne, Simon, & Collins, 2003; Sjøberg, 2002).

Mathematics and science education are in a state of change (Zhou, 2010). Education reform carried out in Latvia has changed in essence the approach to teaching science and mathematics (science subjects) (Noteikumi, 2013). This creates all the possibilities for a full-fledged teaching/learning process that is based on student's and teacher's cooperation in active inquiry-based activity. Studies performed in Latvia some years ago testify that students' interest in learning science is insufficient 1st year students experience difficulties starting their studies at the university due to low level of previous knowledge (Mozeika & Cedere, 2008; Gedrovics & Cēdere, 2014). The student's desire to learn or the cognitive interest is important in the learning process; it develops in the interaction of the significance of the object (value), volition and experience. Without evocation of interest a successful teaching/learning process is impossible.

The interest is a complex phenomenon with several components: cognitive component as cognition, emotional component as emotions and feelings in the cognitive process, voluntary component as volition demands concentration on a particular object of cognition and action (Berlyne, 1960; Izard, 2002; Čehlova, 2002). High level of cognitive interest is expressed as the willingness to delve in the essence of phenomena, understanding of causal relations, independence and disposition in learning, trying to overcome the difficulties on one's own (Čehlova, 2002). The fact that situational cognitive interest develops into stable cognitive interest as a result of using purposeful pedagogical stimuli can be considered the key criterion of developing the cognitive interest. This approach is often used in science education (Lavonen, Juuti, Byman, & Meisalo, 2006).

Two trends dominate in the studies performed so far: stimuli inciting cognitive interest in the teaching/learning process have been explored and the pedagogical action/cooperation that promotes the formation of stable cognitive interest has been studied. Science and mathematics domain has been studied quite well and criticism on insufficient knowledge there interchanges with recommendations how to improve it. Many studies prove that students' have insufficient interest in the sciences (Potvin & Hasni, 2014; Cedere, Gedrovics, Bilek, & Mozeika, 2014); however, there are few studies that offer a possibility to differentiate stable interest from situational interest which is formed under the influence of external factors and can be short-term (Holstermann & Bögeholz, 2007).

Science subjects have their own specifics. In order to master these subjects well one needs the understanding of nature or the sense, going deeper in the essence of phenomena and things, the willingness and patience to observe, explore and analyse the results, the skill to solve qualitative tasks. Problem solving skill and the skill to think in the causal categories are important in the exploration of natural processes. The aim of science subjects is to develop students' skill to apply their knowledge in the solution of different problems and tasks in nature and practical life promoting sustainable development (Lopes, 2011; Gräber, 2013; Noteikumi, 2013).

Despite these common features of these subjects, students' attitude to them is rather different. Students usually have greatest interest in biology, the interest in chemistry and physics is weaker (Lamanauskas, Gedrovics, & Raipulis, 2004; Holstermann & Bögeholz, 2007). Mathematics, in its turn, rather often is really liked by a certain part of students but the greatest majority really dislikes it (Merzyn, 2008). Merzyn in Germany explains differences in the interest among subjects with the fact that physics and chemistry at school are oriented to science and less to the sphere of their application, practical solutions. The teaching/learning approach that is more appropriate to the minority of gifted, particularly interested students than the majority dominates in both the subjects. The interest in biology, in its turn, is promoted by the fact that many children from their early years are connected with that.

In order to solve the low science literacy level of young people in Latvia, this study explores one of the main learning motives - cognitive interest. The study has been performed based not so much on the content components than on the skills that students need to acquire in science subjects. Thus the authors could find out students' cognitive interest in accordance with the today's understanding of science literacy.

In order to understand how to solve this long-drawn problem about the lack of young people cognitive interest in science and mathematics, the following research questions were put forward:

- Do Grade 9 students learn science subjects (biology, chemistry, and physics) and mathematics with interest?
- To what extent is students' cognitive interest expressed in science subjects?

ISSN 1648–3898

Methodology of Research

General Characteristic of Research

This research was carried out in spring 2015. The study was based on students' survey that describes opinion of respondents; cognitive interest in science and mathematics and allows judging about the types of students' cognitive activities and their depth. Data were collected from 12 different basic schools and secondary schools in different regions of Latvia. All educational institutions implement the same teaching/learning content that is defined by the same subject standards.

Participants

The participants of the survey were Grade 9 students from 12 schools of Latvia. Students were invited to participate in survey from different schools in different regions of Latvia. Invitation referred students from 12 schools that territorially represent all Latvian regions. In all schools the students learn to a common Latvian national education standard. The total number of respondents is 237; 57% of them are girls and 43% boys. The average age of respondents is 15.3 years according to the class records. Thus, according to gender and the teaching/learning environment this group can be described as evenly distributed.

Such an age group is chosen on the basis of the idea that during this particular stage of life when the brain activity optimizes abstract thinking develops, therefore, the adolescent becomes able to perceive also contradictory phenomena and look at oneself from the aside (Giedd, Blumenthal, Jeffries, Castellanos, Liu, Zijdenbos, & Rapoport, 1999).

Instrument

The questionnaire of the survey is based on the studies performed earlier (Mozeika & Cedere, 2008; Gedrovics & Cēdere, 2014) and documents regulating education in Latvia (Noteikumi, 2013). The questionnaire included questions on how students' cognitive interest is expressed in science subjects (biology, chemistry, and physics) and mathematics and how students themselves assess their interest in these subjects.

The questionnaire was made on the internet using Google disc, students answered questions online. The questionnaire comprises questions where the answer variants correspond to four value Likert scale and are coded: 1 – no, 2 – rather no, 3 – rather yes, 4 – yes. The questions are formed according to the levels of cognitive interest and are included in the questionnaire in a mixed order. The reliability (inter-item consistency) of the questionnaire according to Cronbach alpha coefficient was .822.

Data Analysis

The data analysis was performed using the statistical software SPSS 17.0 program. The mean values of answers M ($1 \leq M \leq 4$) were used to describe the respondents' opinions. In order to assess the credibility of the differences of mean values in two reciprocally independent groups (boys and girls) the t test analysis of the independent samples was used. To describe the differences of the distribution of respondents' answers in two different groups Pearson Chi Square test was applied. Cronbach alpha was used for stating the reliability of the questionnaire.

Defining the Levels of Cognitive Interest

To define the level of students' cognitive interest, the existing conceptions about the understanding of the formation of cognitive interest (Žogla, 1994; Čehlova, 2002; Purēns, 2015) were used. On higher levels students have a desire to delve in the essence of the phenomena and to use the understood causal mechanisms in order to form one's own understanding about some phenomenon. On the lowest level such absorption in the essence of the phenomena does not happen.

In order to put forward criteria according to which to define the levels of cognitive interest, the adjusted method of V. Purens (Purēns, 2015) was used taking into consideration the specifics of the science subjects. It is important in the acquisition of these subjects to immerse oneself in the essence of the phenomena and processes, the research skills and the skill to apply knowledge in the solution of practical and complex, interdisciplinary tasks, including the mathematical instruments (Science Education in Europe, 2011; apkova, 2011).

The mean values *M* ($1 \le M \le 4$) of the respondents' answers were used as the level indicators (Table 1).

Table 1. Criteria, indicators and levels of cognitive interest.

No	Criterion	Indicators	High level (3.1 ≤ M ≤ 4.0)	Average level (2.1 ≤ M ≤ 3.0)	Low level (1.0 ≤ M ≤ 2.0)
1	Intensity of the cognitive action in the teaching/ learning process	• Students attention in lessons • Students cooperation with teacher	Active, independent cognitive action	Cognitive action is not explicitly active	Cognitive action is inert
2	Interest to discover the essence of phenomena and processes	• Observation • Analysis of results	Explicit interest	Learns willingly but does not seek the essence	No interest in essence
3	Disposition in research activity	• Students independence in practical activities • Cognition of Nature phenomena	Independent and zealous activity	Learns but without enthusiasm	No interest to explore and find out
4	Willingness to solve complex tasks, practice related problems	• Level of task difficulty • Real problem solving	Independently seeks answers to difficult questions	No explicit willingness to seek answers to difficult questions	Does not want to solve tasks that require effort
5	Devoting free time to science and mathematics	• Devoting free time • Cognition in extra curriculum activities	Devotes also one's free time to science and mathematics	Devotes free time episodically	No interest to devote the free time to science and mathematics

The reliability of defining the levels of cognitive interests is described by Cronbach alpha coefficient .806.

Results of Research

The results of Grade 9 students' survey testify that students' interest in science subjects is not high. The questions *Do you think with pleasure about the lessons of biology/chemistry/physics/mathematics?* (Questions A1 – A4) were answered positively (*yes*) about biology by 27.4%, about chemistry by 22.4%, about physics by 21.1% and about mathematics only by 14.8% of the respondents.

The mean values of answers are summarized. Statistically significant differences between boys and girls can be seen in biology, $t(232) = 2.02$, $p = .04$, in which girls expressed more pleasure and in physics where boys had greater interest, $t(228) = 3.79$, $p < .001$. In order to find out more about the respondents' cognitive interest, the set of questions was chosen *Do you want to explore science and mathematics?* The questions included in this section of the questionnaire allow judging about separate subjects as well as about the extent to which students understand the essence of science subjects and their importance in life (Table 2).

ISSN 1648–3898

Table 2. Sample of students' desire to explore science and mathematics (1 ≤ *M* ≤ 4).

Items	Respondents' group	*M*	$\chi 2$	*df*	*p*
B2 Students desire to find out reasons why air after the thunder-storm smells differently	Boys	2.69	12.027	3	.007*
	Girls	3.20			
	Total	2.98			
B4 Students' interest in the constitution and functions of the human organism	Boys	2.85	17.394	3	.001*
	Girls	3.30			
	Total	3.11			
B5 Students like tasks in which they need to construct	Boys	2.79	11.084	3	.011*
	Girls	2.34			
	Total	2.54			
B6 Students' interest in using modified organisms in food production and medicine	Boys	2.53	9.527	3	.023*
	Girls	2.86			
	Total	2.72			
B9 Students desire to understand why glass container breaks if water freezes in it	Boys	2.68	4.023	3	.259
	Girls	2.95			
	Total	2.84			
B10 Students desire to find out how drinking water is purified	Boys	2.88	6.075	3	.108
	Girls	2.85			
	Total	2.87			
B11 Students' interest to explore the mathematical connections and to interpret the obtained results in the solution of the real problem	Boys	2.31	5.977	3	.113
	Girls	2.11			
	Total	2.20			
B13 Students desire to make mathematical equations in order to solve practical tasks that are related to everyday, science, environment and health issues	Boys	2.36	12.605	3	.006*
	Girls	1.96			
	Total	2.13			
B14 Students' interest to master the mathematical instruments using equation systems with two variables, inequality with one variable	Boys	2.32	2.381	3	.497
	Girls	2.11			
	Total	2.20			
B16 Students point of view that the development of the state needs good knowledge in science and mathematics	Boys	3.08	8.734	3	.033*
	Girls	3.43			
	Total	3.27			

In Table 2 *p < .05 – statistically significant differences; α = .95. Since the p-value =1.000>0.05 then cannot reject the null hypothesis that the empirical distribution corresponds to the Poisson distribution. There are six statistically significant items in Table 2: students' desire to find out why air after the thunderstorm smells differently; students' interest in the constitution and functions of the human organism; students like (enjoyment) tasks in which you need to construct; students' interest in using modified organisms in food production and medicine; students' like (enjoyment) to make mathematical equations in order to solve practical tasks that are related to everyday, science, environment and health issues; students' agreement that the development of the state needs good knowledge in science and mathematics.

In Figures 1-4 shown data from girls and boys survey. There are distribution of answers to four questions based on a scale not - rather not - rather yes - yes. All these issues are statistically significant differences between boys and girls. In Figure 1 and Figure 3 highlighting items B4 and B5, where girls' interest is significantly higher. In Fig. 2 and 4 (items B6 and B13) – boys' interest is significantly higher.

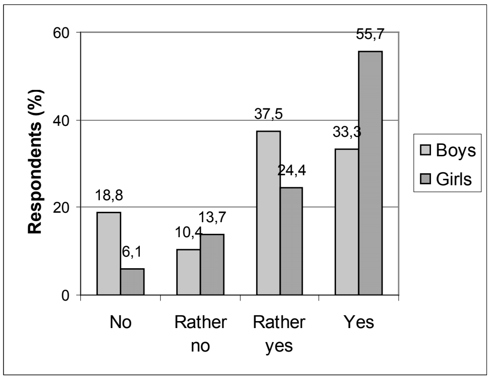

Figure 1: **Students' interest in the constitution and functions of the human organism (B4);**
χ^2 (3, N = 237) = 17.39, p = .001

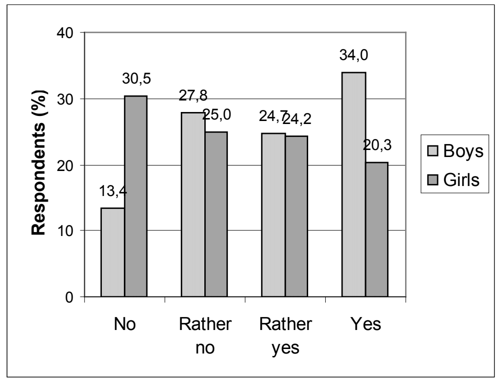

Figure 2: **Students like tasks in which they need to construct (B5);**
χ^2 (3, N = 237) = 11.08, p = .01

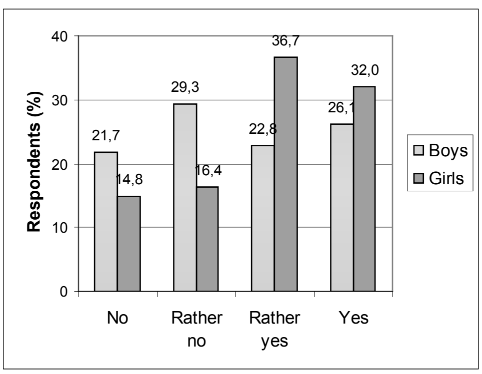

Figure 3: **Students' interest in using modified organisms in food production and medicine (B6);**
χ^2 (3, N = 237) = 9.53, p = .02

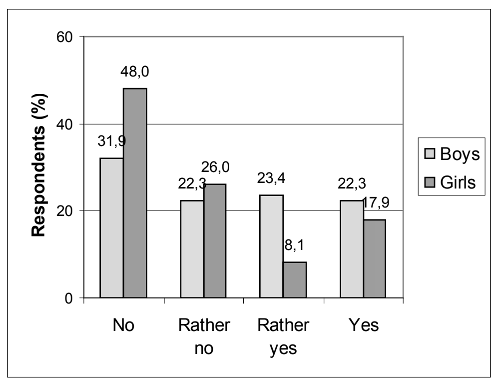

Figure 4: **Students' like to make mathematical equations in order to solve practical tasks that are related to everyday, science, environment and health issues (B13);**
χ^2 (3, N = 237) = 12.60, p = .01

In order to increase knowledge of students' interests in nature, the data were evaluated in accordance with the interests of the cognitive levels of detection indicators (Table 1). Cognitive levels for the indicators used in the corresponding answers the average value M_{aver} (Table 3).

ISSN 1648–3898

table 3. Average level of cognition per criteria.

No	Criterion	Maver	Level of cognition
1	Intensity of the cognitive action in the teaching/ learning process	2.23	average
2	Interest to discover the essence of phenomena and processes	2.68	average
3	Disposition in research activity	2.39	average
4	Willingness to solve complex tasks, practice related problems	2.80	average
5	Devoting free time to science and mathematics	1.90	low
	Average level	2.40	average

Average level of students' intensity of the cognitive action in the teaching/ learning process characterized by the following features: student not always follow the lessons and do all the tasks and seldom tells the teacher what to do in the lessons. Average level of students' interest to discover the essence of phenomena and processes expressed as no explicit students' interest and students' does not feel assured when explaining the causal relationship of simple natural phenomena. Average level of students' disposition in research activity characterized by the students' interest to explore is not pronounced and does not possess perseverance to finish what has been started. Average level of students' willingness to solve complex tasks, practice related problems: students desire to solve interesting but challenging tasks is little pronounced and application of mathematics is of no particular interest. Low level of students devoting free time to science and mathematics - students spend very little free time to science and mathematics. Average level interest to acquire the science subjects is not explicit.

The distribution of respondents per levels shows that the level is average for the majority (67%), 18.4% of respondents have high level and for 14.6% of respondents the level of cognitive interest is low.

Discussion

Students involved in the study will graduate from the basic school after some months. Their opinions expressed in the survey show how far the state education policy is implemented in the practice- how topical are sciences and mathematics at school and whether these subjects are learnt with interest. The obtained results provide an insight in today's schools of Latvia.

Students' Interest to Learn the Sciences

The science subjects in the view of Grade 9 students have not become more important in comparison with the previous studies performed in Latvia (Mozeika & Cedere, 2008; Gedrovics & Cēdere, 2014). The respondents like biology classes the most (M=2.89), the lowest assessment is given to lessons in physics (M=2.37). Biology usually is the sciences subject that students like the most (Uitto, Jutti, Lavonen, & Meisalo, 2006). Merzyn (2008) considers that interest in biology is promoted by students' direct contact with nature. Interest gender differences are also similar to the ones described in literature earlier (Gedrovics, Lavonen, & Raipulis, 2010): girls like biology more while boys are more interested in physics; in both cases the differences are statistically insignificant. Thus, vivid changes in students' attitude to the sciences in such an aspect are not identified.

The next set of questions allows understanding the respondents' cognitive interest in more detail (Table 3). The mean values of answers (M) are higher if the question concerns students' desire to explore the phenomenon or process that is interesting, important or related to practical life (B2, B4, B6).

Students have relatively high interest about the constitution and functions of human organism (M=3.11) but they are much less interested in the growth and reproduction of plants (M=2.27). Although students acknowledge that biology lessons are the most interesting among the sciences still in the expression of the cognitive interest it is essential whether the question is simple or the answers to questions require effort. For instance, the question in biology *Are you interested in the life cycles of microorganisms?* does not raise much interest (*M*=2.25). Students' interest in questions related to mathematics is alarmingly low (B11, B13 and B14; M=2.20, 2.13 and 2.20 respectively).

This once more proves that students do not like, they are not interested and they do not like to learn anything that requires effort. They lack motivation and obviously students do not see the importance of knowing mathematics in their further development.

One of the reasons why students lack interest in learning sciences is the fact that abstract thinking is not yet sufficiently developed at the age of 15. Many abstract concepts are to be acquired in mathematics and chemistry, for example, atoms and molecules in chemistry that exist in reality but cannot be seen. Many people remember chemistry with dislike/aversion after graduating from the school (Atkins, 2015).

The interest to learn chemistry identified in study is higher in comparison with the study performed in Germany. The difference can be explained with a closer link of the content with practical life, the lack of which has been mentioned as the main reason of students' low interest (Merzyn, 2008). A comparatively higher level of interest was found about items B2, B9, B10 that are connected with nature and everyday life (Table 2).

One more important issue is the formulation of the question. Gripping, simply formulated question incites cognitive interest also about a more difficult topic. For example, students seem to be interested to find out why air smells differently after the thunderstorm (*M*=2.98). Students probably do not anticipate that the answer is not so simple because they need both the knowledge of physics and chemistry but most importantly - interest has been aroused. Certainly, the question remains open – how many students would be ready to seek the causes about this natural phenomenon in point of fact? The other two questions included in the questionnaire can be compared in a similar way: the first about the use of modified organisms in food production and medicine (*M*=2.72) and the second about solving a practical issue with an outlined form of mathematical solution (*M*=2.13). The interest to explore is explicitly greater about the first question which focuses on an interesting and significant research object. The second question emphasizes mathematics as a research method that does not promote students' positive attitude. Evocation of cognition and activation of learning with the help of gripping questions becomes more and more topical (Mitra, 2015).

The analysis of the cognitive interest of boys and girls applying Pearson Chi Square test, shows the differences in the distribution of answers that are statistically significant in questions connected with biology and mathematics (Table 2). Boys show significantly greater interest in all questions that need the knowledge of mathematics, except the mathematical question of a theoretical character (B14), where both gender groups have similarly low mean indicators (M_{boys}=2.32, M_{girls}=2.11) and there are no statistically significant differences. The diagrams presenting the distribution of answers (Figures 1-4) testify about rather pronounced polarity of respondents' opinions. 48% of girls and 32% of boys have given categorical "no" thus expressing their negative attitude to mathematics when answering question B13 *Do you like to make mathematical equations in order to solve practical tasks that are related to everyday, science, environment and health issues?* (Figure 4). However, a relatively big part of students (22% boys and 18% girls) like such mathematical tasks.

Students have answered positively the question *Do you agree that the development of the state needs good knowledge in science and mathematics?* (*M*=3.27). Thus, the greatest part of students is aware of the importance of the science knowledge but they lack motivation to refer it to themselves. Students write: *Is it really necessary to teach sciences and mathematics in all schools in the same way? How many people connect their profession with sciences and mathematics?* (from students' remarks in the questionnaire).

Students' science interest in the previous studies performed in Latvia (Mozeika & Cedere, 2008; Gedrovics & Cēdere, 2014) has been assessed as insufficient. Our study partly confirms it; however, due to different methodological approaches the study outcomes cannot be compared unequivocally. This study unlike the previous ones is oriented to skills as the outcome of the cognitive process.

Levels of Students' Cognitive Interest

The assessment of students' cognitive interest according to the specific criteria of the sciences subjects gives a possibility to judge about students' cognitive interest in accordance with the learning outcomes to be reached in these subjects as well as about the cognitive activity that describes the cognitive process itself.

ISSN 1648–3898

According to the criteria that are put forward (Table 1) the calculated average level of respondents' cognitive interest can be assessed as mean, *M*=2.40 (Table 3); however, treating interest separately per each criterion the low cognitive intensity in learning (*M*=2.23) causes worry. It points to students' passivity during the lessons, lack of communication with the teacher. Cognitive interest can be assessed as high if the student does independently all the tasks, always follows the lesson, suggests the teacher what could be done in the lessons (Purēns, 2015).

The indicator about spending the free time is extremely low (*M*=1.9); it testifies that students devote very little of their free time to the exploration of nature and the acquisition of the sciences; the cognitive interest is not deep enough and stable. The interest level corresponding to the specific skills to be mastered in the sciences (criteria 2-4) is considerably higher (*M*=2.39-2.80); thus, judging by the mean values students learn without effort and special interest in attaining the aims of learning.

Students who correspond to high and average level (18.4% and 67% respectively) have a positive attitude to school subjects and they are willing to master them. The interest in the essence of the phenomena and processes, interconnections, the desire to delve into complex issues is characteristic to the higher level. The average level is described by the accumulation of factual information but the absorption usually takes place only with the teacher's help. Episodic interest about some vivid expressions of the phenomena and the lack of desire to delve into its essence characterizes the lowest level (Purēns, 2015).

The results of the study confirm the idea that cognitive interest is a significant learning motive (Schiefele & Wild, 2000), and students' low level of knowledge and skills in the sciences is closely connected with the lack of interest (Zhou, 2010; Hadenfeldt, Repenning, & Neumann, 2014).

Conclusions

Although the sciences subjects have much in common, the students' attitude to them, however, is different. Students, especially girls, like biology lessons the most. The liking towards the lessons in the respective subject on the mean assessment corresponds well to the respondents' cognitive interest and understanding about the importance of this branch of science. On the whole, respondents' cognitive interest in science subjects and mathematics can be assessed as medium; still it is very different and is paced in a wide range as regards particular students. The attention is drawn by the fact, that relatively many students have explicitly low interest in the science subjects included in the study. Boys display higher interest in chemistry, physics and mathematics, while girls have a higher interest in biology. The polarity of interests was also noted.

The level of cognitive interest according to the specific skills to be mastered in the science subjects and the cognitive activity has been defined. Students with mean level of cognitive interest form the majority of respondents; however, 18% of students have a high level. Students have no explicit interest to find out the causal relationships of the phenomena and events and to substantiate them. The willingness to overcome difficulties in learning is less pronounced. Students have a relatively low cognitive intensity in the science subjects.

Opinions expressed by respondents allow concluding that in order to promote higher cognitive interest teachers have to use diverse teaching approaches, inquiry-based science teaching, thus, actualizing students' needs for self-actualization and the aim.

Note

This paper was presented at the 1st International Baltic Symposium on Science and Technology Education (BalticSTE2015) 'State-of-the-Art and Future Perspectives', 15-18 June 2015, Siauliai, Lithuania. It was approved by the Symposium scientific committee and recommended for publication in *Journal of Baltic Science Education*. A short version of this paper is published in the symposium proceedings (https://www.academia.edu/13101334/STATE-OF-THE-ART_AND_FUTURE_PERSPECTIVES).

References

Aikenhead, G. S. (2005). Research into STS science education. *Educación Química, 16(3)*, 384-397.

Atkins, P. (2015). Foreword. In J. Garcia-Martinez & E. Serrano-Torregrosa (Eds.), *Chemistry Education*. *Best Practices, Opportunities and Trends*. Weinheim: Wiley-VCH Verlag.

Berlyne, D. (1960). *Conflict, arousal and curiosity*. New York: McGraw- Hill.

Broks, A. (2014). Scientific thinking – the backbone of modern science and technology education. *Journal of Baltic Science Education, 3(6)*, 764–766.

Cedere, D., Gedrovics, J., Bilek, M., & Mozeika, D. (2014). Changes of 15 years old students' interest in science in Latvia: 2003-2013. In M. Bilek (Ed.), *Proceedings of the 9th IOSTE Symposium for Central and Eastern Europe „Science and technology education for the 21st century"*(pp. 103-112). Hradec Králové: Gaudeamus.

Čehlova, Z. (2002). *Izziņas aktivitāte mācībās* [Cognitive activity in learning]. Rīga: RaKa (In Latvian).

European Commission, EACEA, & Eurydice (2012). *Developing Key Competences at School in Europe: Challenges and Opportunities for Policy. Eurydice Report.* Luxembourg: Publications Office of the European Union. Retrieved March 02, 2015 from http://eacea.ec.europa.eu/education/eurydice/

Gedrovics J., Cēdere D. (2014). International comparative project ROSE. In G. Praulīte, D. Cēdere (Eds.), *Natural Sciences and Pedagogy. Monograph* (pp. 67-112). Rīga: LU Akadēmiskais apgāds.

Gedrovics, J., Lavonen, J., & Raipulis, J. (2010). Application of the different development indexes in the research of science didactics. *Problems of Education in the 21st Century, 22*, 33-44.

Giedd, J. N., Blumenthal, J., Jeffries, N. O., Castellanos, F. X., Liu H., Zijdenbos, A., & Rapoport, J. L. (1999). Brain development during childhood and adolescence: a longitudinal MRI study. *Nature Neuroscience, 2 (10)*, 861–863.

Gräber, W. (2012). Reflections on inquiry-based science education in Europe and outlook. In Bolte, C., Holbrook, J., & Rauch, F. (Eds.), *Inquiry-based Science Education in Europe: Reflections from the PROFILES Project* (pp. 221-225). Berlin: Freie Universität Berlin. Retrieved March 02, 2015 from https://ius.uni-klu.ac.at/misc/profiles/files/Profiles%20Book%202012_10.pdf

Hadenfeldt, J. Ch., Repenning, B., & Neumann K. (2014). Aufgaben zur Erfassung des Verständnisses von Materie [Die kognitive Validität von Ordered Multiple Choice]. *Zeitschrift für Didaktik der Naturwissenschaften, 20(1)*, 57-68.

Holstermann, N., & Bögeholz, S. (2007). Interesse von Jungen und Mädchen an naturwissenschaftlichen Themen am Ende der Sekundarstufe I [Interest of boys and girls in science subjects at the end of secondary stage I]. *Zeitschrift für Didaktik der Naturwissenschaften, 13*, 71-86.

Izard, C. (2002). Interests measurement. In *Encyclopaedia of Educational Research* (Vol. 2, pp. 945-954). London: Coller Macmillan Publisher.

Lamanauskas, V., Gedrovics, J., & Raipulis, J. (2004). Senior Pupils'Views and Approach to Natural Science Education in Lithuania and Latvia. *Journal of Baltic Science Education, 1*, 13-23.

Lavonen J., Juuti K., Byman R., & Meisalo V. (2006). Contexts and Teaching Methods in School Science. In S. Madalāne (Ed.), *III Starptautiskās zinātniskās konferences „Teorija praksei mūsdienu sabiedrības izglītībā" rakstu krājums* [Proceedings of the III International research conference "Theory for Practice in the Education of the Modern Society"] (pp. 277-282). Rīga: RPIVA.

Lopes, B. J. (2011). Pathways of students' conceptualisation during a problem solving task: lessons for teaching physics. *Journal of Baltic Science Education, 10(1)*, 36-52.

Merzyn, G. (2008). *Naturwissenschaften, Mathematik, Technik – immer unbeliebter? Die Konkurrenz von Schulfächern um das Interesse der Jugend im Spiegel vielfältiger Untersuchungen* [Natural sciences, mathematics, technology - increasingly unpopular? The competition of school subjects to the interest of the young people from view of diverse studies]. Baltmannsweiler: Schneider-Verlag Hohengehren.

Mitra, S. (2015). *The global experiment in self-organised learning*. Retrieved March 02, 2015 from https://www.theschoolinthecloud. org/

Mozeika, D., & Cedere, D. (2008). Study on influence of students' interest in natural sciences on the level of knowledge and understanding in chemistry. In I. Žogla (Ed.), *Proceedings of the International conference "ATEE Spring University 2008. Teacher of the 21st Century: Quality Education for Quality Teaching"* (pp. 258-264). Riga: University of Latvia Press.

Noteikumi par valsts pamatizglītības standartu, pamatizglītības mācību priekšmetu standartiem un pamatizglītības programmu paraugiem (2013). [Regulations on national standard of basic education, subject standards of basic education and sample basic education curricula]. Retrieved March 02, 2015 from http://likumi.lv/doc.php?id=259125

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science* Education*, 25(9)*, 1049-1079.

Potvin, P., & Hasni, A. (2014). *Interest, motivation and attitude towards science and technology at K-12 levels: a systematic review of 12 years of educational research.* Retrieved March 2, 2015, from http://dx.doi.org/10.1080/03057267.2014.881626

Purēns, V. (2015). Pusaudžu izziņas intereses veidošanās dialoģiskajā vēstures mācību procesā. Doktora disertācija [Development of Adolescent Cognitional Interest in Dialogical History Studies. Doctoral Thesis]. Retrieved May 2, 2015, from http://www.rpiva.lv/pdf/prom/vp_darbs.pdf (In Latvian)

Schiefele, U., & Wild, K. P. (Eds.). (2000). *Interesse und Lernmotivation*. Münster: Waxmann.

Science Education in Europe: National Policies, Practices and Research (2011). Brussels: Education, Audiovisual and Culture Executive Agency, P9 Eurydice.

ISSN 1648–3898

Sjøberg, S. (2002). Science and Technology Education in Europe: Current Challenges and Possible Solutions. *Connect: UNESCO International Science, Technology & Environmental Education Newsletter*, 27(3-4). Retrieved May 2, 2015, from: http://unesdoc.unesco.org/images/0014/001463/146315e.pdf

apkova, O. (2011). Constructivist beliefs of Latvian mathematics teachers: looking into future. *Journal of Teacher Education for Sustainability, 13(1),* 99–112.

Uitto, A., Jutti, K., Lavonen, J., Meisalo, V. (2006). Students' interest in biology and their out-of- school experiences. *Journal of Biological Education, 40(3)*, 124-129.

Zhou, G. (2010). Conceptual change in science: a process of argumentation. *Eurasia Journal of Mathematics, Science & Technology Education, 6 (2)*, 101-110.

Žogla, I. (1994). *Skolēna izziņas attieksme un tās veidošanās* [The student's cognitive attitude and its formation]. Rīga: Latvijas Universitāte. (In Latvian)

Received: *April 16, 2015* Accepted: *July 05, 2015*

Dagnija Cēdere	Dr.chem., Leading Researcher, Riga Teacher Training and Educational Management Academy, Imantas linija 7/1 , LV-1083, Riga, Latvia. E-mail: dagnija.cedere@lu.lv
Inese Jurgena	Dr.paed., Professor, Riga Teacher Training and Educational Management Academy, Imantas linija 7/1 , LV-1083, Riga, Latvia. E-mail: inese.jurgena@rpiva.lv
Ineta Helmane	Dr.paed., Associate Professor, Riga Teacher Training and Educational Management Academy, Imantas linija 7/1 , LV-1083, Riga, Latvia. E-mail: ineta.helmane@rpiva.lv
Inta Tiltiņa-Kapele	Dr.psych., Leading Researcher, Riga Teacher Training and Educational Management Academy, Imantas linija 7/1 , LV-1083, Riga, Latvia.
Gunita Praulīte	Dr.biol., Professor, Riga Teacher Training and Educational Management Academy, Imantas linija 7/1 , LV-1083, Riga, Latvia. E-mail: gunita.praulite@rpiva.lv