LONGITUDINAL RESEARCH IN THE CHANGE OF GRADE 9 PUPILS' COGNITIVE INTERESTS IN SCIENCES (2003-2013)

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Abstract. Sciences nowadays are an important education component of the modern society. The insufficient level of pupils' knowledge which continues decreasing with every year is a global issue; it creates serious threats to the development of science and technology in Latvia and elsewhere in the world. One of the key requirements of successful learning is cognitive interest in the school subject. Cognitive interest is a complex psychic phenomenon which is based on the individual's psychic qualities, experience and is expressed as stable, self-regulated and positive willingness to pay heightened attention to a particular school subject. The aim of the study is to find out Grade 9 pupils' cognitive interests in the science context and the main trends of the development of these interests. Using the methodology of the international project ROSE students were surveyed in the course of ten years with a five year period. It was found out that pupils had a rather low level of cognitive interest in science. Comparing the data collected in 2003, 2008 and 2013 a statistically significant drop in the cognitive interest has been observed. There are also indications of gender-specific interests.

Keywords: science education, teaching/learning process at school, cognitive interest, knowledge.

Introduction

Lately both the education policy makers and schools all over Europe have paid attention to crucial skills and attitudes of the European youth that will ensure their success not only in choosing the career and professional development but also in their personal life. One of the important factors that hinders the growth of the society's wellbeing is the insufficient science literacy of the young people. The lack of skills in science and technologies today can be considered as the threat to modern economy driven by technologies and science education [1].

The issue how to promote pupils' learning has been much discussed. However, despite the many improvements of the science study process the level of pupils' knowledge in science corresponds little to the needs of the science and technology society. The research [2; 3] indicates that the majority of pupils have little interest in science.

The lack of cognitive interests is a critical obstacle for the learning to be productive. Continuing the previous research [4], which had found out how big pupils' interest in different science issues was, the aim of this study is to make out the following.

- Do pupils consider science and technology important for the society?
- How great is pupils' everyday experience as the promoter of the science interest?
- What are the differences between the opinions and interest of boys and girls?
- What is the character of changes of pupils' cognitive interests in the 10 year period?

The cognitive process in science in school should take place in accordance with the same principles as in science, namely: new knowledge is formed exploring the nature processes and phenomena. As specialists consider science subjects that the majority of pupils consider difficult, become interesting if the learning is based on their previous experience. As it has been clarified earlier [5], pupils' interest in different science topics is rather low; in the time period 2003-2013 it has even decreased although pupils themselves are optimists and assess their interest as "rather interesting".

This study found out how often pupils have come into contact with science outside the school. The researchers have selected questions that describe their attempts and need to turn to concrete science fields in practical life and that form their everyday experience.

Materials and methods

Pedagogical and psychological theories which consider interest as a complex phenomenon with several components- cognitive (cognition), emotional (emotions and feelings in the cognitive process), voluntary (volition demands concentration on a particular object of cognition) and action [6-11] served as the theoretical and methodological basis of the study. All the above mentioned components are also influenced by the external social component. Cognitive interest is one of the kinds of interests which in pedagogy is understood as the interest in learning; it is the personality's desire to learn the essence of some phenomenon and regularities connected with it [12-16]. Research acknowledges that the study process which is interest-driven has several advantages. Pupils aspire to certain proficiency in the chosen field; they are persistent in their endeavours; they develop more diverse and profound knowledge. Stable indicators of cognitive interests are: joy and satisfaction, conscious responsibility for what is going on in the chosen field of interest, the inclusion of interests in the awareness of one's identity, the attempts to implement definite goals of life [17]. It is important to understand that interest is expressed as: the move of the selected psychic processes to concrete objects and phenomena of the surrounding environment; the tendencies, aspirations and needs of the personality to turn to a concrete field of action that provides certain satisfaction; the action stimulus of the personality, which, on the one hand, activates all psychic (cognitive) processes and, on the other hand, makes the action exciting and productive, is also important; the chosen attitude towards the surrounding world that is described by emotions that are connected with vivid expression of action, intentions and volition [12].

Interest in science is gender-specific. Boys are more interested in exploration, dangerous experiments in physics and technology while girls have more pronounced interest in diseases, bogy functions, supernatural phenomena and nature [18].

The present study analyses the results of surveys of Grade 9 pupils from different regions of Latvia (Table 1) which were obtained applying the instruments of the international comparative study ROSE (The Relevance of Science Education) [19]; the methodology has been described earlier [4]. The surveys were conducted in 2003, 2008 and 2013.

Table 1

Description of respondents

Year of the study	Girls		Boys		Together
	N	%	N	%	
2003	624	58.8	437	41.2	1061
2008	384	51.7	359	48.3	743
2013	253	48.6	268	51.4	521
Together	1261	-	1064	-	2325

The study used G and H sections of the ROSE questionnaire, the total number of questions – 77. The results of the studies performed earlier [3] were used for the comparison.

SPSS and Excel programs have been used for statistical processing of data. The Independent-Samples t-Tests (two-tailed) have been used for the comparison. The power of the difference using Cohen's d has been used as an additional check. Cohen's d measures the effect size for the difference between independent samples: no effect at $d < 0.2$, small effect at $0.2 \leq d < 0.5$, moderate effect at $0.5 \leq d < 0.8$, and large effect at $d \geq 0.8$ [20].

Results and discussion

Using the section G of the ROSE questionnaire "My opinion about science and technology" the respondents had to choose one of the answers of the Likert scale: 1 – I disagree, 2 – I rather disagree, 3 – I rather agree, 4 – I agree. The change of the respondents opinions in the time period 2003 – 2008 – 2013 is well-described by the sampling of questions (Fig. 1).

The mean values of answers (M) that on the whole are high testify that Grade 9 pupils assess positively the importance of science and technology in the development of the society and the country. The comparison of the respondents' answers given in 2003 and 2008 indicates the decreasing of the mean values of answers (M). To assess the validity of the differences in the mean values of answers, the analysis of the independent samples t-Test has been performed. For instance, a statistically significant difference was stated with the help of the t-Test among the answers to the statement *Science and technology are important for the society* in the interval of five years – 2003-2008 ($M_{2003} = 3.31$, $M_{2008} = 3.12$, $t = 4.47$, $df = 1796$, $p < 0.001$). However, the assessment of this statement in 2013 is significantly higher than in 2008 ($M_{2008} = 3.12$, $M_{2013} = 3.29$). On the whole it is seen that in the period of ten years pupils' opinions actually have remained unchanged ($\Delta M = 0.02$, $p = 0.65$) and most likely some external factors have influenced the changes in the period of five years. A similar picture appears as regards the statement *Scientific theories develop all the time* (Fig. 1), where the changes in a five years' range are significant ($p_{2003/2008}$ = 0.013 and $p_{2008/2013}$ = 0.09); however, during the whole period pupils' opinion has actually not changed (p = 0.56).

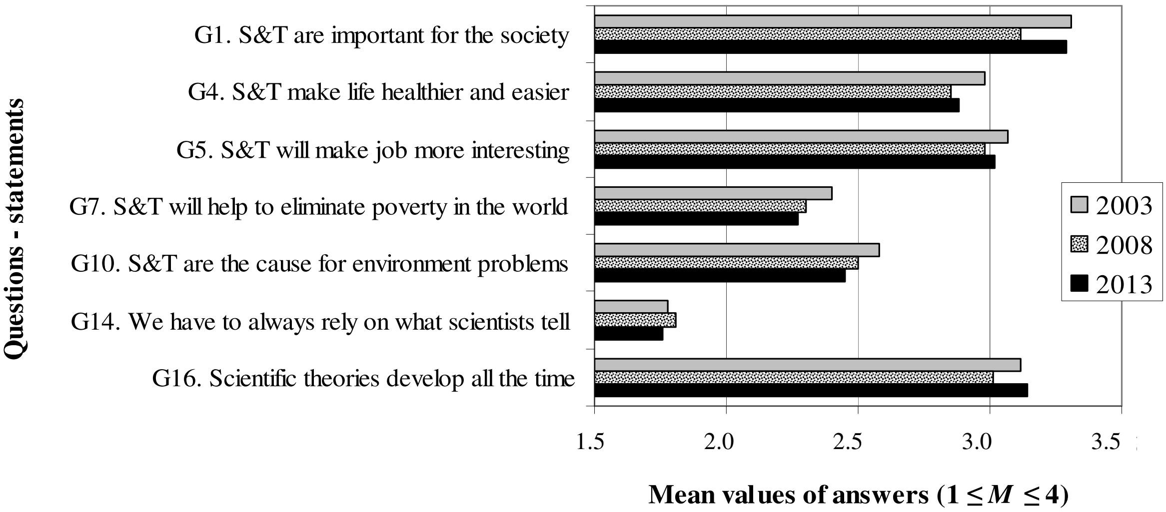

Fig. 1. **Grade 9 pupils' opinions about science and technology (S&T)**

Examining the mean values of other answers it is possible to conclude that pupils in 2013 value lower the importance of science in the promotion of health (G4); they see less the positive impact of science on how interesting the job is (G5) and the elimination of poverty (G7) than in 2003. Such findings prove that science and technology gradually lose value in the pupils' eyes which also leads to decreasing of cognitive interest in this field.

The sampling of questions-statements from section H of ROSE has been used to describe pupils' out-of-school experience (Fig. 2).

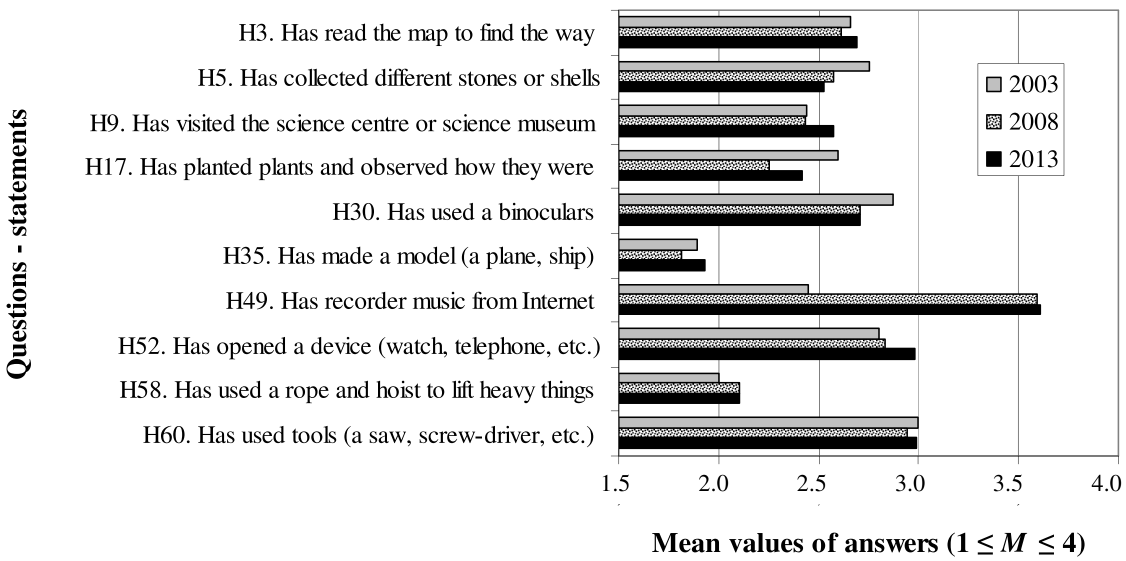

Fig. 2. **Pupils' out-of-school experience in science**

The choice of the mean values of answers (1 – never, 2 – seldom, 3 – rather often, 4 – often), testifies that respondents rather seldom than often have used a map (M_{2003} = 2.66, M_{2008} = 2.61, M_{2013} = 2.69), have collected stones or shells (M_{2003} = 2.76, M_{2008} = 2.57, M_{2013} = 2.53), have used binoculars. Only few have made some model (M_{2003} = 1.89, M_{2008} = 1.81, M_{2013} = 1.93) or have used some additional device to lift heavy things (M_{2003} = 2.00, M_{2008} = 2.10, M_{2013} = 2.10). Thanks to the development of IT since 2008 the number of respondents who frequently record music from the Internet has increased considerably (M_{2003} = 2.45, M_{2008} = 3.59, M_{2013} = 3.61), which with certainty shows pupils' high interest. Comparing the findings of years 2003 and 2013 the use of the t-Test allowed stating significant differences in several questions (H5, H9, H17, H30, H52; $p < 0.05$);

however, the common picture is more important and it testifies about insufficient involvement of pupils in the exploration of nature and other practical out-of-school activities (except the recording of music). All through the research period the researchers have stated rather insignificant everyday experience of pupils that could promote their cognitive interest in school lessons.

In order to compare the girls' and boys' opinions the t-Tests and Cohen's *d* coefficient have been used (Table 2). The table presents the findings that were obtained in the survey conducted in 2013; they indicate significant differences in the opinions of boys and girls in the majority of questions. As several authors have already indicated boys are more interested in technologies, chemistry and physics while girls, in their turn, are more interested in human body, taking care of it, diseases as well as supernatural phenomena [20; 21]. This study, too, confirms the difference in the boys' and girls' interests. For instance, boys have more frequently used different tools (the saw, screwdriver), ($M_b = 3.23$, $M_g = 2.74$), and girls have more frequently planted plants and observed their growth ($M_b = 2.39$, $M_g = 2.44$). Girls have been more active in visiting a science centre and museum than boys ($M_b = 2.50$, $M_g = 2.66$). The calculated Cohen's *d* values on the average indicate a small effect size for the difference between boy' and girls' opinion.

Table 2

Description of respondents' out-of-school activities; comparison of girls' and boys' opinions (data from 2013)

Question	Girls		Boys		p^2	Cohen's d^3
	M^1	*S.D.*	*M*	*S.D.*		
H3	2.68	0.90	2.70	0.96	n.s.[4]	-0.02^B
H5	2.73	0.96	2.34	0.99	< 0.001	0.40^B
H9	2.66	0.91	2.50	0.88	0.04	0.18^A
H17	2.44	0.98	2.39	0.98	n.s.	0.05^A
H30	2.64	0.93	2.78	0.79	n.s.	$-0,16^A$
H35	1.78	0.93	2.08	0.99	< 0.001	-0.31^B
H49	3.72	0.63	3.50	0.88	< 0.001	0.29^B
H52	2.85	1.04	3.13	0.93	0.02	-0.28^B
H58	1.85	1.05	2.34	1.06	< 0.001	-0.46^B
H60	2.74	0.99	3.23	0.86	< 0.001	-0.53^C

See questions in Fig. 2
[1] $1 \le M \le 4$
[2] $p < 0.001$, $p < 0.05$ – statistically significant differences
[3] Cohen's *d*: ^{A} – no effect ($d < 0.2$), ^{B} – small effect ($0.2 \le d < 0.5$), ^{C} – moderate effect ($0.5 \le d < 0.8$)
[4] n.s. – no statistically significant differences ($p > 0.05$)
$\alpha = 0.95$

Conclusions

Interest is a complex psychic phenomenon. It comprises the cognitive, emotional, volition and action components and it is influenced by the social component. Cognitive interest is a crucial component in the study process. A pupil who has developed cognitive interest becomes an active participant of the study process, forms his/her own offer which the teacher can improve in an equal in rights pedagogical cooperation.

It is possible to claim that pupils consider science and technology important for the society; such an attitude is stable and it has actually not changed in the time period 2003 – 2013. However, on the whole Grade 9 pupils' cognitive interest in science and technology carries a neutral character, which means, that interest is not pronounced. It has been found that during out-of-school activities pupils are little connected with hands-on activities in the science field which testifies about a poorly expressed interest. Such pupils' everyday experience cannot serve as the promoter of cognitive interest in the science field.

Pupils' science interests are gender-specific; if this is successfully used in the study process a more effective formation of cognitive interest can be expected both for girls and boys.

The changes of pupils' cognitive interests in the range of 10 years have been fluctuating which indicates the impact of external factors. The increase of science interest that would be needed for the development of the society and state has not been observed during this period of time.

The key component of the formation of the cognitive interest is the skill of the personality to act independently as well as to assess independently one's achievement in order to set new aims. It is significant that the level of pupil's cognitive interest does not always reflect in the assessment of the pupil's work because a good assessment is connected with the social processes in which the societal acknowledgement is essential. In order to receive it pupils can also adjust the expressions of their cognitive interests in favour of those which receive greater societal acknowledgement.

The obtained findings indicate the range of problems that should be taken into consideration when organizing the teaching/learning process that corresponds to pupils' cognitive interests, gender-specific interests, lessons with stronger links to the practical life.

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