ProspectiveTeachers' Opinion about the Content of Modern Basic Education in the Science Context

Dagnija Cēdere[1] Dr. chem.; **Inese Jurgena**[2] Dr. paed.; **Sandra Kalniņa**[3], Mg. paed., Mg. phil.
University of Latvia, Latvia[1;3]; Riga Teacher Training and Educational Management Academy, Latvia[2]
dagnija.cedere@lu.lv[1]; inese.jurgena@rpiva.lv[2]; sandra.kalnina@lu.lv[3]

Abstract: The development of society is closely connected with science and technology education; however, many international and national studies reveal the contradiction between the increasing societal needs and the insufficient quality of education in this field. The science knowledge acquired at school often is formal; it is not based on understanding and students learn without interest. The study is focused on the following theses: modern society needs scientific literacy; learning without interest is unproductive; all subject teachers must give support to education of science literate young people. The aim of the study is to find out the attitude of prospective teachers to science and their opinion about what knowledge and skills in science correspond to interests and needs of Grade 9 students nowadays. Students from two higher education institutions have been surveyed; the questionnaire included both closed and open questions. The 4 point Likert scale is used in closed questions. The participants of the study are prospective teachers who are not connected with teaching science subjects. The survey was organized on-line. SPSS program have been used for data processing. The findings show that on the whole prospective teachers' value highly the importance of science education; besides there is no statistically significant difference between the prospective teachers representing different specialities. Respondents' opinion on some of the science acquisition issues differs depending on their different work and life experience. Unequivocally cognitive interest has been recognized as the learning motive as well as the teacher's role in the promotion of the interest. The study gave a possibility to attract the attention of future teachers to the importance of science education. The obtained results will be further applied in teacher education in higher education institutions.

Keywords: basic school, interest, knowledge, prospective teachers, science education, skills.

Introduction

The development of the society is closely connected with the development of science and technology education; however, many international and national studies reveal a contradiction between the increasing societal needs and insufficient quality of education in this field. Nowadays the people's ability to orient quickly in the changing world applying the knowledge and skills as well as the creative self-development abilities has become more significant (Briede, Pēks, 2014; Science Education in Europe..., 2011). Many specialists on education admit that school graduates frequently have poorly developed short-term memory; they fail to see the main idea and generalize; their knowledge is superficial and fragmentary. They lack the contextual knowledge characteristic to science; they have low interest in science (Cedere, Jurgena, Gedrovics, 2015; Potvin, Hasni, 2014). The lack of knowledge and skills in science and mathematics today is considered a threat to the modern technology and science-driven economics (Pellegrino, Hilton, 2012; Draft Science..., 2013). These facts encourage seeking possibilities to improve the learning content in science and mathematics. ***The aim of the article*** is to find out the prospective teachers' opinion about the role of science in the all-round education process of students in basic school and to evaluate factors that influence a full-fledged acquisition of the learning content.

Theoretical substantiation of the problem

The learning content is the human experience that is specified according to the learner's age peculiarities, society and the age and which is usually divided (grouped) basing on its thematic constituent parts in school subjects, study courses and thematic cycles. The learning content includes concrete knowledge, skills, performance experience, culture and social experience, the experience of intellectual values, conviction and the formation of attitudes that the learners acquires in the teaching/learning process. During the didactic process its subjects- the teacher and the learner as the components of this process come into mutual relations of dependence, conditionality and necessity (Žogla, 2001, 82). The teaching/learning content is one of the components uniting these two subjects. This is a specific bipartite formation. Firstly, it is formed by the knowledge, skills envisaged in the programme that the student has to acquire and character features are nurtured and developed, and,

secondly, the teaching/learning content, the teacher's support - the content of recommendations, the demonstrated model, introduction of the student in the independent work. The teaching/learning content is also the intellectual values that the student acquires with the teacher's help (Žogla, 2001, 96-97).

The selection of the teaching/learning content has always been an intrinsic problem for the teachers. Immediate bringing students closer to life, work and nature takes place in science subjects. The teaching/learning content should correspond to several provisions –the level of difficulty that is appropriate to students' age group; it should facilitate the learning motivation and interest, and adequate to the teaching methods (Geidžs, Berliners, 2000; Potvin, Hasni, 2014). Modern science education content has been elaborated in a united system in physics, chemistry, biology and mathematics so that the student formed an undivided understanding about the processes and phenomena in nature as well as developed science-cognitive skills. The context of the learning content helps to understand the essence of what has been acquired and gain experience of applying the knowledge in real life situations. Today along with the subject knowledge the student also obtains key skills necessary for life (Meyer, 2008; Namsone, Čakāne, 2011; Osborne, Simon, 2003).

Modern science learning is focussed on four reciprocally connected aspects (Draft Science..., 2013):

- *content:* both the current and historical personal, local, national and global issues that need the understanding about science and technologies;
- *knowledge:* understanding about the most intrinsic facts, concepts, explanatory theories that form the foundation of scientific knowledge. Such knowledge comprises both the knowledge about nature and technological artefacts (content knowledge), the knowledge about how such knowledge emerges (procedural knowledge) and the understanding about rational substantiation and application of these procedures (epistemic knowledge);
- *skills:* the ability to explain facts scientifically, to evaluate and perform scientific (research) studies, to interpret data and evidence scientifically;
- *attitudes:* the set of attitudes towards science - interest in science and technologies, approval of scientific approach to the research, awareness and understanding of the environment issues.

Higher education institutions and the lecturer's pedagogical work in them form the education environment in which the future specialists' readiness for the professional activity develops. The readiness for the professional activity is formed by the set of qualities that is the result of the accumulated positive experience and the internal potential of successful pedagogical activity as well as the state of resources for a purposeful activity (Baltušīte, 2012), therefore finding out exactly the students' opinion is important in order to explore the significance of prospective teachers' attitude to science in the education of prospective teachers of different specializations (Muijs, Reynolds, 2012). The studies on the teaching/learning content most frequently involve students or teachers who are the immediate participants of the teaching/learning process (Cedere, Jurgena, Gedrovics, 2015; Nehring, Nowak, 2015; Potvin, Hasni, 2014). However, the opinion of students- the prospective teachers has been little studied so far.

Methodology

Continuing the previously performed studies (Cēdere, Jurgena, Helmane, 2015) students - the prospective teachers whose chosen speciality is not directly connected with teaching of science subjects and mathematics have been surveyed. Respondents' general social and pedagogical psychological experience not their knowledge gained during the studies at the higher education institution has been taken into consideration when forming the research sample. Besides, they have not had a direct contact with science subjects in their study process. Such a sampling of respondents would allow judging more objectively about the place of science in basic education.

The survey has tried to find out students - the prospective teachers' opinion about how Grade 9 students should answer questions about the learning of science according to the real provisions of education and national needs. Such a research position would allow treating the learning content "from the distance", i.e., without involving the immediate participants of this teaching/learning process- Grade 9 students and teachers of science subjects.

The following research questions have been set:

- What is the prospective teachers' opinion about the importance of science acquisition in basic school?

- Does the teaching/learning content of science subjects (biology, chemistry and physics) correspond to the students' needs and interests in basic school?

The questionnaire of the survey is based on the studies performed earlier (Cēdere, Jurgena, Helmane, 2015) and documents regulating education in Latvia (Noteikumi par..., 2014). The questionnaire contains closed and open questions. The closed questions correspond to four value Likert scale and are coded: 1 – no, 2 – rather no, 3 – rather yes, 4 – yes. The questionnaire includes two groups of questions: A) Does the student want to learn (find out about) science? B) How does the student learn science? The open questions are included in the questionnaire to receive additional information about the learning content in science and its implementation in schools that would help to evaluate the teaching/learning process and the factors influencing it more versatile way.

The reliability (inter-item consistency) of the quantitative part of the questionnaire according to Cronbach alpha coefficient was 0.884. The questionnaire was made on the internet using Google disc, students answered questions online. The survey was carried out in October 2016.

The participants of the survey were 151 students from two higher education institutions of Latvia: Riga Teacher Training and Educational Management Academy and University of Latvia, of them 136 were female and 15 male students. 51.7 % of the total number of respondents are full time students and 48.3 % - part time students. Different pedagogy specializations have been represented. The largest respondent groups are: future preschool teachers– 25.8 %, teachers of the creative sectors (dances, music, visual art)– 21.9 %, elementary school teachers – 12.6 %. The respondents' average age is 25.8 years, majority of them (72.4 %) are first year students.

The data analysis was performed using the statistical software SPSS 23 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 the t-test analysis of the independent samples was used. Correlation analysis was used for determining the strength of the relationship between two variables. Cronbach Alpha Test was used for stating the reliability of the questionnaire.

Results and discussion

Results received from the survey data demonstrate that on the whole the prospective teachers have the understanding about the importance of science in ensuring the economic and social growth of Latvia. There are no significant differences between the answers given by the full time and part time students as well as students of different specializations. The issue that knowledge in science is needed in any walk of life is confirmed by the answers given by prospective teachers of dance and rhythmic, music, visual art and teachers of other specializations not connected with science (*"The wider is the person's inner world and knowledge, the more valuable is the person...", "Chemistry and physics is also in art"*). Significant differences according to the data of the t test analysis are only in the question about whether Grade 9 student should be able to make mathematical equations in order to solve practical tasks (Item A8). The answers given by students of creative specializations (M = 1.73) are lower than those given by other respondents (M = 2.38); $t(149) = -3.498$, $p = 0.001$). It can be added that the mean answer of the whole respondents' sample is *rather no*, which means that according to the prospective teachers such integrated skills should not be asked from Grade 9 students.

As the mean values of the answers demonstrate, Grade 9 students should have an interest to find out about simple natural phenomena in order to be able to explain themselves, for example, why the forest smells differently after the rain (M=3.41), in order to know how human organism functions (M=3.50) and how drinking water is purified (M=3.37) (Table 1).

Table 1

Prospective teachers' opinion about Grade 9 students' cognitive interest in science (1 ≤ M ≤ 4)

No	Description of indicators (Group A)	Formulation of indicators	*M*	*SD*
1	A1	The interest to find out why the air after the thunderstorm smells differently	3.41	0.751
2	A2	The willingness to learn more about growing and reproduction of plants	2.84	0.888
3	A3	The interest in the constitution and functions of human organism	3.50	0.692
4	A5	The willingness to understand why the soapy solution is not clear	2.87	1.024
5	A6	The willingness to understand why the glass vessel breaks if water freezes in it	3.17	0.978
6	A7	The interest to learn how drinking water is purified	3.37	0.869
7	A8	Pleasure in solving practical tasks with the help of mathematical equations	2.24	0.985
8	A9	Agreeing on the importance of science knowledge in the national development	3.44	0.726

The second group of questions characterizes the learning content of science subjects. According to the constructivism approach (Brooks, Brooks, 1993) which lies at the basis of learning science, the student has to acquire conceptual knowledge, the skill to carry out an experiment, to explore, analyse and generalize. This group of questions demonstrates how students learn, resp., what the organization of the teaching/learning process is and to what extent students have learned to apply their knowledge in biology, chemistry, physics and mathematics in the solution of simple, practical problems. The respondents' answers show also the opinion about the depth of the cognition in different areas connected with science and mathematics. Is student of Grade 9 willing to learn anything that requires effort? (Table 2).

Assessing the real situation in the teaching/learning process of science in school respondents acknowledge that Grade 9 students should possess certain skills of making observations in nature and their everyday life and to explain them applying the knowledge and skills gained at school. High mean assessment (M=3.07), which means *rather yes* and *yes*, is given to the item B3 about the skill to explain natural phenomena (volcanos, floods, acid rain, fire). Similarly, (M=3.09) respondents are certain that exploring some phenomenon students should have the interest to learn more about it (B9). Less significance is given to the exploration of nature during the free, out-of-school time (M=2.34), which possibly for the majority of students is connected with limited possibilities to perform such an exploration. Respondents marking "*rather yes*" (M=2.99) admit that putting effort in learning sometimes is needed (B10).

Taking into consideration that almost half of respondents are part time students and the range of respondents age is rather broad (18-42 years), respondents were divided into two groups. Group 1 – the first year students who continue their education immediately after having graduated from school, age – 18-19 years, group 2 – aged 20 and older.

Table 2

Prospective teachers' opinion about the science learning content in basic school (1 ≤ M ≤ 4)

No	Description of indicators (Group B)	Formulation of indicators	*M*	*SD*
1	B3	The skill to explain natural phenomena	3.07	0.806
2	B4	The skill to find out the causes of the natural phenomenon	2.88	0.730
3	B5	The skill to analyse problems in nature or everyday life	2.72	0.750
4	B6	The skill to predict the solution of the nature problem	2.34	0.824
5	B8	Enthusiasm in relation to science	2.95	0.823
6	B9	Interest that emerges in the process of exploration	3.09	0.791
7	B10	Selection of hard but interesting tasks	2.99	0.852
8	B11	Spending the free time on the exploration of nature	2.34	0.901
9	B12	Understanding about the work of a professional researcher of the nature	2.30	0.885

It is significant that actually mean values of all answers in group 1 are lower than in group 2 which comprises respondents with greater life and work experience. The answers of both these independent groups were compared using the*t* test. Statistically significant differences were stated about several indicators at $\alpha = 0.05$:

- item A5:$t(104) = -2.610$; $p = 0.010$;
- item A8: $t(104) = -2.892$; $p = 0.005$;
- item B11:$t(104) = -2.449$; $p = 0.016$;
- item B12: $t(104) = -2.196$; $p = 0.030$.

Such results demonstrate that understanding of science as well as apprehension of what should be learnt at school comes with experience (years) and self-experience. Self-experience is the component of consciousness that in an integrated process of the perception, understanding and experiencing the facts, things, phenomena creates new values and influences the person's action in the present and the future. "New (secondary) self-experience does not exist along with the previous (primary) self-experience but interacts with" (Giese, 2010, 87). Self-experience for students who already work in preschools, run dance and rhythmic lessons, carry out pedagogical work for promoting students' musical or art development is their knowledge, skills and attitudes that they have gained in life and which have become personally meaningful (Brigmane, 2014).

As demonstrated by students' answers to the open questions they see the necessity of the constructivism teaching approach in the science acquisition process relating it to the application of students' knowledge in everyday life and the teacher's creative approach to the solution of science problems. Prospective teachers admit: "*Science is a perfect subject in which one could explore what is being taught- go out and explore nature, carry out research experiments*", "*...the teacher should pay more attention to the fact that students are aware of and understand the importance of science in practical life*", "*... for the teaching/learning process to be smooth and successful, the teacher's and student's cooperation and initiative is important*". Many respondents recalling their own science lessons at school appreciate that "*...we had practical classes with microscopes*", "*...we had to collect tulip blossoms...*".

Respondents in their recommendations about improving the science education process in school have most frequently mentioned words *interest, to facilitate interest* (n=247), *practical life, practical activity, practice* (n = 154), *creative, to teach creatively, creative lessons* (n=135). The necessity to develop inquiry skills has been emphasized comparatively less (n=63) which could serve as evidence for the isolation of this concept or is small popularity among the "science non-specialists". The results of the correlation analysis also indirectly show it –a relatively weak correlation between the interest to explore

nature and its processes (A1, A6) and the research (inquiry) activity (finding the causes – B4, problem solution – B5), see Table 1 and Table 2. Correlation coefficient r = 0.13 … 0.32 has been found. The necessity of interest in nature and its processes is assessed considerably higher than the practical, inquiry cognition. Respondents' opinions about the Grade 9 students' insufficient interest in science are reasonable (Cedere, Jurgena, Gedrovics, 2015; Cēdere, Jurgena, Helmane, 2015; Potvin, Hasni, 2014), this problem still exists. Comparing these results with the previously performed study (Cēdere, Jurgena, Helmane, 2015), in which the questions were answered by school students' differences between the mean values of answers given by Grade 9 students and prospective teachers' sample were identified. In teachers' view Grade 9 students' perseverance carrying out a study should be higher. Students should have greater interest in the processes and phenomena in nature and practical life. It is typical that the difference is greater between the opinions of group 2 respondents (older prospective students) and the students. Equally high assessment is given to the importance of the science and mathematics knowledge in the national development. Some statistically significant differences between the students' real attitude to science (school students' opinion) and the prospective students' opinion can be mentioned. To find out the differences t test was used (at $\alpha = 0.05$):

- on stability of interest and perseverance in inquiry (B9: $t(400) = 3.757$, $p<0.01$;
- on the interest to see and observe the changes of substances in everyday life (A5: $t(402) = 6.606$, $p<.01$;
- on the interest to learn how drinking water is purified (A7: $t(405) = 5.046$, $p<.01$).

The support expressed by respondents to the transition to learner-centred teaching/learning process as well as the necessity to improve the system of organizing the learning has common results with similar studies (Jurgena, Cedere, 2015; Jurgena, Gedrovics, 2014).

Conclusions

The readiness of the future teachers for the professional activity is formed in education environment of higher education institutions, accumulating positive experience of pedagogical work and actively participating in the evaluation of the modern complex, changing and multidimensional educational processes therefore exploration of students' opinions is important in order to find out students' attitude to the importance of teaching science in the education of new teachers of different specializations.

As demonstrated by the survey findings there are no significant differences between the opinions expressed by the prospective teachers of different specializations. In general students – prospective teachers assess positively the science subjects and their importance for immediate bringing school students to life, work and nature, they support the transition to learner-centred educational process as well as the necessity to improve the system of learning organization. Answers about the desired changes in the teaching approaches, the willingness themselves to participate in the inquiry-based activities thus implementing their creative abilities describe the above mentioned opinion expressed by the respondents. The prospective teachers who have more life and work experience assess higher the importance of science education in different professions and everyday life.

The prospective teachers consider that the content of science subjects (biology, chemistry and physics) in basic school corresponds to the students' needs, interests and is an integral component of basic education for all students' regardless what profession the student will choose in the future. Emphasizing the interest as one of the most important learning motives respondents require more responsibility from the teachers. At the same time the respondents acknowledge systemic problems and support the constructivism learning approach and incite finding more possibilities for students' practical and creative work. The study gave a possibility to attract the attention of future teachers to the importance of science education. The obtained results will be further applied in teacher education in higher education institutions.

Bibliography

1. Baltušīte R. (2012). *The Pedagogy Students Readiness for Professional Activities in the School Environment*. Synopsis of the Doctoral Thesis. Jelgava: Latvia University of Agriculture.
2. Briede B., Pēks L. (2014). A Constructivist Approach in Teaching in Higher Education for Getting Methodological and Reflection Competences. In Proceedings of the International Scientific

Conference *Rural Environment. Education. Personality (REEP)*, Vol. 7 (CD-ROM). Jelgava: Latvia University of Agriculture, pp. 84 – 89.

3. Brigmane B. (2014). *Pieaugušo pašpieredzes veidošanās mācīšanās procesā* (The Formation of Adults' Self-experience in the Process of Learning). Doctoral Thesis. Rīga: Riga Teacher Training and Educational Management Academy). (in Latvian)
4. Brooks J.G., Brooks M.G. (1993). *In Search of Understanding: The Case for Constructivist Classrooms*. Alexandria. VA: Association for Supervision and Curriculum Development.
5. Cedere D., Jurgena I., Gedrovics J. (2015). Longitudinal Research on the Change of Grade 9 Pupils' Cognitive Interests in Sciences (2003 -2013). In Proceedings of the International Scientific Conference *Engineering for Rural Development*, Vol.14. Jelgava: Latvia University of Agriculture, pp. 742 – 747.
6. Cēdere D., Jurgena I., Helmane I., Tiltiņa-Kapele I., Praulīte G. (2015). Cognitive Interest: Problems and Solutions in the Acquisition of Science and Mathematics in Schools of Latvia. *Journal of Baltic Science Education*, Vol. 14 (4), pp. 424 – 434.
7. Geidžs N.L., Berliners. D.C. (2000*). Pedagoģiskā psiholoģija* (Pedagogical Psychology). Rīga: Zvaigzne ABC. (in Latvian)
8. Giese M. (2010). Der Erfahrungsbegriff in der Didaktik – eine semiotische Analyse/Zeitschrift fur pedagogik (The Concept of Experience in Didactics – a Semiotic Analysis). *Zeitschriftfür Pädagogik*, Vol. 56 (1), pp. 69 – 89. (in German)
9. Jurgena I., Cedere D., Keviša I. (2015). Innovative and Traditional Elements in the Work of Academic Staff: The Views of Prospective Teachers. *Journal of Teacher Education for Sustainability*, Vol. 17 (2), pp. 74 – 90.
10. Jurgena I., Gedrovics J., Cedere D. (2014). Students' Views on the Professional Career Opportunities. In Proceedings of the International Scientific Conference *Engineering for Rural Development*, Vol.13. Jelgava. Latvia University of Agriculture, pp. 522 – 528.
11. Meyer H. (2008). *Was Isteinguter Unterricht?* (What is a Good Lessons?). Berlin: Cornelsen Scriptor. (in German).
12. Muijs D., Reynolds D. (2012). Effective Teaching: Evidence and Practice. *British Journal of Educational Technology*, Vol. 43 (1), pp. 37 – 38.
13. Namsone D., Čakāne L. (red.). (2011). *Rokasgrāmata dabaszinātņu un matemātikas skolotājiem* (Handbook for Teachers of Science and Mathematics). Rīga: VISC. (in Latvian) [online] [19.11.2016]. Available at http://priede.bf.lu.lv/grozs/Didaktika/DZIT/Citi_resursi/DZMP_materiali/Vertesana.pdf
14. Nehring A., Nowak K.H., Upmeier zu Belzen A., Tiemann R. (2015). Predicting Students' Skills in the Context of Scientific Inquiry with Cognitive, Motivational and Sociodemographic Variables. *International Journal of Science Education*, Vol. 37 (9), pp. 1343 – 1363.
15. *Noteikumi par valsts pamatizglītības standartu, pamatizglītības mācību priekšmetu standartiem un pamatizglītības programmu paraugiem* (Regulations on National Standard of Basic Education, Subject Standards of Basic Education and Sample Basic Education Curricula). (2014). MK Noteikumi Nr. 468 no 12.08.2014. Rīga: LR MK. [online] [06.10.2016]. Available at http://likumi.lv/doc.php?id=268342 (in Latvian)
16. Osborne J., Simon S., Collins S. (2003). Attitudes Towards Science: A Review of the Literature and its Implications. *International Journal of Science Education*, Vol. 25 (9), pp. 1049 – 1079.
17. Pellegrino J.W., Hilton M.L. (2012). *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century*. Washington. DC: The National Academies Press.
18. 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. *Studies in Science Education*, Vol. 50 (1), pp. 85 – 129. [online] [10.02.2016]. Available at http://dx.doi.org/10.1080/03057267.2014.881626
19. Draft Science Frameworks (2013). OECD. [online] [19.11.2016]. Available at http://www.oecd.org/pisa/pisaproducts/Draft%20PISA%202015%20Science%20Framework%20.pdf
20. *Science Education in Europe: National Policies, Practices and Research.* (2011). Education, Brussels: Audio-visual and Culture Executive Agency. [online] [19.11.2016]. Available at http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/133EN.pdf
21. Žogla I. (2001). *Didaktikas teorētiskie pamati* (Theoretical Foundation of Didactics). Rīga: RaKa. (in Latvian)