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FINDING POSSIBILITIES TO IMPROVE SCIENCE EDUCATION IN HIGH SCHOOL AND GYMNASIUM

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Abstract. *Scientific knowledge, skills and attitudes are cultural products of great intellectual power and beauty. The future of science education and scientific literacy of youngsters is determined by the educational policy of the country, moreover, it also depends on teachers working at schools and universities. The tasks of reported research work was to explore approachable literature about natural science education in general and to analyse corresponding educational problems particularly in Latvia.*
Key words: *science, scientific literacy, educational process, constructive approach, teaching-learning strategies.*

Introduction

The sphere of natural science development is very wide, complicated and diverse, thus it requires a new point for all. The school must give all citizens the tools to understand the world they live in. It is a new concern. In all cases and at all levels of schooling, in such a context physics or science education for all cannot continue to be the simple academic transfer of contents that we see in many physics classes today. The science education is one of the most important areas of general education to form conception of the world, to acquire practical knowledge, to form definite attitudes and skills, as well as to rise cultural level, to understand link between material environment and society and to take notions about modern technologies. New paradigm of modern education requires new quality approach and new content of education to improve scientific literacy and promote better public understanding of science.

According the educational strategy of Latvia where the care for intellectual and scientific literacy of society is marked as one of the main priorities, author indicate two basic directions of research: 1) to analyse and evaluate the educational research done in different countries and to choose the most appropriate educational strategies for Latvia; 2) to analyse the nowadays situation in science teaching in schools of Latvia.

Scientific literacy for all

About the problem of scientific literacy a variety of research works have been done in the world during recent years. According to American researcher Miller scientific literacy includes two basic dimensions – a basic vocabulary of scientific terms and concepts and an understanding of the process and methods of science for testing our models of reality (Miller, 1995). Almost every author who has written about scientific literacy expressed the idea that scientific literacy meant more than memorizing vocabulary. That allows us to expand the way we think about the terms, it suggest standards of achievement (Bybee, 1997). According with George DeBoer scientific literacy would be humanistic study in which students developed a broad understanding of the regularities of the natural world, the methods that have been used to acquire corresponding knowledge and the ways this knowledge and these methods have affected all of humanity (Buck, 1997).

There is much evidence that many school students and adults have little understanding of basic scientific ideas or processes (Millar, 1996). Surveys of science understanding among the adult population (Durant, Evans, Thomas, 1989) indicate much of the same picture: little understanding and many potentially serious misunderstandings of basic ideas of science. Adults know little about scientific theories; they have surprising gaps in their knowledge about the

physical world and, worst of all, they have little idea about how scientists do in their work (Bryce, 1996).

The educologists of Lithuania (Vaitkus, 1996; Motiejuniene, Lekevicius, 1996; Pečiuliauskiene, Rimeika, 2004) and Latvia (Geske, 2002; Kangro, 2002) claim that basic school learners are not able to apply practically knowledge of natural science. At the same time 56.9% of Latvian pupils evaluate their knowledge in natural science as sufficient and only 6.6% as insufficient (Lamanauskas, Gedrovics, Raipulis, 2004). The evaluation is about knowledge, which acquired in basic school.

Are science lessons really playing an acceptable role in the education of students today? Some researchers have argued that the lack of effectiveness of science teaching is a consequence of the content of the curriculum on offer. During the past century science has changed considerably. Aikenhead argued that present situation has come out of 19 th century university plus deep integration with technology, industry, politics, ethics, the military and other social groups in society. In short, scientific enterprise has become ”socialized”. As well, science itself has evolved into a multitude of disciplines which are themselves integrated combinations of older disciplines. Over the past years, however, the high school science curriculum has not changed its allegiance to the compartmentalized disciplines of pure physics, chemistry, biology, and geology, all decontextualized from a social milieu (Aikenhead, 1997).

Many students achieve little in science because they simply cannot see the point of it. Each lesson builds on the last, introducing new ideas. The “big ideas” get lost in the mass of detail (Millar, 1996). There is a gap between the science taught in school and the science education needed to function within tomorrow’s society at least for the overwhelming majority of citizens (Holbrook, 1999). Partly this gap seems to arise from science teachers’ perception of science education. Many feel it is to provide a basis for further study, rather than to enable a student to function within society. Of course, many perceive it should be both. But it is worth remembering that students go to school to be educated. Science education in school is part of modern general education. And if that education is to guide students to make informed choices, to solve problems within society, to make moral judgments and to be able to communicate and cooperate with others, then these must surely be major facets of science education. But science teachers ignore these in many cases. No wonder students tend to see the science taught in schools as irrelevant (Holbrook, 1999).

Perspectives of natural science education

The central argument, that all youngsters should became more scientifically capable as part of their education, can be considered from theoretical perspectives, which have informed the literature in recent years but are looked at the context of curriculum development, taking methodologies and assessment (Bryce, 1997). Today, a new view of nature and new paradigm of integrate science education has emerged from twentieth century discoveries in physics, biology and chemistry in dialogue with the arts and humanities.

Education is a specially organized process, where we get knowledge, develop our skills and form our attitudes toward our material environment and society. It is not only process of gaining knowledge. Knowledge and skills form human’s intellect, they are developing in teaching/learning process. Attitudes and skills - promote developing moral values during upbringing or value education process. Full scale human’s intelligence today needs integration of intellect and moral (Broks, 2001). Teacher utilizes different theoretical approaches in his or her teaching process.

Some theories are based on the social-cultural perspective of learning From social-cultural perspective the relevancy of school science learning can be understood by comparing the ways in which people learn about the world (Lave, 1988; Saxe, 1990). Learning is a dynamic and recursive (rather than mechanical) process of constructing meaning (Rogoff & Chavay, 1995; Vygotsky, 1978). Language and communication are constitutive in the process of learning.

Learning is, according to the socialcultural theory, regarded as appropriation to intellectual and physical tools which are used to solve problems in everyday life. It is in this context however important that learners in their communication with their peers not only do discuss scientific concepts in situated scientific context but that they observe the epistemological and ontological questions which are appropriate to the subject studied.

Prominent in the literature of science education is the work done on constructivism (Driver and Oldham, 1985), an approach to learning which takes seriously the view that meaning is constructed by the learner on the basis of what she/he already knows. Very often learners create distortions to new ideas or inter-connect different ideas. Thus constructivists dwell upon the activity necessary by learners and the understanding required by teachers of learners' construct during learning. Constructivist learning, therefore, is a very personal endeavor, whereby internalized concepts, rules and general principles may consequently be applied in practical real-world context. Trusted old ideas are very hard to shift and research has steadily revealed the wealth of ideas, half-baked and bizarre though some may be, which require unpacking and modification through enquiry, investigation and discussion. Solomon (1994) and Osborne (1996) admit to the significant body of knowledge we now have about the difficulties encountered in learning science, so much of which is counter-intuitive to pupils (Bryce, 1997).

According to Schulmans (1987) conception, content of learning should be comprehension and reasoning, reflection and transformation. The selection of content for science education might be a problematic issue has been discussed by Roberts (1982) and Broks (2004). A constructivist approach to classroom science supports these reform articulations because students learn science as active constructors, rather than passive recipients of knowledge. As students negotiate their understandings in science in collaboration with teachers and peers, critical thinking becomes the dominant mode of learning over the rote memorization of facts.

Cognitive theorists such as Piaget and Ausubel, and others, were concerned with the changes in a student's understanding that result from learning and with the fundamental importance of the environment. Constructivism itself has many variations, such as Generative Learning, Cognitive Apprenticeship, Problem-Based Learning, Discovery Learning. Regardless of the variety, constructivism promotes a student's free exploration within a given framework.

Equally prominent in science education literature is the debate about practical work and projects and the role of investigative practical science. It seems accepted now that the use of investigative practical work, which encourages pupils genuinely to investigate phenomena, is much more effective rather than practical work which is merely illustrative of concepts or outcomes. Handled well with effective teacher questioning, pupils' own ideas can be made the subject-matter of investigation and their practical skills and scientific methodology improved. An appropriate stress can be placed upon setting out testable hypotheses, variables, using controls and specific techniques, sorting out inferences in relation to evidence, recording and reporting techniques, etc. Useful strategies are ones where activities for pupils require them to use their ideas (as opposed to filling in worksheets) and, in due course to connect these ideas to scientists' ideas. Such strategies resolve the 'process-product' and 'parts-whole' problems which have featured in the last fifteen or so years (Bryce, 1997; Hodson, 1991). The issue remains live in relationship to assessment where the amount of structure to be imposed on tasks is still contentious. Particularly at formative stages, structuring is required to ensure that assessment strategies will be valid and reliable. In order to check for genuine problem-solving ability, however, a degree of openness must apply to the problem passed and to the questions set for pupils to investigate.

The challenge for curriculum development now is to advance teaching strategy which exemplify "science-in-the-making". For curriculum development should recognize the significance of informed theoretical discussion, infused with evidence from research, among those who lead the way (Bryce, 1997). Great difference is between science curriculum for specialists and scientists and science curriculum for public use.

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Science subjects teaching in Latvia's schools at upper secondary level of general education

The system of four education programs for Latvia's upper secondary schools and gymnasiums was introduced from 1999/2000 school year. They are as follows: 1) general education program, 2) humanitarian and social education program, 3) natural science and mathematics education program and 4) professionally oriented education program. Pupils have to choose one of those programs in the beginning of our so called middle stage of education (10^{th} grade or form up to 12^{th} grade or form). Pupils who have chosen science and mathematics education program study biology, chemistry, physics as separate subjects. Pupils study the integrated subject "Science" if they have chosen general education program or humanitarian and social as well as professionally oriented education program. The first project about the school subject "Science" was realized eight years ago. It forces to assimilate physics in 10^{th} form, chemistry in 11^{th} form and biology in 12^{th} form. School subject "Science" for students who have chosen general educational program or humanistic and social education program, physics, chemistry and biology teachers are involved in teaching this integrated subject.

11 physics, 8 chemistry and 9 biology secondary schools teachers from Daugavpils, Kraslava and Rezekne participated in the research. Observation of 28 upper secondary science subjects teachers work during 95 school lessons in overall was realized to determine how their real work correspond to those new ideas for further development of science education.

The students of Daugavpils University faculty of Natural Sciences and Mathematics was involved during their final pedagogical practice period in 2003/ 2004 school year. Students have observed more than 3 science lessons of each teacher. Observing teachers in action is important not only at the start of teacher training but also is one of direct research methods. To gain better and more complete insight in educational process, the author of the article has developed and offered students a questionnaire. Teachers work observation became a search for corresponding answers to those questions. The questions were as follows:

1. What was the teacher's role during the lesson?

2. Did the teacher activate pupil's previous knowledge during the lesson on the basis of known knowledge. Will they new knowledge and skills and make conclusions.

3. Did the teacher offer situations to make pupil's interested in the topic or problem?

4. Did the teacher offer situations for developing pupils power of apprehension and judgment ability?

5. Did the teacher accent situations in acquired knowledge which are directly connected with pupil's living environment.

6. Did the theme of the lesson was integrated with other science subjects or themes ?

Students evaluated all these aspects of educational process as satisfactory or insufficient or did not seen at all during the observed lesson.

According to data analysis of the role of teacher during the lesson (question No1) **35%** of respondents considered that main teachers role during the lessons was related to management of teaching and learning process. Teachers were actively involved in the teaching – learning process as facilitators of learning, instructors or coaches, mentors. But about **40%** respondents showed that teacher was mainly information deliver during their lessons. The account's of students account documents suggest that it is difficult for some teachers to move from the old teaching methods to a new strategy which require new approach for science teaching for students

who have chosen general educational program or humanistic and social education program. About **25 %** respondents concluded that teachers were more information delivers and less managers of teaching and learning process.

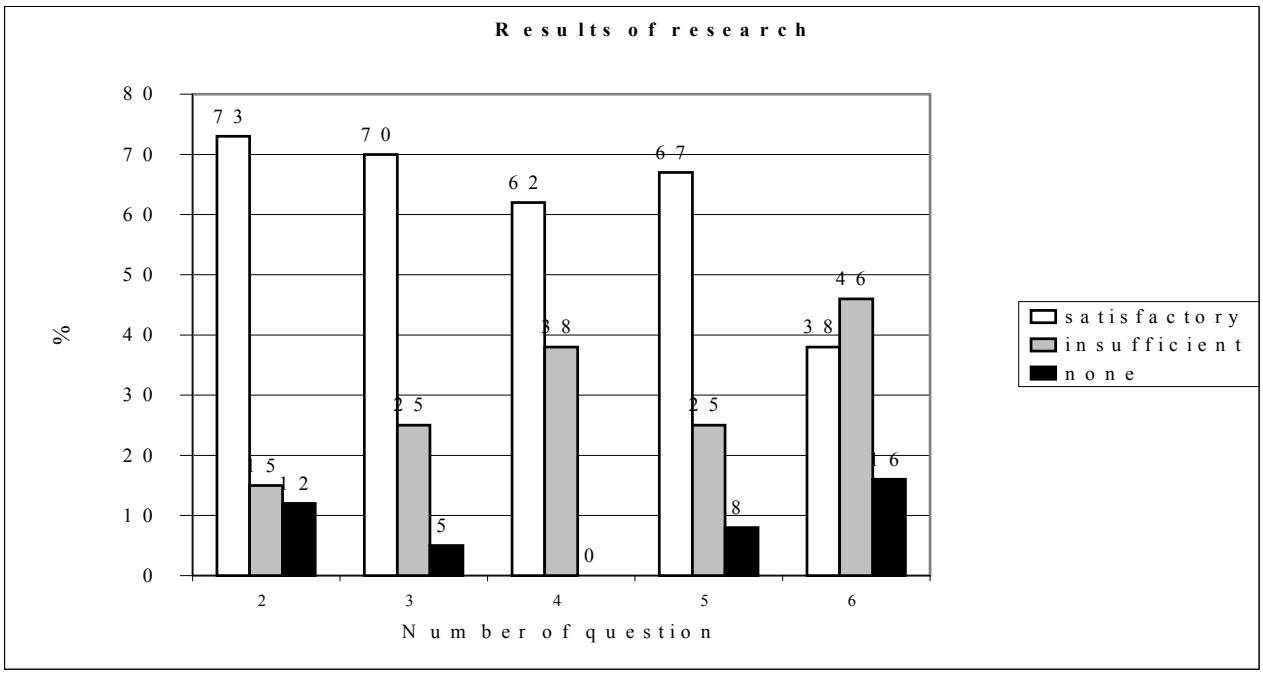

Figure 1. Evaluation of teacher's activities (answers to questions No 2 – 6.)

About 70% teachers satisfactory activate pupil's previous knowledge and offer situations for making pupils interested in the topic or problem. Only 62% teachers offered situations for development pupils' power of apprehension and judgment ability?

Many teachers don't accented (8%) or accented insufficient (25%) situations in which acquired knowledge was directly connected with living environment. About 46% of teachers pay attention insufficient to nature sciences cross disciplinary aspects and 16% do not pay attention to is important aspect.

Constructivists' ideas are neither fully recognized nor utilized at any of the school stages, and much of secondary science teaching is constrained through perceived lack of time and via pressures from examinations. Constructive approach is oriented towards pupils' abilities to apply and acquire knowledge in practice, to solve problems in living environment. Science teachers need to recognize that they educate students to be able to develop their skills, attitudes and awareness as a members of the society through a context of science. It requires special work to prepare corresponding recommendations for teachers as well as teacher educators.

Conclusions

The tasks of reported research work was to explore approachable literature about natural science education in general and to analyse some corresponding educational problems particularly in Latvia. Particular attention has been paid to the following components of contemporary educational process: developing student's thinking skills, they skills to make connections to a known material and to real life situations.

The author was found out that only 35% of science teachers are paying attention to a process of organizing study process, about 40% of science teachers become a source of knowledge to their students.

It was stated that not much attention has been paid to interdisciplinary themes and problems, not much attention has been paid to designing positive social environment and building student's value system.

Science teachers need to recognize that they educate students to be able to develop their skills, attitudes and awareness as members of the society through a context of science.

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Резюме

ПОИСК ВОЗМОЖНОСТЕЙ УЛУЧШЕНИЯ ПРЕПОДАВАНИЯ ЕСТЕСТВОЗНАНИЯ В СРЕДНЕЙ ШКОЛЕ И ГИМНАЗИИ

Лолита Ионане

Согласно многим исследованиям, в эпохе, когда научные достижения широко применяются в различных сферах деятельности человека, в обществе наблюдается низкий уровень естественнонаучной грамотности. В статье рассматривается вопрос о том, как повысить эффективность преподования учебного предмета *Естествознание* в средней школе и гимназии

для тех учеников, которые не проявляют интерес к точным наукам. Предмет *Естествознание* в школах Латвии введен в 1996 году.

По мнению ученых Драйвера, Олдхома, Браиса конструктивный подход является более эффективным для повышения естественнонаучной грамотности молодежи.

С целью исследования учебного процесса автором со студентами – практикантами были посещены и проанализированы 95 уроков интегрированного предмета *Естествознание*, изучаемого в средней общеобразовательной школе в рамках программ, не предусматривающих изучение отдельных предметов естественных наук. В ходе исследования констатировано, что основное внимание на современную организацию образовательной деятельности учащихся уделяло только 35% учителей. Учителя в основном (в 40% случаев) выполняли роль "источника знаний". В 25% случаев учитель больше внимание уделял преподаванию знаний чем на организацию и другой учебной и воспитательной деятельности учеников. Особо исследованы следующие компоненты образовательной деятельности: достаточно ли учителям удается заинтересовать учеников; направлена ли работа на развитие мышления; как осуществляется связь с ранее иученным материалом и конкретными явлениями реальной жизни. Выявлено, что во время уроков недостаточно проявляется межпредметная связь, минимально раскрывается социальный контекст и ценностные ориентации изучаемого материала.

Ключевые слова: естественнонаучная грамотность, общее образование, конструктивный подход, учебный и воспитательный процесс.

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