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INFORMATION COMMUNICATION TECHNOLOGIES IN NATURAL SCIENCE EDUCATION: SITUATIONAL ANALYSIS AND PROSPECTS IN BALTIC COUNTRIES¹

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Introduction

Recently, more and more studies concentrate on the analysis of ICT problems. Both, general (Jonassen, 1996; Crook, 1996; Markauskaitė, 2000; Zylbergold, 2003; Ross, 2004; Woessmann, 2005), and specific didactic issues are being analysed, e.g. how to use ICT for teaching single subjects (Slabin, 2002; Augustonytė, 2005; Pečiuliauskienė, Rimeika, 2005; Praulite, Trokša, Gedrovics, 2005). The advent of this educational technology, and its more widespread access in schools, potentially has an important part to play in re-shaping the curriculum and pedagogy of science (Osborne, Hennessy, 2003). U.Slabin's studies (2002) shows that, creating websites for natural sciences profile university students, are of interest. The author maintains that our epoch is marked with a global environmental crisis and the advent of information age. Extensive implementation of a range of information technologies into the high and higher school curricula and the emphasis on the environmental issues in education are two leading trends in contemporary education.

The implementation of new technologies in the educational process raises new possibilities for both teacher and learner, enhances education quality and makes the educational process more versatile. However, education quality still remains insufficient as the content of education and studies is poorly oriented towards developing new abilities and competencies necessary for people living in an open public society and market conditions. The economy based on information becomes a priority in European countries. It should be noticed that the reality of the open public society and market conditions is not and cannot be ideal and that qualitative education

Abstract. *Information technologies play a crucial role in building a knowledge-based society. However, even the most advanced technologies will not produce a required effect if their use (application) in the educational system is not adequate to the current development of technologies and increased educational needs. The initial information literacy abilities are formed in comprehensive school as presently, these educational establishments have the possibility of employing different information technologies. It is probably often related to appropriate computer technologies and the Internet.*

During the last five years, a number of investigations into the field of natural science education have been carried out. On the other hand, to more accurately identify the situation in different regions of Europe, lack of in-depth expert research can be noticed. Therefore, the latter survey (expert inquiry) is aimed at examining the situation on using ICT in natural science education in Baltic countries. A precondition that the obtained findings will be useful for improving the process of natural science education in terms of ICT applicability and efficient use can be made.

Key words: *natural science education, modern ICT, expert inquiry.*

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must help people not only to accept this reality but also to critically evaluate and advance it. In this case, the most important point is that human must preserve his/her identity, self-sufficiency and to strive for a purport of life. Any actions such as improvements in the education system or implementation of new technologies must be carefully studied and firmly fixed. All possible outcomes, results and impact on further as well as on individual development of a young personality must be evaluated.

We can find plenty of information about school computerization, the areas of using ICT, access to the Internet, teacher competence in ICT, information literacy, teacher training in the field of applying ICT and financing. However, in order to evaluate the usefulness of applied ICT for teaching/learning purposes in terms of the customers using education facilities, the mentioned data is not sufficient (Sjøberg, 2004; Lamanaukas, Vilkonis, 2005; Gedrovics, Lamanaukas, 2006). The recent research has revealed that the majority of the children - comprehensive school students aged from 11 to 18 - have the possibility of using computer and the Internet for learning purposes. The larger part of the learners have a computer and access to the Internet at home. A computer is frequently used for learning purposes – a greater number of the respondents use it for learning purposes at home every day (27.5%) or two-three days a week (29%). The Internet for learning purposes is used less frequently and it seems to be logical as at the same time, the Internet users apply a computer. However, some of those use a computer but reject the Internet facilities. More often a computer and the Internet are not used for learning purposes. Depending on the use of computers for learning purposes at school, the majority of the respondents fall into two categories: more than one third of the students agree they use a computer for learning purposes at school once a week while another third (28.8%) state they never do that (Lamanaukas, Vilkonis, Klangukas, 2007). Research has also disclosed certain differences between the countries the respondents of which participated in the survey.

Broadly speaking, creating the education system that reflects and contributes to the development of our changing world is an important point. In this context, we need to ask how we might change assessment practices to achieve this and what role technologies might play. What is education for? What attributes do we value and need in our young people as workers, as learners? Where does learning happen? What role should the young people play in order to shape their education? How to increase a real interest of the young generation in scientific research? These are the crucial issues to be fully answered. It seems likely that the latter research will at least partly answer the above framed questions.

It is supposed that despite ICT development, certain differences in terms of using ICT in the teaching/learning process in separate regions in Europe exist. A reasoned interest in the introduced situation can be observed in the so called post-soviet area including Baltic countries. Therefore, the chosen **object of research** is using ICT in the process of natural science education in comprehensive school in Baltic countries (Lithuania, Latvia & Estonia). **The goal of research** is a greater awareness of the present situation and prospects linked to the use of ICT for the purposes of natural science education in comprehensive schools in Baltic countries.

The following questions were discussed:

- What is the level of using ICT for the purposes of natural science education in comprehensive schools in Baltic countries?
- Do the teachers use ICT in work practice?
- What are the most popular ICT tools (the Internet, the Intranet, educational software etc.) frequently applied in natural science education?
- How do the experts evaluate the present situation on using ICT in comprehensive school in their own countries?
- What ICT tools are applied in different comprehensive schools in Baltic countries?
- What ICT tools should be created in the future?
- What are the experts' predictions about applying ICT in this field for the next 5 years?
- What are the main factors preventing from/encouraging the use of ICT in natural science education?
- What are suggestions and recommendations put forward by the experts in the field?



Methodology of Research

General Research Characteristics

To undertake research, the method of expert inquiry was applied. To form expert groups, the recommendations on research methodology of social sciences were followed (Tidikis, 2003). The recommendations offer that similar research should be conducted by 5 - 7 people working in a group of experts. The survey was carried out using 'on-line' research i.e. all experts communicated by e-mail. 24 experts participated in qualitative research: 8 experts represented Lithuania, 6 – Latvia and 10 – Estonia.

The reliability of the evaluation method used by the experts depends on the selected experts who must be competitive, have relevant experience and know the field of the researched object. Therefore, the experts were carefully selected considering their competency rates such as official position, scientific degree, experience of scientific and practical work in the field of natural science education and ICT. The strategy of snowball sampling was used to make the representation of experts. Depending on professional status, all surveyed participants are related to the researched object.

Research was completely anonymous and created possibilities of expressing opinions more openly and objectively whereas feedback received in a written form (making comments) allowed avoiding the impact of other experts. The data of qualitative research was processed using content analysis. On the basis of the accepted methods of content analysis, the obtained verbal data array was examined passing four stages:

- multiplex reading of received answers;
- search for semantically close answers and 'key' words;
- establishing categories and highlighting the main statements;
- interpreting the highlighted categories.

The interpretation performed on the basis of the highlighted categories was accomplished at two levels – manifest and hermeneutic. The manifest level of interpretations means that created categories were based on the 'key' words and directly explained. Meanwhile, the hermeneutic level reflects a latent, hidden meaning of the answers.

The interpretation of the answers at hermeneutic level considers that the experts' opinions, including the most competent ones, cannot be the standard of absolute scientific laws on the researched reality. Thus, their positions should not be treated as automatically revealing scientific truth. The experts are only extremely important and influential persons of the society. It is supposed that their opinions, approaches and provisions partly reflect their standard behaviour. Therefore, the experts' opinions are interesting and really wordy. However, it should be perceived that the experts' positions should not be over estimated as they can be subjective and in some cases might be limited and controversial.

Research was conducted in March – May 2007.

Research Instrument

In order to define the situation on using ICT in comprehensive schools in Baltic countries teaching natural sciences, a nine question inquiry including 2 close and 7 open-type questions was prepared. To more exhaustively disclose the discussed topic, the questionnaire pointed up the parameters and indicators of research. The research parameters directly showed research questions whereas the indicators – features used for assessing and evaluating the situation in comprehensive schools in Baltic countries.

Results of Research

General Situational Evaluation

To find out an existing level of using ICT for the purposes of natural science education, the experts were asked to evaluate the level of ICT use as well as the present situation on applying the Internet, the Intranet, educational software and other ICT tools for the purposes of natural science education in



comprehensive schools of every surveyed country.

The surveyed experts' opinions on using the Internet in the process of natural science education point to the conclusion (Table 1) that similar positions on the level of using this net are prevailing. Almost a half of the experts (45%) emphasized that the majority of the teachers did not mention the facilities provided by the Internet. It's worth emphasizing that none of the experts referred to the teachers who did not use the Internet which proves that the Internet is one of the most popular and widely used training aids among the teachers.

The evaluation of the level of using the Intranet at school for the purposes of natural science education reveals that the larger part of the experts (75%) think that only a minor part of their colleagues use the Intranet. A more detailed assessment of the latter parameter according to the surveyed country indicates that the Intranet is more frequently applied in Estonian comprehensive schools. Three experts from Estonia agree that the Intranet is used by all teachers. The last named opinion can be treated as an ambiguous one; however, on the other hand, the Estonians widely apply the system of e-daybook which places the teachers under obligation of daily use of the Intranet. Nevertheless, it should be too fearless to accept this position as absolute truth. Some of the experts admit that the Intranet is not popular in a number of schools and is most frequently applied for administrative rather than for teaching/learning purposes. Broader and more careful assessment is provided below.

The evaluation of the level of using educational software discloses that a greater number of the experts emphasized that the minority of the teachers used them. Only a single expert was far more optimistic and acknowledged that these aids were applied by the majority of the teachers.

In terms of other ICT tools, similar situation can be seen. When evaluating these technologies, a half (50%) of the surveyed experts admit that only a minor part of the teachers apply them in working practice.

In conclusion, the opinion of all surveyed experts about the level of using ICT for the purposes of natural science education in comprehensive school show that the Internet is the most frequently applied training aid. The Intranet is the least common ICT tool as the use and practical weight are poorly disclosed. The experts state that the use of other ICT tools in the process of natural science education is rather complicated and they are applied by the minority of their colleagues. The further and more thorough assessment of the latter indicator points to different reasons:

Table 1. The level of using ICT (N/%).

ICT	Used by everyone	Used by the majority of teachers	Used by less than a half of teachers	Used by the minority of teachers	Not used
The Internet	3/12	11/46	5/21	5/21	
The Intranet			3/12	18/75	3/12
Educational software		1/4	10/42	12/50	1/4
Other forms of ICT		2/8	10/42	12/50	

Situational Evaluation According to the Surveyed Country

Research was also aimed at clarifying the situation on how the experts evaluated ICT application for the purposes of natural science education in comprehensive schools in their countries. In order to receive more precise answers, the addressed question included 4 structural parts i.e. the experts had to present arguments as well as to make comments and their evaluations of using the Internet, the Intranet, educational software and other ICT tools in their own country.

The table below shows basic comments on the categories according to the researched countries.



Table 2. Situational Evaluation According to the Surveyed Country.

LITHUANIA		
Categories		Content of the category
Usefulness	The Internet	Using the Internet offers the teacher endless possibilities of preparing for work in the classroom, for example easily helps with finding latest information. It is a most popular and frequently applied tool to improve natural science education. In general, the possibilities of the Internet are perfectly turned to account in different types of schools.
Problems of teachers' motivation		The teachers are passive users of the Internet. They often tend to see only traditional training aids – course books.
Changes		Along the increase of school computerization, the Internet becomes more and more popular in teaching/learning process. Presently, the great majority of national educational establishments own pretty good Internet links. It is supposed that the recent situation will improve.
Insufficient application	The Intranet	The latter tool is hardly ever applied in practice. It is acclaimed that this system isn't particularly relevant and its usefulness doesn't cover the efforts made for implementing the Intranet. Although in most of the cases the educational establishments are provided with the Intranet, however, it's not applied in educational practice in reality. On the other hand, the purpose of application is not clear enough, and therefore the teachers are not sure about the use of this ICT tool.
Quality and teacher training	Educational software	Not all educational software can be accepted for the purposes of natural science education that highly needs qualitative mother tongue software as the available forms are rarely used by the teachers. Moreover, the larger part of educational software is commercial and rather expensive, and therefore schools fail to obtain them. There is lack of experience and certain types of methodology necessary for applying specific software. Shortage of teacher interest in applying the available software in their work practice can be noticed.
Complicated application	Other ICT tools	Other ICT tools are rarely used. A greater number of schools have poor material facilities which influence a limited supply. Furthermore, the prices are too high to apply other ICT tools. Besides, the teachers are improperly informed about the possibilities of applying ICT in their work places. Sometimes, the teachers use their own developed programs but no single data base for all teachers nationwide exists. To make various presentations, the teachers most frequently use the PowerPoint programs.
LATVIA		
Limited supply	The Internet	Lack of computer equipment in schools and limited access to the Internet. Such situation limits the use of the Internet for teaching/learning purposes. The situation in the rural area remains complicated. Another difficulty is shortage of computers in the rooms of natural sciences. Due to small number of computers and limited access to the Internet in the educational establishments, the teachers often use the Internet at home.
Doubtful efficiency		Using resources provided by the Internet only in the process of natural science education is not enough. The immediate use of the Internet in the classroom doesn't fulfil teacher's expectations and pursued aims. The Internet is most frequently used as information source rather than training aids/resources for learning and the main reason for that is insufficient safety.
Teachers' motivation		The teachers extremely rarely use the Internet for work purposes. One of the reasons is that the majority of the teachers are of older age and that their computer literacy skills are insufficient to effectively use the Internet.
Insufficient application	The Intranet	The system is not fully integrated in schools and needs to be developed. Not applied in practice, as the teachers are not properly prepared to use e-training aids/resources for learning in their work practices.
Lack of information		Lack of certain methodological guidelines prevents from applying the Intranet for teaching purposes. Special training and practical help for teachers (in terms of methodology in particular) are required.



Shortage	Educational software	The severe shortage of the programs of a similar format. The available programs are rarely used. Only a few schools in the country have the educational software databases of a similar format. The problems mainly occur in the fields in localization, storage and classification.
Teacher training		The teachers are not engaged to apply programs in work practice. Furthermore, the older teachers are not properly trained. Poor teachers' experience in applying these programs. It should be emphasized that applying ICT in the process of natural science education mainly depends on personal teacher's enthusiasm and motivation.
Poor basis	Other ICT tools	The amount of ICT to be used in the process of natural science education is very small as local authorities do not help with proper financing in order schools should be equipped with the highly required tools. Digital cameras, scanners and similar technology are rarely applied. Privileged schools have multimedia systems and interactive boards. In exceptional cases the schools own created laboratories equipped with the required ICT tools.
ESTONIA		
Usefulness, possibilities	The Internet	99 % of schools have the access to the Internet where the vast majority of the teachers are provided possibilities of finding a huge amount of useful information on education on mother tongue. The experts agree that 60% of schools have e-facilities and use the Internet to exchange useful information among the members of school community, school office and parents. The possibilities offered by the Internet are used by the students as well as by the teachers. The Internet is most frequently applied as a means of searching for information and planning students' projects and presentations.
Teachers' activity		About 50 % of the teachers nationwide use the websites of education at work. A greater part of the teachers use the Internet almost every day as they must put records in e-daybooks and thus use data bases.
Teacher training		Is not applied as wide as it should be due to special teacher training. A part of the teachers aren't used to using the Internet.
Application		The Internet in the national education system is mainly used for 3 primary purposes: a) administrative; b) exchanging information; c) teaching. 20-25% of the teachers use the Internet for immediate teaching of natural sciences.
Employment possibilities	The Intranet	A significant part of national secondary schools have their own Internet websites and the Intranet. Work of a number of laboratories is based on the Intranet. In most of the cases, the use of the Intranet in comprehensive schools depends on the policy and available information system applied in the educational establishment itself. It can be maintained that about 40% of national comprehensive schools use the information system created by eKool that is devoted to teachers, students and their parents.
Insufficient approach		The Intranet is frequently introduced in bigger schools. In this case, the small ones are still encountering problems.
Application	Educational software	2 types of educational software are most frequently used in the process of natural science education in comprehensive schools (appropriate programs on CD and those freely acceptable on the Internet). About 20% of national schools employ the packages of educational software devoted to learning organic chemistry and other natural sciences. A major part of software is products created in Great Britain. The teachers of natural sciences are acclaimed to be the most active users of these programs.
Restrictions on application		There is a wide spectrum of problems directly related to the use of educational software. First, lack of this production, second – teachers' passiveness and unwillingness to apply this software in practice. It should be noticed that the teachers quite often apply this software spontaneously and with no forward planned purpose. Moreover, educational software of a similar format often doesn't meet the requirements of teaching curricula. On the other hand, only a small part of this software is acceptable on mother tongue. The Ministry of Education doesn't pay enough attention to the problem of translations into the national language.



Unlimited employment	Other ICT tools	The Multimedia projector, digital cameras/camcorders and interactive boards are most frequently used ICT tools. Some of the students succeed in creating and applying certain educational software. Participation in the international projects is very popular. This is the place where informative websites for the purposes of learning natural sciences are created. The most favourite projects are 'Tere, kevad (Hello Spring)', GLOBE, Baltic Week etc.
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On the basis of this assessment we can maintain that the most favourable situation on using ICT in the field of natural science education is in Estonia and the most difficult – in Latvia. Lithuania appears somewhere in the middle. According to the individual parameters, the situation may vary in every country. The experts' evaluations reveal that teachers' motivation for using ICT is higher in Estonia rather than in Latvia and Lithuania. The use of the Internet in all countries is limited due to poor skills at foreign languages. In this case, the situation is much better in Estonia rather than, for example in Latvia.

The range of specific ICT tools applied in the teaching/learning process was under discussion. The experts were asked to name the main and the most popular ICT tools regularly used in the process of natural science education in the national system of general education.

Table 3 indicates the distribution of the multimedia tools prevailing in comprehensive schools according to the country. Certainly, the presented findings demonstrate only tendencies; however, it doesn't mean that a school can use only the tools included in the list. The tables show the descriptions of the tools most frequently mentioned by the experts in their comments.

Table 3. ICT tools most frequently applied in the process of natural science education.

Country	ICT TOOLS
Lithuania	<ul style="list-style-type: none"> • Lap tops • Projectors • PowerPoint program • Equipment for recording data on physiology, electrochemistry and physics supplied with sensors • 'Clever' boards
Latvia	<ul style="list-style-type: none"> • Microsoft Office system. • Licensed educational software. • Training/learning material on the Internet, for example www.liis.lv • Educational software on CD's (Coach Junior + CoachLab+ sensors, ElektriX, CD Multimedia Motion LV, Game „Latvia”, Sensing Science, Laboratory software
Estonia	<ul style="list-style-type: none"> • Interactive websites on the Internet • Educational games • Microsoft Office system. (PowerPoint program is widely applied) • The majority of educational software • Widely applied information material and educational (pedagogical) software • Scanners • The Internet pages (a huge amount of information about vertebrates, plants, ecology) various simulation programs available studying different Ecology topics • Digital cameras and camcorders • GPS and other tools of mobile technologies

The assessment of the received answers discussing ICT application in today's educational practice discloses that the spectrum of the used tools of information expression (multimedia) is rather broad. Nevertheless, traditional tools, for example Power Point, Word programs, DVD players, TV etc. are prevailing. No significant deviations between the surveyed countries were noticed.

Considering teaching/learning needs for educational practice, thorough evaluations of required ICT forms were carried out. Table 4 presents the concluded experts' evaluations and suggestions highlighting crucial proposals for the analyzed question.



Table 4. Suggestions/recommendations about the need of using ICT in the process of natural science education.

Countries	Suggestions and recommendations
Lithuania	<ul style="list-style-type: none"> • First of all, all rooms must be equipped with computers and projectors. At least three computer rooms must be arranged at school so that every learner should be provided the possibility of working at computer and projector. Different techniques of teaching can be used in the classroom: <ol style="list-style-type: none"> 1. Performing creative tasks. 2. Collecting and processing additional information. 3. Work in groups. Sharing the obtained information. 4. Interdisciplinary integration. 5. Efficient time management. 6. Fast knowledge examination. • Tests and the procedure of examination should be arranged using computers and appropriate control programs. • Conditions for establishing collaboration between students and teachers outside the school should be created (for example, e-conferences). • The students should be introduced training material in an appropriate way. Modern ICT should help with encouraging the learners to be actively engaged in natural sciences. • Creative tasks i.e. designing simple programs etc. could help the students with proving their competence in computer literacy. • Natural science portal devoted to the teachers is created (methodological material; educational software etc.); • Obtained licences for designing educational software; • The developed products (educational software) must be available for all teachers of natural sciences, rooms must be equipped with computers and projectors and dissemination provided through the portal; • Not expensive equipment for recording data on physiology, electrochemistry and physics in real time are created; • To operate this equipment, not expensive sensors are created and standard methodologies of laboratory experiments on work with this equipment and sensors are performed and described. • The cordless Internet. • Lack of educational software and databases where all educational material should be collected and easily acceptable for the teacher.
Latvia	<ul style="list-style-type: none"> • The Multimedia tools should be created on the basis of the strict parameters corresponding to the followed curricula. • More attention needs to be devoted to the tools used for teaching chemistry, for assessment of complex reactions in particular. • Tools concentrating on practical work. • The immobile computers and projectors in the rooms of sciences. • To design programs allowing the teachers to easily create visual material similar to that produced by the already available PowerPoint program. • More attention needs to be turned to creating remote learning environments.
Estonia	<ul style="list-style-type: none"> • Educational software should be created and accumulated using mother tongue. • Twofold ICT material should be used in the educational process. Type 1 of the material should serve the teachers the computer literacy skills of which are only of average level. Type 2 should be more complex and include software permitting a teacher him/herself to design the wanted lesson scenario or program. The latter version should be for those having better than basic computer literacy skills. • At the initial stage, appropriate work places for students should be created (adequate supply i.e. computer etc.). • More simulation programs focusing on teaching chemistry and physics • ICT should meet the requirements to the teaching curricula. • More interactive pages on the Internet and accumulation of suitable (ICT) databases.



The prospects of changes in the field of applying ICT for the next 5 years were revealed. The experts were asked to evaluate the prospects relating to the use of ICT for the purposes of natural science education.

The conclusion of the positions of the surveyed countries demonstrates that the predictions about the use of the Internet for the purposes of natural science education in comprehensive school are very optimistic (Table 5). The great majority of the experts (54%) agreed that the situation would substantially improve in the future. Quite a few respondents (42%) thought the situation would be slightly better. Only a single expert supposed that the situation on the use of the Internet would remain stable and no changes in the field would take place in the nearest five years.

Table 5. Changes in ICT for the next 5 years (N/%).

ICT	Situation will substantially improve	Situation will be slightly better	No changes	Situation will slightly worsen	Situation will considerably worsen
The Internet	13/54	10/42	1/4		
The Intranet	2/8	11/46	10/42		1/4
Educational software	5/21	16/67	2/8	1/4	
Other ICT tools	10/42	13/54	1/4		

In conclusion, the surveyed experts' opinions on the prospects of changes in the Intranet show that positions on the use of this ICT tool widely vary. A part of the respondents maintain that the situation will be slightly better (46%), the others agree that the situation will remain the same with no changes (42%). However, on the basis of the received findings, the great majority of the experts accept that changes in applying the Intranet in education practice will not be rapid.

The comparison of the latter indicator according to the surveyed country in terms of the Intranet discloses that the prospects sharply vary. Some positions of the experts from Estonia are more optimistic if compared with those of the respondents from Lithuania and Latvia. Quite a few representatives of this country supported the idea of rapid changes when applying the Intranet at school in the future.

Educational software and other ICT tools were also positively evaluated. Almost every surveyed participant expressed a good opinion of the situational changes in the next 5 years.

The conclusion of the experts' prospects of applying ICT indicates the rapid development of the Internet. The application of educational software and other ICT tools got similar evaluation. In terms of using the Intranet at school for teaching/learning purposes, the prospects are the most pessimistic and the least clear.

The experts also made comments and put forward arguments about the prospects of changes in the field of ICT. The addressed open type question asked to offer arguments and explain possible changes in the next 5 years.

The experts' predictions about the situation of using the Internet for teaching/learning purposes in comprehensive school prove that in the next 5 years:

- the pace of developing ICT in the education system will increase and similar level of using technologies will be achieved in all European countries;
- changes will be under the influence of the younger experts in the field working at school and a better understanding of possibilities provided by the Internet;
- teachers' competence in the field of using ICT for teaching purposes and didactics of teaching natural sciences using ICT will develop;
- the Internet will offer more specific and required teaching/learning material that will be more attractive – interactive. The Internet websites focusing on teaching natural sciences will be more useful as the students will be offered better opportunities to use different programs for data collecting and processing;



- remote teaching/learning will be further developed; it is likely that the nets linking e-learning environments at national level will be created;
- collaboration between schools and establishments of higher education will become more active;
- communication between teacher, student and his/her parents will be more straightforward;
- schools will be provided the possibility of using the cordless Internet.

In comparison with the Internet, the experts' prospects of using the Intranet in schools are less optimistic. Only the minority of the respondents see the progress in this field, for example *'a large number of schools will implement virtual learning environments. A greater part of the teachers will be actively involved'*.

The experts from other countries are more reserved, for example *'Practically will not be used and implemented in the teaching process /Latvia/,'No valid point and need to use' /Poland/,'No fundamental changes in this field are predicted' /Lithuania/.*

The majority of the respondents think that the Intranet will be used for management – administrative rather than for teaching/learning purposes. Despite certain pessimism, the experts see a positive impact of the Intranet and point to the development of remote learning (the pace of development may differ in single countries). The experts from Latvia and Estonia agree that one of the problems is lack of teachers' competence.

The experts' predictions about using **educational software** for the purposes of natural science education in comprehensive school for the next 5 years prove the following major characteristics of the research indicator.

- When predicting the prospects about using educational software for teaching/learning purposes, the issues of teacher training were exhaustively discussed, for example *'Further teacher training in using educational software is necessary' /Latvia/.* It is supposed that to solve the problems dealing with the increase of teachers' competence more literature should be available in the future.
- A number of experts fully agree that more educational software will be created in the future. Some of the respondents indicated the future schools should be equipped with the educational software presently created and tested in universities. It is likely that the young teachers will apply the programs they got used to at university. Certainly, at later stage, new software will be employed.
- When predicting the future of educational software, full attention was devoted to the quality of software considering different aspects, for example *'from a didactic point of view, educational software will be more advanced and encouraging'*. Some of the experts underline that the present educational software focus on individual learning. In the future, the surveyed participants would like to see educational software concentrating on the subject, curricula and standards. Apart from quality, the question of mother tongue is mentioned i.e. in the future, to help the students, more attention will be paid to the educational software supplied with instructions in mother tongue.
- Financing issues are not prevailing, however, funding for creating and obtaining new educational software will have impact, *'everything will depend on a class of a school, technical supply and the number of computers' /Latvia/.*
- A part of predictions are pessimistic, for example *'The development and use of educational software is a slow process; if there is no sufficient government financing and attention paid to this area, it's hard to predict how long and how fast the development and implementation of educational software will take place as considering pedagogical theories no effective strategy for implementing educational software into educational process exist' /Estonia/.*

The evaluation and predictions of other ICT tools are rather controversial. Quite a few experts believe that the use of other ICT tools in comprehensive school in the nearest future will remain complicated due to insufficient financing, for example *'In recent years, schools have obtained only a few video tapes,'though other tools are urgently required, they are still too expensive for schools' /Estonia/.*



It is believed that despite the existing problems, different educational software will be wider applied. The development of communication possibilities is emphasized and the relevance of similar tools is indicated.

Research has also disclosed negative and positive factors in applying ICT for the purposes of natural science education. The assessment of the latter research indicator shows that the experts put forward a number of arguments in their comments. The experts' opinions on these issues highlighting the main proposals are presented below.

Table 6. Factors preventing from/encouraging ICT application in the process of natural science education.

Countries	Preventing factors	Encouraging factors
Lithuania	<ul style="list-style-type: none"> insufficient teachers' computer literacy, lack of competencies in the field of applying ICT; a conservative teachers' position on applying modern ICT in practice; stereotyped rather than modern teaching/learning methods are used; lack of financing; insufficient knowledge of the English language; inadequate infrastructure of a number of schools and improper financing ; the teachers feel lack of valuable information (older teachers in particular) on how to use ICT. 	<ul style="list-style-type: none"> ICT offer possibilities of presenting training material more attractively; Modern ICT helps with achieving better results; ICT encourages applying modern teaching/learning methods in education practice; possibility of communication and sharing personal ideas; ICT tools allow making the teaching/learning process more flexible; ICT provides possibilities of applying innovations in natural science education, helps with preparing for lessons; the Internet is full of relevant training material including pictures, films, schemes etc. The material is picturesque, understandable, memorable and informative. Information in the course books is often not up-to-date one, so the Internet is the place to check it (some precaution should be useful).
Latvia	<ul style="list-style-type: none"> Insufficient teachers' computer literacy; Lack of methodology of how to apply ICT in practice; Economic problems (improper financing, inadequate infrastructure of schools); Shortage of the experts in the field able to adapt appropriate programs for the national system of education. 	<ul style="list-style-type: none"> Possibility of using global resources of information applying them in educational practice; The increasing number of schools able to use the resources provided by the Internet; Constantly increasing amount of information on mother tongue; Gradually increasing infrastructure (computers in every classroom, appropriate software, projectors etc.); Sharper focus on solving the problems of teachers' computer literacy; Progress in the field of designing software.
Estonia	<ul style="list-style-type: none"> The teachers feel lack of special training; Economic problems limit the implementation of technologies; Shortage of educational software and other tools; Lack of time; Lack of educational mother tongue software. 	<ul style="list-style-type: none"> Possibility of communication and establishing international contacts encourages to wider use the facilities provided by the Internet; Constantly increasing students' computer literacy and interest in the latest technologies are the factors determining the use of ICT in comprehensive school; Constant increase in the number of ICT experts and support provided by the Ministry of Education are the main factors encouraging effective implementation of these tools.

The summary of different opinions and comments passed by the experts from Baltic countries shows that appropriate conclusions can be reached. With no respect to varieties observed in the national education systems, similar problems in the field of applying ICT can be noticed. No significant deviations



between the countries were noted. The experts admit that all comprehensive schools encounter the same problems and difficulties at all stages of education.

The respondents think that these recommendations are the most important for the future. Table 7 shows the generalized experts' suggestions on effective ICT application.

Table 7. The most important recommendations.

Countries	Recommendations
Lithuania	<ul style="list-style-type: none"> • To encourage teachers to be interested in modern ICT and in the possibilities of its implementation; • To put emphasis on creating methodology of ICT application in education; • To create and develop methodology of applying the Internet and the Intranet in education; • To put a sharper focus on the publication of methodical material and conducting seminars and conferences; • More attention to school financing; • To create an optimal methodology of distribution and financing; • To create testing programs in Lithuanian; • To create a unique database at national level.
Latvia	<ul style="list-style-type: none"> • Larger investment and development of infrastructure in comprehensive schools should improve the situation; • To reduce software prices; • To concentrate on research that either justify or deny the effectiveness of these technologies; • To publish appropriate material in order to help the teachers with a greater awareness of using ICT in their work practice.
Estonia	<ul style="list-style-type: none"> • A larger amount of computer equipment in schools; • A greater number of the experts in the field in comprehensive schools; • The further development and use of the Intranet between school staff and parents; • To offer an ICT expert a work place to look after the Intranet system and provide information (flash lights) for the teachers about modern technologies and possibilities of applying them; • A strategy and logical plan for successful integration of educational software into the process of natural science education are necessary; • To prepare and implement the projects that help with bringing new things into education practice; • To create an ICT model that corresponds with the teaching curricula.

Conclusions and Discussions

The situation on applying ICT in the education systems in Baltic countries is similar. It is determined by the rapid development of ICT, the general peculiarities of Europe as a region, political-economical factors etc. In spite of the common features, certain differences exist. These can possibly be conditioned by varying country's economical situation that directly influences the possibilities of comprehensive schools to use the latest ICT.

The experts agree that the Internet is the most frequently used ICT tool. The Intranet is the least popular in the teaching/learning process and is often used for administrative purposes. Moreover, the teachers find difficult to explain the mission of the Intranet in the educational process as from a didactical point of view it remains unclear. The comparative assessment of the surveyed Baltic countries reveals the tendency that this system is commonly applied and practically used in Estonia.

The assessment of the experts' opinions on the use of the Internet shows it being frequently applied. Nevertheless, two basic problems can be faced - how to ensure more didactically purposeful use of the Internet in the training/educational process and how to guarantee sufficient teachers' ability and adequate motivation for using it. Another burning issue common for every country is that the older teachers do not accept innovations, and therefore technical abilities to use the Internet do not mean it will be effectively and purposefully used in the educational process. However, a general tendency is clear – the use of the Internet rapidly increases and qualitatively grows. It is likely that this tendency will become stronger in the future.



The experts think that due to the use of educational software a number of problems appear almost in every country. It is determined by a position of a school rather than by the general national policy on education. The production of these tools can hardly be centralized as every country has its own national education standards. On the other hand, every teacher on his/.her own is not able to create educational software, and thus only individual initiatives can be observed. It is expected that the question of developing high quality products will remain opened in the future.

The spectrum of used multimedia tools is rather broad, however mainly traditional tools such as Power Point, Word programs, video players, TV etc. are prevailing. The small countries face an extremely pressing problem which is no tool is supplied with mother tongue.

The main factors preventing from the use of ICT for the purposes of natural science education are similar in the majority of countries. They include teacher training (competencies), economical, management, political etc. problems. In the future, every period will face specific interferences in ICT development. The experts suggest that a closer collaboration between comprehensive and higher schools is necessary. Such situation is crucially important for higher schools that train the teachers of natural sciences for comprehensive schools. International collaboration, the increase in teachers' qualification, improved training of science teachers, growing financing and requirements for education quality (including general education) etc. will remain the major factors encouraging the use of ICT.

Prognostically, the experts' opinions are much the same – for the next 5 years, the Internet will rapidly develop whereas no changes in using the Intranet are predicted. The experts maintain that educational software will significantly growth. It is likely that first all, the changes will be determined by varied teachers' qualifications in the field rather than by technical possibilities. In the future, changes in school environment will be more rapid as young experts in the field having a more positive attitude towards ICT will come to schools. Then, the factor of competitiveness will become more decisive in both sectors – comprehensive and higher school. The experts suppose that the issues of financing will not prevail in the future. Nevertheless, more relevant tasks will be coordination of standards, teaching content and other training aids/resources for learning with appropriate level of ICT. The respondents emphasized that the development of communication possibilities would be extremely important in the future. International collaboration will be more active. Obviously, appropriate ICT tools will need to be created.

Despite positive and objective actual evidences in the context of ICT included in the reports of the majority of contract research, a number of questions still remain unsolved. These issues are relevant not only to the education system in Lithuania but also to other Baltic countries. It is proved by the findings received from the content analysis of experts' qualitative survey. Data interpretation revealed a number of problems encountered not only by the social persons of our education system but also by the institutions of other Baltic countries applying new technologies.

When predicting further actions, the experts as the main actors of this research the opinion context of which was one of the most important factors disclosed a rather detailed evaluation of the present situation. On the basis of the positions taken the situation looks more complex. First, the discussed questions are highly relevant: Is the progress of ICT application in comprehensive schools directly related to financing? Will financing and supply with ICT improve if teachers and other employees of the education system avoid and sceptically evaluate these tools? Certainly, infrastructure and material support for schools are very important but specific experience suggests it is not enough to ensure efficient application of these tools. With reference to research carried out by M.Vilkonienė in 2006, where the data was collected using long-term educational (during external audit of schools) experience not structured instrument (the author states that this tool 'does not reflect the real situation of using ICT'), the obtained results showed that the abundance of computer equipment in schools did not encourage using these tools and did not solve the problems of teacher qualification.

The second question discusses the ways of changing the present situation on insufficient teachers' competence in using ICT? Every member of a modern society must acquire at least minimum of skills at using a computer and be able to employ the tools of information technologies in personal and public activity. When dealing with this task, education, comprehensive school and teacher in particular play an important role. However, the teachers still feel lack of experience and knowledge



of how to effectively apply ICT in the educational process and how to receive qualified and regular methodological support?

The third question focuses on cohesive and purposeful integration of these tools into educational practice. How to ensure effective and meaningful application of these tools? Unhappily, no balance between the use of computers, projectors, educational software, course books and teaching curricula exist. This issue should be debated at all levels of the education system. In-depth educational research also plays a crucial role as it helps with informing the politicians on education and other social bodies about the real ICT situation.

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