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SCIENCE LEARNING SYSTEMS NEWLY RECEIVED BY LITHUANIAN SCHOOLS AND THEIR POTENTIAL APPLICATIONS IN TEACHING PHYSICS

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Abstract

Wider knowledge update is always a big challenge for schools. In the event of changes in the curriculum, a question naturally arises: where teachers and students will get new teaching materials. It is necessary to renew textbooks and other teaching tools and to help teachers learn how to work with new knowledge. Natural science laboratory material base in secondary schools has been renewed by implementation of the project "Infrastructure of technology arts and natural sciences". However, to achieve the desired result, it is necessary to find out whether there is sufficient infrastructure, whether new equipment conforms to expectations of the teacher, whether teachers are able to learn independently and appropriately use new laboratory equipment and modern tools. All this added together can require a systematic teacher training.

The paper presents research connected with the new equipment and teaching tools received by Lithuanian secondary schools under the project "Infrastructure of technology arts and natural sciences" and their potential application in teaching physics. Information gathering and data processing unit Xplorer (GLX), Science Learning Systems (Nova and Spark) with sensors are analyzed. Questionnaire survey results of the teachers having this equipment are presented.

Key words: *science learning system, teaching physics, educational equipment, teachers' opinion.*

Introduction

Science education is based on the principle of renewal formulated in the General Programmes of Secondary Education and General Didactics (Vidurinio ugdymo bendrosios programos, 2011). Renewal principle requires not only a new teaching content and new textbook or other methodological materials, but also the development of new teaching methods, which encourage students' self cognitive activity and critical innovation.

The obvious need for change clearly demonstrated results of international research, revealing poor Lithuanian students' achievements. Lack of Lithuanian students on natural science literacy testify studies in PISA (2006, 2009), TIMSS (2007), *The Usage of General Programmes and Education Standards* (2008). International project ROSE can also be mentioned (The Relevance of Science Education) (http://www.roseproject.no/), the results of which showed that students often have a negative attitude towards natural science teaching in schools. At the same time they understand that science and technology are important for future life. Therefore, it is necessary to search for new forms and ways to really interest students in a particular field of knowledge.

In recent years there were observed quite significant changes in Natural Science Education. Renewed General Programme of secondary education was approved in 2011. The Programme has been renewed through teacher-practitioners, researchers and content experts. Public

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hearings were held with representatives of the teachers, parents' and children's associations, high schools. The main aim of renewed secondary education is to ensure that students are ready for further education, professional activities and personal life. The Programme focused on the quality of education: education content meets the changing needs of society and shall maintain the harmony between education levels; education content accessible and efficient throughout the education system, education content changes continuously (Jakimovas, 2011).

Renewed physics curriculum highlights the main idea - change in processes at school: the transition from learning formulae and training to applying them into deeper understanding of the phenomena and laws, the ability to apply them in new, non-standard situations, solve problems, develop creativity, move from the practical works according to a detailed description into planning and carrying out self research.

It is proposed to carry out a minimum of 4 - 6 laboratory works of which at least two should be carried out as a self-study for students who have chosen a general physics course. Advanced physics course is proposed to carry out 6 - 10 experiments works at least four of which should be carried out independently as a research. It is recommended to perform several computer supported lab. works by using new technologies, which are rapidly penetrating into everyday life of young people. No coincidence that educational theoreticians and practitioners in the spotlight - effective adaptation and usage of new technologies in educational practice.

Physics is one of the first areas where the possibilities which computers and other ICT may offer for the employment of new teaching methods are still being explored. A variety of computer applications have been developed and used in teaching Physics, such as spreadsheets, multimedia, simulations, computer-based laboratories and etc (Bernhard, Lindwall, Engkvist, Zhu, Degerman, 2007; Finkelstein, Adams, Keller, Kohl, Perkins, Podolefsky, Reid, LeMaster, 2005; Pol, Harskamp, 2005; Wieman, Perkins, 2005).

Computer-based teaching can help us deliver a deep and meaningful physics education, increasing the interaction between the student and the concepts under investigation. Interactive, multimedia experience cannot replace the real laboratory work but can enhance the learning process of many students, help them find the relation between the theoretical principles and the observed behaviour in an easy and intuitive way (Avouris, Tselios, Tatakis, 2001). Since Physics is an experimental science, the role of lab-work in physics education has been often paid attention by research studies (Bernhard, Norrköping, 2001; Harms, 2000; Sassi, 2001).

Wider knowledge update is always a big challenge for school. In the event of changes in the curriculum, a question naturally arises: where teachers and students will get new teaching materials. It is necessary to renew textbooks and other teaching tools and to help teachers learn how to work with new knowledge. Schools seriously lack of modern technology teaching aids. Therefore, knowledge renewal process of individual subjects will be gradual, it will take a few years (Gudynas, 2010).

Poor school laboratory equipment base largely determines the decrease in interest in natural science. Students do not have the conditions to carry out practical works, experiments lack of equipment and materials needed for laboratory works. Implementation of the project "*Infrastructure of technology arts and natural sciences*" has made an important step towards solving this problem. The goal of this project is to expand opportunities for students choosing a learning direction corresponding to their various interests and demands. The main objective of the project is the modernization of secondary schools, renewal of physics, chemistry, biology, art and technology teaching tools, and equipment. 404 schools are provided with equipment and modern training facilities for 77 million litas (LTL) on this project since 2009 **(**Projektas „Technologijų, menų ir gamtos mokslų infrastruktūra". Švietimo ir mokslo ministerijos švietimo aprūpinimo centras, http://www.sac.smm.lt/index.php?id=26e). On the other hand, the renewed training tools require new methodological recommendations for science subjects.

Problem

In order to improve the Lithuanian students' competencies of natural sciences development of learning environment must be consistent and systematic. Laboratory equipment base of natural science teaching in secondary schools has been renewed by implementation of the project "*Infrastructure of technology arts and natural sciences*". However, to achieve the desired result, it is necessary to find out whether there is sufficient infrastructure, whether new equipment conforms to expectations of the teacher, whether teachers are able to learn independently and appropriately use of new laboratory equipment and modern tools. *All this added together* can require a systematic teacher training.

Object, Goal

The object of the research is the equipment and training tools received by secondary schools under the project "*Infrastructure of technology arts and natural sciences*" and their usage in teaching physics.

The main goal - to analyze the equipment received for application in physics teaching and to explore the situation of using this equipment.

Research Methodology

General Characteristics

The analysis of three types of Science learning Systems (*Xplorer* GLX, *Nova* and *Spark)* newly received by Lithuanian secondary schools under the project "*Infrastructure of technology arts and natural sciences*" was carried out.

In order to clarify the situation of the usage of this equipment in teaching Physics, questionnaire survey for teachers was conducted. The questionnaire consisted of 16 questions, four of which were open-ended. Closed-ended questions were rated in four range scale. Open questions were asked to explain the most positive and the most negative aspects of the usage of new equipment. Also the teachers were asked to give comments if they considered to be necessary.

Research Sample

72 physics teachers of Lithuanian secondary schools took part in survey, 58 of which - women and 14 - men. All respondents are with university education - physics or physics and computer science teachers. According to educational qualifications: 6 - teachers experts, 48 - teachers methodologists, 14 - senior teachers and 4 - teachers. 67 % of respondents have high pedagogical qualification and considerable work experience at school: 12/17% work at school more than 31 years, 18/25% teaches physics for 26-30 years, the same number (18/25%) for 16 - 20 years. Only 4/5.6% of respondents work at school approximately five years.

Research Results

Science Learning Systems: Xplorer GLX, Nova and Spark

Lithuanian secondary schools have been equipped with modern teaching aids under the project "*Infrastructure of technology arts and natural sciences*". Physics teaching rooms

received three types of science learning systems (Xplorer GLX, Nova and Spark) with the necessary teaching equipment (kits of kinematics and dynamics, equipment for gas laws testing, resistance measuring sets, counters of background radioactivity, etc.) and electronic sensors (distance, force, pressure, charge, current, voltage, magnetic field, rotary, photogate, microphone, temperature, etc.). Each of these Science learning Systems can perform more than 50 experiments in Physics.

The ***Xplorer GLX*** (Figure 1) is a data collection, graphing, and analysis tool designed for science students and educators. The *Xplorer GLX* supports up to four sensors simultaneously, in addition to two temperature probes and a voltage probe connected directly to specialized ports. The *Xplorer GLX* is fully functional stand-alone handheld computing device for science. It also operates as sensor interface when connected to a desktop or laptop computer running Data Studio software. An optional mouse, keyboard, or printer can be connected to the *Xplorer GLX's* USB ports. The *Xplorer GLX* contains an integrated speaker for sound generation and a stereo signal output port for optional headphones or amplified speakers. The *Xplorer GLX* collecting data made simple (Figure 2). With or without a computer, capture and analyze live data anytime and anywhere. Turn it on - Xplorer GLX powers on instantly. Connect sensor and press *Start* - you have live data.

Figure 1: Xplorer GLX front view.

Figure 2: Data collecting with Xplorer GLX.

Print directly from the Xplorer GLX to a variety of printers. Transfer files from Xplorer GLX to computer or another Xplorer GLX with your USB flash deive (Figure 3).

Figure 3: Data transfer from Xplorer GLX.

Science Learning System ***Nova5000*** (Figure 4) has been developed specifically to meet the needs of educators and students alike, helping schools to transform their teaching and learning experience. The *Nova5000* brings innovative, user friendly and affordable technology into the classroom, straight into the hands of students. *Nova5000* integrates standard computer functionality with scientific data logging and math software. The *Nova5000* includes the following SoftMaker applications for advanced office functionality. *TextMaker* - a full-featured word processor, including a thesaurus, footnotes, on-the-fly spellchecking, and the ability to insert a table. Generally compatible with Microsoft Word documents. *PlanMaker* - a full-featured spreadsheet program, providing the full calculation power and visualization features of a modern, high-end spreadsheet package. Generally compatible with Microsoft Excel worksheets. *Presentation* is an application for creating multimedia presentations and slideshows that includes extensive graphics and text tools to support a wide range of subject areas. Students can use this powerful tool to create multimedia presentations from essays written in TextMaker or from data collected in PlanMaker, as well as design a template, build slides, and import graphics and pictures. Generally compatible with Microsoft PowerPoint presentations.

Figure 4: Nova 5000 front view.

Figure 5: SPARK front view.

Science Learning System ***SPARK*** (Figure 5) *is* an all-in-one mobile device that seamlessly integrates the power of probe ware with inquiry-based content and assessment. With it's large, full-colour display, finger-touch navigation and completely intuitive data collection and analysis capabilities, SPARK completely redefines the concept of easy-to-use-so the focus remains on the learning of science. *SPARK* is designed to become the centre of school's discovery-based science learning environment, providing both teacher and student the embedded support for exploring scientific concepts. The *SPARK* Science Learning System includes more than 60 free guided inquiry pre-installed *SPARK* labs - standards-based guided inquiry labs in a unique electronic notebook format. These *SPARK* labs completely integrate background content, data collection and analysis, even assessment - all within the same environment. Students no longer need to navigate to a separate file for instructions or even refer to paper manuals. Everything you need is right there in context.

Teachers about Situation of Using Science Learning Systems in Physics Teaching

72 physics teachers of Lithuanian secondary schools took part in survey about situation of using Science learning Systems newly received by their schools.

Most teachers use a computer in their teaching process for about 10 years. Computer

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as assistant is already 15 years for 8/11% of respondents. Some time later, a computer and a projector was put into use in the teaching process (for 12/17% - 10 years, for others - less), as well as interactive whiteboards (for 4/5.6% - 8 years, for others - less).

To the question how often computer tools are used in lessons, the teachers responded (Table 1) that the computer usually is being used in each lesson (30/42%), and computer with projector is being used in many lessons (54/75%). Respondents work less frequently with the interactive whiteboard: only 16/22% of respondents using it in some lessons. Even 44/61% of respondents do not use the interactive whiteboard. Teachers started to use interactive whiteboard not so long ago in Lithuanian schools, therefore still many teachers lack the skills to work with it.

Table 1. Teachers about computer usage in teaching process (N /%).

How often these tools are used:	In each lesson	In many lessons	In some lessons	Do not use
1. Computer	30/41.7	26/36.1	8/11.1	8/11.1
2. Computer with projector	10/13.9	54/75	6/8.3	2/2.8
3. Interactive whiteboard	4/5.6	8/11.1	16/22.2	44/61.1

Ability to work with computers, should allow respondents easily to absorb the new equipment. Questions pertained to know, what kind and how many educational tools the school has received under the project "*Infrastructure of technology arts and natural sciences*". Teachers' responses showed that the most of schools received the kit for Geometrical and wave optics (60/83%), *Information gathering and data processing unit Xplorer GLX* (58/81%) and the Electronics kit (56/78%). 20/28% Physics teachers received the Science Learning System *Nova5000* with sensors and a 4/5.6% - Science Learning System *SPARK* and the spectrophotometer. According to the received quantity of educational tools, it should be noted that only part of the schools has received a sufficient number of sets, which makes possible to perform laboratory work in the classroom. And that is just kit for Geometrical and wave optics (10-12 sets) and Electronics kit (12-15 sets). Other educational tools were received of 1-2 sets. So, these tools can be used only as demonstrations or for individual tasks.

To the question about the necessity of new educational tools, 34/47% of respondents replied that they are needed. 14/19% of respondents noted that the kit for Geometrical and wave optics is very much needed and only 4/5.6% of respondents – that the Xplorer GLX and Nova is very much needed. Some of the respondents have no opinion about the necessity of educational tools (18/25% - about the Xplorer GLX and Electronics kit), although schools received them and teachers could use them in the teaching process. Other respondents who do not have spectrophotometer (12/17%) said that it would be necessary for physics teaching. Apparently, the teachers' interest in new technologies encourages the desire to apply them in the teaching process.

Respondents were also asked how teachers, who have new measures, use them in teaching physics. Analysis of the responses showed that most teachers use the kit for Geometrical and wave optics (76.7%) and Xplorer GLX (44.8%) in certain classes (Figure 6). 20% of respondents, those who have Nova, use this *Science Learning System* in many lessons, and 30% - in certain classes. However, as we can see, about half of the respondents do not use these tools at all so far.

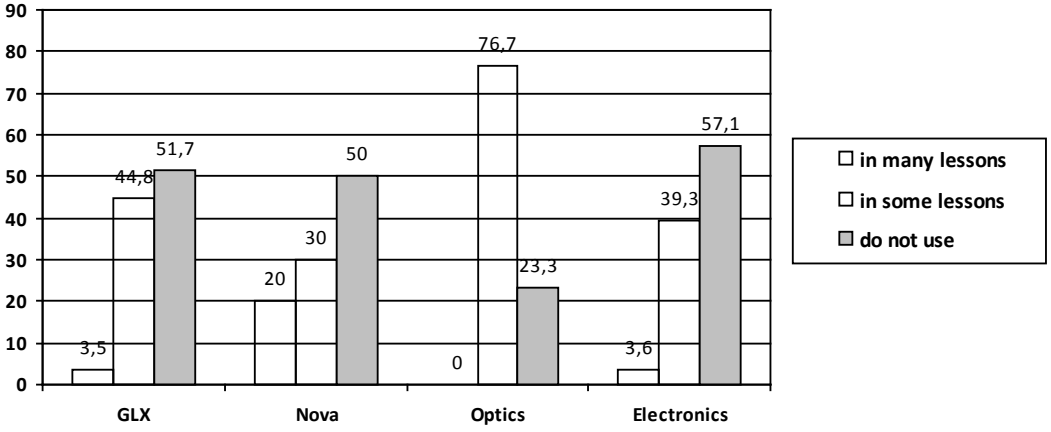

Figure 6: Teachers about new measures usage in teaching physics (%).

To the question for what purpose teachers use the newly received measures respondents indicate that in most cases (in certain classes) measures used for demonstrations (50%) and laboratory works (44.1%) (Figure 7). A small percentage of respondents use these measures in every lesson for demonstrations (17.6%). Least respondents use them for independent research work (not used - 76.4%), and individual tasks (not used - 70.6%). This suggests that teachers are not sufficiently mastered the capabilities of new equipment and methods of their application for teaching physics.

Respondents were asked to distinguish the most positive and the most negative aspects of new measures, and to explain why some of them do not yet apply devices mentioned above in teaching process. The responses highlighted the following key points.

The most positive aspects of using of new measures:

• Innovation. New tools make research work closer to modern standards. Students like innovations that promote motivation, interest in teaching the subject.

• Improvement. When working with these devices improves both teacher and pupil. Physics lesson becomes more interesting; students can observe and investigate phenomena that are difficult to demonstrate with conventional means.

• Integration. Big opportunities for research work, integrating different subjects. Students apply knowledge not only of physics, but also of other subjects when performing experiments with Science learning system. A lot of mathematical knowledge is required in order to analyze the obtained results.

• Feedback. Both theoretical and practical applications are necessary for the demonstrations and laboratory works. Result is quite fast theoretical and practical performance comparison. Both teacher and student can see what knowledge or skills is lacking.

• Accuracy of the results. Fast and accurate data processing and graphical presentation. Big opportunities for data analysis.

The most negative aspects of using of new measures:

• The high cost of time. Measures, especially GLX, are too complicated to use in every lesson and takes too much time. These measures require quite a lot of time to prepare for the lesson.

• Misaligned general education programs. The use of measures is not in line with the general programs. There are no intended hours for work with new measures and for students research work. Require more lessons in which could be used new measures.

• Lack of skills. Advanced measures, lack of skills to use, need practical tips, advices.

• Laboratory work descriptions. The difficulty consists the fact that there are no works descriptions in Lithuanian language and adapted to the educational program.

• Lack of measures. Schools provided with insufficient number of measures sets, as well as sensors to them (GLX, Nova, Spark).

Why the new measures are not used yet:

• Lack of experience. Struggling to master the measures, lack of experience, there is no time to read the instructions in English, takes a lot of time preparing the lesson, unable to extracurricular activities.

• The need for improvement. When the experiment is performed, the helper is required, practical tips are needed. Teachers expressed a desire to improve, to gain experience, to work in a group with other teachers and take time to understand.

Conclusions

Teachers have noted that science learning systems (Xplorer GLX, Nova and Spark) with the necessary teaching equipment and electronic sensors have wide application possibilities in teaching physics. They distinguished the most positive aspects of using devices mentioned above such as innovation, improvement, integration, feedback, accuracy of the results.

Teachers indicated that in most cases newly received measures are used for demonstrations and laboratory works. Only a small part of respondents use them for independent research work and individual tasks. This suggests that teachers are not sufficiently mastered the capabilities of new equipment and methods of their application for teaching physics.

It should be noted that only part of schools has received a sufficient number of educational tools sets, which makes possible to perform laboratory work in the classroom. Another part of schools have received only 1-2 sets. So, these tools can be used only as demonstrations or for individual tasks.

About half of the respondents use new educational tools in teaching physics, however another part - do not use these tools at all so far. Teachers indicate that the main cause why the new equipment is not in use is the lack of experience. They expressed a desire to improve, to gain experience, to work in a group with other teachers.

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