MODERN TOOLS FOR POPULARIZATION AND MOTIVATION STUDENTS IN PHYSICS TEACHING

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Abstract

The project "Modern ICT tools in science and economic disciplines and their presentation" (ICTEDUCA) takes place in the period between June 2009 and June 2012. The project was aimed at improving the quality of the study programmes of the physics teacher training by means of using information and communication technologies (ICT) in physics teaching and show relations between subjects. Some surveys in the Czech Republic show that physics is negatively evaluated by students in primary and secondary schools. In this article it is described some possibilities how to popularize in physics and science education using modern tools. The first part this article describes a searching interdisciplinary relation, which has an assignment to show connections between physics phenomena and human body. In the second part is introduced a voting system, through the teachers improve students in their lessons. The last part of the article attend to remote control experiments, which students, experimenters, teachers or any users can control all our experiments from its personal computer through the Internet from the website http://www.ictphysics.upol.cz/remotelab/.
Key words: *biology teaching, ICT, interdisciplinary relations, physics teaching, remote experiment, voting system.*

Introduction

The Czech teachers meet a problem of unpopularity of physics in the primary and secondary schools. How show the research PISA (Programme for International Student Assessment), knowledge Czech students get worse form year 2006 to 2009 in science area. Höfer□s research (2005) validates that biology and informatics are the most favourite subjects in area science, mathematics and informatics. Therefore is effort of relation between biology and ICT. The students perceive learning some science subject (physics and chemistry) as necessary evil, which is requirement memorized. (Hawking, 2005). Departmental didacts are trying of inclusion popularized elements into teaching science (Škoda, et. al., 2009). Škoda divides in several points, how popularized science. Two of them occupy with transfer more favourite science subject (ICT, biology) into not so much favourite subject as physics.

A huge popularity ICT by students and a stormy evolution in an area of boundary disciplines of science (molecular biology, biophysics and medical application) generalize a effort of their applying in teaching science. These trends are impulse for teaching science in more integration. This is a popularized step, because it would be eliminate isolated and separated understanding science and using new technology in teaching. In this article is introduced qualitative research of three possibility how popularized teaching physics.

Interdisciplinary Relation between Physics and Biology

Currently, the aim in the Czech secondary schools is not to obtain the largest possible amount of knowledge but to try to equip them with competences and a general view (Kolektiv autorů VÚP, 2007). The teachers' role is to show students that science is a common part of everyday life. People meet physical phenomena on every step, but they did not even realize it. It is important to motivate students that it is useful to know about phenomena and things around them. This factor can motivate students for further learning. In the education it is important to continue in students' experience, so teachers can remove the feeling of separation knowledge learned in school from life and isolation of school subjects.

One way of engaging students' interest in physics is to involve untraditional teaching elements. Interdisciplinary relations are a motivating tool in physics teaching. The development of medicine and technology depends on development of physics. Therefore it is important to acquaint students with principles and advances in medicine. One of many examples can be measurement of blood pressure. Measurement of pressure is an ordinary examine in a doctors' office. In the next part is introduced an example of the interdisciplinary relation in teaching of physics and biology. The topic is the pressure in the blood circulation and its measurement.

Measurement of Blood Pressure in Teaching Physics and Biology

Measurement of blood pressure can be included in physics and in biology of human. In physics it can be involved in mechanics of liquids, pressure in fluids and gasses, in biology it can be included in learning about the blood circulation in human biology. Physics teachers work with simplified situations as incompressible liquids and steady flow, so the situation of circulating blood must be simplified. In physics lesson students learn about terms as the static pressure, dynamic pressure, continuity equation, Bernoulli's equation, laminar and turbulent flow, Reynolds number. Biology teachers use terms as the blood circulation, blood pressure, systolic and diastolic pressure. The blood pressure is the result of hydrostatic and dynamic pressure of blood. The value of blood pressure changes during the cardiac cycle. Flow blood in the artery and veins need a constant supply of energy. The necessary work is carried by cardiac muscle. The highest value is in the ejection of blood into aorta, it is called systolic pressure. It is the overpressure made of the cuff, which the heart overcomes. The lowest value of blood pressure is called diastolic pressure. It is the pressure when the blood flows laminar. In physics lessons Pascal is used as a unit of pressure, but the blood pressure is measured in torr (millimetr of mercury). This unit is specific in medicine, because doctors previously used it for measuring of mercury manometer. The conversion relation is 1 Pa= $7,5\cdot10^{-3}$ torr. The normal value of systolic/ diastolic blood pressure of a healthy patient is around 120/80 torr.

Procedures Measurement of Blood Pressure

Routine measurements of blood pressure are most commonly made by the cut-off method. For measurement by this method doctors need a sphygmomanometer and a stethoscope. The sphygmomanometer consists of a cuff, which is placed on the patient's arm in the height of patients' heart, the balloon for inflating of the cuff, the pressure in the cuff is monitored by a pressure gauge (Figure 1).

Figure 1: Measurement of blood pressure (Vagnerová, 2009).

When a patient has a cuff on his arm, a doctor inflate doctors the balloon over the value of the systolic pressure. No sounds are heard in the stethoscope, which is placed over the artery downstream from the cuff is heard no sounds. Then the doctor loosens the pressure in the balloon. When the pressure in the balloon is the same as the systolic pressure, the doctor hears characteristic sounds. The blood begins to circulate through the artery, but the flow is turbulent. The turbulent flow accompanied by murmurs. Afterwards the pressure in the balloon drops and the pressure in the artery get to its normal value and the circulation becomes laminar and the sounds fall silent. The pressure at which the murmurs fade is the diastolic pressure. The Reynold's number holds an important function- it characterized the flowing type (laminar, turbulent). When the Reynold's number is higher than 1000, the flow is turbulent, if the Reynold's number is lower than 1000, the flow is laminar. The Reynold's number depends on mean velocity of flow in tube, radius tube and density of flowing liquid, dynamical viscosity (Davidovits, 2008, Cameron et al., 1999, Silbernagl et al., 2004). The measurement requires experience, quit and good hearing. The cuff must be fixed in the correct height of heart, otherwise the measured value are increased or decreased of hydrostatic pressure. Nowadays, digital devices are used, but they run at the same principle as sphygmomanometer and a stethoscope together.

Voting Systems in Teaching Sciences

Last few years, electronic voting systems became very useful multimedia tool in teaching and learning process at schools. These systems created a revolution in education through devices offering unprecedented opportunities for student involvement and assessment. Each learner response device gives individual students a voice while equipping teachers with a revolutionary tool for delivering dynamic lessons tailored to the immediate assessment of student performance.

Voting devices are developed to be used to answer questions on a interactive whiteboard or a computer connected to a digital projector. The results show up on the projecting screen in color-coded bar graphs, which can be converted to a pie chart. Modern voting devices look like cell phones and they have full text-capability. Students can select from multiple choice, sorting, yes/no (or true/false), text entry (open-ended questions), number entry and a scale where they rank preferences and more.

Today, a number of voting systems can be purchased from different companies. Generally, voting systems comprise four primary elements: a tool for presenting lecture content and questions (e.g. a computer, connected to a digital projector), electronic handsets for remote answers to teacher's question, receivers that capture these responses and the software that collates and presents students' responses.

This specially developed software typically allows teachers to assign full quizzes of varying difficulty and gives students the opportunity to register answers at their own pace.

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Teachers can alter the assignment's length of time to challenge learners. **Question leveling** is used for differentiated instruction. Teachers customize the level of each question to target learner profiles and enable students to venture deeper into the curriculum.

Device registration is the process of telling the receiver how many devices and device groups there are in the classroom. You need to register devices before you begin a voting session. Once you have registered them, you can take the devices and the receiver with you and use at different classroom.

The teacher's motivation for using modern voting systems should be above all to provide students with the opportunity to engage with the new content material of a lesson, to allow them to apply the content of lesson to practical programming problems and to provide an alternative feedback mechanism to students on their understanding of the learning content.

There are many benefits of using voting systems during lessons. First of all it makes lessons more interactive and interesting for students and involves the whole class to the learning process. Since the teacher can choose between named and unnamed answers to questions, the anonymity allows students to show their opinion without embarrassing themselves. Furthermore, the correct usage of these systems helps teacher to identify problem areas and allows him flexibly change the lesson content depending on what students are finding difficult.

On the other hand, some problems with using the voting systems at schools stopped their expansion. Firstly, setting up the devices takes too much time and can distract from the learning content. Voting is not anonymous in some situation for example. Some students could also vote randomly and mislead the teacher.

Taking into account these advantages and disadvantages, it seems that the usage of voting system is at least controversial. Our experience from lessons at secondary schools (Kainzová et al, 2009), lectures at university and teaching adult learners (Kainzová et al., 2010) enables us to agree with the opinion (Draper et al., 2004), that benefits stayed fairly stable while the disadvantages changed, as one would hope, as we improved our practice.

Remote Control Experiments

The gigantic expansion of the Internet has an immense effect on the physics education. An access to a remote laboratory and its use during physics lessons provides the teacher with the possibility to change a common physics lesson and to make it more interesting for students, who are not very motivated to science studies today.

The web based remote control laboratory is a system that enables users (students or teachers) control of real experiment from a remote location using internet and an ordinary web browser. The possible schema of such a remote experiment is illustrated in Figure 2.

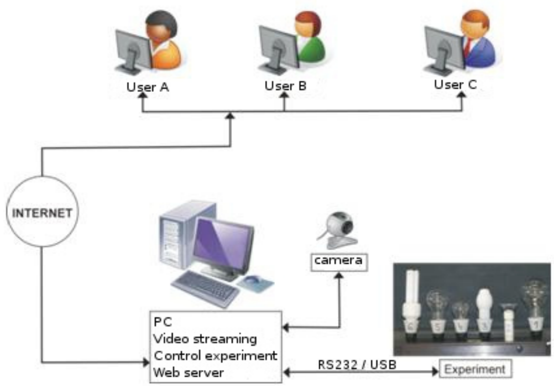

Figure 2: Typical schema of remotely controlled experiment.

Remote laboratories offer new opportunities for students to engage in laboratory-based learning, providing both increased flexibility and opportunities for resource sharing (Bright et al., 2008).

This section presents three remotely controlled physical experiments: Volt-ampere characteristics of six different light sources, Determination of gravity from the time of the mathematical pendulum and Study of fluid flow in tubes that are located at the Department of Experimental Physics at Palacky University in Olomouc. These experiments are freely available on the website http://ictphysics.upol.cz/remotelab/.

The first remote control experiment (Volt-ampere characteristics of six different light sources) consists of laboratory AC power supply. This power supply is equipped with the interface RS232 and it is possible to control the power supply from a personal computer. Other instruments are two digital multimeters and six different light bulbs (e.g. incandescent, energy saving, LED, halogen light bulb, etc.).

The second remote control experiment allows measuring the value of gravity *g* on the fourth floor in new building of our Faculty of Science. *Gravity prospecting evolved from the study of the Earth`s gravitational field, a subject of interest to geodesists for determining the shape of the Earth. Because the Earth is not a perfect homogeneous sphere, gravitational acceleration is not constant over the Earth`s surface* (Telford et al., 2004). Students from around the world can compare its real results (for example for his/her location) with real results measured in the laboratory through the Internet. The newest remote controlled experiment is Study of fluid in tubes. This third remote control experiment is composed of three flow rate Vernier sensors, three Vernier barometers, one USB Vernier thermometer probe, two interfaces Vernier SensorDAQ, DC circulation pump and closed system of transparent tubes filled with water.

Students, experimenters, teachers or any users can control all experiments from its personal computer via the Internet from the website http://www.ictphysics.upol.cz/remotelab/. The access on the website with experiments is available free, without registration, 24 hours and 7 days a week.

Conclusions

The unpopularity of physics forces departmental didacts and teachers to popularize physics. In this article are introduced three possibility of popularization of physics. First possibility shows relation between biology of human and physics, which it shows close connection medicine and physics. In physics lessons students would be inform about devices of medicine, which they can meet in a doctor's office or in hospitals.

Informatics we can integrate in physics teaching through two activities. Through voting system teacher connects dynamical students in lessons and obtains their attention. The voting system can teachers used as a tool for obtaining feedback and testing, which is for teachers saving of time.

Another possibility, how motivate students in science, are experiments. In physics teaching and learning there can be used various types of experiments. It depends on the teacher and the school environment, which type of experiment is realized. The experiment has a central position in physics education. It is the only way to develop students handling skills, communication and cooperation competences that we need for the life in our society. From this point of view a crucial role in the use of ICT will have the remote experiments.

Dormido (2002) sayed that educators must have an open attitude and that they should sensibly incorporate technological development, because otherwise they may risk teaching the students of today how to solve the problems of tomorrow with the tools from yesterday

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References

Bright, Ch. & Lindsay, E. & Lowe, D. & Murray, S. & Liu, D. (2008). Factors that impact learning outcomes in Remote Laboratories. In: *Proceedings of Ed-Media 2008*. World Conference on Educational Multimedia, Hypermedia and Telecommunications. Vienna, Austria.

Cameron, J. & Skofronick, J. & Grant, R. (1999). *Physics of the Body.* Madison*:* Medical Physics Publishing. p. 111-116.

Davidovits, P. (2008). *Physisc in Biology and Medicine*. Academic press USA 2008, p. 101-114.

Dormido, S. (2002). Control Learnig: Present and Future. In: *Proc. 15th IFAC World Congress on Automatic Control.* Barcelona, Spain.

Draper, S. W. & Brown, M. I. (2004). Increasing interactivity in lectures using an electronic voting system. *Journal of Computer Assisted Learning 20* (2), p. 81-94.

Hawking, S. (1995). Černé díry a budoucnost vesmíru. Mladá fronta. Praha, Czech Republic.

Höfer, G., & Svoboda, E., (2005). Některé výsledky celostátního významu „Vztah žáků ZŠ a SŠ k výuce obecně a zvláště pak k výuce fyziky".In: *Moderní trendy v přípravě učitelů fyziky.* Plzeň: Západočeská univerzita, p. 52-70.

Kainzová, V., & Říha, J., Kořená, D. (2010). Využití hlasovacího zařízení při testování prekonceptů. In: *Trendy ve vzdělávání 2010*. Olomouc: UP.

Kainzová, V., & Říha, J. (2009). Final Evaluation of Pupils´ Pre-concepts at Elementary Schools in the Czech Republic. In.: V.Lamanauskas (Ed.), *Development of Science and Technology Education in Central and Eastern Europe* (Proceedings of 7th IOSTE Symposium for Central and Eastern Europe, 14-18 June 2009). Siauliai: Siauliai University Publishing House.

Kolektiv autorů VÚP. (2007). Rámcový vzdělávací program pro gymnázia. Praha: Výzkumný ústav pedagogický. Retrieved 23/05/2011, from<http://www.vuppraha.cz/wp-content/uploads/2009/12/RVPG-2007-07_final.pdf>.

Silbernagl, S., & Agamemnon, D. (2004). *Atlas fyziologie člověka.* Praha: Grada Pulishing a.s. p. 187-201.

Škoda, J., & Doulík, P. (2009). *Několik poznámek k popularizaci výuky přírodovědných obsahů ve vzdělávání*. Retrieved 3/6/2011, from http://pf.ujep.cz/files/_konferenceKPG/kolar/Skoda-Doulik.pdf.

Telford, W. M., & Geldart, L. P., & Sheriff, R. E. (2004). *Applied Geophysics – 2nd ed.* Cambridge University Press.

Vagnerová, Z. (2009). *Vysoký krevní tlak*. Retrieved 23/5/2011, from <http://www.ordinace-lekarny.cz/clanky/Vysoky_krevni_tlak_priznaky_a_lecba.html>.

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