

# Interactive Forms of Technical Education Support in Primary and Secondary Schools

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**Abstract**—This papers presents, how eLearning or its modification, the blended learning plays a key role in increase of scholars' interest at Elementary and Middle schools in the world of science and technology. Authors used their experiences with education, organization of popularization activities, skills in developing eLearning elements and also a rich database of educational materials gathered by eLearn central team members over past years, to achieve an increasing trend of students' motivation and interest. In addition creation of interactive educational-popularization modules and the competition "Electronics without secrets", for kids and youth is discussed.

## I. INTRODUCTION

Nowadays, information - communication technologies (ICT) fast development is for young generation every day certainty and children and youth can keep up with this fast progress. They were born to world of information technologies where constant access of internet and basic computing equipment is certainty for public.

### A. Internet

Internet, its applications and service supports, touches our lives every day. The experts expect that an intelligent network on the internet will be the driver for the next round of innovations, productivity enhancement and employment [1]. On the other hand internet, websites, computer multimedia, video games, augmented reality are components of a "new media" specified as digital, often having specific properties such as: manipulative, networkable, dense, compressible, and interactive [2].

Today the internet as a tool for gaining information has a dominant position.. Especially young people favor this method of gaining information prior to the traditional sources [3].

### B. ELearning

At the same time, human has inside itself ability to learn something new from own experience long time ago. Constructive approach and interactivity principle are based on natural human properties – playfulness and curiosity. Therefore, these ideas have found a wide application in modern pedagogic concepts [4].

By combination of internet, interactivity and education it can be achieved well known eLearning which represents interactive entry to information.

The term eLearning was introduced by J. Cross, CEO of „Emergent Learning Forum“, and author of the book titled „Implementing eLearning“ in 1998. He said: “eLearning is learning on Internet Time, the convergence of learning and networks. eLearning is a vision of what corporate training can become. eLearning is to traditional training as eBusiness is to business as usual.” [5].

Principle of internet operation is very simple and advantage of this system of education is that the role of student has changed from passive consumer of offered information to active “surfer”.

Among other advantages eLearning of standard face to face education methods at School or University belong: multimedia features, independency on time or place, simple use, and huge scope of information selection [6].

From this point of view eLearning introduces effective motivation tool with fastest access to huge amount of new information [7]. By conjunction of eLearning support and standard education rises very interesting way of education “blended learning”, reaching high level of education effectiveness. Implemented interactive multimedia features and gaining of practical skills by solving of experimental assignments assure high effectiveness of learn handling by students [8]. Interactive applications attract student's attention and the whole education process changes from standard to learn by play.

### C. Insufficiency of Technically Qualified Professionals

The increase of motivation and interest for students at technically focused Middle schools and Universities is at present one of the highest priorities of education in the technical field. Insufficiency of technically qualified professionals is a worldwide problem.

Eminent demotivation factor for most of the students is the idea that the essence of curriculum and the following application is mainly involving natural sciences especially mathematics and physics, thus subjects based on logical connections sometimes hard to understand, requiring abstract thinking [7].

Selection of career is one of the most important and most serious steps in human life. Decision making about future professional career is made usually at the end of Elementary school studies, meaning scholars at age of 14 and 15 years in Slovakia. Transfer of scholars to an eight year Grammar school runs through the fifth class of Elementary school, meaning at the age of 11. The scholars are getting to the selection of their University study specializations when they are in second class at Middle school or in sixth class of the eight year Grammar school, i.e. at the age of 17.

Foreign and domestic researches confirm that in professional orientation and career selection scholars are influenced by their parents [9 - 11]. Their attitude to career selection is influenced by low social prestige of technical and craft specializations.

Furthermore, the researches point at marginal influence of teachers on this career selection and steadily growing influence of non-formal environment. Accordingly, available statistical data confirm reduction of interest for career selection in technical specializations. The solution to this situation of technical specializations is a worldwide issue what proves for example document entitled "Report to the President, Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America 'Future' [12].

Majority of scholars with above standard study premises, including those technically oriented, are outgoing for Grammar schools. Average knowledge level of scholars at Elementary school classes is consequently reduced and there is a reduction in level of knowledge in second class of Elementary schools. So, for Secondary vocational schools and trade schools are then arriving scholars with average or below average achievements. Those are often scholars that are arriving for the above mentioned schools for a reason, that they will not pass the admission exam. For the Middle schools to survive this "fight for life" it is necessary to also accept and educate these scholars that are not motivated enough and don't have enough premises to study technically specialized subjects. The result is overall decrease of knowledge and skills level of school leavers from these schools. Previously there were mostly scholars from Secondary technical schools applying for technically specialized Universities which had good level of technical knowledge and skills before and had an idea about upcoming curriculum. Nowadays students arriving to such Universities are more than 2/3 of students from Grammar schools, whose technical knowledge and idea about upcoming curriculum is poor. This aspect is illustrated by the fact that more than 60% of students failed to pass the first year of bachelor study at Faculty of Electrical Engineering and Information Technology at Slovak University of Technology in Bratislava.

These are the main reasons highlighting the importance and actuality of the topic: Factors of increasing motivation for study in technically focused Middle schools and Universities and increasing educational quality in the field of technical and natural sciences at the same time [13].

The aim of this contribution is to show the way how to increase interest of scholars at Elementary and Middle schools in the world of science and technology in which the key role plays eLearning or its modification blended learning.

## II. CURRENT STATE OF TECHNICAL EDUCATION

If we consider the newest outcomes and achievements in the field of science and technology, it is important and necessary to ensure a parallel education process satisfying key requirements, such as: up to date content, high quality, provided in an effective, interesting and modern form. All these factors are also connected with students' motivation affecting the growing tendency of interest. If we accept all of the rapidly involving technical fields, it is highly problematic to provide and transfer an up to date basic knowledge and its' practical applications for students.

### A. Teaching of Technical Subjects

Teaching of technical subjects was, and is expensive and it demands special rooms, energy consumption, workshop equipment, education materials, machinery and equipment maintenance. Many schools have got rid of those "burdens" and transformed it to theoretical plane. Some of the schools completely dropped technical subjects and replaced them by theoretical ones or began to teach information technologies instead.

Result of this situation is the lack of qualified and skilled manpower, particularly in industrial production sector, and at the same time high rate of unemployed youth in the country. One of the possible solutions is to educate and train professional experts. Therefore, the question of the day is the dual system of professional training and education prepared by the Ministry of Education of SR [14]. According to their requirements employers should define, what kind of subjects to encourage in order, to maintain appropriate graduates as trained employee candidates.

### B. Technical Subjects at the Margin of Interest

Above mentioned state today, when crucial influence of research & development results and knowledge on all society regions of life shows up, is alarming. Society awareness about which areas of research, development and innovation contribute is reduced a lot. Consequently, from that results lots of and therefore dominant interest of youth about information technologies, management and similar when technical subjects are at the margin of interest. It did not come to society awareness, that in most of manufacturing corporations, especially those which produce big added value, informatics or managers with technical knowledge are wanted who understand at least basic technical concepts and terms and which have much better premises for progress in career and are a bigger addition to company and the whole society. On this statement even the fact does not change a lot, that without extremely fast progress in the field of techniques/technologies would sustainable progress not be possible. Therefore, it is necessary to endeavor for balanced preparation of creative employee adequate to improvement needs in all areas including to-day not attractive technical areas.

### C. Popularization of Technical and Natural Sciences

This situation is gradually changing. Many science popularisation activities are intensified, for example at our faculty FEI STU in Bratislava, too. Open days (Fig. 1) are indispensable part of the semester, every year researchers are actively participating on the Researchers' Night event (Fig. 2). We provide technical laboratory excursions for



Figure 1. University Open Doors day



Figure 2. Researchers' Night event

secondary school students and interested groups for a professional experience. Scientific measurements and demonstrative laboratory experiments are also prepared for students as part of the Days of science and technology event [15].

The project "Energy up close ([www.energia.zblizka](http://www.energia.zblizka)), made possible to participate in the organization of targeted excursions for nearly 3812 elementary school pupils [16, 17]. This activity was sponsored from 2011 to 2013 by the E.ON foundation and power engineering company ZSE [18].

It was the experience of the Czech Republic [19] (Masaryk University, Faculty of Education, Department of Technical Education and Information Science) (URL: <http://www.hses.cz/science-slam.html>, <http://www.hses.cz/divadlo-techniky.html>), but also of other EU countries (project Ingenious (<http://ingenious-science.eu/web/guest/research-report>)), that directly confirmed the growing trend of interest achieved by technically competitive activities involving children. Organization of technical competitions, introduction of easy assemble robotic kits in teaching (simple robotic systems are assembled by children themselves, soldered and programmed), was utilized even with primary school first grade students.

#### D. Electronics Around Us

Even when it is longer clear that young persons are aware of information technology resources surrounding them which they exploit in everyday life (cell phone, computing and office tools, black and white electronics, internet, car or security), they do not express interest in knowing what is inside those black boxes and why they can communicate visually or by voice.

One of the basic lines of activity which may help to motivate youth for interest in studying and participate in solving tasks of research, development and invention in a field of electronics in general and particularly in Slovakia is search for new ways of motivation during class work at Elementary and Middle schools to study technical subjects including electronics. For example, by illustration of connection between theoretical knowledge of natural sciences (mathematics, physics, eventually chemistry) with application of this knowledge in electronics or other fields of technical subjects. It is necessary, but possible for sure, to search indeed simplified but adequate examples of new solutions in such manner, that difficulty of the study will not discourage, but on the contrary attract especially ambitious and creative students to wide possibilities of self-application [20].

### III. SUPPORTING PROJECTS

A proven effective approach in the educational process is the implementation of Blended learning.

Team of eLearn central since 2004 is focusing on the creation of high grade courses, implementing useful elements, such as interactive education modules, short interactive materials for popularization purposes [7, 13, 20]. These courses were since then utilized in the learning process for many subjects, to support projects and for the popularization of science and technology. Major part of these courses, are freely available for the wide audience, including adapted versions for primary and secondary school students in the form of 20 educational modules.

Our activities in the field of interactive technical education support development, improvement and implementation in primary and secondary schools are in the present financially funded by two projects:

#### A. KEGA 020STU-4/2015

Grant KEGA 020STU-4/2015 "Interactive forms of support of the technical education in primary and secondary schools" (supported by the agency KEGA the Ministry of Education, Science, Research and Sport of the Slovak Republic)

The proposed project is focused on increasing motivation and interest of students in their further studies mainly at secondary technical schools and universities. The main attention is oriented on development and implementation of progressive approaches such as eLearning, blended learning and hands on activities in teaching, education and extra-curriculum teaching at elementary and secondary schools.

The project includes preparation and creation of a set of practical experiments with detailed procedures and teacher guides as well as worksheets for students, moreover targeted inquiry-based learning for students and teacher workshops.

These approaches and activities are focused on desired knowledge improvement, technical skills and abilities of students in the field of electronics and information technology. Educational modules to be created will be providing teachers and students in their active educational process.

#### B. APVV SK-CZ-2013-0174

APVV bilateral project Contract No.: SK-CZ-2013-0174 "Aspects and factors, causing the small interest in the study of the technical disciplines" (the Slovak Research and Development Agency).

This project deals with a basic investigation and research of aspects and factors resulting low interest of students in technically oriented education, and the introduction of possible solutions for the elimination of this problem.

Expected outcome will ensure a new technical and scientific cooperation and the definition of a strategic approach in order to improve the present situation of technical education, in addition to increase the number of qualified specialist and experts for the job market.

#### IV. TARGETED INQUIRY BASED ACTIVITIES FOR STUDENTS

As a part of our work, we are denoting a great attention for knowledge improvement and technical expertise to develop students' capabilities in the field of electrotechnics, electronics and information technologies, in order to increase interest for technical secondary schools and universities. New educational approaches as eLearning, blended learning and new discovered teaching techniques are highly investigated, not only for internal but also external teaching activities at primary and secondary schools. Main targeted group involves primary school students of fifth and ninth grade and secondary school pupils. Connection of the right technology and approach with experimental seminars is considered thereby a highly effective solution.

#### A. Multimedia Educational Modules

We are preparing 20 topics for processing, connected with electronics and information technologies, which will be provided as basis of a multimedia database, freely available on the portal "eLearn central". Each of them utilizing the open source platform Moodle [21], containing one author sheet including a section of applications and news from praxis, interactive elements (for e.g.: flash animations, videos etc.), set of test questions, a discussion forum and individual tasks for practical works. Created eLearning materials mentioned above were updated and new ones were prepared in accordance with requirements of the targeted group – second level students of primary and secondary schools.

**eLearning text:** The submitted eLearning materials textual composition was provided in clear format to emphasize the main idea of the issue, divided into small blocks that connect the central motive [22]. Large amount of hypertexts was added for those who are interested to learn more. For each physical phenomenon we have tried to supplement an pictures (Fig. 3), illustration image (Fig. 4), graph or even animation.

**Interactive animations:** In the module we used all the created Adobe Flash animations by our eLearn central

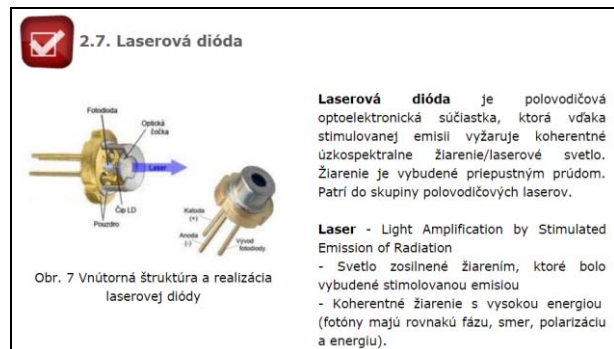


Figure 3. Interactive module Semiconductors diodes - Laser diode



Figure 4. Interactive module Introduction to Semiconductors - The classification of materials by conductivity

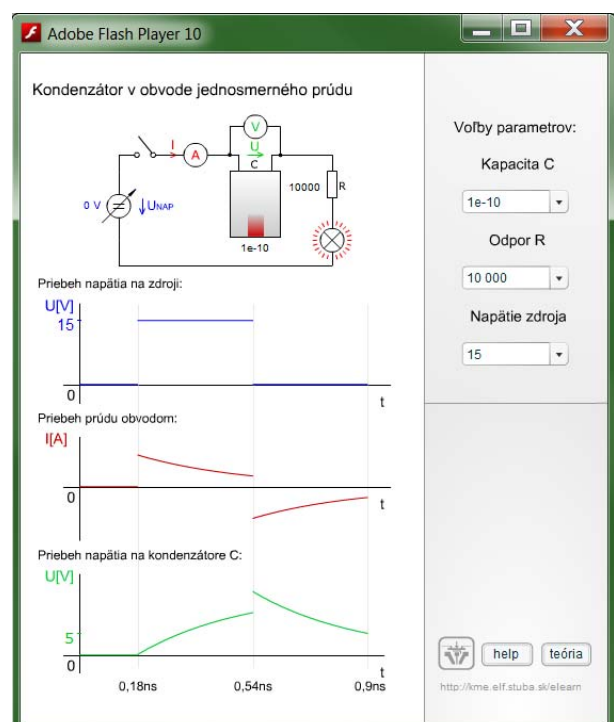


Figure 5. Interactive Flash animation - Capacitor in circuit with applied direct signal



team members [23, 24]. Each individual animation was updated (Fig. 5), errors identified and removed, and divided into smaller units – micro-animations. These micro-animations were used also directly in the educational text to ensure a more clear understanding of the topic.

*Tests:* Creation of quality tests is a continuous challenge for us. If we consider that the test should contain questions defined in such a way that the solver can directly study from its content is an extremely difficult task. These tests are also used to measure the success of educational goals.

As in the case of test lengths primarily shorter tasks were used to enhance student confidence and his/her determination to continue the course. Formal parts of the test detect the acquired knowledge and skills (Fig. 6). Questions are defined clearly, to be effective and fulfilling its goal [25].

In the definition of test questions we utilized the denomination of students' activities to achieve desired goals listed for each level of Bloom's taxonomy of cognitive objectives [26].

The originality of our approach lies precisely in the combination of knowledge, experience and skills, which in itself accumulates the solving team as it ensures quality content educational materials, new pedagogical practices very efficient formal preparation, personal experience of research and the continuous interest to increase motivation of students.

By this approach will be processed also a database of eLearning materials, provided for secondary and primary school teachers as a basic source for their own educational process. The listed fundamental sources will be utilized as a standard education support, in addition for the preparation of experiments in laboratories.

In present, 6 basic modules are in the process of finalization: Passive elements, Introduction to Semiconductors, Semiconductor diodes, Stabilization diodes, Bipolar Transistor, Unipolar Transistor and Operation amplifier.

*Laboratory of technology:* Based on the defined topics, sets of experimental and practical tasks are prepared, with subsequently secured equipment for the realization of measurements in a newly built laboratory of technology located at FEI STU in Bratislava.

Reconstruction and preparation of these areas will be accomplished by our own institution and financially supported by sponsorships (business sector contribution

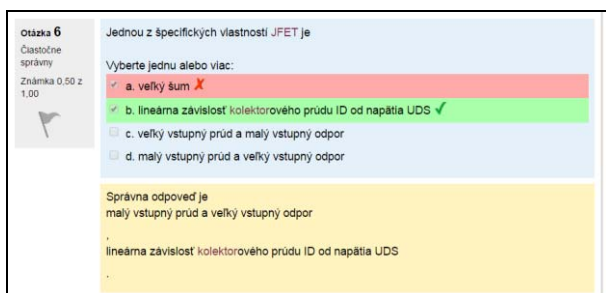


Figure 6. Interactive module Unipolar transistor - Question in test and feedback

etc.). Main tasks of this laboratory will include the preparation of practical seminars according to the above mentioned modules with tutorial materials, moreover workshops for secondary and primary school teachers for experiment flow explanations and instructions. This experimental basis will be utilized also for demonstrative solutions for "Days of experimental techniques" events. Technical support will be provided by the Institute of Electronics and Photonics in required cooperation. Our aim is to introduce and involve Days of experimental techniques in the regular education process with the combination of pedagogical and team work experiences with high quality e-learn projects to increase the effectiveness, quality and motivation for primary and secondary school learners.

## B. Competition "Electronics without secrets"

Potential of competitions as the learners' motivation is very well known. Just to mention one of a well established excellent competition, we point out Zenit (URL: <http://zenit.edu.sk/>), aimed for higher qualified students. However our target group involves learners with lower interest and motivation, for which the competition "Electronics without secrets" creates a chance to accomplish a task without advanced skills. The proposed challenge will be divided in two rounds for two categories, primary and secondary schools. The theoretical contest will ensure the participants to get in touch with the world of electronics, meaning theoretical basics. Mysteries of circuitry will be tried out and solved in the practical part of the competition.

Winners will be provided not only by valuable prizes, but also opportunity to participate in a tour of the best laboratories at the Institute of Electronics and Photonics, in addition they may get an offer to actively take part in various scientific experiments. Our aim is to create a tradition of a repeatedly organized competition every year. This year, the contest opens on 17/11/2015 and will be available at URL <http://uef.fei.stuba.sk/tajomstvo> (Fig. 7 and Fig. 8).

## V. CONCLUSION

More than ten years of active work in the field of development, creation and implementation of eLearning materials and many years of experience in electronics

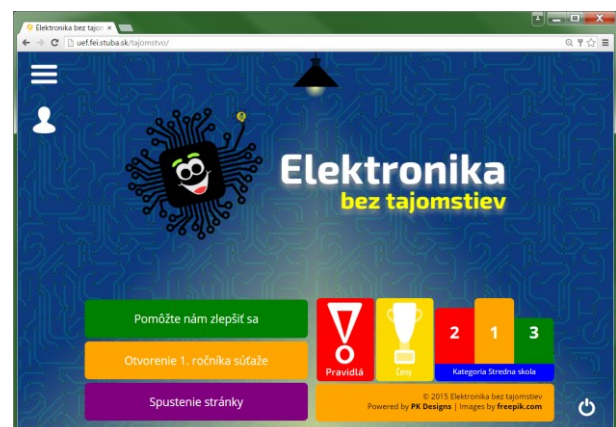


Figure 7. The competition "Electronics without secrets": Intro

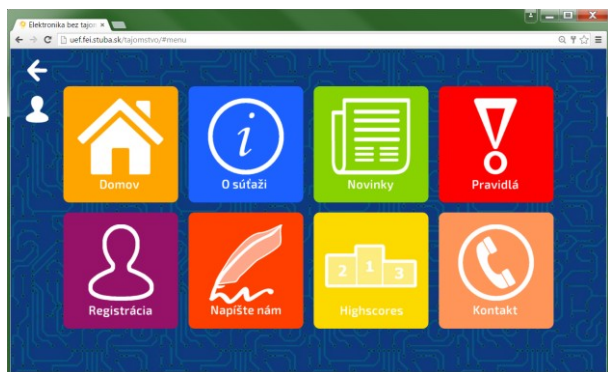


Figure 8. The competition "Electronics without secrets": Menu

education at Faculty of Electrical Engineering and Information Technology, Slovak University of Technology in Bratislava has been put to use in this work. This experience enabled the possibility to create scientific and educational platform, fully adequate for professional competencies improvement in physics and technical subjects in accordance with requirements of the industry. The platform includes portal for educational materials, sharing proven methodologies, connection with specialized institutions and options for further cooperation. The platform is primarily designated for scholars of primary and secondary schools.

Our activities in this field are, in the present, financially funded by two projects Grant KEGA 020STU-4/2015 "Interactive forms of support of the technical education in primary and secondary schools" and APVV bilateral project Contract No.: SK-CZ-2013-0174 "Aspects and factors, causing the small interest in the study of the technical disciplines".

Education modules for courses are being prepared and experimental lab has been built where scholars of primary and secondary schools can gain skills in the field of electronics with knowledge from eLearning

eLearning as training for practical implementation of experiments, knowledge verification and acquisition of the methodology for problem solving is one of the most effective ways of education. This mixed teaching (blended learning), however, places greater demands on overall success and efficiency of teaching linked with web technologies, methods of lectures and practical exercises.

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