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The application of information and communication technologies in teaching vocational subject Electrotechnics

Introduction

For the third millennium are characteristic the extensive changes in all spheres of social and political life. These changes affected the global world in many areas, including science, technology and are fundamentally changing the thoughts and actions of people. Society in the third millennium is characterized also as information society, where founded and obtained information are not only important, but especially they become dominant by their rapid use and application. The results of development in science and technology are its implementation in advanced information and communication technologies.

Extensive changes in the third millennium affected the area of education in the horizontal and vertical division. Not coincidentally, it is necessary to respond to these changes, in so far as school elementary, middle and high has priority to prepare its graduates to the new environment in which the graduate will continue to operate. In the case of secondary and higher education is a priority in order to prepare graduates to make them applicable in a competitive labor market. This requires a thorough theoretical and practical preparation of graduates at a high level using not just the appropriate teaching aids, modern didactic procedures, appropriate methods and the latest technologies, but also the application of information and communication technologies in the educational process.

1. Brief characteristics of the project

In the Slovak Republic were since 2008, implemented changes in regional education caused by school reform of elementary and secondary schools. The main idea of this reform is the transition to creative and humane education whit orientation on the student. But the idea of humane education has shifted completely to another position, as it is generally more creative and humane education understands. As a result of the ongoing school reform on the primary and secondary schools is in the maximum extent possible to prefer the human subjects in teaching at the expense of science and technology from technical subjects for which there has been an extreme reductions of class hours, which was reflected in the framework curricula of the school educational program, teaching and learning in secondary schools.

Simultaneously with the school reform of primary and secondary schools has gradually implemented the reform of higher education in Slovakia. The result is transition to a three-stage system of higher education. This resulted in the need to modify the focus of the study programs, as well as the contents of individual subjects. There was a reduction of time subsidy for science but also technically oriented subjects.

As the study of science and technical oriented subjects at higher education institution in the first and the second stage requires a very well-prepared high school graduates in science and technically oriented subjects, due to school reform is expected that requirement has not implemented and is not implemented at all. The reality is that high school graduates are with their knowledge of natural science and technical aimed subjects at the average respectively lower than average level. This is documented by the fact that the change the prom system caused that students of vocational schools can baccalaureate in mathematics and physics as an optional fifth subject. As the knowledge of students in this field are often inadequate, it is then very difficult to choose the appropriate pace and form of teaching at universities.

In the teaching of subjects in newly certified teaching and non-teaching study programs of the first and second level of higher education with focus on technology highlights the synthesis of theoretical knowledge and practical experience in the field. Supporting documents to comply the goals envisaged depend primarily on scientific research for teaching. The current study materials are inconvenient and too broadly focused, while they are not oriented at a specific program of study, which is a part of the subject matter, where is not fulfilled the basic requirement of guarantors of new study programs, simultaneously there are absent the research results from the last period.

On this basis, there is a need of creating new teaching materials, the content of which will be in accordance with the new study programs and will also be modern and attractive way to present the latest knowledge in the field. In addition, shall meet the latest requirements of the educational preparation of teaching materials (implementation to the problematic task of teaching, PISA tasks, more experimental activities in teaching, etc.).

The basis for scientific research grant project KEGA no. 011UMB-4/2012 (duration of the project 01.01.2012 – 31.12.2014), is mainly the current state of education science and technology subjects at high school and university. We consider it important in view of the unsatisfactory state of educational materials, to analyze this situation and find starting points to improve the current situation.

The aim of the project submitters is therefore the creation of comprehensive study materials, which are in line with the newly certified learning programs at Matej Bel University in Banska Bystrica and the Technical University in Zvolen.

The main part of the project is the creation of two college textbooks with multimedia DVD (assigned to textbooks). The content of textbooks will reflect

the results of the regional education reform, and the results of the reform of higher education. Also in these books will be integrated the latest results of research areas, which the textbooks will be addressed.

The first university textbook will be focused on electrotechnics and electronics using PC, multimedia and simulation programs. The second university textbook will be focused on technical physics. In addition to the classical textbooks electronic textbooks will be created supplemented a number of multimedia attachments (pictures, graphs, simulations, teaching self-tests, presentations, qualitative and quantitative tasks, real experiments, computer-aided experiments, video-experiments, etc..), which will be determined for daily and external form of study.

In addition to these university books there will be created two scientific and one monograph. One scientific monograph will be focused on didactic teaching physics to analyze the effectiveness of teaching this subject at universities of technical orientation using modern teaching equipment. The second scientific monograph will address the efficiency of heat transfer, depending on the surface profiling of to heat of the exchange surfaces. Monograph planned in the project will deal with the thermometry in practical applications and will follow up on the monograph named Thermometry in industry (published in 2010 in Zvolen) and will serve as an additional study material for contactless temperature measurement.

Creating a learning material will be used for the needs of science and technical focused subjects at newly certified learning programs first and second cycle of higher education. For illustration and the need for this article we present just some such:

- Teaching technical subjects – Master's degree, full-time and the part-time study, FPV UMB B. Bystrica;
- Teaching of Technical Education – Bachelor's degree, full-time study, FPV UMB B. Bystrica;
- Teaching of Physics – bachelor and master study, full time study, FPV UMB B. Bystrica;
- Wood Technology – Bachelor and the master study, part-time and the full-time study, DF Zvolen;
- Ecotechnology – bachelor and master study, part-time and the full-time study, Technical University Zvolen.

For the university textbooks will be created multimedia programs that will complement textbooks in electronic form. To create and edit video experiments will be used high quality digital video camera available at the Department of Physics, Electrical Engineering and Applied Mechanics to Faculty of Wood Sciences in Zvolen and the fully equipped editing room available at the Faculty of Natural Sciences UMB in Banska Bystrica. The preparation of real and by the

computer support lab experiments and the measurements will be carried out by the above-mentioned work.

Solutionist team consists of knowledgeable academics who have several years of experience in dealing with research projects such as APVV, VEGA, KEGA. Because the grant project is assigned to the Faculty of Natural Sciences UMB, research team consists of university academics from the faculty in the number of six members (one professor, three associate professors and the two assistant professors).

Department of techniques and technologies FPV UMB under the leadership of prof. Mgr. M. Ďuriš, CSc. has long been engaged in innovative methods and forms of teaching technical subjects at all levels of education, while members of the department reached in this regard excellent results. Solutionist team from the workplace is a guarantee of high quality and professionalism of the project outputs on which they will cooperate. Abovementioned team complements academics from Wood Technology University in Zvolen in the total number of seven members (two associate professors and five assistant professors).

Department of Physics, Electrical Engineering and Applied Mechanics at DF TU in Zvolen under the leadership of doc. RNDr. M. Gajtanskej, CSc. long-term on applied research and achieved in this area, excellent results (doc. Gajtanská won the Vice Prime Minister of Slovakia and Minister of Education Science and Technology in 2006). In addition applied research department in recent years deals with innovative forms and methods in the field of physical education at universities of technical orientation.

2. Application of information and communication technologies in vocational subjects

From a teacher of Vocational subject, whether taught in high school or university, is expected to have acquired a key competence, enabling it to implement the learning process with the support of information and communication technologies (ICT). Teacher whit adoption of computer competency, which can be included in the information and computer literacy, use in educational work modern teaching tools (interactive whiteboard, non-commercial educational software), and self-made teaching tools using PowerPoint presentation.

The inclusion and active application of whiteboard to the educational process in recent years has become commonplace especially on the secondary school and university schools, where the interactive whiteboard purchased solutions in various projects. As the interactive whiteboard and their quality are quite different from each other when they need to pay attention to the selection of such parameters that will be also as much as possible used by teachers as well as students in the learning process.

Multimediality of interactive whiteboard as a means of innovative change, by its effectiveness is still a need for a stronger and more important phenomenon of our modern times and schools. Its contents are a combination of text, sound, graphics, animation, video and film sequences closely related interactivity itself during the course of lesson. They are thus the means for comprehensive education in the broadest sense and meaning. Multimedia, as a means of efficient and quality work at school and directly in teaching requires fulfillment of several important criteria by the teacher:

- Average working knowledge of ICT,
- Knowledge of working with specific software and applications that are used in the subject,
- Creativity in preparation for the teaching unit,
- Likeability and teamwork,
- Looking for the latest trends in teaching,
- Transparency of its work.

Multimedia are therefore in a certain sense an integral part of a progressive trendy teacher. Therefore, schools that are interested to grow qualitatively are required auditory map the current state of their ICT equipment and technology. One of the ways to increase the credibility of the school is also an interactive whiteboard and related new concepts of teaching and interactive communication system. This equipment certainly raises the interest not only of students for a school or department, but also the awareness of their own potential and quality for professional growth. Speaking of interaction and an interactive whiteboard, respectively interactive environment, we mean completely equipped classes or classrooms whit necessary technology. These are:

- interactive whiteboard,
- projector,
- voting machine,
- laptops for learning,
- Interactive Systems (various accessories for each subject),
- visualizers,
- Internet.

The school environment in terms of the teaching is the perception of interaction very important concept. It's active environment system in interaction of participants in the subject. Although the teacher play a key position and is the primary element in conjunction with the students, the interactive effect is more efficient if the role of teacher and student during solving of interactive tasks will be equal footing. Interaction can therefore be understood as a stimulus of active interaction, which partial result is a student activity, general verbal speech, gained knowledge, skills, habits, and higher level of attention associated with motivation and self-presenting.

In the subject of Electrotechnics is a variety of ways and opportunities to through various software's and applications use, improve, streamline and make the teaching more comfortable. Already a mere transfer of data from your laptop / PC to the desktop of interactive whiteboard attracts one's interest of student. However, there are many of other new elements that can increase the attention of students and how to streamline the teaching. Students can be motivated to study also through interaction in combination with their own creative work and support of complex ICT, respectively media with a wide range of freely available or commercial software. As already mentioned, the most common computer-aided software application used by teachers is PowerPoint, which has many features to process a very broad range of subjects, thematic units, or themes. As a sample pf simply prepared topic in the subject of Electrotechnics, respectively in thematic units of Electricity in physics are "schematic symbols of electrical circuit". Topic is processed into a set of images that are time depending on operational demonstration of any brand, whether electrical part depends on the hyperlink either to additional informative text or image, audio or video sequence, but also to verify the theoretical knowledge gained through teaching self-test in interactive environment.

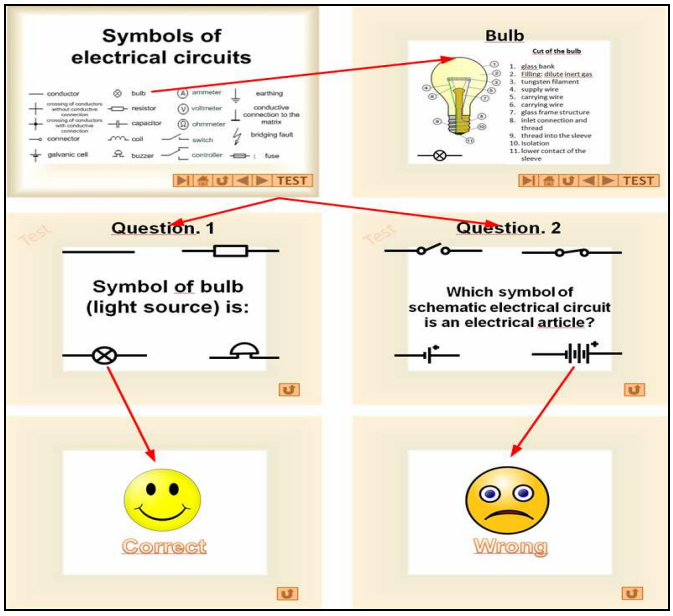

Figure 1. Snapshots of interactive presentations in a hyperlink

New phenomenons in the interactive environment are program equipments with direct focus on interactive whiteboard, and thus create an interaction between the teachers and student through the compatible applications such as Ac-

tivInspire, Flow! Works, but also other programs, for which were in the present processed numbers of thematic interactive teaching topics for each subject. However, each teacher has his own idea about his lesson, because he must take the main focus on the composition of the class which he is already pretty well known. So it's important to prepare for the students "tailor-made" educational learning objectives, to adapt the curriculum much as possible to create the reversible ideals of teacher and student. Therefore teacher has the opportunity and space to fully use the software and technical equipment, which the school disposes (Figure 2, demonstration of interactive learning through the workbook in ActivInspire software application).

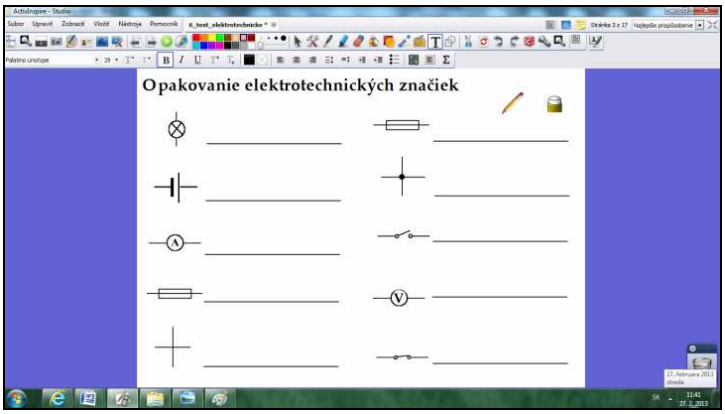

Figure 2. Shots workbook to repeat the curriculum

One way to verify the students' knowledge during any phase of the lesson is opportunity of interactive voting using the voting device (Figure 3), which in a short time evaluate the success or failure of education.

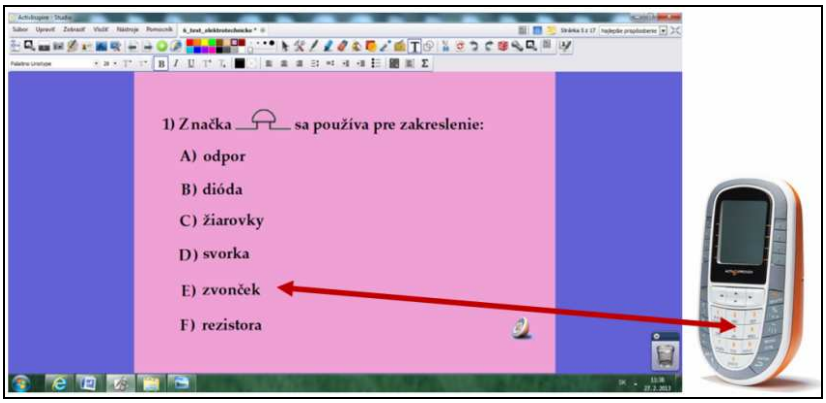

Figure 3. Testing and voting equipment knowledge

Teacher of vocational subject, which has acquired computer competence and is therefore even after teaching content of his syllabus sufficiently adept, has many options in his vocational subject to develop pupils in technical and creative thinking. An integral part of teaching by so disposal teacher is also using those activating teaching methods and concepts of learning that create conditions for the development of creativity of students themselves.

If the teacher is creative and thinking he's looking for a way to convey students information regarding the content of the curriculum in the vocational subject by interesting and attractive way, which must also be appropriate to students age students. One of the possibilities is also intermediation of the curriculum through a presentation software PowerPoint. This program allows the teacher to use a variety of templates, animations and inserting video sequences, use a variety of simulations, hyperlinks and other offers that program has. If created presentation teacher properly combines with different stages of a selected type of teaching unit, with appropriate teaching methods in compliance with the specific principles of teaching, then the pupils' interest in the content of the curriculum in vocational subject will be large.

Assessment of student performance in vocational subject is currently paid considerable attention. The effort of the teacher should be rating the student not only for the standard output – verbal answer eg. before the whiteboard, or an evaluation of the written work, but as often as possible to evaluate the student by teachers verbal rating but also student should be rating his self of his own performance. There are other possibilities, where student performance evaluates another student while a final evaluation and the classification of student performance realizes the teacher of Vocational subject.

An integral part of the learning process in assessing the pupil performance in vocational subjects is the feedback to the teacher as well as for the pupil. For teacher is necessary the information, how students understood the explained subject matter and if the applied procedures and methods were used were correctly. For the student is feedback necessary, because if he understood the subject matter and subject matter intrigued him, he actively participates in the learning process that plans, organizes and directs the teacher.

Recently, is increasingly emerging the opinion that the on the lesson students should work independently, to be active and even were able evaluate themselves individually, to see the extent to which they understand the subject matter. One of the possibilities teachers to allow students how gain like this feedback is that the discussed subject matter processes in the form of presentation in PowerPoint a presentation application, part of which will be designed educational self-test. Didactic self-test should have a hyperlink to the individual slides which contain curriculum and given the information. Basically the point is that the student on its own pace tested to what extent he managed to understand discussed subject matter. A student answers a question that has three or four

offered answers. If the student answers incorrectly, the hyperlink gets to part of presentation, where the subject matter is prepared. The pupil is trying again to understand the curriculum and through the button he gets back into the environment to the issue and trying to choose the correct answer, which it also moves to the next question of the subject matter. In this way the student test himself to how well he understood the explained curriculum.

This way designed didactic self-test can teacher of Vocational subject apply in any of the phases of a teaching unit (eg. fusing phase, diagnostic phase), therefore directly in teaching, or the teacher can share the didactic self-test presentation to students on the website of the school where students can through the code open the page so the students can test their knowledge also at home, under the conditions that the student has the ability to connect to the internet at home.

In another part of the paper we present a preview of the presentation on the theme of electrical circuit with the proposed didactic self-test (Figure 4). The topic is discussed in thematic unit electric current in the first year at Secondary School in the subject Electrotechnics in field of study Electrical Engineering. The topic is also part of Electrotechnics theme, which is classified as the compulsory subjects in the curriculum in the newly certified teacher (FPV UMB) and non-instructional study (DF TU in Zvolen).

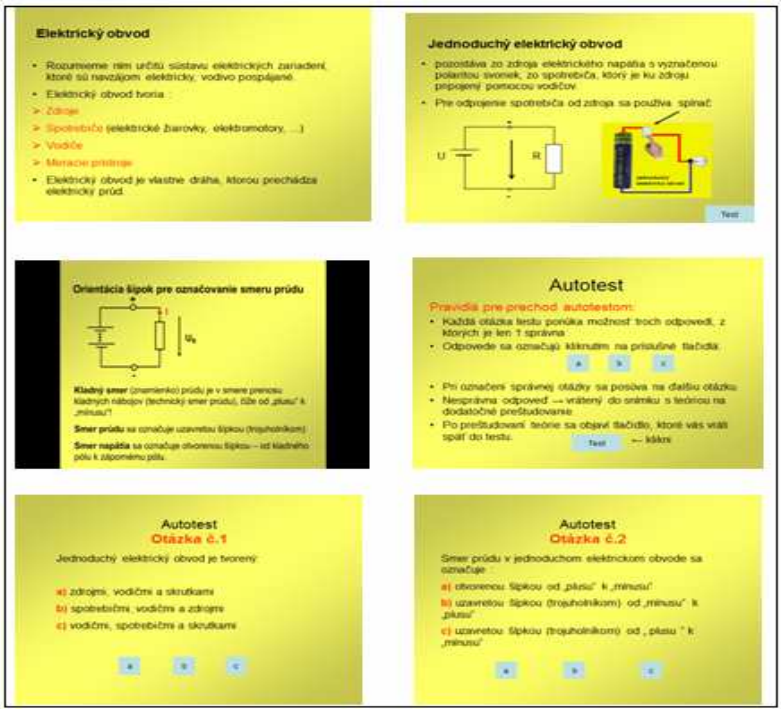

Figure 4. Example of an interactive presentation with self-test

3. Experimental research for verifying the effectiveness of interactive action

The aim of experimental research is to find out what kind of impact has the usage of interactive environment, interactive presentations and demonstrative workbooks on the level of knowledge and skills of pupils and students in the subject of Electrical Engineering. Attention will be paid to knowledge and skills in the first three levels of the Niemierko‘s taxonomy of educational objectives. In order to meet the goals of research, it is necessary to formulate the main and working hypothesis with regard to the issues examined.

The main hypothesis is formulated as a assumption that the teaching of selected topics from Electrical Engineering using presentation of selected topics in an interactive environment via ICT and whiteboard will significantly affect the level of knowledge and skills of students at technical schools and universities in the first three areas of Niemierko‘s taxonomy (remembering, understanding, specific transfer). To be able to confirm or refute the main initial hypothesis, we formulated the following working hypotheses:

H1: Pupils or students of the experimental group in which the subject of Electrical Engineering is taught with ICT and whiteboard at the end of the experimental teaching will statistically reach better results in terms of remembering than students taught in the control group that are traditionally taught without presentations, demonstrative workbooks and interactive boards.

H2: Pupils or students of the experimental group in which the subject of Electrical Engineering is taught with ICT and whiteboard will reach at the end of the experimental teaching statistically better results in terms of understanding than students taught in the control group that are traditionally taught without presentations, demonstrations workbooks and interactive boards.

H3: Pupils or students of the experimental group in which the subject of Electrical Engineering is taught with ICT and whiteboard will reach at the end of the experimental teaching statistically better results in terms of specific transfer than students in the control group that are traditionally taught without presentations, demonstrations workbooks and interactive boards.

The main group, suitable for our research will be students of first year at technical schools and students of first year at accredited masters degree programs at universities. The research sample will consist of 100 to 120 pupils and students from Banská Bystrica. To be able to objectively determine whether the proposed teaching will have an impact on the level of knowledge and skills of pupils and students, the sample is divided into two groups: control and experimental. We split the groups according to the results of entrance tests, so the group with poorer results will be determined as the experimental. In order to achieve the objectives and to verify hypotheses, we proposed the following research methods and techniques of experimental research:

– literary method, the method of content analysis of pedagogical documents natural pedagogical experiment – the main method of research,

- non-standardized educational test to verify hypotheses (H1, H2),
- non-standardized practical test to verify the hypothesis (H3),
- statistical methods, test criteria and procedures for the processing of research results.

Results of the initial didactic test will be evaluated and the level of knowledge of pupils and students of 1st and 2nd group will be statistically compared by double choice Wilcoxon t-test. All observed and measured results of the output tests will be quantitatively and qualitatively proceeded and evaluated by statistical methods via MS EXEL and by using specialized statistical system SPSS BASE 13.0. The program's basic version counts all common, widely used descriptive statistics (median, mode, quartiles, arithmetic, geometric and harmonic mean, variance, standard deviation, confidence intervals for the mean), and many other special descriptive statistics.

The results obtained from didactic tests will be processed in tables and graphs. SPSS system facilitates data analysis through graphical outputs creating a wide variety of available diagrams (eg boxplot, histograms, 2D and 3D scatterplots, normal plots, QQ plot graphs) and for the testing of divisions a series of tests are available (Kolmogorov-Smirnovov test, Lillieforsov and Shapiro-Wilks test, etc.).

Conclusions and recommendations for teaching practice:

a) Publication of research results in scientific journals and conference proceedings,
b) To encourage teachers‘ creativity, qualitative growth, efficiency and collaboration,
c) Design and create own simple interactive presentations and simple demonstration workbooks in order to improve the efficiency and the knowledge of technical school pupils and university students in the subject of Electrical Engineering.

Conclusion

The application of ICT by teachers of training courses in high school or university is now one of the basic conditions to implement teaching which is illustrative, reasonable and understandable for students, and must also submit updated information so that the lesson become memorable and motivational. Only in this way, it is possible for pupils and students to understand the taught curriculum. If the teacher is able to combine his creative approach to teaching with appropriate information and communication technologies, then the success in teaching and students knowledge attending vocational subject should occur as soon as possible. The answers will be given by the forthcoming experimental research.

References

Adámek R., Baranovič R., Brestenská B., Bučko M., Jakab F., Karolčík Š., Kireš M. a kol. (2010), *Moderná didaktická technika v práci učiteľa*, Košice: Elfa, s.r.o. ISBN 978-80-8086-135-3.

Bobot V. (2012), *Interaktívne vyučovanie v školských vzdelávacích programoch*, Bratislava: MPC, 64 ss. ISBN 978-80-8052-432-6.

Ďuriš M. (2004), *Krátky technický a výkladový a náučný slovník pre učiteľov technických odborných predmetov*, Banská Bystrica: FPV UMB, 188 ss. ISBN 80-8055-918-X.

Abstract

New trends in education are one of the priorities of each educational institution. Quality, technical equipment of schools, knowledgeable educators, but above all the effort of leadership, whether the management to generate qualitative and innovative environment for teachers and pupils, is a guarantee of higher levels of education and subsequently, to education. Information-communication technologies (ICT) are increasingly becoming a part of not only the General, but also for vocational education. New technology, computer technology and software are intended to help in improving the level of creative abilities of teachers and students, which is the output of the qualitative growth of the pupil, and then the society. The contribution demonstrates several ways of using ICT and the associated interaction during class of Electrotechnics using whiteboard, presentation or demonstration workbook. Efficiency and quality of this teaching hours, is then compared with the traditional teaching. The relevant contribution is a stimulus to creativity of teachers and educators to provide students the highest possible quality of education that schools provide.

Key words: project KEGA, interaction, interactive board, hypothesis, presentation, creativity, electronics, demonstration workbook, non-standardized didactic test.